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Editors Desk

Marching towards global leadership!

The Indian chemical industry stands as a cornerstone of the nation's economy, playing a crucial role in supporting industrial and agricultural growth while underpinning numerous other sectors. Globally competitive, India ranks sixth in chemical production and third in Asia, with the sector contributing 7 per cent to the country's GDP. Valued at $220 billion in 2023, the industry is on a strong growth trajectory, expected to reach $300 billion by 2030 and surge to $1 trillion by 2040, propelled by a robust CAGR of 9.3 per cent.

The industry is witnessing strong growth, driven by rising domestic demand fueled by population growth and rapid urbanization. India is poised to contribute over 20 per cent of the global increase in chemical demand by 2040. Key end-user industries such as agriculture, automotive, electronics, and packaging are propelling this momentum—especially in specialty chemicals, which are projected to grow at a 12 per cent CAGR to reach $64 billion by 2025, along with significant expansion in the petrochemicals segment.

India's drive for self-reliance has led to a series of strategic policy initiatives aimed at strengthening domestic manufacturing of essential chemicals and APIs. Notable among these are the Production-Linked Incentive (PLI) schemes, 100 per cent FDI permitted through the automatic route—which brought in $22.8 billion from 2000 to 2024—and the development of Petroleum, Chemicals, and Petrochemicals Investment Regions (PCPIRs). These efforts are fueling significant capital inflows, with the sector expected to draw $100 billion in investments over the next decade. Backing this growth, chemical exports jumped 106 per cent from 2013 to 2022, with organic and inorganic exports projected to reach $82.4 billion in 2024.

Additionally, as global companies diversify their supply chains away from China, India is emerging as a compelling alternative, thanks to its cost advantages and skilled talent pool. This shift is further strengthening India's position in global markets, with chemical exports rising steadily—particularly to regions like Europe, the US, and Africa—as international buyers increasingly seek dependable and competitive suppliers.

In terms of challenges, India relies heavily on imported raw materials, especially for petrochemicals and specialty chemicals, leaving the industry exposed to global price volatility. The significant dependence on imported APIs and intermediates—primarily from China—also presents considerable supply chain vulnerabilities. Other key challenges facing the industry include limited availability of feedstock, and a talent gap in chemical engineering, with only around 1,400 graduates emerging each year from top-tier institutions.

Chemical manufacturing is inherently resource-intensive and produces considerable waste, resulting in environmental and regulatory pressures. Compliance with stringent environmental regulations and the growing demand for sustainable practices are driving the need for significant investments in green technologies.Insufficient logistics and port infrastructure can lead to higher costs and export delays. Challenges such as unreliable power supply and elevated energy expenses affect production efficiency. Meeting global safety and environmental regulations, like Europe's REACH standards, is essential for exports but often involves significant complexity and expense. Additionally, prolonged approval procedures for new projects can slow down investment timelines.

The Indian chemical industry is on a path to sustainable growth, supported by proactive government policies, rising investments, and a strong emphasis on innovation. Companies are ramping up R&D efforts and exploring green alternatives to align with global standards and drive the production of sustainable, high-value chemicals. India's competitive advantages—such as low costs, strong policy support, and increasing global confidence—position the country to potentially triple its share of the global chemical market by 2040.

The Compendium provides a holistic perspective of the sector by featuring opinions and interviews of thought leaders from the government, industry, academia and R&D organizations. CIO 2025 has sections on Chemicals, Battery & Semicon, Supply Chain, Digitalization, Sustainability, and Petrochemicals.

Looking forward to your valuable feedback!

Happy Reading!

Pravin Prashant
Executive Editor
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MESSAGE

I am delighted to know that Indian Chemical News (www.indianchemicalnews.com) is publishing the 5th edition of its compendium titled 'Chemical Industry Outlook 2025' in April 2025.

The theme of the Compendium is "Driving Efficiency and Growth". The Compendium, a Collector's Issue, has become one of the main reference points for the Indian chemical industry. It offers a comprehensive overview and analysis of the industry.

The Indian Alkali industry is poised for steady growth, driven by increasing domestic demand and export potential. By embracing technological advancements and sustainability practices, it can secure a strong position in the global chemical market while contributing significantly to India's industrial and economic development.

The industry has witnessed steady growth of 3.8% over the past decade. Alkali industry have been demand drivers witnessing robust growth in the last decade.

India is among the leading producers of alkalis, with a significant installed capacity for both caustic soda and soda ash. Indian industry is bound to realign its strategy in the light of unprecedented capacity additions in the next few years.

The future of India's alkali market looks highly promising, with robust growth projections. As the demand for alkali products continues to rise across various industries, the potential for this market continues to expand.

The Compendium highlights all contemporary issues and offer a growth chart for the development of the Indian chemicals and petrochemicals sectors.

I extend my best wishes and success to *'Chemical Industry Outlook 2025'*.

Ajay Virmani
President

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CCFI

MESSAGE

I am pleased to learn that Indian Chemical News is publishing the 5th edition of its compendium title 'Chemical Industry Outlook 2025' in April 2025. The theme 'Driving Efficiency and Growth' gels well with the agrochemical industry which has been on a growth trajectory over the years.

The market has been very volatile due to acceleration in raw material cost, lower consumption, agro climatic changes and less incidence of pest and diseases. On the positive side resent forecast by Indian Metrological Department of above average monsoon during 2025 has raised expectation of higher economic growth in Asian's 3rd biggest economy. This would mean higher exports of agrochemicals to maintain our second position globally. 'As a result, exports will continue to be the main source of income for the agrochemical sector, bringing in about 53% of the total revenue.

Against cheaper imports from China, CCFI has been pursuing since long an increase in custom duty to safe guard indigenous industry. However latest move by the government to impose anti-dumping duty would give some respite.

The Indian agrochemicals industry is projected to clock a robust compound annual growth rate (CAGR) of 9% from 2025 to FY 2028, driven largely by government support, expanding production capacities, a flourishing domestic and export market, with a steady stream of innovative products.

The future looks promising because India will continue to benefit from China +1 strategy of global players and the fact that key molecules will no longer be protected by patents.

CCFI continues to create awareness among the pesticides users by conducting training programs and knowledge dissipation through video films so as to create a positive image of indigenous agrochemical Industry.

We are grateful to ICN for the media coverage and extend my best wishes for future.

Harish Mehta
Senior advisor

23rd April, 2025



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The theme of the Compendium "Driving Efficiency and Growth" is apt considering the prevailing growth opportunities in the Indian chemicals and its allied industry.

India's agrochemical exports can increase to over Rs 80,000 crore in next 4 years. As the exports of agrochemicals stood at Rs 43,223 crore in FY 2022-23, ACFI expects India's agrochemical exports to exceed the domestic consumption of agrochemicals.

The USP of India's agrochemical industry is its quality and affordable prices making its products the first choice of millions of farmers across 140 countries. Given the potential and opportunity ahead, India is well-positioned to be the global leader for agrochemicals manufacturing and exports.

India has one of the lowest per capita consumption of crop protection chemicals per hectare, indicating a significant scope of growth for the crop protection chemicals in India. While there are opportunities, the sector has also been associated with a variety of issues, ranging from environment and sustainability, health of humans and animals, soil and water, to some serious disease and contamination afflicting the living and non-livings alike.

Indian Chemical News (ICN) is a credible information platform for Chemicals, Petrochemicals and Energy sectors and trying to contribute to the growth of these sectors by creating awareness about Govt of India's initiatives of making these sectors 'Aatm Nirbhar'.

The Compendium is a collection of interviews and opinions dedicated to help specialist markets and industry communities exchange ideas and innovations in the field.

I wish 'Chemical Industry Outlook 2025' all success.

Dr. Kalyan Ballav Goswami,
Director General
Agro Chem federation of India (ACFI)

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The theme of the Compendium is "Driving Efficiency and Growth". The Compendium, a Collector's Issue, has gradually been becoming reference book for the Indian chemicals and allied industry.

India's agrochemical sector has witnessed enormous growth in recent years, positioning itself as a major contender in the global market. With an export size that reached US$5.5 billion in 2022, the sector is projected to reach a market value of US$14.5 billion by FY 2027-28, up from around US$10.3 billion today.



According to World Trade Organization, India was the world's second-largest exporter of agrochemicals in 2022, with major export markets being China, Japan, Brazil, and the USA. India's US$5.5 billion worth of agrochemical exports in FY 2022-23 exceeded US exports worth US$5.4 billion.

With the right regulatory support and policy reforms, the Indian market is poised to become a global growth engine. The affordability and high quality of agrochemical products makes India, an attractive destination for agrochemical manufacturing.

I am hopeful that the Compendium discusses and highlights all contemporary issues and offer a growth chart for the development of the Indian chemicals and petrochemicals sectors.

I extend my best wishes and success to the 'Chemical Industry Outlook 2025'.

Yours sincerely,

Durgesh

Durgesh Chandra Sharma
Secretary General
CropLife India

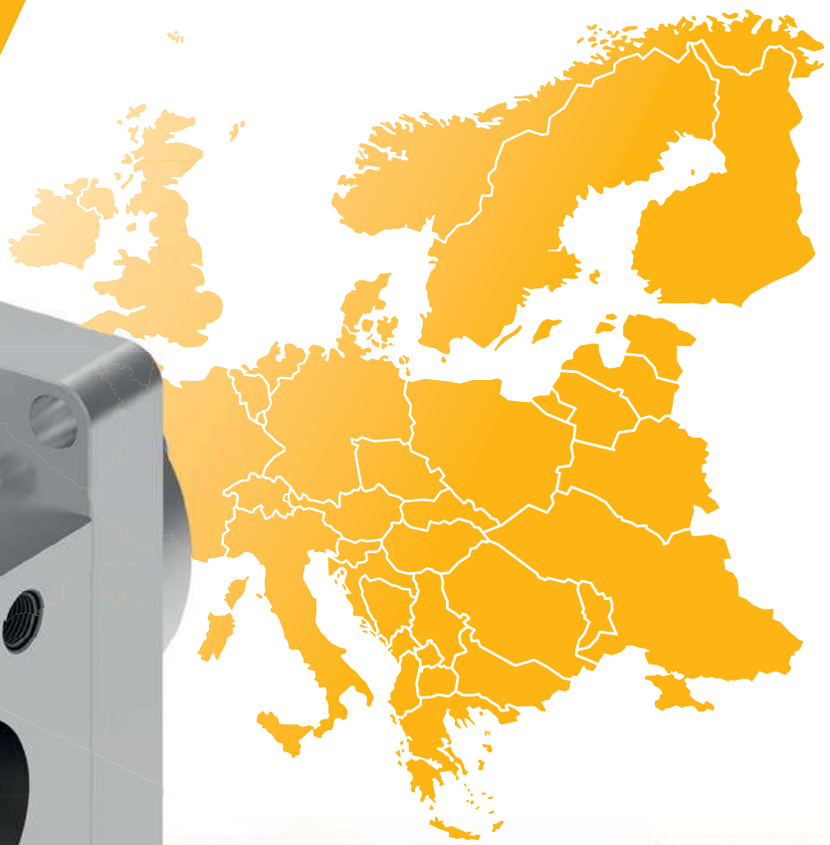
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With the global population at around 8 billion, set to grow by 1.2 billion by 2030 and an additional 2 billion by 2050, which means more demand for food and protein. Despite this, food insecurity is a growing concern. Currently, about 10% of the global population, face food insecurity. If trends continue, this number could rise to between 800 million and 1 billion by 2030. Agrochemicals become vital in this context, playing a crucial role in enhancing crop yields and ensuring global food security.

India is on the cusp of an agrochemical revolution, and there's plenty to be excited about! As the 2nd largest exporter of agrochemicals in the world and a top player in crop protection production, India's agrochemical sector is set for remarkable growth. With domestic innovation picking up pace and a strong focus on manufacturing competitive post-patent products, the market is expected to expand at a healthy rate, yielding a bountiful harvest of opportunities in the agrochemical sector.

I am hopeful that the Compendium discusses and highlights all contemporary issues and offer a growth chart for the development of the Indian chemicals and petrochemicals sectors.

I extend my best wishes and success to the 'Chemical Industry Outlook 2025'.

Pradip Dave
President, PMFAI & Chairman, Aimco Pesticides Ltd.

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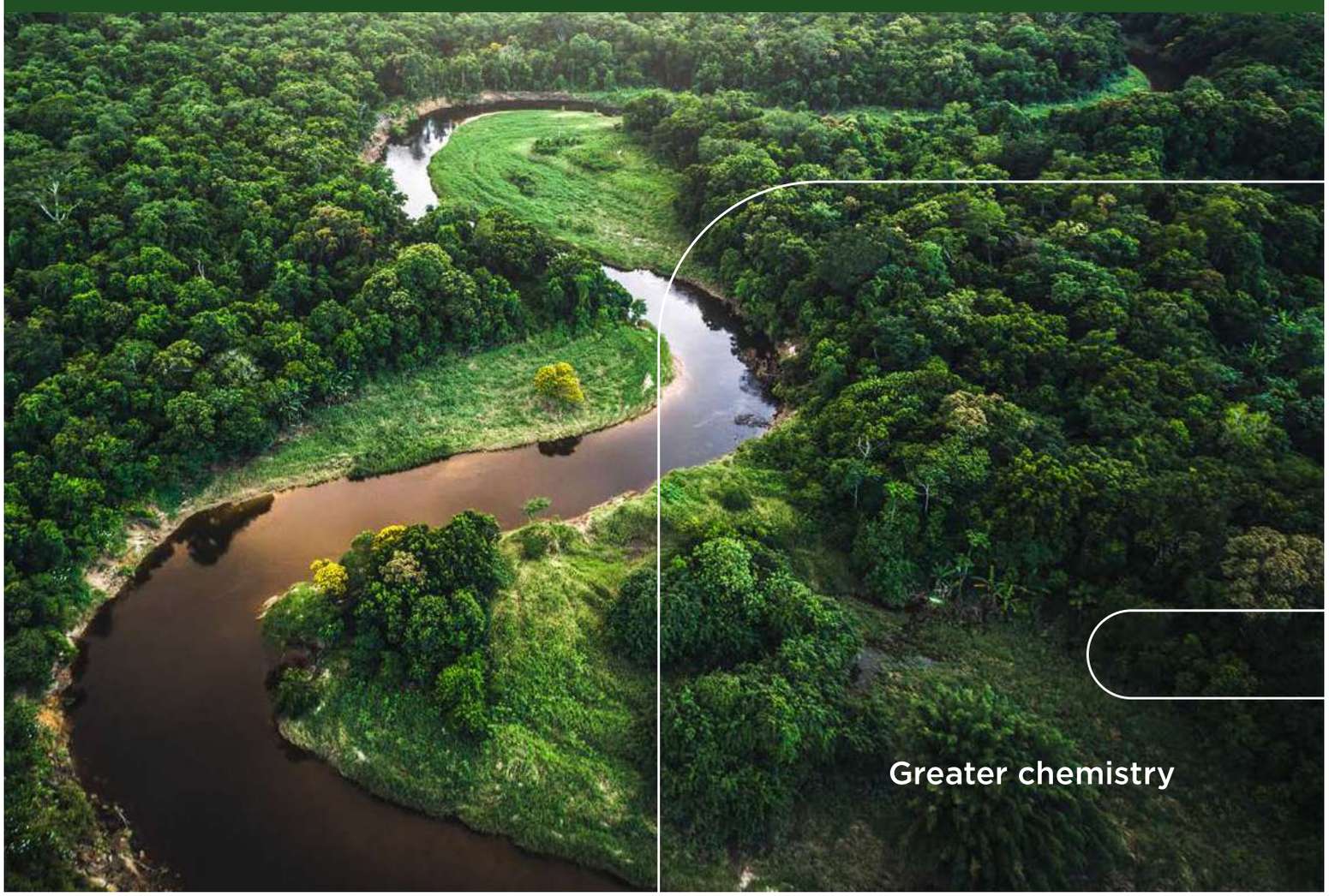
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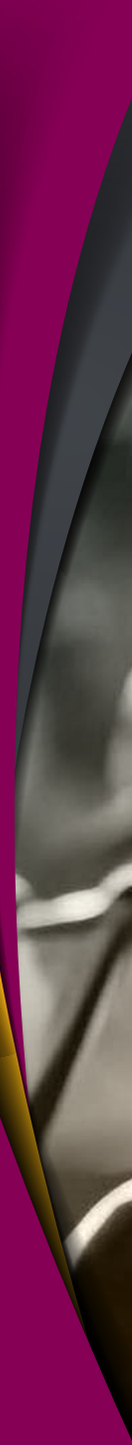
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RESILIENCE TO RISE: INDIA'S CHEMICAL SECTOR POISED FOR A STRONG REBOUND

Having demonstrated notable growth and resilience throughout 2024, the industry has solidified its position as a significant contributor to the nation's economy **TEAM ICN**

The Indian chemical industry has been undergoing significant transformation, driven by a mix of government-led initiatives, private sector investments, and global strategic shiftsare the pillars of Indian economy.

The Indian chemical industry is undergoing a transformative phase of accelerated growth, positioning itself as a key player in the global chemicals value chain. Driven by rising domestic consumption, robust export potential, and increasing demand from end-user industries such as agriculture, pharmaceuticals, automotive, and construction, the sector has become a cornerstone of India's industrial landscape. Contributing over 7% to the national GDP and ranking among the top six producers globally, the industry is expected to reach a market size of $300 billion by 2030.

India's chemical market is currently valued at $220 billion and is projected to reach $300 billion by 2030, reflecting a compound annual growth rate (CAGR) of 8.1% from 2021 to 2030. This expansion is driven by robust domestic consumption and increasing demand from end-use industries. The sector attracted cumulative foreign direct investment (FDI) inflows of $21.7 billion from April 2000 to September 2023, benefiting from 100% FDI under the automatic route, which bolstered investor confidence and facilitated growth.

A long-awaited National Chemical Policy is being finalized to provide a comprehensive framework for regulation, R&D, skill development, and exports. The policy is expected to focus on standardization, ease of doing business, and investment promotion, aligning with India's goal of becoming a $300 billion chemical industry by 2030

Major Investments and Capacity Expansion

Indian chemicals and petrochemicals sectors received significant attention, with the government anticipating $87 billion in investments over the next decade to meet rising demand. This initiative aims to increase annual consumption from the current 25-30 million metric tons to 46 million tons by 2030.

Among Chemicals, specialty chemicals emerged as a high-growth segment, reaching nearly $40 billion by 2023 and is poised for continued growth at a 10-12 per cent CAGR, driven by innovations and increasing demand across various applications. Agrochemicals also showed promising growth prospects, with a projected CAGR of 8.3% until 2027, supported by the expanding agricultural sector and the need for enhanced crop protection solutions. For FY24–25, Indian chemical companies have collectively committed significant capex, with estimates ranging from Rs. 30,000–40,000 crore across key players, based on prior announcements and ongoing projects.

Policy Reforms and Government Initiatives

The Indian government implemented several policy measures to support the chemical industry. Union Chemicals and Fertilizers Minister J P Nadda emphasized the government's commitment to addressing challenges faced by the chemical industry. He assured necessary policy interventions to boost the sector's growth and highlighted the importance of reducing imports, enhancing research and development, and improving skill development.

One of the key initiatives is the Production-Linked Incentive (PLI) Scheme, which offers companies incentives on incremental sales from products manufactured in domestic units. This scheme aims to boost the country's manufacturing capabilities and



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reduce reliance on imports. In the Union Budget for 2023-24, the Department of Chemicals and Petrochemicals was allocated approximately US$ 20.93 million to support this endeavor.

Additionally, the government has been developing Petroleum, Chemicals, and Petrochemicals Investment Regions (PCPIRs) around the country's refineries. These specialized zones are designed to facilitate petroleum and petrochemical production by leveraging shared infrastructure and support services, thereby accelerating industrial development.

To further promote the industry's growth, the Chemical Promotion Development Scheme (CPDS) has been established. The scheme provides grants-in-aid to various organizations and industry associations to conduct workshops, seminars, and studies. The insights gained from these activities help the Department of Chemicals and Petrochemicals formulate informed policy decisions.

The Sustainability Push

The industry has been increasingly focusing on sustainability as a core part of its growth strategy. Recognizing the environmental challenges posed by rapid industrialization, many companies within the sector are adopting green chemistry principles, circular economy practices, and cleaner production technologies to reduce their ecological footprint. There is a growing shift toward using renewable feedstocks, energy-efficient manufacturing processes, and waste minimization techniques. Leading players are investing in R&D to develop biodegradable alternatives and reduce dependence on fossil fuels.

Regulatory frameworks, such as the Responsible Care initiative promoted by the Indian Chemical Council (ICC), are being widely adopted by companies to ensure adherence to environmental, health, and safety standards. The government, too, has introduced various policy incentives and compliance mechanisms to encourage sustainable manufacturing practices and promote green infrastructure.

Collaboration between industry, academia, and startups is fostering innovation in areas such as carbon capture, green hydrogen, and bio-based chemicals. Furthermore, companies are publishing sustainability reports and aligning with global ESG frameworks, showcasing a clear commitment to transparency and long-term environmental stewardship.

Key Highlights

- Production-Linked Incentive (PLI) Scheme for Chemicals
- Petroleum, Chemicals and Petrochemicals Investment Regions (PCPIRs)
- Green and Sustainable Chemistry Push
- Strengthening of Research & Innovation Ecosystem
- India's Role in Global China+1 Strategy
- Digital Transformation and Industry 4.0 Adoption

Challenges Galore

Despite its strong growth potential and strategic importance, the chemical industry continues to grapple with deep-rooted challenges that threaten to undercut its global ambitions. One of the most pressing issues is the complex and often inconsistent regulatory environment. Companies must comply with overlapping central and state-level laws governing environmental safety, hazardous waste handling, and industrial licensing. The lack of a harmonized regulatory framework like the EU's REACH creates delays, raises compliance costs, and exposes firms—especially small and mid-sized ones—to legal uncertainties.

Infrastructure constraints remain a major bottleneck. The sector suffers from poor connectivity, outdated port facilities, and a shortage of dedicated chemical logistics infrastructure such as hazardous material corridors and integrated industrial parks. Another critical challenge lies in the volatile supply and pricing of raw materials. India imports a large portion of its chemical feedstocks, intermediates, and specialty inputs, making it highly vulnerable to global supply chain disruptions, geopolitical tensions, and foreign exchange fluctuations. The absence of backward integration amplifies this exposure, with manufacturers often forced to absorb cost shocks that squeeze margins and hinder planning. The industry faced challenges, particularly from increased input costs and global economic



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dynamics.

Moreover, the sector faces a widening talent and innovation deficit. While India produces a large number of chemical engineers, there is a shortage of professionals skilled in emerging technologies such as digital process control, AI-enabled manufacturing, and sustainable product design. R&D spending remains modest, and industry-academia collaboration is limited, curbing innovation in high-value segments like advanced materials and specialty chemicals.

Overcoming the Trump Factor

Donald Trump's return to the presidency in 2025 has brought a wave of protectionist trade measures that are set to significantly affect global supply chains, with the Indian chemical industry caught in the crosshairs. Among the most consequential moves is the implementation of a 10% baseline tariff on all US imports, coupled with elevated, country-specific tariffs aimed at reducing the US trade deficit. India has been singled out with a 26% tariff, a development that directly threatens the competitiveness of Indian chemical exports to the American market.

The United States is one of the top destinations for Indian chemical exports, particularly in high-value segments like specialty chemicals, dyes, and intermediates for pharmaceuticals and agrochemicals. The imposition of steep tariffs immediately inflates the landed cost of Indian products in the US, eroding their price advantage and making them less attractive compared to domestic or tariff-free alternatives. This policy is likely to lead to a short-to-medium term decline in export volumes, squeezing margins and disrupting long-standing supply arrangements between Indian producers and American buyers.

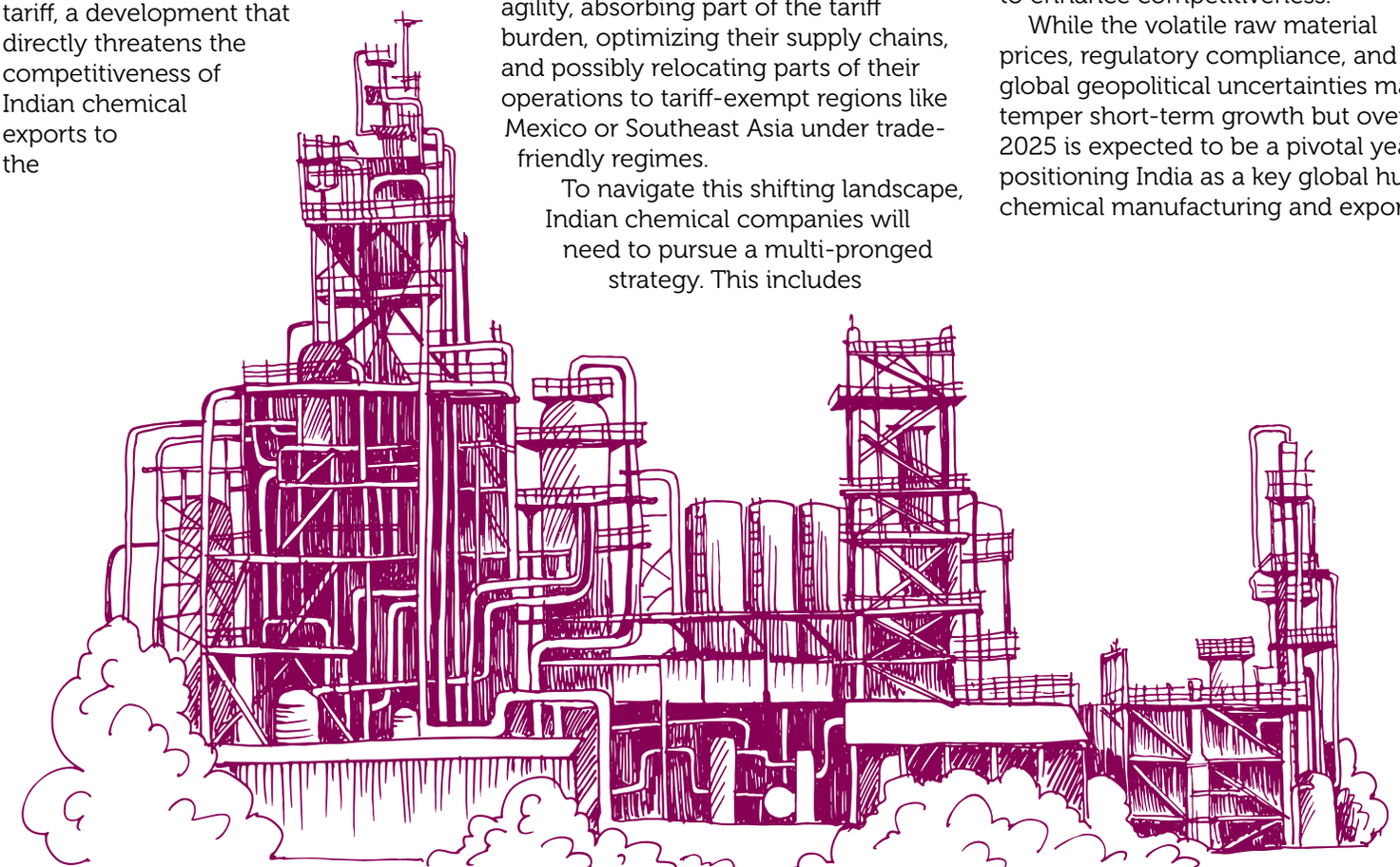
However, the outlook is not entirely negative. Trump's parallel tariff escalations on Chinese imports—many of which compete directly with Indian chemicals—could offer an unexpected opening for Indian exporters. If Chinese products are hit with even steeper duties, and if Indian firms are able to maintain quality and price discipline, they may capture market share vacated by Chinese competitors. This would require Indian companies to act with agility, absorbing part of the tariff burden, optimizing their supply chains, and possibly relocating parts of their operations to tariff-exempt regions like Mexico or Southeast Asia under trade-friendly regimes.

To navigate this shifting landscape, Indian chemical companies will need to pursue a multi-pronged strategy. This includes diversifying export markets to reduce dependency on the US, investing in process innovations to lower costs, and enhancing product differentiation through R&D and sustainability initiatives. Equally important will be policy engagement with the Indian government, which must now balance trade diplomacy with support for domestic industry competitiveness.

Outlook Remains Bright

The Indian chemical industry is poised for a strong rebound, driven by robust domestic demand, global supply chain diversification, and government support for manufacturing. With the sector expected to grow at a CAGR of 8–10%, specialty chemicals, agrochemicals, and green chemistry segments will lead the charge. China+1 strategies adopted by global firms will continue to benefit Indian exporters, while rising capital investments—particularly in petrochemicals and specialty production—will strengthen capacity and innovation. Policy reforms, PLI schemes, and a push for sustainability and circular economy practices are set to enhance competitiveness.

While the volatile raw material prices, regulatory compliance, and global geopolitical uncertainties may temper short-term growth but overall, 2025 is expected to be a pivotal year, positioning India as a key global hub in chemical manufacturing and exports



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EXPLORING STRATEGIC ACQUISITIONS AND PARTNERSHIPS TO EXPAND PRODUCT OFFERINGS

We aim to expand by advancing sustainable agriculture through biopesticides, biostimulants, and eco-friendly green molecules



DR. R. G. AGARWAL
Chairman Emeritus
Dhanuka Agritech

Q How has the overall performance of Agritech been in 2024 and what are your expectations from 2025?

Dhanuka Agritech Limited has been progressing well beyond its expectations. During 2024, the annual turnover of Dhanuka Agritech increased by about 17 per cent, from Rs. 1,758 crore to around Rs. 2,035 crore which was more than the expected target. It is imperative that such a market response speaks about its superior efficacy and popularity among the farmers. During 2025, Dhanuka is expected to reach around Rs. 2,500 crores due to the widening of our product portfolio with exclusive solutions developed in coordination with Japanese companies.

Q Given the current geopolitical scenario and tariff war, how would you explain the emerging scenario of agrochemicals in India?

The recent imposition of a 26 per cent discount tariff by the United States on Indian imports has significantly increased the cost of Indian agrochemical exports to the US. This move could reduce demand for these products in the short term. The same has been deferred by the US for 3 months.

However, despite the hike in tariff, it is 26 per cent for India but it remains lower than that of major competing countries such as China, where the total tariff stands at 54 per cent and has been further increased to 225 per cent. In comparison, the customs duty imposed on other countries like Vietnam (46 per cent), and Bangladesh (37 per cent) are still higher than India's. This scenario could provide Indian agrochemical companies with a relative advantage in the US market, as Indian supplies would be subject to lower customs duties. If Indian companies can maintain competitive pricing strategies, they could significantly benefit from this opportunity.

However, the imposition of higher tariffs on Chinese agrochemicals in the US may lead Chinese firms to dump their excess supply to other markets at reduced prices. This could intensify competition for Indian exporters in non-US markets. We must adopt a wait-and-watch approach to assess how the situation evolves.

The trend of diversifying supply chains away from existing core manufacturing markets, influenced by geopolitical factors, could present India as a preferred destination for agrochemical manufacturing. The conflict in regions like Ukraine has disrupted food supplies in the European Union, leading these nations to turn to India and other regions for their agricultural



needs, potentially boosting Indian agrochemical exports to the EU.

Your recent acquisition of fungicides like Iprovalicarb and Triadimenol from Bayer AG marks a significant step into global markets. What inspired this move, and how do you expect it to impact Dhanuka's growth trajectory?

Dhanuka Agritech has been a strong player in the Indian agrochemical market for more than four decades. This takeover of two new molecules from the agrochemical giant Bayer AG will enrich Dhanuka's portfolio. Additionally, it will also strategically serve to provide a vaulting platform to ingress into the markets of over 20 countries across Latin America, Europe, the Middle East, Africa, and Asia, including India. This will result in the transition of these products from a domestic angle to a global outlook. Our company was not a player in the international market, but with the acquisition of these two products, it will become easier for our company to export other pesticides to these markets.

Dhanuka anticipates a substantial increase in its topline product solutions. In 2023, these two products generated approximately Rs. 220 crore in revenue. Dhanuka aims at a 12-15 per cent EBITDA margin following the acquisition of these molecules thereby, improving the overall profitability. We project the revenue generation in India to commence by the first quarter of FY26, with global operations scaling up by the fourth quarter. Our team is completing the formalities of documentation in the countries for the transfer of the registration and brand ownership from Bayer to Dhanuka's name.

What is Dhanuka's overall expansion plan for 2025-30?

In the coming years, Dhanuka Agritech plans to grow its business by focusing on sustainability by increasing the development and promotion of sustainable agricultural solutions, such as biopesticides, biostimulants, and other eco-friendly green molecules. The company's strategies for developing consortia of pesticides and biopesticides would not only increase the broad-spectrum efficacy but also provide a means for resistance management against pests thereby providing sustainability to commercial agriculture as well as organic farming. We believe that organic pesticides alone may not be successful on a large scale. A combination of organic and inorganic pesticides is likely to be the roadmap for the future.

We also plan to expand into new international markets, apart from where we already hold Bayer registration, and also for our other products. At our technical plant in Dahej, we are manufacturing Bifenthrin Technical with over 98 per cent purity and plan to register this product in multiple countries. Additionally, we aim to develop tailored products and strategies to meet the specific needs and requirements of different countries, regions, and crops.

We are exploring strategic acquisitions and partnerships to enhance product offerings, gain access to new markets, and strengthen the company's competitive position in the industry. We are also in negotiations with various international companies for the contract manufacturing of various intermediates.

> **During 2025, Dhanuka is expected to reach a figure of around Rs. 2,500 crores due to the widening of our product portfolio with exclusive solutions developed in coordination with Japanese companies**

With plans to expand into over 20 countries, what strategies are you employing to ensure Dhanuka stands out in the competitive international agrochemical market?

Dhanuka has introduced a range of new pesticides, including insecticides, fungicides, herbicides, and microbial fertilizers. While Iprovalicarb and Triadimenol will provide a strong initial entry, we are continuously exploring opportunities to widen the product portfolio of the company, introduce novel consortia of chemicals and or biologicals, and develop new formulations relevant to the international markets. We will conduct thorough market research to understand the specific crop protection challenges and farmer needs in each target country and offer tailored products accordingly.

We plan to explore and introduce more sustainable and environmentally friendly agrochemical solutions, aligning with the growing global emphasis on green agriculture. We will penetrate new geographical markets domestically and internationally to capture a larger customer base and capitalize on emerging opportunities in agriculture.

From drones to precision agriculture tools, technology is reshaping farming. How is Dhanuka leveraging these advancements to empower farmers and enhance productivity?

To promote the evaluation, awareness,

and dissemination of new and proven advanced technologies in the remotest villages of the country, Dhanuka is forging collaborations with public institutions. By leveraging the resources and expertise of both partners, this Public-Private Partnership (PPP) approach aims to contribute to a more vibrant and sustainable agricultural ecosystem in India.

As part of this initiative, Dhanuka has already signed a Memorandum of Understanding (MoU) with ICAR and has begun working with various stakeholders, including agricultural universities, ICAR research institutions, and Krishi Vigyan Kendras (KVKs), to transfer new technologies to farmers. We have signed MoUs with 15 agricultural universities, fostering mutual support. In addition to conducting live demonstrations, training sessions, and extension activities, we are also sponsoring scholarships and participating in student training programs furthering our shared commitment to agricultural development.

Q With increasing pressure to adopt eco-friendly practices, how is Dhanuka balancing profitability with sustainable innovation, such as your partnerships with Japanese firms for green chemistry?

Dhanuka Agritech has adapted to changing market conditions. It envisages its industry roadmap to reach consumer preferences by focusing on research and development to create innovative products tailored to meet the demands of modern agriculture. We have expanded our product range to include sustainable and eco-friendly biological solutions with 6 different categories of biopesticides, biostimulants, and PGRs in response to growing consumer interest. Further, we are marketing various digital technologies tools including automatic weather stations, and precision sensors to monitor the irrigation requirement, nutrients, etc. Dhanuka also has invested in agri-drone manufacturer IoTechWorld Avigation for standardization of crop-specific SOPs for precise application of smart farming solutions, helping farmers increase efficiency and productivity.

> **“The trend of diversifying supply chains away from existing core manufacturing markets, influenced by geopolitical factors, could present India as a preferred destination for agrochemical manufacturing”**

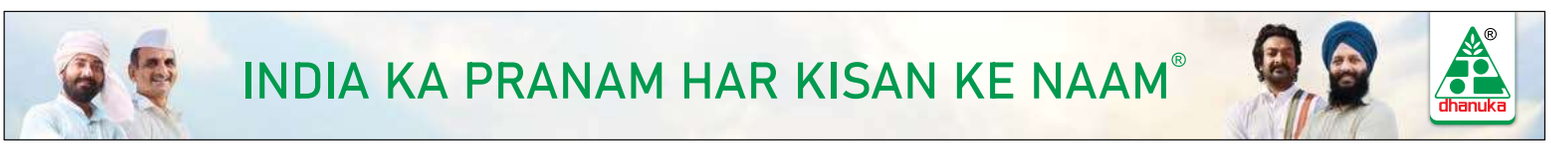
Q Dhanuka has a reputation for supporting Indian farmers. Can you share a specific initiative—like the Dhanuka Agritech Research and Technology Centre (DART)—and its impact on smallholder farmers?

Dhanuka has always been a pioneer in the sector of agrochemicals and always strives to provide innovative and novel product solutions to farmers. We are also engaged in trial demonstrations to have a comparative study between the framer practice and Dhanuka's technology. One of the demonstration trials was conducted by Dhanuka for the production of groundnut using its novel product solutions at PDKV (Punjab Rao Deshmukh Krishi Vidyapeeth), Akola. In the demonstration plot, an 81 per cent yield increase in the groundnut was attributed to Dhanuka's agritechnology. This enhancement resulted from a combination of factors including higher pod count per plant, increased shelling percentage, heavier (1,000 kernel) test weight, and a premium of Rs. 1,000 per quintal in the market.

The increase in productivity of groundnuts because of the application of Dhanuka's product solutions following GAPs was duly certified by PDKV, Akola. Such demonstrations encourage farmers to follow GAPs to enhance their production and productivity as one of the most important principles of extension is "Seeing is Believing". One of the key interventions was seed treatment with Vitavax Power, which prevented early-stage plant mortality. As a result, the increased plant population contributed significantly to the overall yield improvement.

Q You have been a pioneer in R&D. What new agrochemical products Dhanuka launched in 2024 and what are in the pipeline for 2025?

In 2024, we launched Lanevo, the broad-spectrum protection against sucking & chewing insect-pest together; Purge, a herbicide developed in collaboration with Nissan Chemicals, Japan for the Soyabean crop; Mycore





Super, an AMF with 100 per cent endomycorrhiza that establishes a faster symbiotic relationship with the roots and facilitates better nutrient & water uptake by the crops. We also launched Miyako, a Cyenopyrafen 30 per cent SC (acaricide) having control on all types and all stages of mites; and Roxa, a pre-emergent herbicide, designed to control resistant Phalaris minor in wheat.

The upcoming products in the pipeline for 2025 include Dinkar, a weedicide; Melody Duo, a fungicide acquired from Bayer; and Melody Compact Fungicide acquired from Bayer.

Q What do you see as the biggest challenges facing the agrochemical industry in the next decade, and how is Dhanuka preparing to address them?

The major challenge that looms over the agrochemical industry in the next decade is the large-scale prevalence of parallel grey market and spurious agrochemicals in the market.

Dhanuka has taken various steps to address this menace. We have signed a comprehensive MoU with ICAR, marking a significant milestone in our collaborative efforts to strengthen research and extension activities aimed at benefiting farmers across the country. By leveraging the collective resources and expertise of both organizations, we are poised to make substantial advancements in agricultural practices and contribute to the welfare of farmers. We have made video film, and Do's and Don't's posters for the farmers' awareness to purchase all the agri inputs after scanning through the QR code against original bills.

We appreciate the proactive measures taken by the Ministry of Agriculture in canceling the registrations and licenses of approximately 7,000 companies that failed to comply with the KYC requirements prescribed by the CIB&RC. The remaining 2,600 companies are now required to undergo the next round of KYC, which includes providing comprehensive details of their manufacturing units, infrastructure, machinery, laboratories, instruments, manpower, production capacity, and more.

We regularly work with various state and central agriculture departments on multiple reforms in the sector. The new Integrated Pesticide Management System (IPMS) has been finalized with active contributions from the industry, in which our company is a participating member. However, the system has not yet been launched but it should be launched at the earliest possible to ensure transparency and efficiency.

Pesticides play a critical role in safeguarding agricultural output and should be used judiciously, strictly following recommended guidelines. Our company has deliberately exited from the production of red triangle-labeled products and is committed to using only safe molecule

WILL CONTINUE TO CONTRIBUTE, INNOVATE AND CO-CREATE A GREEN AND SUSTAINABLE ECOSYSTEM

We are in the bio-based specialty chemicals and continuously co-creating with customers and de-bottlenecking plants to meet the needs of customers



SAMIR S. SOMAIYA
Chairman & Managing Director
Godavari Biorefineries

Q Biorefineries have gained significant attention in the quest for sustainable and renewable energy sources. How does Godavari Biorefineries contribute to the development and production of sustainable bio-based products?

The world continues to rely on fossil resources to meet its needs. If you take the example of energy, about 85 per cent of the world's energy needs are met from coal, oil and gas. Countries such as Norway consume over 100,000 kwhr per person, China consumes 30,000 kwhr per capita and India is still at 8,000 kwhr per capita. As India develops, its energy consumption will increase. It is important that this growth comes along with renewable resources so that we can grow and mitigate climate change at the same time, ensuring the sustainability of the planet.

Godavari Biorefineries is a company that is demonstrating this transition to the use of renewable resources. Godavari converts agricultural feedstock physically, chemically and biologically into food, fuel, chemicals and materials. Innovation is the cornerstone of our development. We have over 50 scientists constantly working with feedstocks, conversions and end-use applications. We partner with our customers to co-create solutions to aim and create renewable substitutes that have enhanced properties than the fossil intermediate that they substitute.

Finally, we are also working in the area of soil. Soil is the source of our feedstock. Fossil economies extract carbon, deplete the resource and then move to the next carbon source to extract the resource. Renewable economies extract carbon from the soil, deplete the same, but if farming is done right, then regenerate the soil. Renewable economies are circular, but this circularity must be worked on as we regenerate the resource. To improve agriculture, Godavari along with the research institute K. J. Somaiya Institute of Applied Agricultural Research (KIAAR) are working with our farmers to actively ensure soil is healthy for the immediate and the longer run.

Q How favorable government policies are accelerating growth of bioenergy, ethanol and bio-based specialty chemical segments in the country?

India is rich in soil, sun and has millions of farmers. With these resources, we have to play to our strengths and have to transition from the oil economy to the soil economy. With this in mind, the Government of India is focusing on the green energy transition. Biofuels enhance energy security, mitigate climate change and help farmer income security

The Government set a target to achieve 20 per cent blending by 2030 and that was advanced to 2025, which we have achieved. The NITI Aayog is now examining to expand this beyond 20 per cent. When policies are well articulated, the ethanol industry, the farmers, the automakers, the equipment manufacturers, all come together to make this transition a reality.

How is Godavari Biorefineries as a strong player in the sector contributing to the government of India's ambition?

Our business is into sugar, biofuels, co-generated electricity and bio-based chemicals. As the government is going for 20 per cent blending, Godavari is actively making ethanol from sugarcane juice and B Heavy-molasses. We expanded our capacity from what was 200,000 liters per day in phases to 600,000 litres per day. Now, we are adding a 200,000 liters per day facility of grain/maize based ethanol, which will use maize and other grains to add to feedstock to supplement and increase capacity. It would be implemented in the second half of FY26.



The biorefinery industry is constantly evolving and requires continuous innovation. What role does R&D play in the overall growth of the company?

There are three aspects of the research we do. First is the research on the soil. The carbon and soil regenerative practices that will make sure that we have the carbon which is required to be transformed. The fossil economy is extractive, and biorefining can also be regenerative. We can always extract from the soil but if we do it wrong, it can get poor in carbon. But if we do it right, the soil has the ability to regenerate.

The second area of research is the conversion of this biomass into food, fuel and biochemicals. We have a lot of scientists working on physical, chemical, and biological transformation.

And the last aspect is where we work with customers to co-create with them. They also have their transitional journeys and are looking at products that we make including drop-ins or could be an applicational substitute with enhanced properties.

Similarly, when I talk about regenerative farming, we have to co-create value with farmers. It is an emphasis on renewables, emphasis on co-creating work with either the farmers or customers, and the emphasis on innovative science whether physical, chemical or biological.

> **As the government is going for 20 per cent blending, Godavari is actively making ethanol from sugarcane juice and B-molasses. We expanded our capacity from what was 200,000 liters per day in phases to 600,000 litres per day**

Godavari Biorefineries has a strong focus on sugarcane based products. How does the company ensure sustainable sourcing practices and support for the local agriculture community?

We are working with our farmers on regenerative agriculture which is good for both short term and long term. We have a separate independent, agriculture research institute, KIAAR, where a lot of research is done in combination of drip farming, intercropping with sugarcane, looking at regenerative practices and remote sensing. This involves the whole range of traditional with modern science, looking at sustainability in the short and the long run and to help farmers improve crop yield and income.

Can you highlight any recent advancements or technological innovations that Godavari primarily implemented to enhance its biorefinery operation?

We are advancing three aspects. One is we are going into a maize/grain based ethanol facility to supplement the feedstock from sugarcane and to mitigate climate risk. The second aspect is that we are in the bio-based specialty



chemicals and continuously co-creating value added products with customers. Whether that is the need for a product which has properties in the substituting fossil or substitutes purely as a drop-in, we are working on new chemicals continuously. We will come with new products or enhance capacities as we go forward.

> **We are working to co-create value with our farmers and our customers, using research and innovation as our strong foundation for growth**

Q Sustainability has become a key priority for businesses worldwide. How does Godavari Biorefineries integrate sustainable practices into its overall operations, including resource consumption and emission reduction?

We are fundamentally sustainable as much of our feedstock is biogenic carbon. Our energy also primarily comes from biogenic carbon - bagasse is our main energy source. We do use some amount of coal, but overall our energy matrix, the carbon we consume for energy or for chemical operations, the majority of that is biogenic carbon.

Q In addition to bioethanol, what other bio-based products does Godavari produce?

We make a host of bio-based chemicals that find applications in a variety of fields including skin-care, cosmetics, agrochemicals, paints, coats, and pharmaceutical intermediates. Our scientists are continuously working, and co-creating with customers to expand the bouquet of products available to them.

Q What are the key strategic priorities and growth plans for the Godavari Biorefineries in the segments that you operate?

Climate change has to be addressed and also in terms of transition to green energy, Godavari will continue to contribute and play its role. In this direction, there could be three sets of customers. The first set of customers are an end use customer who may want to buy a product that comes from natural or renewable feedstock. Another set of customers may be looking at a green substitute for an existing fossil product that has enhanced properties. The third would just be looking at reducing the chemical footprint.

Our customers are in either one category or in two or all three of the above. We are seeing the growing interest among our chemicals in this transition. In summary, there is a wider interest in the green transition in chemicals. In India, there is an articulated policy in the transition to renewable energy. We are actively participating in both these transitions.

We are living in exciting times. We have to realize that each one of us, individually and as institutions, have to look at sustainability in our processes and co-creating with customers and also co-creating value with the supply chain. We have to create value and look at research as a bedrock of that value. That's how I look at it and Godavari follows this process very sincerely ICN

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OUR BUSINESS GOALS ARE ALIGNED WITH SOCIETAL GOALS

We are investing in building assets in the US and also building a chlorine derivative portfolio across India at multiple sites



JAYANT V. DHOBLEY
Business Head & CEO
Global Chemicals, Fashion Yarn and Insulators
Aditya Birla Group

Q Aditya Birla Chemicals has shifted its focus from commodity to specialty chemicals business. How are you moving in this direction?

Actually, we are focused on both commodities and specialty chemicals. In the commodities business, there are certain years when we make more money and in certain years, we make less. But over the cycle, it's a very profitable business. We are the largest player in the chlor-alkali business, which can be called a commodity. Chlor-alkali has been proven to be a long- term cash generator and a value generator for us. Similarly, chlorine derivatives, which are more on the specialty side, offer very good margins and return on capital. Some of the other specialty products we make such as epoxies, phosphates and sulfides. We have a balanced portfolio, and we intend to grow all our businesses as and when the opportunities present themselves. While we may be relatively increasing the share of specialties in our portfolio, we don't go to a view saying we will grow only in specialty. We want to grow in both but we want to grow in specialty a bit more. At the same time, we are balanced in our approach.

Q Sustainability has become a buzzword for the chemical and petrochemical sectors. How is Aditya Birla Chemicals focusing on sustainability and retaining high output while promoting environmental stewardship?

I will divide sustainability into three pillars. The first pillar is safety. There can be no chemical company that can have a sustainable business model without running its operations safely. So, we have a very high focus on safety. We take a lot of effort in training our people and we do proper process safety analysis, process hazard analysis, and safety of our chemical operations. This is a very important part of sustainability.

The second part of sustainability is how operation affects the immediate environment around us. Such a matrix includes emissions to water, emissions to air, and hazardous waste landfills. I am happy to say, for example, we are one of the largest users in the chemical industry of renewable power. Almost 25 percent of our power needs are met with renewable energy. We work continuously on process intensification to reduce our water footprint and to reduce the amount of products we send to landfill.

The third part of sustainability is to create a more sustainable outcome for customers. For example, many of the products we make are used in water treatment chemistries. We are one of India's largest players in chemicals for treating potable water. Our chemistries enable safe drinking water, and similarly in epoxy business, these are used to formulate and prevent corrosion of products in automobiles and construction





We are a very large player in the food industry due to our phosphates portfolio, which is used in processed meat, aquaculture, and shrimp farming through our sulfide portfolio

in order to increase the life of infrastructure. These also contribute to sustainability. We are also working on water- based chemistries to replace solvent chemistries, for example epoxy formulations. Therefore, we look at sustainability in three ways: the safety, impact of our operations and to make products that enable our customers to pursue sustainability.

Q You have been focusing on designing wind mill blades through the epoxy business. Now, you are trying to enter the sports sector by planning a conscious effort to build a brand?

Epoxy carbon composites offer some of the best strength to weight ratios out of all materials. It is suitable for reliable mechanical performance with low weight. These composites are used in sports as well as in automotive and windmill blades. But, sports are very special because sports are also very personal. When we talk of a sportsperson using a snowboard, we know it is their passion. Most of these sports people are also equally passionate about the environment. We are one of the first in the world to introduce a product which allows epoxies to become completely recyclable. We do believe that sports lovers, who are usually nature lovers, would like surfboards made of epoxies that can be recycled. There is some amount of bio-renewable content in it but this actually enables circularity. Under certain special conditions, we can recover the polymer matrix, and carbon fiber matrix, and repurpose it for other products.

Q How is Aditya Birla Chemicals creating bonds that touch billions of lives?

There are many examples. The chemicals we make are used to treat drinking water, used by millions. We work very hard on reducing the use of fossil fuel for energy to reduce our carbon footprint. Our innovations in



the area of epoxy are aimed at reducing solvent emissions in order to enable circularity. All of these ultimately result in good for society. At Aditya Birla Group, we genuinely believe that our business goals should be aligned with what is good for the society.

Q Would you comment on the Aditya Birla Group's versatility and adaptability to cater to various markets globally due to its diversified product portfolio?

We have a global portfolio that caters to a variety of segments of course in India and in South East Asia. We are also present in Europe and are putting up a plant in America. We are a very large player in the food industry due to our phosphates portfolio, which is used in processed meat, aquaculture and shrimp farming through our sulfide portfolio. We are present in segments like wine, food preservation through our chlorine derivative portfolio. We are supporting industries like chemical, agrochemical, pharma and cosmetic. Our caustic business supports the textile industry, mining industry and so on. The broad portfolio allows us to touch different industries and enable customers to be successful.

> **We are also working on water-based chemistries to replace solvent chemistries, for example epoxy formulations**

Q What is your expansion plan that is under execution?

We are investing large in recyclable epoxies. We are investing in building assets in the US which is an ongoing project. We are building a chlorine derivative portfolio across India at multiple sites. We are consciously also expanding our caustic capacity. There are expansion projects going on but our investments are not only for expanding business but we are also in renewable power and process intensification aimed at using less water. We are investing in technologies that reduce the amount of waste and these are also important investments for us ICN

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FOCUSING ON COST AND QUALITY TO REMAIN PREFERRED SUPPLIER FOR OUR VALUED CUSTOMERS

Our revenues grew by over 30% and we also had a good bottom line (PBIT) performance of over Rs. 300 crore for the chemicals segment



SABALEEL NANDY
Executive Director & CEO
DCM Shriram Chemicals

Q Key achievements of DCM Shriram Chemicals during FY 2024-25 to enhance its market position and operational efficiency?

We had a successful FY 24-25 during which it was much about "New Rubber hitting the road" and we were able to successfully commission many of our planned investments. During the last 24-30 months, we had been executing a major Capex plan of over Rs. 3,200 crore, many of which are now commissioned and yielding desired results. These include the 850 TPD expansion of caustic soda capacity at Bharuch, thereby making our Bharuch plant the country's largest single location chlor-alkali plant and making DCM Shriram Chemicals the country's 2nd largest player with an annual caustic soda capacity of a million MT per annum. We also commissioned 2 new "caustic soda flakes" plants of 300 MTPD each, taking our total capacity of flakes to 900 TPD. Our new flaker plants are run exclusively by ladies.

Moreover, a new 52,000 MTPA hydrogen peroxide (H_2O_2) plant is marking the entry of DCM Shriram Chemicals into potentially the value-added segment. H_2O_2 has wide and emerging applications in many traditional and new age industries.

The company also expanded aluminium chloride capacity and the annual capacity today stands at over 50,000 MTPA. We are also going to commission a 50,000 MTPA epichlorohydrin (ECH) plant soon. As we know, the majority of ECH globally gets consumed in the manufacturing of epoxy resins.

Also, in 2024, we announced new significant projects including entry into advanced materials with a proposed investment of Rs. 1,000 crore and a further expansion of aluminium chloride and entry into calcium chloride. Most of these are expected to form a part of the offerings from the business in the current fiscal.

We are gradually transitioning to renewable power which stands today at over 50 MW through group captive mode, thus enhancing our green power share to over 20 per cent of the total power consumed at Bharuch. We also commissioned a new state-of-the art 120 MW captive power plant to cater to the increased energy demands owing to expansion of caustic and other plants.

Q Could you provide an overview of DCM Shriram Chemicals' revenue performance for FY 2024-25, highlighting key growth metrics and any significant year-over-year

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changes?

DCM Shriram Chemicals has had a good year during FY 24-25. Our revenues grew by over 30% and we also had a good bottom line (PBIT) performance of over Rs. 300 crore for the chemicals segment. We have enjoyed the benefits of the new plants being commissioned through the majority of the bottom-line benefits that have accrued from the cost-side interventions, from the new power plant as well as benefits that our digitization initiatives have begun to bear.

Q Based on the global events of the past few months, what are the company's projections and strategic priorities for the upcoming fiscal year to sustain and enhance revenue growth?

At DCM Shriram Chemicals, the outlook for FY 25-26 remains cautiously optimistic. The FY 24-25 has been much better than the year before, i.e. FY 23-24 but we are yet to be anywhere close to what we had achieved in FY 22-23, mainly because the prices have significantly corrected since the peaks of 2022.

However, 2025 started with the threats and counter-threats to global trade through multiple pronouncements of tariffs by several countries. Though there is a current state of pause and indications are that situations will normalize, we would like to continue to be vigilant about global trade flow impacts due to such tariff pronouncements.

As a business, we will continue to work on the fundamentals around cost and quality and persist in our endeavour to be the preferred supplier of choice for our esteemed customers.

Over the last 24-30 months, DCM Shriram Chemicals has invested over Rs. 3,200 crores in Bharuch plant, the country's largest single location caustic plant, for various expansion and new products

Q DCM Shriram Chemicals has signed a Memorandum of Understanding (MoU) with Government of Gujarat to invest Rs. 12,000 crore in manufacturing of chemical and petrochemical products by 2028. How do you see this

investment unfolding in the future?
Over the last 24-30 months, DCM Shriram Chemicals has invested over Rs. 3,200 crore in its Bharuch plant, the country's largest single location caustic plant, for the various expansion and new products. In Bharuch, we are a part of the GIDC cluster (Gujarat Industrial Development Corporation). The advantage of being in a cluster is that there are downstream consumers for our products. These mutual dependencies with our co-located customer industries have over the time evolved into a symbiotic relationship between the players and it is almost a scenario where member industries are cooperating with each other for maximizing their own performance potentials.

Given this context and in light of the emergence of the belt as a chemicals hub of the country, we continue to remain bullish about the prospects of the state of Gujarat going forward. The signing of the MoU with the Gujarat government of Rs. 12,000 crores is a manifestation of our continued bullishness towards the state and our own conviction about the long term opportunities on offer in the chemicals space for us.

Q DCM Shriram Chemicals has made an interesting announcement related to the Flaker plant being run exclusively by ladies. This looks like a unique move within the chemical industry at large. Please tell us more about this.
During the last year, we commissioned 2 new caustic soda flaking plant (flakes are the solid form of caustic soda, the other product form being "lye", in which caustic soda is in liquid state), each having 300 MTPD capacity and in what is probably a first for the industry, we are having these new flakes plants run exclusively by ladies. In fact, it's not just the operations and maintenance – ladies manage the accompanying support functions like QC, packing, etc. The flakes plants are in fact a "no-men" zone and we have received significant interest from peer industries, customers and other partners/stakeholders about this move.

Q We also read that DCM Shriram Chemicals is engaging "differently-abled" people in their Bharuch plant. What is this about?
We have for long espoused the mantra of WIDE which stands for "We are Inclusive, Diverse and Equitable" and for us, "diversity" is beyond just gender. About a year back, our warehouse team undertook an experiment to enroll differently-abled people for managing warehouse operations. Little did we know that after a year, we will have over 25 per cent differently-abled colleagues in our warehouse. Our differently-abled colleagues have been extensively trained on safety and other aspects of working inside a plant and we are happy to mention that it is today much beyond an experiment that has the promise of becoming a way of life for the warehouse.

Q You have recently signed an MoU for research collaboration with the Institute of Chemical Technology (ICT). How is the company's collaboration with ICT shaping up?
We are proud to have entered into a long partnership with ICT. Under this partnership, scientists at our Innovation Center will work closely with the professors at ICT to progress the frontiers of research through collaboration and partnership. We have also jointly agreed that "sustainability", "greening" and "value-addition" will be the key themes for this partnership. Moreover, we intend to offer interesting internship opportunities to the ICT students at our Innovation Centre and plants. Though it is still early days, we have already articulated for ourselves a charter of joint research and are looking forward to some interesting breakthroughs in the months to come.

> **The signing of the MoU with the Gujarat government of Rs. 12,000 crores is a manifestation of our continued bullishness towards the state**

Q DCM Shriram Chemicals has been taking significant steps towards further digital transformation of the business. Please share with us the details?

At DCM Shriram Chemicals, we have launched a project to further deepen our safety and digital excellence. We have called this "Project BLESSED" where BLESSED is an acronym that stands for "Becoming a Lighthouse

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through Exemplary Safety Systems and Excellence in Digitalization". While on one hand, we are working on 2 parallel streams related to Workplace Safety and Process Safety Management, on the other, we are using Digital & Analytics to understand better the "how and why" of operating performance so that our processes are run even more efficiently. We have engaged world-class partners /enablers to help us in this journey and it is our intent to make BLESSED a cornerstone of our D&A transformation journey.

Q Contribution of renewable energy in the total energy mix of the company. How do you see it changing in future?

Caustic soda manufacturing is a power hungry operation and we believe this offers us a significant opportunity for greening and having more renewable power in our mix. With this conviction, we have been progressively deepening our renewable power footprint including noteworthy increases in the last 24 months. We have over 50 MW of renewable power in our mix and over 20 per cent of our power today comes from renewable sources. We will continue to explore further addition of renewable power in the overall power mix.

Q How integral are the CSR projects for the company's overall vision? Which key projects were prioritized in FY 2024-25 and what outcomes have been achieved?

As a group, DCM Shriram has always believed in growing with the communities where one operates. Long before rules around CSR were formulated, the group has worked towards improvements of the lives of the people and communities around us.

At DCM Shriram Chemicals, we have adopted specific items from the overall group's CSR charter, in close consultation with the DCM Shriram Foundation and translated them into specific measurable programs of CSR for us. For example, under the aegis of "Kishori Utkarsh Pahel" (KUP), one of the flagship initiatives of the "DCM Shriram Foundation", at Bharuch, the chemicals team is working towards promoting health awareness of adolescent girls. Further, under a different program, to promote green cover, we have set a target to plant 1 million saplings. Another of our CSR programs aims at de-silting of check-dams under which we will plan to conserve an additional quantum of over a billion litres of water. Yet another has been in the area of waste handling for municipalities and/or village clusters – one of the first such large scale deployments of our waste handling model was recently done in Bharuch by our CSR team.

At DCM Shriram Chemicals, CSR isn't a one-off event. We run these programs on a mission mode and the objective is to deliver significant on-ground impact. Thus most of our programs require 2-3 years of persistent implementation

OUR LONG-TERM PLAN FOR POLYMER BUSINESS IS RAPIDLY TAKING SHAPE

Deepak Nitrite's philosophy has always been to drive import substitution and help reduce India's import bill

Q Emerging trends in the global chemical industry and its impact on the Indian chemical industry in the wake of the ongoing geopolitical situation and US-China trade war?

The global chemical industry in 2025 is navigating a transformative phase, driven by innovation, sustainability, and geopolitical shifts. Key trends include the adoption of digital technologies like AI and predictive analytics to enhance efficiency and sustainability. The industry is also focusing on decarbonization and circular economy initiatives to meet environmental goals. However, challenges such as supply chain disruptions, high energy costs, and regionalization due to geopolitical tensions persist.

The ongoing US-China trade war has significantly impacted the global chemical landscape. With US tariffs on Chinese imports have disrupted supply chains, the trade war has led to increased costs and market fragmentation, affecting global efficiency. For India, these global dynamics present both challenges and opportunities.

The Indian chemical industry, a key pillar of the economy, is benefiting from robust domestic demand and government initiatives like the Production-Linked Incentive (PLI) scheme. India's specialty chemicals sector is poised for growth, driven by demand in agriculture, pharmaceuticals, electronics semiconductor and advanced polymers. The long-term outlook for the Indian chemical industry remains positive, with opportunities to strengthen its position in the global value chain.



MAULIK MEHTA
CEO & Executive Director
Deepak Nitrite

Q Key milestones achieved by the Deepak Group during FY24-25?

The year 2024-25 has been very challenging for the Indian chemical industry including Deepak group with pressures on demand due to oversupply and Chinese dumping, pricing pressures due to recessionary trends in the European and US markets. However, due to our resilient business and focused strategies, we were able to achieve significant milestones during this period.

Deepak Group, through its subsidiary, Deepak Chem Tech has set up a production facility at Dahej to manufacture polycarbonate resins with an initial capacity of 1, 65,000 MT per annum for which we have entered into an agreement with Trinseo. We recently began production of engineering polymers at our state-of-the-art polycarbonate compounding plant at

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Manjusar, Savli in our subsidiary Deepak Advanced Materials.

Q With a diversified portfolio catering to multiple industries, which segments have shown maximum growth and how has the company adapted its operations to meet varying demands?

We cater to multiple industries and products having varied end applications ranging from agro intermediates to dyes and pigments, plywood industry, epoxy resins, textiles, petrochemicals among many others. At Deepak, our philosophy has always been to drive import substitution and help reduce the nation's import bill — phenol being one of the most recent products introduced under this strategic approach. We are further targeting other products such as polycarbonate resins for which currently the country is completely dependent on imports. By adding new chemistries such as fluorination chemistry, Deepak group has created a strategic backward integration for our agro chemicals.

Q In the light of the financial performance during Q3 FY25, are there new strategic initiatives or adjustments to existing plans to enhance profitability and operational efficiency? How do you see your performance in FY 2024-25?

Performance during FY 24-25 was marked by a unique confluence of events. Normally, the business cycles of advanced intermediate and phenolics are such that on an overall basis they complement each other. Persistently, stubborn raw material costs have also impacted product margins. We have taken several measures to ensure that profitability and productivity are meaningfully improved.

The company has entered into medium term agreements which align well with its expanded capacity. We have also completed our expansions and cost improvement initiatives for agrochemicals and dye intermediates. This will yield higher volume at a lower cost for segments where demand is resilient.

We introduced new products from existing assets which will have revenue and margin improvement, Methyl Isobutyl Ketone (MIBK), Methyl Isobutyl Carbinol (MIBC), acetophenone and other backward and forward integrations are expected to be commissioned shortly. This will expand our footprint in the energy sector as well as establish our foray into advanced solvents for life science applications.

Q The company has signed MoUs with the Govt. of Gujarat and a binding term sheet with Petronet LNG. How do these agreements

fit into Deepak Group's long-term strategic vision and what benefits are anticipated?

Deepak group has been an early adopter of Make in India, Make for the World. We aim to make India self-reliant in responsible chemistry. We as a strategy believe to produce products which substitute imports and thereby reducing India's import bill and making India self-sustained. Towards this, we have signed two MoU's with Govt. of Gujarat to cumulatively invest Rs. 14,000 crore to set up state-of-the-art units in PCPIR region at Dahej to manufacture specialty chemicals for agrochemicals and pharma sector, phenol and acetone which cater to laminates and plywood industry and bisphenol which cater to epoxy and adhesives sector.

In March 2024, Deepak Chem Tech Ltd. (DCTL) commissioned a fluorination plant in Dahej, Gujarat.

> **We have signed two MoU's with Government of Gujarat to cumulatively invest Rs. 14,000 crore to set up state-of-the-art units in PCPIR region at Dahej to manufacture specialty chemicals, phenol, acetone, and bisphenol**

Further down the chain, we plan to manufacture polycarbonate (PC) resins, PC compounds and other advanced materials which have applications in electrical and electronic components, high end telecommunication devices, automotives, aviation, mobility industry, renewable energy medical and consumer devices, construction, lighting and furniture industries, to name a few.

What is the latest development on acquisition of Trinseo's polycarbonate technology license and stade equipment assets? How is this acquisition going to contribute to Deepak's growth?

Our long-term plan for the polymer business is rapidly taking shape. Having entered into long term agreements for pipeline supply of critical feedstock and contracted to acquire German assets for the final product viz polycarbonate resins, we are actively working to complete the entire value chain. We are acquiring their globally accepted brand. India continues to import almost 300 KTA of polycarbonate resin. Deepak will be producing about 160 KTA in the first phase. The project is targeted to be commissioned by December 2027.

Could you elaborate on the strategic importance of this plant and how it enhances the company's backward integration for agrochemical intermediates?

Last year in March, we commenced our state-of-the-art fluorination plant, and it was a landmark moment for Deepak as the group forayed in the expertise of fluorination chemistry which is core to our future growth plans. Fluorination chemistry plays a significant role in various fields, including materials science, pharmaceuticals, agrochemicals, and electronics, offering a diverse range of properties and applications. This development strengthens Deepak's backward integration for crucial agrochemicals, enhancing the company's value chain resilience as well as participation in various contract manufacturing opportunities.

Deepak Group has been focusing on strategic investments and building a resilient business model through strong integration. Key initiatives that were undertaken in FY24-25 that align with this strategy?

The current developments strengthen the company's backward integration for crucial agrochemicals and establish Deepak Group as a R&D hub for responsible chemistry in India. It is because of the company's integrated model and India's stability and consumption push that has provided a significant bulwark to our growth fundamentals.

Our considerable investment plans include upstream, downstream and sunrise segments. We are implementing world-scale capabilities which shall be used as a specialty chemical in flavors and fragrance segments, manufactured from recovered byproducts of phenol. We are undertaking projects to manufacture PC and compounds which are downstream derivatives of the phenol chain. With the commissioning of photo halogenation and fluorination capacities, we are securing our key raw material supply and gearing up for new product capabilities.

What is the overall expansion plan of the Group? How much investment is earmarked for these expansions? How are you going to arrange the investment? Could you provide details on these projects and their expected impact on the company's growth?

We have signed 2 MoUs with the Govt. of Gujarat, which encompass an investment to the tune of about Rs. 14,000 crore towards the fulfilment of our objective of enhancing our capabilities and seizing the



opportunities in both domestic and international markets particularly in building blocks, intermediates and specialty chemicals.

Various projects entailing an outlay of around Rs. 2,000 crore are in the final stages of implementation, and these are being commissioned which include projects to manufacture MIBK and MIBC, which are products in the phenol chain, Nitric Acid plant, enhanced nitration and hydrogenation facilities and agrochemicals. We have also signed an agreement with Trinseo to procure the assets, license the technology for manufacture of Polycarbonate which is currently imported in India.

These projects shall be funded by a mix of debt and internal accruals. Since we have a very strong balance sheet and cash generation of around Rs. 1,000 crore, we are holding a very healthy financial position for funding the investments.

Q What is the current status of the development of the R&D Centre at Savli, Vadodara. By when is it expected to be ready and what will be the focus of this facility in terms of developing new products or technologies?

With its ability to develop advanced intermediates, our R&D facility is crucial to our success. Our state-of-the-art R&D facility at Savli, Vadodara shall be commissioned soon. Central to the mission of the Savli R&D Centre is the emphasis on sustainability. The facility will prioritise the development of processes and products that minimise environmental impact, aligning with global trends toward greener and more sustainable industrial practices.

We have a strong line of products offered to various segments of industries for varied applications. These products shall be announced at appropriate time in due course.

Q Beyond the current projects, what are Deepak Group's plans for capital expenditures in the upcoming fiscal years, and which areas are prioritized for investment?

Currently, the company is focussing on the commissioning and completion of the various ongoing projects such as the MIBK and MIBC project and Nitric Acid projects. We are targeting to commission these projects in the upcoming year as well as rapidly progress on the Poly Carbonate project which shall be a key growth driver for Deepak group with our strategy of import substitution.

Q Deepak Group has a dedicated policy for Employee Health, Safety, Environmental Protection, and Quality. What specific initiatives were undertaken in FY 2024-25 to enhance sustainability and what outcomes have been observed?

In November 2024, Deepak Nitrite

By integrating future-focused, sustainable practices, Deepak Group is well-positioned to lead the chemical industry's shift toward greener operations. In FY 2023–24, we reduced our annual emissions by 12.49 per cent

released its inaugural Sustainability tReport, reaffirming our unwavering commitment to embedding ESG principles in every project. Sustainability is integrated into our core operations—each initiative is designed with energy-efficient technologies to minimize carbon footprint, repurpose waste into value-added products, and align with the 3R principles: Reduce, Reuse, and Recycle.

Over the years, we have implemented wide-ranging measures to cut carbon emissions, recycle water and waste, improve energy efficiency, and prioritize people-centric practices. Notable efforts include scaling biomass use in our boilers from 30 MT to 100 MT per day by utilizing ETP sludge, thereby reducing dependence on conventional fuels. We have also invested in energy-efficient infrastructure, such as a biomass conveying system and Advanced Process Control (APC) systems in our cumene and phenol plants, leading to significant utility and chemical savings.

In FY 2024 alone, we invested over Rs. 22 crore in environmental conservation projects. Milestones include the commissioning of a Spent Sulphuric Acid Concentration (SAC) unit at Nandesari, and the deployment of advanced wastewater treatment technologies—Activated Sludge Process (ASP) and Membrane Bio Reactor (MBR)—achieving 80–90 per cent treatment efficiency. We've also implemented Ultra Filtration (UF), Reverse Osmosis (RO), Mechanical Vapour Recompression (MVR), and Multi-Effect Evaporator (MEE) systems to maximize water reuse.

Q How is Deepak Group leveraging digital technologies to enhance manufacturing processes across its facilities, such as those in Dahej and Vadodara, to improve efficiency and product quality?

We have formed a Digital Innovation Lab with an IT team and innovative business team members. This team shall be identifying use cases and experiment the same on our Private LLM. Presently, we are in the Multi Cloud Environment wherein we have created a Data Lake created by collecting data from SAP, CRM, LIMS, and likes on google cloud using VERTEX AI. This data lake can be used in predictive analytics – based on past data, the model will get trained with the trend and give predictions based on regression on Demand, price; Scenario simulation - Financial Planning & Demand Forecasting, Automation in Projects AI is driving our plant. We have set up Smart Manufacturing using Advanced Process Controls (APC) at our phenol facility. Real-time monitoring of critical variables allows APC to optimise performance and make timely decisions. Due to this, we were able to increase our production by 2 to 3.5 per cent, decrease our CO2 emission, and reduce process deviations by 2 to 7 per cent.

Q The company has been recognized for its ESG efforts, receiving awards for Health & Safety Excellence, Waste Reduction, and Green Innovation. Can you share more about these achievements and the initiatives that led to them?

At Deepak, we believe that ethics, aesthetics, and economics can harmoniously coexist, guiding our journey toward responsible industrial leadership. In 2024, we published our inaugural Sustainability Report, marking a key milestone in our commitment to sustainable growth. By integrating future-focused, sustainable practices, Deepak Group is well-positioned to lead the chemical industry's shift toward greener operations. In FY 2023–24, we reduced our annual emissions by 12.49 per cent and significantly expanded the use of renewable energy to reduce reliance on fossil fuels.

Recently, we have registered a S&P Global ESG Score of 56/100 which is an impressive 20 per cent growth from the previous year. We have received a rating of "B" in the CDP (Carbon Disclosure Project) on two key categories – Climate Change and Water Security. This is a milestone in our sustainability journey. Our Hyderabad unit won Gold award at the 16th EXCEED Green Future Environment Awards 2024 for Water management. We also earned seven Gold Awards for safety case studies at the National Safety convention ICN



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Our strategic objectives include developing new technologies and products to meet emerging customer needs and deliver long-term value



KARTIK BHARAT RAM
Joint Managing Director
SRF

Q Overall performance of SRF Limited in FY24-25 and expectations in FY25-26?

SRF Limited delivered a mixed performance in FY24–25, with revenue growing by 12 per cent to Rs. 14,693 crore and EBIT rising 6 per cent to Rs. 2,336 crore. The chemicals business faced early challenges due to weak demand and inventory issues but showed recovery in the second half, while the packaging films (renamed as Performance Films & Foil) business faced challenges due to global overcapacity, offset by a focus on value-added products and cost efficiencies. In FY25, the technical textiles business recorded a stable performance.

Looking ahead to FY25–26, SRF is cautiously optimistic, driven by new product launches, improved capacity utilization, and a projected ~20 per cent growth in the chemicals segment. The company remains vigilant about global uncertainties but is confident in its innovation-led strategy and operational resilience.

Q In October 2024, SRF approved capital expenditures totaling approximately Rs. 1,500 crore. What were the primary projects identified for this investment?

In October 2024, SRF approved capital expenditures totalling approximately Rs. 1,500 crore. The primary projects identified for this investment include production facilities for fourth-generation refrigerants. This project aims to establish new production facilities for fourth-generation refrigerants at Dahej, Gujarat. These refrigerants have a much lower Global Warming Potential (GWP) and a reduced carbon footprint. The estimated cost for this project is Rs. 1,100 crore.

Another significant project involves setting up a manufacturing facility for BOPP-BOPE film production, in Indore, India. This initiative allows SRF to expand its BOPP substrate production while exploring the new BOPE substrate. It also aligns with the company's sustainability goals, as polyolefin substrates like BOPP and BOPE are known for their recyclability and environmental benefits due to their mono-family composition. The projected cost for this project is Rs. 445 crore. These projects reflect SRF's commitment to sustainability and innovation, aiming to enhance production capabilities while reducing the environmental impact.

Q How does the establishment of new production facilities for fourth-generation refrigerants at Dahej, Gujarat, align with SRF's long-term strategic goals?

The establishment of new production facilities for fourth-generation refrigerants at Dahej aligns closely with SRF's long-term strategic goals, particularly those outlined in our Aspirations 2030. SRF's long-term strategic goals emphasize sustainability, innovation, and technological leadership. The new production facilities for fourth-generation refrigerants will have a much lower Global Warming Potential (GWP) and carbon footprint, which directly supports SRF's commitment to environmental sustainability.

Moreover, SRF's strategic objectives



include developing new technologies and products to meet emerging customer needs and deliver long-term value. The production of fourth-generation refrigerants represents a significant technological advancement in the refrigerants industry, positioning SRF as a leader in innovation and technology. Overall, the establishment of new production facilities is a strategic move that supports SRF's long-term goals, while also enhancing market position and reputation.

Q What potential benefits does SRF anticipate from expanding its BOPP substrate production and exploring new BOPE substrates?

Expanding its BOPP substrate production and exploring new BOPE substrates offers several potential benefits for SRF. This initiative aligns with SRF's sustainability goals and enhances its production capabilities. Firstly, polyolefin substrates like BOPP and BOPE are known for their recyclability and environmental benefits due to their mono-family composition. This means that these substrates can be recycled more easily, reducing the environmental impact and supporting SRF's commitment to sustainability. Secondly, expanding BOPP substrate production allows SRF to meet the growing demand for this material, which is widely used in varied packaging applications. By increasing its production capacity, SRF can better serve its customers and capture a larger market share.

Exploring new BOPE substrates also provides SRF with an opportunity to innovate and offer new products to its customers. BOPE substrates have unique properties that make them suitable for various applications, and by venturing into this new area, SRF can diversify its product portfolio and stay ahead of market trends. Overall, these initiatives are expected to enhance SRF's production capabilities, support its sustainability goals, and provide new opportunities for growth and innovation.

Looking ahead to FY 2025–26, SRF is cautiously optimistic, driven by new product launches, improved capacity utilization, and a projected ~20 per cent growth in the chemicals segment

Q How did SRF navigate economic or industry-specific challenges in 2024 to maintain or enhance its revenue streams?

In 2024, SRF faced macro-economic and industry-specific challenges but managed to navigate them effectively to maintain and enhance its revenue streams. The company operates across different business segments, including fluorochemicals, specialty chemicals, performance films & foil, technical textiles, and coated and laminated fabrics. This diversification helps mitigate risks associated with any single



segment and provides a more stable revenue base.

SRF's focus on innovation and research and development (R&D) plays a crucial role in overcoming challenges. The company invests in developing new products and technologies to enhance its competitive edge and allow it to tap into new markets. SRF emphasizes operational excellence by optimizing its production processes, reducing costs, and improving efficiency. This approach helps the company maintain profitability even in the face of economic uncertainties. At SRF, operational excellence is a cornerstone of its strategic and manufacturing philosophy, deeply embedded through the principles of Total Quality Management (TQM).

The company's commitment to excellence is reflected in its globally certified plants, robust quality systems, and continuous improvement culture. The company has made strategic investments in expanding its manufacturing facilities and capabilities. For example, SRF's recent foray into Cast Polypropylene (CPP) film marks a strategic expansion of its Performance Films and Foil Business (PFB), aligning with the company's dual focus on growth and sustainability. SRF's commitment to sustainability and environmental responsibility resonates well with global customers and stakeholders. The company's efforts to reduce its environmental impact and promote sustainable practices has strengthened its reputation and market position. These strategies and actions enabled SRF to navigate the economic and industry-specific challenges of 2024 effectively, ensuring continued growth and profitability.

> **The establishment of new production facilities for fourth-generation refrigerants at Dahej, Gujarat, aligns closely with SRF's long-term strategic goals, particularly those outlined in our Aspirations 2030**

Q With 19.8 per cent of SRF's electricity mix coming from renewable sources in 2024, what steps has the company taken to increase this percentage?

SRF has embedded sustainability into its long-term strategic vision, particularly under its "Aspirations 2030" framework. The company is actively pursuing a multi-pronged approach to enhance its renewable energy footprint. This includes investments in solar and wind energy projects, both on-site and through power purchase agreements (PPAs), to reduce dependency on conventional energy sources. SRF is also exploring energy efficiency upgrades across its manufacturing units and integrating green building practices to lower overall energy consumption. Additionally, the company's sustainability roadmap emphasizes decarbonization and circularity, aligning with global ESG benchmarks and India's national renewable energy goals

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SUYOG KOTECHA
CEO and Executive Director
Aarti Industries

Q What were the primary contributors to Aarti Industries Limited (AIL) revenue in FY 2024-25, and how did different segments perform relative to expectations?

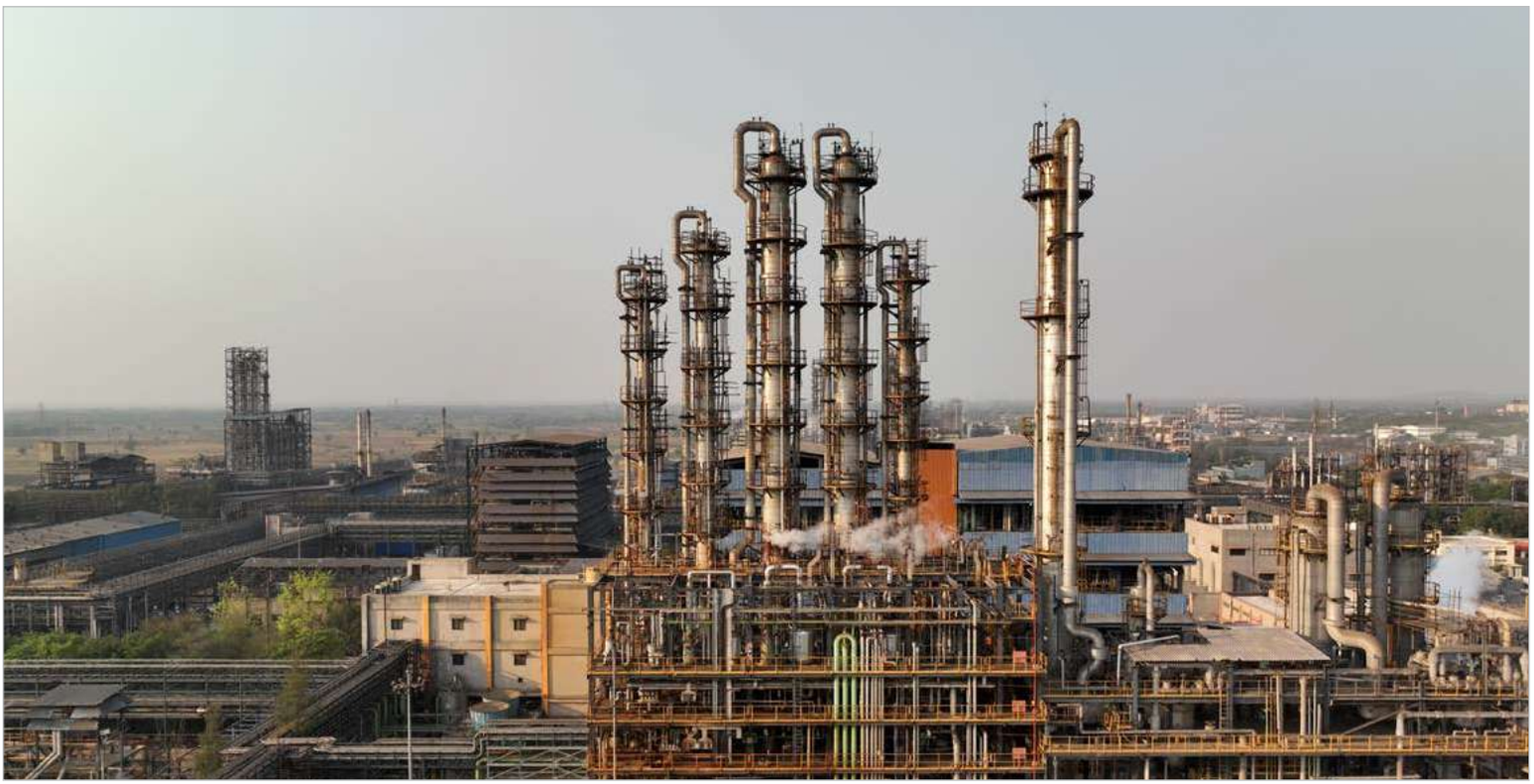
FY25 remained a year where we reaped the benefits of staying the course on our core philosophy: chemistry-led value creation. AIL achieved a consolidated revenue of Rs. 8,046 crore in FY24-25, marking a 15 per cent year-over-year growth. Our performance was underpinned by volume-led growth across our diversified product segments, despite the volatility in global pricing. Agrochemical intermediates remained under pressure, but the real traction came from performance chemicals and polymer additives, where our backward integration and customer stickiness helped us outperform market expectations. We witnessed early signs of recovery in demand for dyes, pigments, and pharma intermediates, but the pricing remained subdued. Another major contributor to our growth was the increase in the volumes of Energy applications, which are still in the market development phase. AIL's Energy Business achieved strong volume growth, driven by expanded market reach across the US, Europe, and India. Thus, the diversified product mix across end-markets is a testimony to the resilience we've built into our portfolio, which supports our growth.

Q AIL reported a 15 per cent increase in revenue in FY25, totalling Rs 8,046 crore. What were the primary drivers behind this growth?

The 15 per cent revenue growth in FY25 was primarily driven by volume and wasn't incidental but intentional. We placed a sharp focus on capacity utilisation, commercialising key projects and working closely with customers to deliver at scale. The commissioning of new capacities in our Nitrotoluene and Ethylation chains, coupled with consistent execution and scaling up of volumes across various value chains, including specific products such as MMA, enabled us to tap into latent demand. Additionally, the commissioning of new projects and a focus on high-value specialty chemicals contributed to the top-line growth. The fact that we achieved revenue growth amid global disruptions shows the strength of our integrated, future-ready model.

Q Despite economic headwinds, AIL maintained its capital expenditure plans of investing a total of Rs. 3,000 crore in new chemical value chains and high-potential products. What areas received the most investment, and what returns are anticipated?

Capex at AIL is not just a number, but a roadmap to the future. A large part of Rs. 3,000 crore has already been invested over the last few years, directed towards developing new chemical value chains in Nitrotoluene, Chlorotoluene, and newer Ethylation platforms, aligned with growth trends. Our capital expenditure (Capex) for FY26 is expected to be below Rs. 1,000 crore. A pilot plant at Jhagadia (the new greenfield site) has already begun



Our export revenue in FY25 increased by approximately 21 per cent to Rs. 4,425 crore, with a sequential rise led by robust demand in the US and Europe especially for specialty chemicals and advanced intermediates

operations, while the multipurpose and calcium chloride plants are expected to be commissioned by Q3 FY26. However, significant volume contributions from these assets are anticipated from FY27 onward, post-stabilisation and ramp-up. These strategic investments aim to enhance our product portfolio and cater to the growing demand for specialty chemicals. The anticipated returns include increased market share, improved margins, and strengthened global partnerships.

Q AIL earmarked about Rs. 1,800 crore for capital expenditures in FY25. What are the key projects or areas receiving these investments? How do these capital investments align with AIL's long-term growth objectives and market expansion plans?

The Capex in FY25 was approximately Rs. 1,372 crores. This capital expenditure was channelled into key projects that bridge current capabilities with future aspirations, from piloting high-value products at Jhagadia (the new green field site) to strengthening our Chlorotoluene value and advanced intermediates platforms. These investments align with our vision to be a "Global Partner of Choice" with a differentiated portfolio. These investments future-proof our manufacturing backbone and reinforce our position in the global supply chain.

Q AIL planned to complete several projects by 2024, including the third long-term contract unit at Jhagadia and the NCB capacity expansion at Vapi. What is the current status of these projects, and how will they impact AIL's production capabilities?

Both the third long-term contract unit at Jhagadia and the NCB capacity expansion at Vapi have been successfully commissioned. The Jhagadia unit enhances AIL's ability to fulfil long-term supply agreements,

while the NCB expansion increases production capacity from 75 KTPA to 108 KTPA, supporting growth in downstream products.

Q What specific upgrades were made to the acid unit at Vapi, and how do they contribute to operational efficiency and sustainability?

The acid unit at Vapi underwent a significant upgrade, focusing on energy recovery, emission control, and process intensification. With Phase I complete, we have already seen marked improvements in emergency efficiency and a reduction in emissions that contribute to AIL's sustainability goals. On the one hand, this reflects our principles that operational efficiency and sustainability are not mutually exclusive, but rather interlinked. Our recognition on the CDP A list for both climate and water security reflects the measurable progress we have made in this direction. The outcome is not just lower cost but a future-proof operation aligned with the global expectations.

Q Exports showed sequential growth in 2024. Which international markets or products significantly contributed to this trend?

Export revenue in FY25 increased by approximately 21 per cent to Rs. 4,425 crore, with a sequential rise led by robust demand in the US and Europe especially for specialty chemicals and advanced intermediates. Customers worldwide are increasingly seeking resilient, compliant, and agile partners, and our integrated model is the ideal fit. We have also expanded commercial presence in newer regions to build pipeline diversity.

Q AIL's near-term emission reduction targets have been validated by the Science-Based Targets initiative (SBTi). What specific strategies are in place to achieve these targets?

SBTi validations are not the finish line for AIL; it's actually a starting point. Our multi-pronged strategy targets emissions reduction through increased renewable energy use, investments in low-emission processes, and circularity initiatives. This includes optimising energy efficiency, expanding renewable energy in operations, and implementing waste-to-energy solutions.

Certified under ISO 50001, AIL uses an IT-based Energy Management System to track and drive progress. Key projects—such as Variable Frequency Drives (VFDs), waste heat recovery, steam compressors, and biomass substitution—have already reduced energy use and emissions. In FY24, energy-saving measures resulted in over 6.3 million kWh of savings. Investments in hybrid renewable power and cleaner fuels have also been significantly scaled up. With renewable power expected to account for over 75 per cent of our purchased energy mix by FY27, we're on track to reduce our carbon footprint significantly. Further sustainability measures include advanced distillation, NOx abatement, zero liquid discharge, and hazardous waste recycling. Every plant upgrade, every molecule redesign, now considers carbon impact. At AIL, emissions control should be integrated into the design, rather than being treated as an afterthought.

Q AIL increased its investments in renewable energy sources during fiscal year 2024. What percentage of the company's energy mix is now derived from renewables, and what are the future targets?

As of FY24, AIL commissioned a 13.2 MW hybrid renewable power plant, reinforcing our push towards energy transition. We are progressively tilting our energy mix towards renewables, and our next milestone is to reach a point where more than 75 per cent of our purchased power requirements going forward will be met through renewable sources.

Over the next three years, this will be further accelerated through a mix of captive green projects and green power procurement.

Q Aarti Circularity, a wholly owned subsidiary of AIL, has formed a joint venture with Re Sustainability to establish a plastic recycling facility in Hyderabad, at an outlay of Rs. 100 crore. What is the current status of the project and long-term targets?

Aarti Circularity's joint venture with Re Sustainability is a bold step toward material circularity. The Rs. 100 crore Hyderabad project, currently in the pre-construction stage, is designed to process hard-to-recycle multilayer plastics using advanced recycling technology. Over time, we aim to recover value from waste at scale, reduce our dependency on landfills, and offer recycled raw materials as feedstock back into the petrochemical supply chain. It's about closing the loop. The project is progressing as planned, with long-term targets focused on promoting circular economy practices and enhancing operational sustainability.

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AIL ranks between 1st and 4th globally for 75 per cent of its product portfolio. What strategies have contributed to achieving and maintaining this market position?

AIL's strong global ranking is a result of its commitment to quality, innovation, and customer-centric approaches. Our global leadership is rooted in deep strengths, including an integrated operating model, a de-risked and diversified portfolio, and long-term customer relationships. With over 100 products supplied to more than 1,100 customers in 60 countries, we have earned trust by consistently delivering value-added, cost-effective solutions. Our R&D-driven innovation, with 250+ scientists and 40+ new products under development, ensures we stay ahead of market needs. Strategic capital expenditures in high-margin value chains and emerging chemistries, such as electronic chemicals, membranes and polymer additives, further reinforce our edge. At AIL, we build enduring leadership through science, scale, and sustainability.

What programs has AIL implemented to promote employee well-being, gender equality, and community development in 2024?

People are the cornerstone of our success. We firmly believe a thriving organisation is built on the well-being of its employees. This belief is reflected in our comprehensive approach to employee welfare, encompassing five key dimensions: career, financial, social community, health, and well-being. These pillars of well-being are integral to our organisational culture, driving engagement, productivity and satisfaction.

We conduct regular employee surveys on well-being through renowned external agencies. Our scores on the dimensions of well-being have crossed 90th percentile globally. 72 per cent of our workforce have a thriving and positive view of life against a global average of 35 per cent.

By investing in our people and communities, we not only enhance individual fulfilment but also strengthen our collective capacity to achieve excellence. AIL has implemented various programs focusing on employee health and safety, learning and development, diversity and inclusion, and community engagement.



Aarti Industries Limited (AIL) and UPL Limited (UPL) formed a 50-50 joint venture (JV) Augene Chemical Private Limited to manufacture and market specialty chemicals. What is the latest development on this front?

The joint venture, Augene Chemical Private Limited, established by AIL and UPL, is progressing with plans to manufacture and market specialty chemicals. We are working on finalising the product lines that can create mutual advantage, technology and market reach. The synergy lies in leveraging the strengths of the two partners to build a platform for differentiated specialty chemicals catering to global demand. This arrangement will enable India to demonstrate its ability to collaborate and partner in creating world-class chemical manufacturing assets that deliver innovative specialty chemicals to the world

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OUR FOCUS WILL BE ON PRODUCT DIVERSIFICATION OVER THE NEXT FIVE YEARS

We aspire to be a leading chemical company, delivering innovative solutions that enrich lives



AMIT AGARWAL
Managing Director
Jindal Speciality Chemicals

Q What were the primary contributors to Jindal Specialty Chemicals' revenue in FY 2024-25 (so far)? How did different segments perform relative to expectations? What were the primary drivers behind this growth?

Jindal Specialty Chemicals' key revenue driver in FY 2024-25 is Acetonitrile, widely used in pharmaceuticals, agrochemicals, and laboratory applications. The pharma and agro sectors remain the strongest contributors and are expanding its global footprint while maintaining a strong domestic presence.

Jindal Specialty Chemicals (JSC) is part of the Jindal Group, a diversified conglomerate with leadership in textiles (denim, shirting, and sustainable fabrics) and packaging (BOPET films under Aegios Polyfilms). The Group emphasizes innovation, sustainability, and global expansion across its business segments.

Q How was the Acetonitrile segment performance in FY 2024-25 and what are your expectations for FY 2025-26?

Acetonitrile remained a high-growth segment in FY 2024-25, driven by strong demand from the pharmaceutical, agrochemical, and laboratory industries. Recognizing this sustained demand, we are expanding our ACN production capacity in Gujarat to better serve the market better. This expansion will further strengthen our presence in critical sectors like pharmaceuticals and agrochemicals, reinforcing our commitment for a better tomorrow.

Q What is your present production capacity of Acetonitrile and future expansion strategy?

Currently, our Acetonitrile production capacity stands at 10,000 tons per annum. With growing market demand, we are strategically investing in capacity expansion to strengthen our leadership position. Our future strategy includes adopting advanced production technologies, enhancing operational efficiencies, and scaling up infrastructure to meet evolving industry needs while maintaining the trust of our clients. This expansion will reinforce our presence in key domestic and

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international markets, ensuring high-quality, reliable supply to critical sectors like pharmaceuticals and agrochemicals.

Q What are the JSC's long-term growth objectives and market expansion plans for the next five years?

Jindal Specialty Chemicals aspires to be a leading chemical company, delivering innovative solutions that enrich lives. With a strong foundation in Acetonitrile, we are expanding into high-value specialty chemicals for FMCG, pharmaceuticals, agrochemicals, and advanced materials. Over the next five years, our focus will be on product diversification, capacity expansion, and leveraging cutting-edge technology to strengthen our global presence and meet the dynamic needs of the industry.

The company has earmarked Rs. 1,000 crore for Greenfield investments over the next five years, in addition to ongoing expansion plans. Many of these projects focus on products being developed for the first time in India, powered by advanced technology and high levels of manufacturing complexity.

> **Currently, our Acetonitrile production capacity stands at 10,000 tons per annum. With growing market demand, we are strategically investing in capacity expansion to strengthen our leadership position**

Q Could you share the details on the company's employee well-being and community development programs in FY 2024-25?

In FY 2024-25, Jindal Specialty Chemicals reinforced its commitment to employee well-being through health check-ups, stress management programs, employee assistance initiatives and comprehensive safety

training. Our focus remains on fostering a safe, healthy, and engaging work environment. On the community front, we actively contributed to education, skill development, infrastructure improvement in areas surrounding our manufacturing plants, driving meaningful social impact.

Q What are the key strategies and market opportunities for Inulin's launch in FY 2025-26, and how do you foresee its impact on the business?

For the launch of Inulin in FY 2025-26, our key strategies include market penetration in the FMCG, nutraceutical, and pharmaceutical sectors, leveraging its growing demand as a natural dietary fiber and prebiotic. We aim to establish strong partnerships, focus on product differentiation, and expand into high-potential global markets. This launch is expected to enhance our product portfolio, drive revenue growth, and strengthen our position in the specialty ingredients segment.

Q What is the planned production capacity for Inulin, and how does JSC aim to position it in the market upon launch?

Jindal Specialty Chemicals is set to launch a greenfield project with an innovative, in-house-developed technology and a c-GMP-compliant manufacturing facility with a production capacity of 10,000 MTPA. This launch positions JSC as a key player in the growing Inulin market in India, contributing to the "health and wellness" sector while driving economic growth in the Jammu & Kashmir region.

A major milestone includes setting up India's first inulin manufacturing plant based entirely on indigenous technology—demonstrating our R&D excellence and engineering capabilities. Designed specifically for export markets, the facility will meet the stringent compliance standards of global clients such as Nestlé, Abbott, and others.

Q Are you planning to manufacture other products, and what is the timeline and scale of your planned Capex investment?

Jindal Specialty Chemicals has a strategic capital investment plan with a stage-wise commissioning of multiple projects over the next 3-4 years. The company is expanding beyond chemical intermediates to establish itself as a trusted and approved partner for marquee end customers.



> **For the launch of Inulin in FY 2025-26, our key strategies include market penetration in the FMCG, nutraceutical, and pharmaceutical sectors, leveraging its growing demand as a natural dietary fiber and prebiotic**

Q What are JSC's plans for achieving net carbon zero? What specific strategies are in place to achieve sustainability targets?

At Jindal Speciality Chemicals, sustainability is a conscious choice — one that balances the environment, people, and the economy. Through responsible practices like water conservation, renewable energy adoption, and zero-emission processes, we're not just reducing our footprint — we're enabling innovation that drives long-term growth and impact. Because true progress means protecting the planet while enriching lives.

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MAULIK PATEL
Chairman & Managing Director
Epigral

Q How would you explain the emerging trends in the chlor-alkali business in India and globally? And how prepared Epigral is to tap the growth opportunity?

We see strong potential in the chlor-alkali industry due to its applications across various sectors that are directly linked to daily consumption. Both globally and in India, we anticipate that the demand for chlor-alkali products will remain robust and gradually increase each year. Epigral, with its capacity for caustic soda, is well-positioned to meet this growing demand.

Additionally, we have evaluated various downstream co-products, such as chlorine and hydrogen, to ensure we operate as an integrated player in the industry. Epigral has strategically chosen co-products that we can consume in our operations, which has improved our efficiency. By selecting import-substitute products that utilize these co-products, we have also contributed to the nation by reducing dependency on imports, aligning with the Government of India's initiatives of Atmanirbhar Bharat and Make in India.

Q What are the three main challenges that the Indian chlor-alkali sector is facing and what could be the suggested solutions to overcome these challenges, according to you?

In India, the chlor-alkali or caustic soda industry faces the challenge of producing chlorine alongside caustic soda. Instead of viewing this as a setback, we identified a range of products that utilize chlorine, which has strengthened our profit and loss statement as well as our balance sheet. By turning this challenge into an opportunity, we have enhanced our company's performance. Another significant challenge for the caustic soda industry is the high cost of electricity required for production. To address this, we have installed our own power plant, which has improved our operations and overall efficiency, benefiting the company.

Q Could you elaborate on the strategic initiatives Epigral undertook in 2024 to enhance its market position and operational efficiency?

We periodically evaluate our strategic initiatives and continuously evolve better. Specifically, in 2024, we commissioned an additional capacity of CPVC Resin of 45,000 TPA, which increased our total capacity to 75,000 TPAs, the world's largest capacity in a specific location. Additionally, we commissioned the CPVC Compound facility, and hence, we will now cater both resin and compound to pipe manufacturers based on their needs. During the year, we have set up a pilot plant for making pipes at our facility to provide consistent quality and be a reliable partner. In the last fiscal year, Epigral further announced the expansion of our CPVC Resin and epichlorohydrin capacity; we are doubling both capacities, considering the growth opportunities we see for these products.

Epigral has raised funds for the company from the capital market through QIP, where institutional investors participated and showed



confidence in the company's vision. With these funds, we strengthened our balance sheet and it improved our rating from Crisil AA— to Crisil AA.

Q The company reported a 37 per cent revenue growth in the first nine months of FY2025, driven by a 15 per cent increase in sales volume from high-value derivative and specialty products. What strategies contributed to this significant growth?

Since the financial year 2018-19, we, at Epigral, have made a strategic decision to diversify our business by leveraging chlorine and hydrogen as co-products. As part of this strategy, we have ventured into the production of CPVC, epichlorohydrin, chloromethanes, and hydrogen peroxide. This diversification has enabled us to serve various industries domestically while providing high-quality products that substitute for imports. As a result, the company has become more resilient compared to others in the industry during periods of economic slowdown. This strategic shift has significantly contributed to the company's overall performance.

Q Key projects being rolled out by Epigral to achieve their growth in coming years? Can you share an update on the progress so far?

This year, various capital expenditures (Capex) we undertook in the past have begun to yield results and will continue to contribute to the coming years. In FY2024, we successfully commissioned a CPVC Resin plant with a capacity of 45,000 tons per annum (TPA), a CPVC compound facility with a capacity of 35,000 TPA, and a chlorotoluenes value chain facility. These expansions, along with other capacities commissioned in previous years, will positively impact on our business performance this year and next year.

We have also announced plans to increase our CPVC Resin and Epichlorohydrin capacities for further growth. These additional capacities are expected to be commissioned in FY2027, and we anticipate they will start contributing from that time onwards, with an expectation to reach optimal performance by FY2028. For future growth, we have already acquired around 100 acres of land close to our current plant. Our focus will be on developing new chemistries that will drive the company's growth.

As a growth-focused company, we will carefully plan and allocate our capital expenditure to ensure robust growth in the coming years.

Q Could you share an overview of the major Capex projects Epigral has undertaken recently, including their objectives and expected timelines?

Recently, the company announced plans to expand its capacity for CPVC Resin by 75,000 TPA and Epichlorohydrin (ECH) by 50,000 TPA. These expansions are driven by anticipated growth in demand both in India and globally. Additionally, they will enhance the captive consumption of chlorine and hydrogen, further strengthening our integrated complex. The projects are expected to be commissioned in the first half of FY2027.

> **We have made a strategic decision to diversify our business by leveraging chlorine and hydrogen as co-products**

With this expansion, we will become the largest manufacturer of Epichlorohydrin in India and the largest manufacturer of CPVC Resin in the world.

Q How has the commissioning of the additional 45,000 TPA CPVC Resin capacity in April 2024 impacted production capabilities and market reach?

It has allowed us to produce more to meet the domestic demand for CPVC Resin and increase our presence and market share among various customers. As the demand further increases we are ready with the capacity to meet the same.

Q What has been the effect of the new CPVC compound facility commissioned in June 2024 on your product offerings and customer satisfaction?

The CPVC Compound facility has allowed us to serve all types of CPVC pipe manufacturers. Previously, we could only cater to selected manufacturers, but now, thanks to our presence in the compound, we can fulfill the needs of all pipe manufacturers. Additionally, we have recently obtained NSF certification for our CPVC resin and compound, confirming that our products are suitable for drinking water purposes. This underscores our commitment to quality and further strengthens our brand.

Q With the inauguration of your first R&D Centre in Ahmedabad in November 2023, what key projects or innovations have emerged, and how do they align with Epigral's long-term goals?

The R&D center plays a crucial role in guiding integrated chemical manufacturers like Epigral. Our R&D center is working further downstream of the chlorotoluenes value chain that we recently commissioned. In addition, the center is focused on improving the processes for our existing products and enhancing overall efficiency. The team is also engaged in developing new molecules for the specialty business.

Q What digital transformation/ automation initiatives has Epigral implemented in 2024 to enhance operational efficiency, supply chain management, and customer engagement?

Improving operational efficiency is an ongoing process at Epigral, and we have implemented several enhancements at the plant level. These efforts are evident in our operating performance and are directly reflected in our profit and loss statements. The company has deployed various tools and digitized multiple processes to monitor operations within the plant. With our state-of-the-art facility, we have focused on enhancing safety, which directly contributes to continuous improvements in performance and efficiency.

Q The commissioning of an 18.34 MW Wind Solar Hybrid Power Plant in Q1 FY24 showcases Epigral's commitment to sustainability. How has this initiative influenced your environmental footprint and operational costs?

At Epigral, we are continually working to improve our footprint and protect the local environment surrounding our production plant. We commissioned an 18.34 MW wind and solar power plant over a year ago, and as a result, approximately 8 per cent of our power requirements are now met through green energy. This initiative has not only contributed to environmental preservation but has also been cost-effective, as it is cheaper than conventional grid electricity.

Q Your current phase of expansion/diversification is coming to its completion in 2027. What is the strategy for the next phase of expansion/diversification? Are you looking at new and emerging segments?

As a leading integrated chemical company, we are continuously researching various formulations that are feasible for the Indian market. Epigral, being a domestic-focused company, is looking at the growing demand for qualitative products for domestic consumption and considering the increase in household spending power. We are evaluating various projects where the demand for such products is going to increase substantially in the long term.

Q Where do you want to see Epigral in 2032?

In the long term, Epigral aims to expand its product portfolio to serve other industrial segments. By 2032, we want to be recognized as the leading integrated multi product chemical player globally, allowing us to add value to our stakeholders ICN

> **In 2024, we commissioned an additional capacity of CPVC Resin of 45,000 TPA, which increased our total capacity to 75,000 TPAs, the world's largest capacity in a specific location**

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EXPECTING INVESTMENT OF RS. 500-600 CRORE ON GREENFIELD DAHEJ PLANT OVER NEXT 2-3 YEARS

Production capacity rose by 30 per cent last year, driven by strong performance in the infrastructure segment, allowing us to operate at high utilization levels



PRAKASH RAMAN
Managing Director
Silox India

Q Latest industry trends and challenges in chemicals, anti-corrosion, paints and coatings? What strategic initiatives were undertaken by Silox India in 2024 to enhance its market position and operational efficiency?

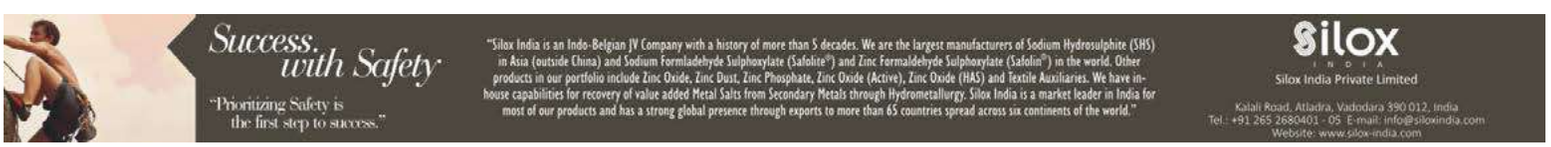
The performance of the textiles sector last year was a mixed bag. We have seen consistent demand from the domestic market, but we witnessed a downturn in export due to geo-political situation, driven by the Ukraine war, supply chain disruptions and lesser demand from Europe. The fluctuation in the cotton price impacted the sector badly in the beginning of 2024, however it improved towards the second half and by the fourth quarter, it started becoming more positive and robust. Overall, the textile market has grown but not to the expected level due to turbulence in the overseas market.

Regarding automotive industry, our primary exposure is into the tyres and tubes. The demand profile is more stable as most of the automotive manufacturers recently did well in terms of volumes and numbers, however for our main product range i.e. the Zinc oxide and derivative, we have seen lot of competitive pressure on margins. The paint and coating is positive segment with the continued investment in the last 2-3 years on the infrastructure by the government on railways and airports. We see a sustained demand domestically and consistent demand growth from overseas.

Q What's your forecast for the year 2025? How do you see the Trump factor affecting the global supply chain and your products?

We expect the challenges to continue in the beginning of 2025, especially from the demand side where most of the customers were expecting the demand to come back strongly from second quarter onwards. However, we are seeing lack of clarity on demand due to the new situation emerging out of Donald Trump's policy and few other disruptions.

We have a long value chain and our products predominantly not be directly going to the USA but as intermediate product used in some other country. Industry is generally positive due to hawkish China policy and expecting it to be a business opportunity, mainly the chemical manufacturers from India.





Today, close to 38 per cent of our energy comes from the green source including wind and solar. By mid-2026, 70 per cent of our energy would be green which will save 29,000 tonnes of CO2 emissions per year

We have started getting new inquiries directly from the US, however, these inquiries need to be translated into business.

What is the present production capacity of your plants? Any expansion or increment in the production capacity in FY 25-26?

Production capacity rose by 30 per cent last year, driven by strong performance in the infrastructure segment, allowing us to operate at high utilization levels. At our Atladra and Ekalbara units in Vadodara, the performance was mixed because of the zinc oxide getting impacted due to competitive price situation, performance of the textile segment and hydro business.

However, we are positive on long term growth and going ahead with full speed on our investment in Dahej which will eventually increase our production capacity between 30 to 35 per cent for some of our key product lines. We also continue to focus on optimizing the processes and de-bottlenecking the capacity.

What is the Capex that you have invested in FY 24-25 and what's the plan for the Capex investment in FY 25-26?

Last year, most of our Capex has been either into de-bottlenecking or regular maintenance as per our plan. As far as the new investment is concerned, we will have more clarity once the approval from the Board comes by June 2025. This will be the highest capital investment of Silox at the group level, for the greenfield site at Dahej. Currently, we are just working on the engineering part and once we complete this, we will go to the Board for the final investment approval. We expect the Capex to be anywhere between Rs. 500 to Rs. 600 crore over the next 2 to 3 years.

Keeping the political situation and Donald Trump strategy of



putting additional tariffs on some of the countries, what should be the India strategy with respect to chemicals, recycling and corrosion refining and what's the role that Solix India sees for itself in making India a global manufacturing hub?

I see this both as a threat and an opportunity. Since China continues to be a major supplier, there are clearly a few opportunities opening up for India. We anticipate more requests from new customers whom we never used to serve due to competitive position. It is very clear that the manufacturers are likely to diversify the source of supply. We are looking into how we can use the opportunity for our finished products. At the same time, we must wait to see if there are any challenges we need to prepare because of the ongoing negotiations between the US and India.

What are you planning to manufacture at your new facility at the Payal Industrial Park? Any numbers on the production capacity and by when do you plan to start the construction work?

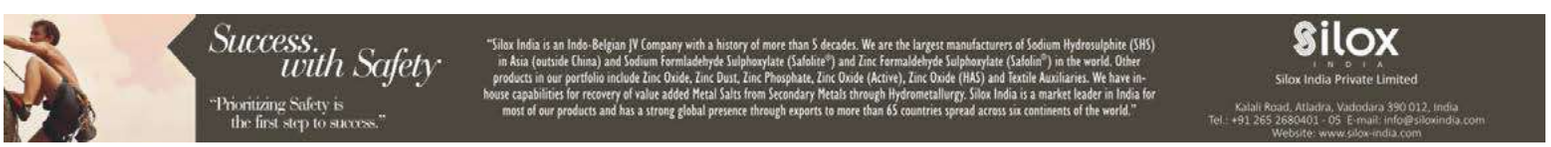
This new facility will produce all of our Sulphoxylate products and Zinc Oxide and Zinc derivatives. We will do backward integration in making some of the intermediates too. Overall, we are looking into an additional capacity of 30 to 35 per cent that will help us in meeting the future growth demand of the market. We expect to start the commercial production by the first quarter of FY 2028. We are at the advanced stage of engineering and awaiting permission to start construction.

You are a global leader in Sodium Formaldehyde Sulphoxylate (Safolite) and Zinc Formaldehyde Sulphoxylate (Safolin). Any new innovations or what's the next product you are looking for from a global leadership point of view?

Customers are now looking for more efficient and environment friendly products. We are working on the formaldehyde free sulphoxylate which is for specialized application like baby clothing. We are customizing our product to meet the specific application requirements. We have started working with a few customers and preparing ourselves to meet their specific requirements.

We have started targeting some of new market segments with the right quality product at the right pricing. We also have a few innovations to optimize the packaging to reduce wastage. We are also improving sustainability by adopting energy transition. In the last two years, 75 per cent of steam at our plants is getting produced from bio-based sources. Today, close to 38 per cent of our energy comes from the green source including wind and solar. By mid-2026, 70 per cent of our energy would be green which will save 29,000 tonnes of CO_2 emissions per annum. We have been adopting new technologies to reduce the usage of water and have been able to reduce the consumption approximately by around 34 per cent in the last two years.

Silox Group recently inaugurated a state-of-the-art Research and Innovation Centre in Vadodara, Gujarat. Could you elaborate on the strategic objectives behind this and how it aligns with Silox India's vision for innovation and



growth?
We have invested €2 million in our new Research and Innovation Center, set to be fully operational by July 2025. The Center will focus on fundamental research and application development for new products. The initial focus will be on the existing products. Additionally, it's going to be majorly focused on the recyclability or enriching of the precious metals. Today, we don't do much of the development work for our overseas entities but now we will be able to provide for the application development needs of the group entities in Europe or Canada.

Q You are also planning another manufacturing facility at Paradip industrial area for recycling of lithium batteries. What will be the Capex and the manufacturing capacity of the plant?
Recyclability is going to be a key business opportunity. We have developed a pilot plant, and both R&D and final stages are completed for the recovery of the precious metal from the used batteries and other sources. Now, we are in the stage of scaling up to an industrial scale. We have successfully completed the land acquisition for the project, developed technologies and pre-qualifying some material made with some of the key customers. We are expected to have a clear vision on this probably by the third quarter this year and will be going back to our company's Board before the end of the year for the future investment.

Q How has Silox India integrated digital technologies into its operations in 2024 to enhance efficiency and competitiveness?
We are doing it in two stages. For example, our Atladra site is more than 40 years old and we have limitation in terms of going fully digital especially in the manufacturing. But, our proposed plant in Dahej is going to be completely a plant for the future. The primary focus is just to minimize the man-machine interaction and avoiding transportation of any intermediate products, develop closed loop manufacturing process.

> **We have invested €2 million in our new Research and Innovation Center, set to be fully operational by July 2025. The center will focus on fundamental research and application development for new products**

We started using digital tools more on the logistics and are going more and more digital for avoiding the repeated paperwork and getting into their online real time data. We will be using digital tools for our people management in terms of the access control for security and safety of the people. We have just included some of the AI enabled system for safety management tools and also the visitor management besides for the training and development of the employees and teams in lead management.

Q Silox India has been recognized for its CSR initiatives, including awards for health and nutrition efforts. What projects were prioritized in 2024, and what outcomes have been achieved?
I am proud to mention that we have spent more than the statutory requirement with focus clearly on areas where we operate today because there are communities present close to our manufacturing sites. Most of our effort is focused in and around Atladra, Ekalbara, and Silvassa.

We are working on skill building capabilities with the local ITIs. We have a combination of 40 ITIs in the Vadodara district and we help them in building the skills by enhancing the English and computer skills of the student who will be passing out. The second project is mainly focusing on hunger and education for street children. We have been providing the support for the last 3 years and closed almost 350,000 meals every year for the street children. Other major projects are on sustainable agriculture and biodiversity.

Q Your sustainability roadmap for FY 2025-26 and how are you planning to achieve it?
Being a European entity, there is a CSR requirement supposed to be fulfilled in the beginning of 2026 and now it has been delayed by two years. We have already started working on it and compiling all the reporting requirements in our operations and defining our sustainability goal by 2030. We will be clear before the end of this year as we are collecting the data and are engaged with the external partners to help us in defining the report. Especially, our auditors are working with them to clearly define what is going to be the part for each of the entities and also for the global Silox group.

Our growth will be coming from existing products, our focus on innovation and from sustainability. We will be investing in all the three segments for the future

ALL SET TO BEGIN AN AMBITIOUS NEW GROWTH PHASE WITH FOCUS ON SUSTAINABILITY

We have made strong progress in expanding our UV oligomer and monomer portfolio, guided by our innovation strategy and close collaboration between our R&D teams



PREMAL A. DESAI
Chief Executive Officer
hubergroup

Q hubergroup has been acquired by Murugappa's MAVCO Investments and Avenue Capital. How is this acquisition expected to influence the company's strategic direction and operations in India and globally?

hubergroup, a global leader in specialty chemicals and print solutions, was recently acquired by a consortium comprising MAVCO Investments, a private entity belonging to select members of the Murugappa family, and funds managed by Avenue Capital Group. The sale and purchase agreement, initially announced in November 2024 was concluded in April 2025.

The transaction marks the beginning of an ambitious new growth phase under the new owners and hubergroup is set to accelerate ahead. With a focus on global customer reach and long-term value creation the company will continue its ambitious trajectory, leveraging its prime position for growth in the specialty chemicals market and its established leadership in the print solutions industry.

Q The company has announced a business realignment to focus on supplying raw materials to the chemicals industry. Could you elaborate on the strategic reasons behind this shift and how it positions the company for future growth?

As part of our strategic diversification, we launched hubergroup Chemicals as the second pillar of our global business - expanding our proven expertise beyond inks into the broader chemicals market. This move reflects our commitment to delivering high-performance chemical solutions that cater to a wide range of industries including coatings, adhesives, and specialty applications.

With products designed in Germany and Made in India, we bring together the best of innovation, precision, and cost efficiency- delivering value-driven solutions tailored to evolving customer needs. Our robust manufacturing infrastructure, global reach, and customer-centric approach allow us to collaborate more effectively, drive technology-led growth, and contribute meaningfully to a sustainable chemical future.

Q How has hubergroup India's business strategy evolved in 2024, particularly with the shift towards supplying raw materials to

Designed in Germany
Made in India
UV-Oligomers
Rosin based Resins
UV-Monomers
Lamination Adhesives
Polyurethane Resins
Ketonic Resins
Pigments & Concentrates
hubergroup chemicals



the chemicals industry?
2024 has been a dynamic and successful year for our chemicals business, despite global challenges such as supply disruptions and geopolitical uncertainties. While these factors have posed difficulties in certain regions, they have also created new opportunities for growth in others. As a group, we have remained committed to innovation, developing cutting-edge products that have not only expanded our market reach, but also strengthened our reputation as a long-term, sustainable partner with a diverse product portfolio.

We have seen significant growth in the Energy Curing UV segment, successfully establishing business relationships with key market players. Additionally, we are diversifying our portfolio with synergistic solutions for rubber and adhesive applications, reinforcing our position in these industries. Our recent progress in lamination adhesives further underscores our strategic expansion and market impact.

> **In response to the global shift towards paper-based packaging, hubergroup has developed HYDRO-i -a next-generation, water-based ink system crafted for sustainability without compromising on performance**

Q Could you provide updates on the major Capex projects initiated in FY 2024-25 and their expected contributions to future growth?
With a production capacity of over 350 KTPA across our two modern manufacturing plants, we are expanding to better serve key industries such as inks, coatings, construction, flexible packaging, and adhesives. As the industry moves towards thermal-cured and water-based coatings, we are investing in new technologies and increasing our capacity to meet these demands while supporting environmentally friendly innovations. We're also growing our energy curing

systems capacity, reinforcing our commitment to cutting-edge chemical solutions.

To support this growth, we are building a world-class, integrated R&D facility to bring all our innovation efforts together. This will help us collaborate more effectively and speed up product development. These strategic steps are designed to boost our long-term growth and drive meaningful progress toward sustainability.

Q hubergroup India has invested significantly in UV oligomer production. Key R&D initiatives undertaken by the company in FY 2024-25 and how have they contributed to product innovation and market competitiveness?

At hubergroup, we have made strong progress in expanding our UV oligomer and monomer portfolio, guided by our innovation strategy and close collaboration between our R&D teams in India and Germany. Working under the theme "Designed in Germany, Made in India," this partnership blends deep technical knowledge with fast execution.

In FY 2024–25, we increased capacity for both our own products and custom manufacturing to meet the rising demand for energy-curing applications. While we started with commonly used grades, our recent R&D focus has shifted to developing advanced, high-performance technologies.

Q The company inaugurated a state-of-the-art chemical plant for UV oligomers at its Vapi site, expanding production capabilities by 800 MT per year. How does this expansion align with hubergroup's overall product strategy, and what markets are you targeting with this increased capacity?

Expanding into the UV oligomers space marks a significant milestone in hubergroup's innovation-led growth strategy. With rising demand for high-performance polyester acrylates in advanced coatings and niche applications, we established a cutting-edge UV oligomer plant in Vapi to address this evolving need.

Over the past year, we have completed two debottlenecking phases to boost capacity and meet growing market demand - reflecting our agility and commitment to delivering specialized, high-value solutions. The strong demand of our products highlights the trust we have built through consistent innovation and our focus on performance-driven, sustainable technologies.

Q With paper fast emerging as a key alternative in the global transition from plastic, how is hubergroup leading this change through innovation?

In response to the global shift towards paper-based packaging, hubergroup has developed HYDRO-i -a next-generation, water-based ink system crafted for sustainability without compromising on performance.

Jointly created by our teams in India and Germany, HYDRO-i offers a wide colour gamut and versatile application range, making it suitable for labels, paper cups, tea tags, ice-cream cones, wrappers, carry bags, e-commerce envelopes, sacks, and corrugated boxes. Engineered for excellent print aesthetics, high press efficiency, and eco-conscious formulation, HYDRO-i stands as a testament to hubergroup's ongoing commitment to sustainable innovation.

Q How is hubergroup driving sustainable innovation in flexible packaging inks and adhesives to meet the evolving demands of the global packaging industry?"

Our sustainability roadmap is anchored in practical, high-performance solutions. For VOC reduction, we have introduced HYDRO-i FILM WB LAM, a water-based gravure ink system that delivers exceptional print quality while supporting eco-conscious packaging.

We offer a full range of solvent-free adhesives, enabling safer, greener lamination workflows. In the space of recyclable packaging, our Gecko Plus NTNK PU inks and the advanced Gecko Plus LVNT series—specially formulated for new-age substrates like MDO and HROB—deliver improved anti-blocking properties, particularly when used with 2K matt OPV systems.

To support lightweight packaging, we provide both water- and solvent-based barrier coatings that maintain integrity while minimizing material usage. For brands exploring biodegradable and compostable options, our Gecko-branded inks are certified and ready for use. Notably, all Gecko inks also offer low migration performance, ensuring compliance with global food safety standards.

Q The company has been focusing on sustainable packaging solutions. How does hubergroup ensure compliance with evolving global sustainability regulations in the specialty chemicals and printing industry? Can you elaborate on your sustainability goals for FY 2024-25 and beyond?

At hubergroup, sustainability is at the core of our innovation strategy. We are committed to developing bio-based and environmentally friendly solutions that align with evolving global regulations.

A key highlight of our efforts is the launch of sustainable, bio-based UV

Designed in Germany
Made in India
UV-Oligomers
Rosin based Resins
UV-Monomers
Lamination Adhesives
Polyurethane Resins
Ketonic Resins
Pigments & Concentrates
hubergroup chemicals

oligomers at the European Coatings Show 2025. These advanced resins, designed for wood and plastic coatings, offer excellent reactivity and stain resistance while containing an impressive 50 per cent bio-based carbon content. As regulatory frameworks tighten around monomer acrylates, the demand for sustainable raw materials in the paints and coatings industry is rising. In response, we are leveraging renewable building blocks such as sorbitol and xylitol, ensuring compliance with global sustainability standards while delivering high-performance products.

Our Sustainability Report is updated annually and made available on our website. Additionally, we are actively working on Scope 3 carbon footprint assessments and have initiated our EcoVadis group application.

Q What digital initiatives has hubergroup India implemented in FY 2024-25 to enhance operational efficiency and customer engagement?

Digitalization has always been a key focus area and an integral part of a long-term strategy to enhance operational efficiency and organizational agility at hubergroup. In FY 2024–25, this vision took a major leap forward with strategic investments aimed at streamlining functions and improving customer experience. A significant step in this direction was the implementation of the Laboratory Information Management System (LIMS) and Electronic Lab Notebook (ELN) across our R&D and application labs.

These digital tools have transformed the way we manage data - improving traceability, boosting lab productivity, and accelerating product development timelines. By digitizing core workflows, we've been able to minimize errors, enhance cross-team collaboration, and respond to customer requirements with greater speed and precision.

Q The company expanded its rural healthcare support in Gujarat by introducing medical vans equipped for dental and eye care, serving 16 remote villages weekly. What outcomes have you observed from this initiative, and are there plans to extend similar programs to other regions?

Fartu Dawakhanu is a hubergroup wellness initiative delivering essential healthcare support to underserved communities across Vapi and the Valsad district. It is a mobile clinic initiative, launched in partnership with Rotary Vapi Riverside. Since November 2022, two medical vans - followed by dedicated Dental and Eye units in March 2023 - have been delivering free consultations and medicines across 16 remote villages each week. Staffed with doctors, nurses, and essential equipment, the initiative has already screened over 60,000 individuals. The Dental Van has reached over 21,000 people, promoting oral hygiene and treating dental issues, while the Eye Van has examined more than 23,000 individuals, diagnosed over 700 cataract cases, and distributed 6,000+ spectacles.

Q How is hubergroup Chemicals leveraging major trade shows to showcase innovation and build engagement with customers?

We maintain a strong and consistent presence at leading industry events—both in India and on the global stage. We actively participate in major international exhibitions such as the European Coatings Show (ECS), American Coatings Show, PaintIstanbul & Turkcoat, and more. In India, our presence is equally prominent at trade shows like Printpack India and Paint India.

Q Could you elaborate on the strategic vision behind the "ONE huber" initiative and how it strengthens your global alignment and customer focus?

> **With a production capacity of over 350 KTPA across our two modern manufacturing plants, we are expanding to better serve key industries such as inks, coatings, construction, flexible packaging, and adhesives**

The "ONE huber" initiative is designed to unlock synergies across our global organization by aligning business units, functions, and geographies under a unified strategic vision. By fostering seamless collaboration between teams worldwide, it enables more efficient resource management, faster problem-solving, and the ability to deliver customer-centric solutions with greater speed and precision. This integrated approach encourages cross-border ideation, co-development, and streamlined strategy implementation - ensuring that innovation flows freely across regions while respecting local market nuances.

Ultimately, "ONE huber" is about creating an agile, collaborative ecosystem that delivers value through unity, while celebrating the strength of diversity

DRIVING SUSTAINABLE GROWTH THROUGH CONTINUOUS INNOVATION

The company has actively pursued global expansion through a combination of strategic partnerships, capacity enhancements, and customer-centric approach



VAIJANATH KULKARNI
Executive Director & COO
Galaxy Surfactants

Q Major initiatives undertaken by Galaxy Surfactants during FY 24-25 to drive growth and innovation? How have these influenced your business operations and market positioning?

In FY 24-25, Galaxy Surfactants continued to drive growth and innovation through strategic investments in sustainability, digital transformation, and product innovation. Our focus on green chemistry and eco-friendly formulations led to the development of next-generation biodegradable specialty such as Galseer DermaGreen, Galseer Tresscon, and Galseer Flexcon, addressing the rising global demand for greener, milder and beauty care solutions. Galaxy also worked on developing sustainable technologies and has come up with products like GalEcosafe (the first one to produce in India & AMET). In Home Care solutions, we have invented technologies in the field of encapsulation of enzymes and green process for fabric softener. These innovations not only strengthened our market presence but also reinforced our commitment to regulatory compliance and environmental responsibility, making us a preferred partner for leading brands worldwide.

We also accelerated our digital transformation journey, integrating automation, AI-driven analytics, and ERP enhancements across our operations. These efforts have optimized supply chain management, improved operational efficiencies, and enabled better data-driven decision-making. Additionally, our continued investment in R&D and advanced manufacturing capabilities has allowed us to remain agile and responsive to evolving market needs, ensuring the timely delivery of high-performance specialty ingredients.

Beyond business expansion, our sustainability and talent development initiatives have played a pivotal role in reinforcing our market leadership. This year, Galaxy entered the Top 5 Club in 'Great Place to Work' in the chemical industry. This has strengthened our employer's brand, helping us attract and retain top talent. Meanwhile, our enhanced ESG commitments, including waste circularity and responsible sourcing, have positioned us as a trusted and sustainable industry leader. These collective efforts have propelled the Galaxy towards long-term growth, resilience, and continued market leadership.

Q How did Galaxy Surfactants' revenue in FY 24-25 compare to previous years? Were there specific product lines or markets that significantly contributed to this performance?

India, which constitutes a significant portion of our business, recorded flat performance this quarter and for the full fiscal year. This was primarily due to the lingering impact of the previous quarter's slowdown, compounded by a more than 40 per cent rise in fatty alcohol prices from Q2 onwards, leading to a slower-than-expected recovery in the performance segment. However, we remain optimistic about growth



in the coming quarters, supported by improving economic indicators and gradual market normalization.

The AMET region also experienced flat performance. While macroeconomic challenges persist, early signs of demand recovery and easing supply chain disruptions make us cautiously optimistic. We are taking proactive steps to strengthen our market presence and capture emerging opportunities as the region stabilizes.

In contrast, the Rest of the World (RoW) has been a bright spot, delivering double-digit growth this quarter and for the full fiscal year. This strong performance reflects our strategic focus on global expansion and the rising demand for premium specialties. Growth in RoW has been driven by continued momentum in Europe, APAC, and North & Latin America. This quarter, we achieved 9 per cent volume growth in RoW, with YTD volume growth at 17 per cent, led by mass specialties.

On a YTD consolidated basis, revenue has grown by 11 per cent from Rs. 3,830 crore to Rs. 4,250 crore and EBITDA has grown from Rs. 498 crore to Rs. 510 crore, which is a 2.5 per cent growth. On EBITDA /MT, it is broadly in line with the performance of Rs. 19,868 vs PY 20,019/MT.

These results reflect our continued focus on operational excellence, cost efficiency, and strategic agility, positioning us well for sustained and profitable growth.

In FY 2024-25, Galaxy Surfactants strategically directed its capital expenditures towards enhancing production capabilities, expanding its global footprint, and strengthening sustainability initiatives

Q What percentage of revenue was allocated to R&D in FY 24-25 and how does this investment reflect your commitment to innovation?

Galaxy remains one of the leading companies in India in the specialty chemicals space, consistently investing in R&D talent and infrastructure. Our innovation team comprises many PhDs, postgraduates, engineers, and technologists. Galaxy has recently developed a state-of-the-art BioScience Innovation capability equipped with molecular biology expertise. The Galaxy group has invested more than Rs. 150 crore in various innovation capability-building initiatives in recent years.

As a result, we are one of the leading Indian companies in our industry, with 111 approved patents and 32 patents applied for—6 of which were granted in FY 25 alone. For two consecutive years, we have won the 'Best Innovative Ingredient' award at the in-cosmetics global show, making Galaxy the only Indian company to achieve this accomplishment.



With such commitment, we have introduced new innovative products in areas such as mild cleansing, natural and modern preservation, DermaCare for sensitive skin, ultra-low dioxane sulfates, green chemistry-based amino acid surfactants, fabric softeners, and encapsulated enzymes. This diverse range of innovative products enables us to be the only Indian company serving various global brands in the Home Care, Personal Care, and Beauty segments.

Q What were the primary areas of focus for your capital expenditures in FY 24-25? How have these investments enhanced your production capabilities or operational efficiency?

In FY 24-25, Galaxy Surfactants strategically directed its capital expenditures towards enhancing production capabilities, expanding its global footprint, and strengthening sustainability initiatives. A significant milestone was the company's recent strategic partnership with a global customer for Engineering, Procurement, and Construction (EPC) services. This initiative is expected to facilitate the establishment of performance surfactants and specialty ingredients plants overseas, reinforcing Galaxy's global presence and contributing to long-term growth.

Additionally, the company continued investing in capacity expansion, particularly in specialty care ingredients catering to premium personal care and beauty formulations. These investments align with the increasing demand for superior-performance and sustainable products, enabling Galaxy to better serve its customers and meet growing market demand. Strengthening production capabilities in this segment not only drives revenue growth but also solidifies Galaxy's position as a key player in the personal care, beauty & home care industry.

Q What strategies has Galaxy Surfactants employed to expand its global footprint and penetrate new markets? How have these strategies contributed to the company's growth and diversification?

Galaxy Surfactants has actively pursued global expansion through a combination of strategic partnerships, capacity enhancements, and a customer-centric approach. One of the key initiatives in FY 24-25 was the company's collaboration with a global customer for Engineering, Procurement, and Construction (EPC) services, which is expected to facilitate the establishment of performance surfactants and specialty ingredients plants in international markets. This move aligns with Galaxy's vision to strengthen its global presence and cater to the growing demand for sustainable and high-performance personal care ingredients in developed markets.

In addition to partnerships, the company has focused on market-specific product innovation to meet regional consumer preferences. Expanding its specialty care ingredient portfolio to cater to premium personal care brands has been a key differentiator, allowing Galaxy to penetrate high-growth markets in Europe, North America, and Southeast Asia. By leveraging its research and development capabilities, the company has introduced tailor-made solutions that comply with stringent global regulatory standards, ensuring relevance and competitiveness in new geographies. Galaxy has demonstrated revenue of CAGR of 9 per cent in the last 10 years and 10 per cent CAGR in Specialty Product Revenues.

Q Galaxy Surfactants has been recognized for its sustainability efforts, including achieving water positivity by restoring more water to the environment than it withdraws. Could you elaborate on the strategies and projects that led to this accomplishment?

The company's approach is rooted in optimizing water usage, increasing recycling and reuse, and supporting large-scale water harvesting initiatives. A major milestone was its achievement of becoming net water positive, where more water is restored to the environment than withdrawn for operations. This was accomplished through improved water efficiency across manufacturing sites, investments in advanced water treatment technologies, and process innovations that minimize water consumption.

One of the key initiatives driving this achievement is the company's focus on rainwater harvesting and groundwater recharge projects in water-stressed regions. Galaxy has partnered with local communities and NGOs to develop watershed management programs, ensuring long-term water availability for both industrial and agricultural use.



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> **We have achieved 27.76 per cent renewable energy usage in India, and 20.10 per cent across our global operations. Our goal is to reach 75 per cent renewable energy usage by 2030**

Additionally, it has implemented closed-loop water recycling systems within its production facilities, significantly reducing freshwater dependency. By adopting circular water management principles, Galaxy has not only enhanced operational sustainability but also contributed to local water security.

This effort has resulted in Galaxy being 1.4X water positive consistently for the past three years. In addition, Galaxy is actively working towards transitioning all its operations to run on renewable energy sources. We have achieved 27.76 per cent renewable energy usage in India, and 20.10 per cent across our global operations. Our goal is to reach 75 per cent renewable energy usage by 2030.

Q Your company received the Gold Innovation Award at HPCI India for the ingredient Galseer Flexcon. Can you share the development process and the unique benefits this product offers to consumers?

The ingredient was developed through extensive R&D efforts aimed at addressing key challenges in the personal care industry, such as achieving high-performance conditioning while maintaining environmental sustainability. Galaxy's innovation team worked rigorously to formulate a solution that offers enhanced sensory benefits, superior conditioning, and improved formulation stability—all while aligning with the global shift towards eco-friendly and biodegradable ingredients.

Galseer Flexcon stands out due to its multifunctionality, catering to both hair and skin care applications. It provides deep conditioning, reduces frizz, and enhances softness without the use of traditional silicones, which are often criticized for their environmental impact. The product has been designed to seamlessly integrate into various formulations, offering formulators flexibility while meeting evolving consumer demands for cleaner, more responsible beauty solutions.

Q Key focus areas of Galaxy Surfactants' CSR policy, specifically regarding projects related to water conservation, women's empowerment, education, and healthcare?

Galaxy Surfactants' CSR policy focuses on six key areas: health and hygiene, women's empowerment, education, environmental protection, community development, and disaster relief. Under Aarogya Vardheeni, the company distributed maternal and child health kits, organized blood donation camps, and provided medical support for underprivileged children. The Stree Unnati initiative promoted menstrual hygiene awareness and skill development for women, while Gyan Sanjeevani supported education in underprivileged areas in Maharashtra and Gujarat through study material distribution, vocational training, and building school infrastructure.

On the environmental front, the Paryavaran Suraksha initiative includes waste management support, tree plantation drives, and cattle feed assistance. Galaxy is proud to have planted and maintained 2,09,000 trees as of March 2025 and is working with a vision to plant an additional 3,00,000 trees by 2030, taking the cumulative plantation target to 5,00,000 trees.

Rural development efforts under Samajeek Utthaan included building water storage facilities and school infrastructure, benefiting communities in Gujarat and Maharashtra. Additionally, Aapda Rahat focused on disaster relief, aiding flood-affected families in Ankleshwar and Bharuch. These initiatives reinforce Galaxys' commitment to sustainable and inclusive growth

Q How does the company plan to advance its sustainability agenda across various operations?

Galaxy remains committed to driving sustainable growth through continuous innovation, operational excellence, and responsible environmental practices. Looking ahead, the company aims to enhance its green chemistry, bioscience-based portfolio by increasing the share of biodegradable and bio-based ingredients. Strengthening its ESG commitments, Galaxy plans to achieve net water positivity, further reduce carbon emissions, and expand its renewable energy usage.

The specialty chemicals industry is witnessing strong growth, driven by increasing demand for sustainable and high-performance ingredients across personal care, home care, and beauty applications. With regulatory bodies tightening environmental norms, the shift towards green surfactants and specialty care ingredients is accelerating. Companies like Galaxy are well-positioned to capitalise on this trend by leveraging advanced research, digitally advanced supply chain capabilities, and a strong commitment to sustainability ICN

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DIVERSIFYING PRODUCT PORTFOLIO TO UNLOCK NEW REVENUE STREAMS

Aligned with our growth strategy, the focus is on continuous improvement, cost reduction, and water, waste, carbon, and energy management



RAJESH SRIVASTAVA
MD & CEO
Cohizon Life Sciences

What motivated rebranding from Sajjan India to Cohizon Life Sciences? How does this align with the company's strategic objectives and future vision?

Cohizon Life Sciences' rebranding signifies a strategic shift towards enhanced customer centric approach, research & development, sustainability through continuous improvements, developing new chemistry platforms, and diversification & expansion of customer base in specialty chemicals industry segment. The company aims to be a leading Contract Development and Manufacturing Organization (CDMO) partner through responsive solutions, pioneering R&D, digital transformation, and sustainable practices, while empowering its workforce. This aligns with their vision of creating sustainable value for all stakeholders.

How has Cohizon Life Sciences' performed in FY 2024-25? What factors have driven the company's growth including product categories or market segments that contributed most?

The chemical industry is facing a tough time in terms of the revenue prospect. Our significant amount of revenue comes from the agrochemical sector which has seen inventory issues and pricing competition from China. This has resulted in muted growth and has impacted our revenue. While we have maintained sales volumes year-over-year, we are subsequently working on our strategic offerings and initiating new projects. In this challenging period, our focus has been on continuous improvement and ensuring that we have maintained our wallet shares with all our key customers.

Key business initiatives launched by Cohizon Life Sciences in FY 2024-25? How do these initiatives align with the company's long-term growth strategy?

Aligned with our growth strategy, the focus is on continuous improvement and cost reduction. We have initiated an internal drive "Lakshya" across the company using lean & six sigma tools and techniques along with digital interventions in our key processes at manufacturing and other functions. We have significantly enhanced our approach towards customer connects and using key account management with the support of structured program management to provide enhanced experience for our customers. We are also focusing on diversifying our product portfolio and customer base to unlock new revenue streams.

Total Capex allocated for FY 2024-25? Which key areas received the most significant investments? Any major facility expansions, plant modernizations, and greenfield projects planned or completed this year?

During FY22-24 we have spent more than Rs. 800 crore capital investment to build world class capacity of vapor phase chlorination and fluorination facility at Ankaleshwar along with a state-of-the-art R&D facility at Navi Mumbai. We are also making significant



> **We have initiated an internal drive "Lakshya" across the company using lean & six sigma tools and techniques along with digital interventions in our key processes at manufacturing and other functions**

investments in upgrading our safety and environment standards. For FY 2024-25, we have allocated Rs. 200 crore in augmenting capacities, pilot plants, and infrastructure.

Q How much Capex has been dedicated to research and development? Are there any notable projects in the pipeline?

Amongst our growth pillar, one of the important pillars is identifying new products and R&D plays a major role in identifying it. Over the past two years, we have focused and invested significantly in setting up a state-of-the-art R&D Facility at Navi Mumbai as well. We are also planning to construct a pilot plant at Ankleshwar to accelerate product development.

Q Any significant product launches or service expansions in FY 2024-25? What gaps are you addressing?

In FY 2024-25, Cohizon Life Sciences invested in an R&D Facility which is focused on providing cost-effective, scalable, and safe process development for agrochemical innovators. We had identified a clear gap: while companies excel at molecule discovery, they often lack in-house expertise for an efficient lab and kilo lab scale-up. Our new center will directly address this, helping them bring their innovations to market faster.

Q What are the key digital transformation initiatives currently underway at Cohizon, and how do they align with the company's broader strategic goals?

Cohizon's digital transformation focuses on efficiency and growth. We are implementing AI for yield optimization at our plants, a CRM for sales insights, a SaaS travel & expense solution, and a digital procure-to-pay process. These initiatives are critical to achieving our strategic goals of operational excellence, sales expansion, cost-effectiveness, and regulatory adherence.

Q Specific sustainability initiatives that Cohizon has implemented in FY 2024-25 to reduce its environmental footprint, particularly waste management and emission reductions? What's your plan for FY 2025-26?



> **Over the past two years, we have focused and invested significantly in setting up a state-of-the-art R&D Facility at Navi Mumbai as well. We are also planning to construct a pilot plant at Ankleshwar to accelerate product development**

As a responsible organization, our strategic focus comprises water, waste, carbon, and energy management. In FY 2024-25, we prioritized water and energy conservation. To reduce water usage, we conducted internal audits and implemented conservation measures, resulting in significant reductions. Looking ahead to FY 2025-26, we have secured a hybrid renewable energy agreement (wind and solar), which will significantly decrease our emissions.

Q How does Cohizon's leadership foster a culture of innovation and sustainability within the organization and what initiatives are in place to empower employees in these areas?

Cohizon Life Sciences' leadership prioritizes innovation and sustainability through transparent practices, aligning with UN SDGs and Responsible Care principles. Employee empowerment is fostered through the Cohizon Academy of Excellence, promoting continuous learning, and an inclusive workplace that emphasizes open communication, diversity, and equal opportunities. These initiatives ensure the company's position as an industry leader in both innovation and sustainable practices.

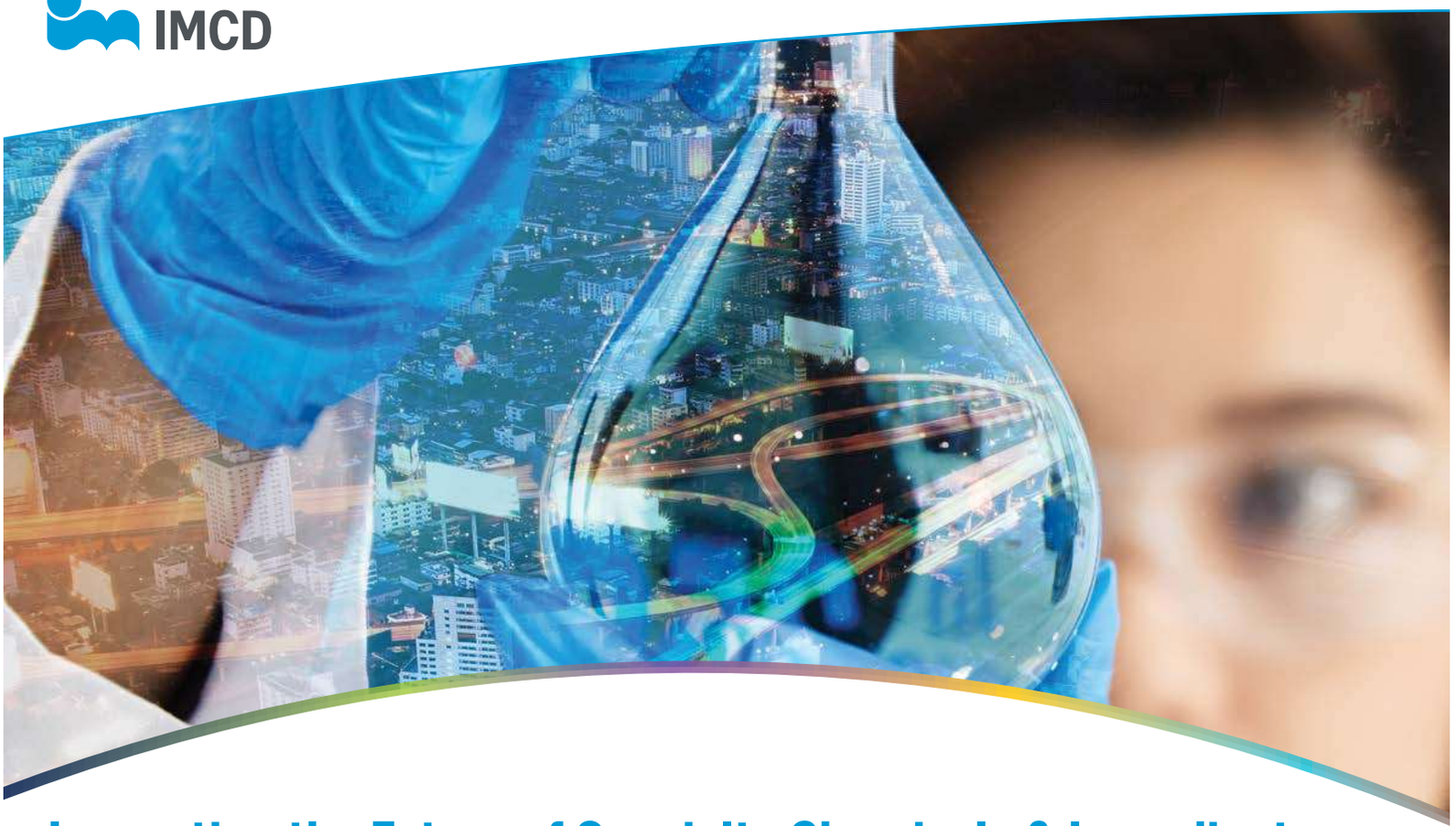
Q Cohizon's CSR efforts concentrate on health, education, upskilling, environmental sustainability, and disaster response, benefiting over 200 villages in Surat and Ankleshwar. Insights into flagship CSR projects undertaken by Cohizon and their impact on the communities served?

Cohizon's CSR initiatives prioritize health, education, environmental sustainability, and disaster response. In our commitment to improving healthcare access, we partnered with the J.B. Mody Cancer Centre in Ankleshwar to expand their cancer OPD facility. Additionally, our collaboration with the AgaKhan Rural Development Support Program resulted in the implementation of various eco-friendly and community-strengthening projects, including tree planting, water harvesting, biogas units, and solar pump installations.

Q Would you like to add anything from your side?

As an organization, we are committed to strengthening our relationships with customers through the implementation of continuous improvement initiatives focused on cost efficiency and sustainability. This commitment has provided us with greater resilience compared to previous years and has paved the way for future collaboration with our customers to drive business growth. Our people continue to be at the core of our strategies. To reinforce our dedication to fostering a positive and inclusive workplace, we will continue to invest in skill development and embrace diversity and inclusion as key elements of our organization

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RAJAVELU N. K.
CEO - Crop Protection Business
Godrej Agrovet

Q How has the Crop Protection Business of Godrej Agrovet Ltd. performed so far in FY2024-25?

The Crop Protection Business delivered modest growth in FY 2024-25, despite challenges like erratic monsoons and shifts in farmer sentiment. Strong pricing gains, particularly in the vegetable segment, drove top line growth, though overall performance fell short of internal projections. Profitability remained resilient, supported by a favorable product mix and strategic initiatives such as targeted customer programs and enhanced channel engagement. As we close the fiscal year, we expect continued momentum in herbicides and differentiated offerings, particularly in cotton and horticulture. These efforts position us for accelerated growth in FY 2025-26.

Q What's your outlook for the coming year?

The coming year looks promising, driven by early forecasts of a normal monsoon and favorable commodity trends, particularly in cotton. We anticipate strong growth in cotton, seed production, and new crop segments like maize and rice, supported by stable sowing patterns and improved farmer confidence. The launch of Ashitaka, our innovative maize herbicide, will be a key milestone, enhancing our portfolio in expanding maize cultivation regions. With a focus on innovation, channel efficiency, and sustainable solutions, we aim to deliver improved performance and create long-term value in FY 2025-26.

Q Are new products mainly chemical-based, or is there a mix of chemical and biological solutions?

Our product pipeline focuses on chemical-based solutions, offering reliable and broad-spectrum crop protection. However, we are increasingly investing in sustainable options, combining the strengths of chemical and biological technologies. Through our partnership with Provivi, we are co-developing residue-free Integrated Pest Management (IPM) solutions. These efforts are expected to grow our biological offerings, particularly in high-value and export-sensitive crops, aligning with global sustainability standards.





Our distribution network, built over 27 years, includes 9,000+ distributors and 30,000+ retailers, ensuring timely product availability across India

Q Can you elaborate on your drone-based pest control solutions and Integrated Pest Management (IPM)?

Our IPM strategy integrates chemical and biological solutions, cultural practices, and precision technologies to reduce reliance on broad-spectrum sprays. Collaborations with innovation-driven partners are helping us develop holistic solutions for crops like rice and corn, with early trials showing promising results. In drone-based applications, we are focusing on precision pest control for crops like cotton, maize, and paddy. These initiatives ensure efficient product usage, reduced labor dependency, and better coverage, enhancing crop health while supporting sustainable practices.

Q What will be the cost of these new products?

Pricing for our upcoming IPM solutions will depend on field trial results and regulatory validations. Designed to complement conventional products, these solutions aim to reduce chemical sprays, lower input costs, and enhance crop health. Our focus remains on affordability and scalability to ensure accessibility for both large and smallholder farmers. These solutions will balance innovation and cost-efficiency, improving farm profitability and environmental sustainability.

Q Which crops are your biological products targeting?

Our biological solutions currently focus on rice and corn, two of India's most widely cultivated crops. For rice, we aim to reduce chemical dependency while maintaining high pest control efficacy, benefiting residue-sensitive markets. In corn, we target pests like fall armyworm, integrating these solutions into IPM frameworks to support ecological balance and long-term soil health. Field trials for both crops are in advanced stages, with early results indicating cost-effective, environmentally friendly solutions.

Q How are digital platforms enhancing farmer training?

Our platforms like Hello Godrej and Digi News provide real-time advisory, training, and awareness tools. To date, Digi News has trained over six lakh farmers with easy-to-understand content on crop management and sustainable practices. We are set to launch the Sankalp app, which will serve as a one-stop platform for product information, order placements, and loyalty programs, deepening

engagement with farmers and retailers. These initiatives empower farmers with knowledge and tools to boost productivity and adopt sustainable farming practices.

How is satellite data being integrated into these platforms?

Satellite data integration enhances our digital platforms with real-time, location-specific crop insights. This supports precision recommendations for pest management, irrigation, and nutrient application, mitigating risks tied to weather variability. Additionally, satellite-based tools track acreage, crop stress, and harvest progress, offering better pricing forecasts and demand planning. These insights promote efficiency, transparency, and financial inclusion across the agri-value chain.

What is your company's role in the pesticide industry?

Godrej Agrovet is a significant player in India's pesticide industry, offering a diverse portfolio of insecticides, herbicides, fungicides, and plant growth regulators. Our subsidiary, Astec LifeSciences, strengthens our B2B presence with its expertise in contract development and manufacturing, supplying globally recognized agrochemical solutions. Through international collaborations, we bring advanced technologies to Indian farmers while expanding our footprint in export markets. Our vision is to combine domestic leadership with global competitiveness, driven by innovation and sustainability.

What unique value does your company offer to multinational partners, especially Japanese firms?

Godrej Agrovet offers an end-to-end partnership model, spanning product development, regulatory support, and commercialization. With strong brand equity, a robust distribution network, and advanced R&D capabilities, we enable rapid market entry and localized adaptation for international agrochemical companies. Collaborations with Japanese firms have resulted in differentiated crop protection products for Indian farmers, and we continue to explore alliances to bring innovative, sustainable solutions to both domestic and global markets.

> **Our IPM strategy integrates chemical and biological solutions, cultural practices, and precision technologies to reduce reliance on broad-spectrum sprays**

Can you outline your distribution strategy in India?

Our distribution network, built over 27 years, includes 9,000+ distributors and 30,000+ retailers, ensuring timely product availability across India. The Godrej Sankalp program digitizes supply chain operations, enhancing transparency and efficiency. Regional strategies and digital platforms like Hello Godrej strengthen farmer trust and improve product adoption. Looking ahead, we aim to further integrate data-driven insights and build a farmer-centric retail ecosystem.

How do you combat counterfeit products?

To protect product integrity, we use QR-coded packaging for traceability, enabling instant verification. A dedicated task force identifies counterfeit activities and collaborates with authorities to eliminate them. Awareness campaigns and training for farmers and channel partners further ensure only authentic solutions reach the market, safeguarding farmer livelihoods and trust.

How is Godrej Agrovet expanding its market presence?

Our expansion strategy focuses on innovation, global collaborations, and digital transformation. With a robust R&D pipeline and collaborations with global leaders, we bring advanced, localized solutions to farmers. Digital platforms like Digi News and Sankalp enhance engagement and accessibility, while targeted regional strategies support penetration into new crop segments like maize, rice, and horticulture. By focusing on sustainability and cost-effective solutions, we aim to transform Indian agriculture into a more resilient and efficient ecosystem.

Have there been any recent changes in distribution





strategies?
We have enhanced our distribution model with digital tools like the Godrej Sankalp platform, improving supply chain transparency and efficiency. Tailored regional strategies and data-driven insights help channel partners optimize stocking and respond to seasonal demand. These changes make distribution a strategic enabler of growth and farmer connectivity.

What role does in-licensing model play in your growth?

The in-licensing model enables us to rapidly expand our portfolio with innovative technologies from global partners. It complements our R&D efforts, diversifying our pipeline with high-value products that address emerging pest challenges. Strong partnerships with global innovators ensure successful localization and adoption of these solutions, reducing R&D risks and accelerating timelines.

How do you balance patented and off-patent products?

Our portfolio combines patented innovations and off-patent products to deliver cost-effective, comprehensive solutions. Patented molecules address critical pest challenges, while off-patent products provide affordability and scalability in price-sensitive markets. This balance ensures adaptability to market needs and supports sustainable agricultural practices.

What's the long-term vision for agrochemical division?

We aim to become one of India's top 10 agrochemical companies within five years, focusing on innovation, sustainability, and farmer-centric solutions. Digital platforms, global collaborations, and advanced R&D will drive our growth, while sustainability initiatives like IPM and biological products will enhance resilience and environmental stewardship.

How does CSR fit into your strategy?

Our CSR initiatives align with sustainability and rural empowerment, promoting pollination programs, IPM education, and climate-smart farming. By enhancing livelihoods and resilience, we foster inclusive growth while contributing to the well-being of farming communities.

How does Godrej engage with local communities?

We empower farmers with knowledge and tools to adopt sustainable practices through initiatives like Hello Godrej and Digi News. Our focus includes soil health, biological alternatives, and innovative methods like drone-based crop protection. Collaborations with farmer organizations and NGOs ensure alignment with broader rural development goals, building lasting relationships with local communities.

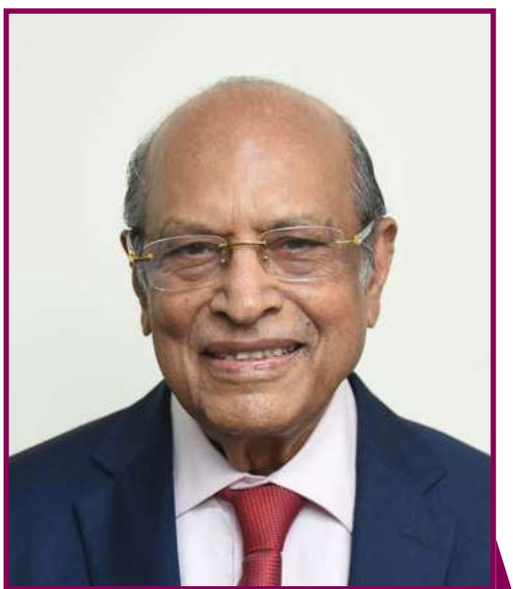
What's your outlook on India's agrochemical market?

India's agrochemical market is poised for significant growth, driven by evolving farming practices and the demand for food security. Key crops like cotton, rice, and maize offer opportunities for advanced and sustainable solutions. With low per-acre pesticide use, there is room for innovation and growth, supported by digital advancements and improved infrastructure. This positions India as a critical player in global agriculture

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In its 50th year, the company exports to over 40 countries and operates a sustainability-driven supply chain with zero discharge and zero waste

By RAHEEL SHAH



DR. KISHORE SHAH
Chairman
Sauradip Chemical Industries



RAJIVE SHAH
Managing Director
Sauradip Chemical Industries



JAIDEEP SHAH
Executive Director
Sauradip Chemical Industries

Q Key milestones achieved by Sauradip Chemical Industries in 2024?

As of 2024, Sauradip Chemical Industries has made considerable advancements in its dedication to sustainability, innovation, and growth. The company is targeting Rs. 1,000 crore in revenue over the next five years, fueled by effective strategies in sustainability and product innovation.

The company has adopted sustainability and green initiatives such as zero discharge manufacturing and development of eco-friendly products. Sauradip allocates 6-7 per cent of its revenue to research and development, fostering the creation of sustainable and innovative products while maintaining a competitive edge. Besides enhanced market presence, Sauradip earned recognition in 2024 for its outstanding contributions to sustainability, green chemistry, and innovation, affirming its leadership in environmental responsibility.

Q How has been the overall performance of Sauradip in 2024 and what is the expectation from 2025

In 2024, Sauradip Chemical Industries delivered impressive results, driven by its focus on sustainability, innovation, and expanding market reach. The company saw solid growth and set an ambitious goal to achieve Rs. 1,000 crore in revenue over the next five years. This progress is supported by a broader product range and entry into new markets. Sauradip concentrated on expanding its range of eco-friendly products, notably biodegradable surfactants like Alkyl Polyglucoside (APGs), which have gained popularity in industries such as cosmetics, personal care, and textiles.

The company has committed

to a zero discharge manufacturing process, emphasizing environmental responsibility. Sauradip strengthened its position as a leading supplier of green chemical solutions, both in India and internationally.

In 2025, we will continue growing our portfolio of sustainable surfactants and bio-based chemicals to meet the rising demand for eco-friendly solutions. The company will prioritize green technologies, further solidifying its commitment to sustainability. We will focus on expanding into international markets, particularly in Europe and North America, where demand for sustainable products is strong. Strengthening partnerships with like-minded companies and industries focused on sustainability will open up new avenues for growth.



Sauradip Chemical Industries received Rasayan Udyog Award

Q Is Sauradip Chemical collaborating with industry bodies or academic institutions on sustainability initiatives?

Sauradip Chemical Industries actively partners with both industry organizations and academic institutions to advance sustainability efforts. Notably, the company has supported infrastructure upgrades at the Institute of Chemical Technology (ICT) in Mumbai and launched a Visiting Fellowship Lecture series to strengthen connections between academia and industry. Chairman Dr. Kishore Shah emphasizes the importance of collaboration and the creation of chemical clusters to drive innovation and sustainable development.

Sauradip prioritizes the creation of biodegradable, plant-based products like Alkyl Polyglucoside, providing non-toxic alternatives to meet the increasing demand for sustainable solutions

Q Do you see bio-based chemicals replacing conventional ones in the near future?

Bio-based chemicals present a promising alternative to traditional petrochemical-derived substances, driven by the need for more sustainable solutions, efforts to cut carbon emissions, and growing consumer interest in environmentally friendly products. Although the transition is gaining traction, it still faces several hurdles.

Key drivers behind the shift to bio-based chemicals include environmental advantages such as lower carbon footprint and reduced environmental impact. Unlike fossil fuels, bio-based chemicals are made from renewable biomass, supporting long-term sustainability. Consumers and governments are pushing for greener, safer alternatives. Breakthroughs in biotechnology and green chemistry are enhancing the efficiency and affordability of bio-based solutions.

Barriers to wider adoption include higher production costs. Competing with low-cost petrochemicals remains a challenge. Availability, scalability, and responsible land use for biomass must be carefully managed. Ensuring that bio-based chemicals match or exceed the performance of conventional options is critical.

In terms of strategies for moving

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Dr. Kishore Shah has been awarded Lifetime Achievement Award at Century of Chemistry. The award was given by West Bengal Governor

forward, continued innovation is key to improving efficiency and reducing costs. Public - private partnerships can accelerate development and market entry. As consumer awareness grows, demand will help drive scale and investment.

Q How does Sauradip manage hazardous waste disposal in an environmentally responsible way?

Sauradip Chemical Industries demonstrates a strong commitment to environmental care, especially in handling hazardous waste. Their production methods are designed for zero liquid discharge and effluent-free operations, effectively eliminating the risk of environmental pollution. They also provide products such as dust control agents, which assist other industries in minimizing waste and cutting down emissions.

Emphasizing sustainability, Sauradip allocates 6–7 per cent of its revenue toward research focused on developing non-toxic and eco-friendly solutions. These innovations not only support environmental goals but also help industries manage costs. In essence, Sauradip integrates clean manufacturing, green product offerings, and continuous innovation to drive responsible waste management and environmental sustainability.

Q What initiatives has Sauradip taken to reduce waste and improve recycling?

Sauradip is dedicated to minimizing environmental impact by implementing a range of important sustainability measures, including achieving zero discharge and effluent-free production processes; and encouraging eco-friendly practices via social media campaigns.

These efforts underscore the company's strong commitment to environmental responsibility, focusing on waste reduction, increased recycling, and the broader adoption of sustainable practices within the chemical sector.

Q What steps are being taken to reduce the carbon footprint of your manufacturing process?

Sauradip is focused on lowering the carbon impact of its manufacturing activities through a series of targeted initiatives, including adoption of environmentally friendly technologies; designing products and processes to minimize carbon emissions; and promoting Eco-conscious events like the "Green Living Fair," Sauradip fosters awareness and engagement in sustainability among stakeholders.

These actions reflect the company's strong commitment to embedding sustainable practices into its core operations, with the goal of reducing carbon emissions and championing environmental stewardship.

Q How do you ensure that your raw materials are sustainably sourced?

To ensure that raw materials are sourced responsibly and sustainably, Sauradip Chemical Industries generally adopt a range of essential strategies including supplier evaluations and sustainability certifications often validated through certifications like Fair Trade, FSC, or ISO 14001; maintaining transparency and traceability to track the origin of raw materials and ensure clarity throughout the supply chain.

Other measures include collaborating with eco-friendly suppliers, focusing on renewable Inputs, advancing Green Chemistry, following ethical and environmental guidelines, and commitment to ongoing Improvement

Q What role does R&D play in making products more ecofriendly?

R&D plays a crucial role in driving Sauradip's efforts to make their products more eco-friendly. By encouraging innovation and promoting sustainability, R&D is central to enhancing both the company's product lines and manufacturing processes. Our projects focus on creation of non-toxic, eco-friendly products; non-toxic chemicals, eco-friendly alternatives including products like Alkyl Polyglucosides (APGs), which are biodegradable and renewable; minimizing environmental impact in production



Rajive Shah has been awarded "Rasayan Udyog Yuva Shri Award" by Prof. G. D. Yadav, President, Indian Chemical Society

through zero discharge technologies and energy-efficient production; sourcing sustainable raw materials and formulations such as bio-based feedstocks and sustainable formulations; assessing product life cycle including eco-conscious design, and recycling and reuse; collaborations with industry and academia including innovation partnerships and sustainable client

> **With sustainability as a core business strategy, Sauradip dedicates 6-7 per cent of its revenue to R&D, prioritizing sustainability within its business model**

ssolutions and innovations in waste reduction and recycling.

With sustainability as a core business strategy, Sauradip prioritizes sustainability within its business model. Our R&D initiatives are vital to enhancing the eco-friendliness of products. Through advances in non-toxic chemicals, sustainable manufacturing practices, and waste reduction, the company is committed to reducing its environmental impact and reinforcing its dedication to sustainability in the chemical industry.

Q How is Sauradip implementing green chemistry principles in product development?

Sauradip Chemical Industries integrates green chemistry principles into its product development to enhance environmental sustainability. Sauradip produces items such as APGs from renewable, plant-based materials, replacing traditional petrochemical surfactants. This approach promotes the use of sustainable raw materials and helps minimize the ecological footprint.

The company adopts green technologies that aim to minimize waste generation and harmful emissions during production. Sauradip designs products that are non-toxic, biodegradable, and safe for the environment.



Sauradip Chemical Industries has been honored with the Export Award 2024-25 from the Indian Speciality Chemical Manufacturers Association for the fourth consecutive year. The award was presented by Nadir Godrej, Chairman, Godrej Industries and Prof. Aniruddha Pandit, Vice Chancellor, ICT to Rajive Shah and Jaideep Shah

Sauradip Chemical Industries embodies green chemistry by prioritizing sustainable practices like utilizing renewable feedstocks, cutting down on waste, and ensuring safer, more eco-friendly chemical products.

Q How does Sauradip balance profitability with sustainability?

Sauradip Chemical Industries skillfully balances financial success with environmental responsibility by incorporating sustainable practices into its business operations. Our key approaches include development of eco-conscious products; cost efficiency through green manufacturing; capitalizing on the market demand for sustainable solution; promoting circular economy and reducing waste; building strategic partnerships and obtaining certifications; and commitment to long-term sustainability.

Q How has Sauradip integrated sustainability into its core strategy?

Sauradip Chemical Industries has effectively woven sustainability into its core strategy by implementing several key initiatives that align environmental stewardship with its business objectives. These efforts are reflected in their product development, manufacturing processes, research and development, and overall corporate vision.

Sauradip prioritizes the creation of biodegradable, plant-based products like Alkyl Polyglucoside, providing non-toxic alternatives to meet the increasing demand for sustainable solutions. We also invest in R&D for sustainable innovations; zero discharge manufacturing practices; commit to circular economy and waste minimization; ethical sourcing of raw materials; energy-efficient operational practices and sustainability as a catalyst for business growth.

Sauradip's ambitious goal of reaching Rs. 1,000 crore in revenue within five years highlights how sustainability serves as a driver for long-term business success, market expansion, and enhanced brand reputation ICN

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ACQUISITION OF MAPRIL IN PORTUGAL WILL STRENGTHEN OUR PRESENCE IN EUROPE

As a leader in the water and environment management sector, we played a transformative role in shaping the industry's response to climate change and water scarcity



AJAY POPAT
President
Ion Exchange (India)

How do you view the current state of the water treatment industry in India? What are the key challenges and opportunities?

India's water treatment industry offers significant investment opportunities. Key challenges are water stress, ground water depletion, urban water scarcity and infrastructure inadequacy. With increasing urbanization and industrialization, Government of India's proactive emphasis is on sustainable water management, including conservation strategies and water reuse mechanisms which provides ample opportunity to water companies, innovators and start-ups.

How has the overall performance been for Ion Exchange (India) so far in FY 2024-25?

For 9 months of FY 2024-25, on a consolidated basis our operating income increased around 21 per cent YoY. Profit after tax increased around 18 per cent on a YoY basis.

What is the total order book as of now and what is the expectation from FY 2025-26?

As of now, we have a healthy consolidated order book reflecting strong demand across industrial and municipal sectors. Aided also by strong enquiry pipeline, we expect FY 2025-26 to be equally promising.

Recently, the company expanded its European presence with the acquisition of a Portuguese company. How is this going to impact the performance of the company?

Our acquisition of MAPRIL in Portugal is a strategic move to strengthen our presence in Europe. It gives us direct access to European markets and brings us closer to customers in the region. With MAPRIL's established presence in key business sectors, this acquisition complements our strengths and opens up new opportunities in developed markets that are increasingly focused on sustainability and water reuse. Over the foreseeable long term, we see this significantly contributing to our business performance.

What is the current status of development of your Roha plant?

Our Roha facility, which will significantly increase our manufacturing volumes for world-class ion exchange resins, adsorbents, etc., is expected to be operational during the first half of this financial year. It will meet increasing global demand for our high-

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performance ion exchange resins-used in industries, municipalities and home water solutions.

Q The company also ventured into the production of membranes for various applications in water treatment. How is this contributing to the company's overall performance?

Our pioneering initiative of membrane manufacturing through the HYDRAMEM brand in 1987 led to development of membrane market and their application in India. By offering indigenously manufactured membranes meeting global standards in our state-of-the-art manufacturing facility we've been able to reduce import dependence, offer cost-effective membrane products to meet increasing demands for UF/RO/NF and MBR membranes in India and global markets we serve. This initiative also supports the "Make in India" vision. Membrane business will continue to positively contribute to our company's performance.

Q What role does Ion Exchange (India) play in the push for sustainable water management, especially in the context of climate change?

Ion Exchange's strength lies in its unique ability to provide 360° sustainable solutions for water and wastewater treatment to industries, homes and communities – across both urban and rural geographies. Our technologies and pioneering efforts in promoting sustainable water management concepts include 30+ Zero Liquid Discharge (ZLD) systems enhancing sustainability quotients of our customers; 15+ desalination plants in India and abroad; largest range of effluent treatment solutions, drinking water technologies under our ZeroB brand right from Suraksha Tap Attachment to High Recovery RO (HRR) to our alkaline and hydrogen water solutions. Furthermore, our recent innovations showcase our continued commitment to deliver additional value for the cause of sustainability. Our newer ion exchange and membrane technologies are designed to improve water quality and recovery.



We offer an exciting range of advanced oxidation technology solutions at affordable costs for treating high strength industrial effluents. Our exciting waste-to-energy solutions to help municipalities and communities turn waste into valuable resources like purified water, green energy and nutrient-rich fertilizers whilst enabling sustainable waste management.

Thus, as a leader in the water and environment management sector, Ion Exchange has played a transformative role in shaping the industry's response to climate change and water scarcity. We have consistently delivered cost-effective, energy-efficient and environmentally friendly solutions that seamlessly align with SDG 13 (Climate Action).

> **Our Roha facility, which will significantly increase our manufacturing volumes for world-class ion exchange resins, adsorbents, etc., is expected to be operational during the first half of this financial year**

Q With the rising concern over water scarcity and quality, how do you see technology transforming the water treatment sector?

Technology is playing a pivotal role in transforming the challenges into business opportunities, both in India and globally, on the principles of "doing more with less". Innovations and technology led development/upgradation. In India and the geographies, we serve, that faces significant challenges related to efficient water management, our digital water solutions provide predictive

analytics, reduce manual intervention and optimize energy and chemical use and with significant reduction in maintenance costs, reduced down time to improve efficiency of water management process.

At Ion Exchange, we are excited to offer these innovations integrated with digital intelligence into our systems to deliver higher efficiency, reduced operating costs and improved compliance for our customers.

Q What latest digital/technological advancements the company has adopted to help industries optimize chemical usage and reduce cost?

Technology is reshaping the water industry by making it smarter, more efficient and sustainable. For India, which faces multiple challenges as explained above, embracing these innovations is essential to secure its water future. We have been providing clients with customized chemical and total water management solutions through our equipment and performance chemicals. In recent times, we have enhanced our value prepositions by developing affordable and reliable online monitoring tools and IoT-enabled remote management platforms. This allows our customers to track water quality parameters in real-time. It optimizes chemical dosing, reduce wastage and will enable predictive insights.

Q Sustainability is a key focus for many companies today. How does Ion Exchange (India) incorporate sustainable practices in its operations?

At Ion Exchange, sustainability is not just a responsibility – it is at the very core of our business purpose: to conserve the planet's most precious resources through total water and environment management solutions. Our operations are also certified under ISO 14001, ensuring that we consistently follow stringent environmental protection guidelines with regular compliance monitoring. Emissions from our factories remain well within the permissible limits set by the Central Pollution Control Board (CPCB) and our facilities actively work on reducing water footprints in non-product applications like cleaning, gardening and domestic use.

In terms of water conservation, we are committed to replenishing water used in our operations and to this end, we continuously invest in advanced and efficient technologies that ensure water is reused and recycled within our manufacturing processes. For energy conservation, we are committed to sustainable operations by harnessing solar energy across our factories and offices. By installing solar panels at multiple locations, we reduce our carbon footprint, lower dependence on conventional energy sources and actively promote the use of clean renewable energy.

> **At Ion Exchange, sustainability is not just a responsibility – it is at the very core of our business purpose: to conserve the planet's most precious resources through total water and environment management solutions**

Q How Ion Exchange (India) has been helping companies achieve water conservation goals by offering solutions that allow them to recycle maximum amounts of water?

Pollution and increased demand have made good quality water scarce and expensive, both in terms of direct cost of water and the effect of unsuitable water on plant economics and product quality. Meanwhile, disposal norms are getting tighter and their enforcement stricter. Ion Exchange help its customers to effectively and economically solve their water scarcity problems by conserving vast volumes of water and protecting the environment by reducing discharge, while generating substantial savings for them.

Our effluent recycle solutions are integrated to yield optimal benefit. For instance, recycle systems are combined with specialty water treatment chemical programmes that substantially reduce water discharge (for example, cooling tower blowdown); and state-of-the-art effluent treatment plants are integrated with zero liquid discharge processes. They are backed by comprehensive operation and maintenance services, for high performance continuity.

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Significantly Lowers ZLD Costs
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Industries that have installed our effluent treatment, recycle and zero liquid discharge systems have gained an excellent payback on their investment.

Q What are some of the latest innovations or technologies that Ion Exchange (India) has adopted or developed?

IonSite Digital Twin offered by us enables plant operators to monitor and optimize the performance of their plants in real-time with real time analytics prediction and prescription to mitigate failures. The Advance Oxidation Technology – TADOX recently licensed from TERI addresses the gap and challenges in treating complex effluents produced by textile, chemical, paper, tannery, and petrochemical industries in a very cost-effective way.

Our widest range advanced and new biological process ensures significant reduction in footprint, energy and chemical costs. We are equally excited by the success of newer membranes to enhance water, resource recovery and making ZLD affordable to every industry together with advances and innovations in green chemistries. Our innovative, world-class products like INDION Hemo (high purity water for artificial kidney dialysis), FDA compliant excipients and APIs for the pharmaceutical industry complement our solutions for high purity water requirements of these industries.

For home water consumers, our innovative alkaline, hydrogen water POUs have added the width to an otherwise exciting range of domestic softener, high water recovery ROs. Last but not the least – our foray in converting waste-to-energy not only adds to the circularity quotient of our customers but also offers holistic solutions to municipalities and communities to use waste as a resource for generating valuable by-products like water, green energy, and nutrient-rich fertilizers.

Q How does Ion Exchange (India) approach research and development to stay ahead in the competitive market?



Ion Exchange's R&D center is recognized by the Department of Scientific and Industrial Research (DSIR), Government of India and continues to be the core of our growth over last six decades. Our R&D centers in India focus on product innovation, process improvement and customization based on sector-specific needs. We closely collaborate with global technology partners, research institutions and customers to co-create solutions. Our approach to R&D is both proactive and responsive - addressing current market demands while also anticipating future trends such as climate adaptation, green chemistry, and digital water technologies.

Q What do you believe will be the next big trend in water treatment and how is Ion Exchange (India) preparing for it?

The big trends will be convergence of water technology with digital solutions in order to identify (in real time) and, provide cost-effective solutions for emerging contaminants, PFAS, etc.; adapting nano technologies for purification and separation processes; alternate water reuse and circular water economy through affordable desalination, recycle, and ZLD; IoT enabled decentralized and modular systems for water, wastewater, waste-to-energy treated at community, commercial and industry level and resource recovery (like recovering nutrients or energy from wastewater) and carbon-neutral treatment systems will also gain prominence.

Ion Exchange continues to invest in these areas through internal R&D, strategic partnerships and technology acquisitions. Our goal is to be future-ready and offer solutions that are not just efficient but also environmentally and economically sustainable.

Q What is your vision for Ion Exchange (India) in the next 5 to 10 years, especially in terms of market expansion and innovation?

Our vision is 'to be the leader in our business which is so vital to people's lives and the environment'. Supporting this vision statement, we plan to consolidate our global footprint, deepen our presence in existing markets and offer innovative membranes, chemicals, digital solutions and specialty resins. We will continue to uphold our commitment to excellence, sustainability and customer-centric innovation and service

ACTIVELY PLANNING TO EXPAND OUR OPERATIONS BEYOND INDIA

Shiva Engineering Services (SES) has become a true partner in turning breakthrough formulations into scalable, operational realities

Q What strategic initiatives did Shiva Engineering Services (SES) undertake in FY 2024-25 to enhance its position in the Engineering, Procurement, and Construction (EPC) services?

Over the last 15 years, we have built a solid foundation at SES—not just with our clients, but also with a strong vendor network that plays a big role in smooth EPC execution. In FY 2024-25, we focused on taking that further.

One of the big moves this year was starting collaborations with technology partners who have their own proprietary technologies. The idea is simple: while they bring the technology, we come in as the turnkey EPC partner, delivering the full project from concept to commissioning. This approach is helping us tap into new and growing sectors like biofuels, specialty chemicals, and circular economy projects.

We also spent time strengthening our vendor systems. We have begun a formal prequalification process that uses data from past performance to help us make more informed and timely decisions. That's been a big support in improving procurement speed and reliability.

Alongside this, we've been improving our logistics and execution models so we can deliver projects faster and more efficiently. These steps are part of our larger goal to be more agile, bring added value to our clients, and continue building trust through reliable, end-to-end EPC solutions.



ASHISH PARIKH
Business Head
Shiva Engineering Services

Q SES operates across various sectors, including Process Chemicals, Flavors & Fragrances, Consumer Goods, Low Carbon Fuels, Circular Economy, Petrochemicals, Polymers, Engineering Plastics and Masterbatch, Industrial Facility, and GMP Facility. How does this diversification contribute to the company's financial stability and growth?

When we started, our very first project was quite simple developing as-built P&IDs for a specialty chemical plant. Since then, we've come a long way. Today, we are handling large-scale greenfield Capex projects across multiple industries. This journey has been possible because we kept expanding our domain knowledge and project experience along the way.

Diversifying into various sectors has been one of our core strengths. It's given us a broader platform to operate from and helped us build cross-domain expertise, which adds a lot of value in both design and execution. From a financial standpoint, this diversification helps us maintain stability. It also shields us from sector-specific risks, which is important in today's ever-changing market landscape.

Q How has the overall performance been for SES in FY 24-25 in terms of number of projects bagged and what's the total value and expectations from FY 25-26?

FY 2024-25 has been a very successful year for SES. We kicked off the year by delivering a large-scale greenfield project for a leading specialty chemicals

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> **We collaborate closely with our clients from early stages, often engaging with their R&D and pilot plant teams to understand the chemistry, process sensitivities, and desired outcomes**

client, an important milestone that set the tone for the months ahead.

Following this, we secured multiple new projects across diverse sectors, including ink manufacturing, recycling, specialty chemicals, flavors & fragrance, construction chemicals, and renewable fuels. It's been encouraging to see strong growth not just in terms of business volume, but also in the overall maturity and capabilities of our organization.

This year has also validated some of our strategic bets, especially our focus on long-term partnerships with technology providers. These associations are already opening new doors, and we expect them to give us a strong competitive edge in the years ahead.

Looking forward to FY 25-26, we are aiming to further scale up, both in terms of project size and geographical reach. We are actively planning to expand our operations beyond India, using a lean execution model that allows us to remain agile and cost-effective while serving global clients. Overall, we're optimistic and confident about continuing this growth trajectory.

Q The company's revenue performance during FY 24-25 with key growth metrics and expectations from the upcoming fiscal year i.e. FY 25-26? What factors would contribute to continuing the growth momentum?

FY 24-25 has been one of the most promising years for SES in terms of revenue growth and business expansion. We've seen a healthy volume of projects, from greenfield Capex projects across sectors like recycling and renewable fuels. These sectors not only brought in new business but also strengthened our overall capability. Another key contributor to this year's performance was our ability to take on larger, more complex projects end-to-end from basic and detailed engineering to procurement and construction. This full-scope delivery helped us create more value per project, which directly translated into better topline performance.

Looking ahead to FY 25-26, we are expecting continued growth, supported by a well-focused initiative. First, our long-term collaborations with technology licensors will help us tap into projects where technology plus EPC delivery is expected. Second, we are investing in digital tools, lean execution



models, and expanding outside India to serve global clients in a more agile way. Our team structure is also evolving to support larger-scale project delivery, and we're building internal capabilities around cost optimization, faster execution, and quality control, all of which will play a big role in sustaining momentum.

Q How does SES collaborate with clients to integrate R&D efforts into the design and development of specialty chemical plants?

We collaborate closely with our clients from the early stages, often engaging with their R&D and pilot plant teams to understand the chemistry, process sensitivities, and desired outcomes. Our process engineering team has deep experience in scale-up projects, whether it's from lab to pilot scale or pilot to commercial production.

We have successfully delivered multiple such projects where scale-up was a key requirement. In each case, our involvement included process simulation, scaled-up mass and energy balances, utility planning, and eventually translating those into a detailed engineering package that supports safe, efficient, and cost-effective execution.

What sets us apart is that we don't just stop at design. We support clients all the way—from process design to equipment sizing, material compatibility reviews, HAZOP studies, layout development, and even procurement support and construction planning. This end-to-end involvement ensures that the transition from R&D to commercial production is seamless and future ready. In short, SES becomes a true partner in turning breakthrough formulations into scalable, operational realities.

Q Could you elaborate on the major capital investments SES made in FY 24-25 and their anticipated impact on the company's growth?

In FY 24-25, we made some focused capital investments that are aligned with our long-term vision. A large part of that went into strengthening our core engineering capabilities investing in advanced design software, simulation tools, and improving our digital infrastructure to ensure faster, more accurate project delivery.

We also put significant effort into building our in-house capabilities to take on full-scope EPC projects. This includes enhancing our construction management tools, procurement systems, and project tracking mechanisms, so we're well-equipped to deliver turnkey projects with greater control and efficiency.

Another key area of investment was talent. We have brought in experienced professionals in critical areas and initiated specialized training programs to align our team with the evolving demands of EPC projects. Additionally, as we prepare to expand our footprint outside India, we have started developing a lean execution model and building strategic partnerships in target regions. These steps are setting the foundation for global operations in the near future.

All these investments are aimed at one goal: positioning SES for sustainable growth. We want to be a future-ready EPC partner, known not just for engineering excellence but also for agility, global reach, and long-term value creation.

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Q Could you share insights into SES's upcoming projects and strategic focus areas in the near future?

In the near future, we are focusing on growing the number of EPC projects we take on, while continuing to support our clients with EPCM services. We have seen how delivering complete, end-to-end solutions from basic engineering all the way to construction and commissioning can really make a difference, and we're building on that momentum.

A big part of our strategy is moving towards greener and more sustainable sectors. We are already involved in several projects related to renewable fuels, biogas, chemical recycling, and other circular economy initiatives. These projects often involve both technical complexity and careful execution, and that's where our experience and integrated approach come in handy. Right now, we are working on multiple renewable fuel and recycling projects. We are also seeing growing interest in areas like sustainable chemical manufacturing and solvent recovery systems.

Q The company was awarded an EPCM contract for a specialty chemicals multipurpose plant near Bharuch, involving operations like hydrogenation, bromination, chlorination, and nitration, with an investment of approximately Rs. 230 crore. Could you provide details on SES's specific contributions to this project?

Our involvement began at the concept development stage, where we created a detailed site master plan. This included planning for process areas, utility blocks, tank farms, ETP, storage facilities, admin buildings, and internal road networks—designed to optimize space, ensure safe man and material movement, and enable future scalability. Early-stage planning like this not only supports operational efficiency but also helps reduce overall Capex.

Once the concept was locked, we delivered the Basic Engineering Package along with cost estimation to help the client firm up their investment decision. From there, we moved into full-scope detailed engineering covering civil & structural, equipment design, piping, electrical, instrumentation & controls, fire & safety systems, and more. Our team also supported the client with procurement assistance, vendor integration, and on-ground construction management, acting as a single-point EPCM partner. Overall, SES acted as a one-stop solution for the entire project from concept to construction with a strong focus on safety, timelines, and smooth execution.

> **At SES, we have been actively aligning ourselves with the global shift towards sustainability and circular economy**

Q How has the company contributed to advancing the circular economy, and what specific sustainability projects were implemented in 2024?

At SES, we have been actively aligning ourselves with the global shift towards sustainability and the circular economy. In 2024, we took concrete steps by expanding our project portfolio in this space. We've been awarded several recycling projects covering areas like batteries, textiles, and other critical waste streams. These are emerging markets, and our aim is to become a leading EPC partner for clients in these sectors.

Alongside recycling, we're also focusing strongly on renewable fuels. We've delivered engineering solutions for multiple projects in Compressed Biogas (CBG), green ethanol, and green methanol—both in India and internationally. Our scope in these projects varies from FEED package development to detailed engineering and modular designs for ease of execution.

Q How does Engineering Services help with advanced tech integration in greenfield chemical projects?

We have had the opportunity to work on several greenfield projects where integrating client-owned or partner-provided technologies was a key requirement. Whether the technology is developed in-house or licensed from a third party, our role is to ensure it can be successfully scaled and implemented into a commercially viable plant.

We typically start with thorough understanding of the process and, wherever needed, running simulations to validate its performance under various operational parameters. When the technology is at a lab or pilot stage, our team supports the scale-up through detailed mass and energy balances, equipment sizing, and utility requirement estimation. Over the years, we have delivered multiple such projects taking processes from lab to pilot, and pilot to commercial scale, which has given us valuable insight into the complexities and nuances of such transitions ICN

PLANNING TO EXPAND OUR MANUFACTURING FACILITY IN VADODARA

MAAG can leverage its expertise in filtration and processing to develop and integrate chemical recycling technologies into existing petrochemical workflows



ALBERTO GHEZZI
Vice President Sales - Industrial Pumps
MAAG Group

How has the overall performance of MAAG Group been in 2024 and what are your expectations from 2025?

In 2024, MAAG Group focused on strengthening its market position and showcasing its solutions for the polymer, chemical and petrochemical industries with highlights including participation in various exhibitions. For 2025, the company aims to continue this focus, with a new corporate look and umbrella brand strategy, and a focus on four key areas: pump & filtration systems, pelletizing systems, pulverizing systems, and recycling systems.

In terms of expectations, the MAAG Group will continue to serve the needs of the polymer, chemical, and petrochemical industries. MAAG will implement a new brand identity and umbrella brand strategy to enhance its position in the industry and the market. We will continue to dedicate resources to innovation and state-of-the-art technology to deliver high-performance solutions to its customers.

How are you strengthening your position in the market?

Our focus is on the application and segment where MAAG gear pumps can be offered. The MAAG gear pump offers economical, innovative solutions that meet the demands of the chemical and petrochemical industries. This focus will be accomplished through the delivery of excellent products and service.

What strategy does the Group implement to drive innovation in its product lines, such as pumps and filtration systems, while ensuring they meet the exacting standards of the clients?

Fostering a corporate culture that values experimentation, risk-taking, and continuous learning is a critical aspect to ensure continued innovation. Leadership must champion innovation and provide the resources and support necessary for the success of innovative initiatives. We ensure, the innovation strategy should be aligned with the overall MAAG business goals and objectives to ensure that innovation efforts focus on areas that are most important to the business. Encouraging collaboration between different teams (e.g., engineering, marketing, and sales) can lead to more innovative solutions. Further, encouraging employees to stay up-to-date on the latest technologies and trends is also an important aspect of encouraging innovation. Researching

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and adopting new technologies, such as artificial intelligence (AI), virtual reality (VR), and blockchain, can create new opportunities for innovation.

MAAG is developing more energy-efficient pumps or filtration systems that reduce environmental impact. Allocating sufficient resources (time, budget, personnel) to innovative efforts is crucial for success. Understanding the specific needs and requirements of clients is essential for developing innovative products that meet their standards. This can involve conducting market research, gathering feedback from clients, and regularly evaluating product performance.

Q How does MAAG Group balance innovation with maintaining its reputation for reliability in highly technical industries like chemicals and petrochemicals?

> **We are predicting MAAG Chemical pump will achieve 25 to 30 per cent increase in business by 2030**

MAAG emphasizes finding the "optimum solution for a particular customer requirement". We offer integrated and customizable systems in process technology chemical and petrochemical industries. MAAG is committed to developing sustainable and durable products reflecting the "Next Level Solutions" standard. MAAG Group places a high value on after-sales service, ensuring customers have ongoing support and expertise. MAAG Group has a global presence with manufacturing facilities in Switzerland, Germany, Italy, USA, China, India, along with sales offices in various countries.

Q What are the new products that you are going to launch in the global market in 2025 and how are these going to contribute to the Group's growth?

MAAG is going to launch a new CHEMX pump by the end of 2025, which will be the next level solution for chemical and petrochemical industries customers. This launch will be beneficial to customers by increasing plant efficiency and boosting production. Furthermore, the new, upgraded pump is expected to be an economical solution. CHEMX pumps are designed for high-pressure, high-volume pumping applications



that occur in the chemical and petrochemical industries. These pumps are designed to withstand corrosive and other harsh fluids. These fluids could be caustic, abrasive, and at high temperatures. In addition, the pumps can handle a wide range of viscosities and temperatures.

What is the current operational profile of MAAG Group in India and what is your expansion plan for India?

MAAG India factory is in operation from 2016. We plan to expand our manufacturing facility in Vadodara, fostering stronger partnerships and contributing to the market's continued development. At present, we have dedicated sales and service teams from each product of the MAAG group.

MAAG is aiming to start small capacity machines here in India which further help customers to recuse the overall project cost and shorten the lead time. The expansion plan aims to leverage the strengths of all our centres of excellence globally, focusing more on the India market. MAAG Group offers 24/7 spare parts availability through the "my MAAG web shop". We have a global service network, including grinding centres for rotors and die plates, which supports the polymer industry.

How would you explain the growth trends for the Group in India?

India's chemical and petrochemical industry is experiencing robust growth, driven by increasing domestic demand, export opportunities, and supportive government policies, positioning the country as a global manufacturing hub. For MAAG Industrial pump, this means a promising market with opportunities for expansion and investment. India's growing population and increasing per capita income fuel demand



MAAG is set to launch its next-generation CHEMX pump by the end of 2025, offering advanced solutions for chemical and petrochemical industries

for chemicals and petrochemicals across various sectors, including pharmaceuticals, agriculture, textiles, and consumer goods. Growing global awareness of sustainability is creating opportunities for the development of eco-friendly chemicals and petrochemicals. The growth in the chemical and petrochemical sectors presents significant opportunities for your group to expand its operations and invest in new projects.

Q Where do you see the MAAG Group in India in 2030?

India aims to expand the chemical industry market size to US$2 trillion by 2047. The global chemicals and petrochemicals market is projected to grow from US$4.6 trillion in 2021 to US$6 trillion by 2028. The demand for chemicals in India is expected to increase from $212 billion now to $850 billion by 2040. Very large opportunities to meet very large and fast growing domestic demand for chemicals and also to help India become a global manufacturing hub. Indian Petrochemicals industry has immense potential for growth, and with proper government support and industry collaboration, it can emerge as a significant player in the global petrochemicals market. All factors above are giving MAAG chemical pump market growth opportunities and increasing the market share. We are predicting MAAG Chemical pump will achieve 25 to 30 per cent increase in the business by 2030.

Q How would you approach expanding MAAG Group's presence in emerging markets like India where demand for Chemical is growing?

MAAG Group in India focuses on providing high-precision solutions for chemical and petrochemical industries. We develop localized marketing campaigns that resonate with Indian consumers and highlight the sustainability of their products. While we explore opportunities within petroleum, chemicals, and petrochemicals, we emphasize sustainable practices and environmentally friendly products that will help India's growing focus on green technologies and net-zero emissions. India's growth in specialty chemicals provides opportunities for MAAG chemicals pumps. MAAG Group can explore opportunities under the "Make in India" initiative and offer skids from local factories.

Q How do you see technological advancements, like automation or digitalization, shaping MAAG Group's offerings, and what are your strategies to lead in these areas?

MAAG is focusing on adopting digital technologies like AI and IoT to optimize production processes, reduce costs, shorten delivery time and improve product quality. The company offers pumps with 3D printing technology which is the fastest solution for some of the chemical applications. We serve a diverse client base, from small manufacturers to global corporations.

Q How do you ensure your solutions remain adaptable and scalable across this spectrum?

MAAG's wide range of chemical pumps allow for easy customization and adaptation to different process requirements and production volumes. This modularity also facilitates scaling up or down the system's capacity as needed. MAAG Group's core expertise lies in process technology for the chemical, and petrochemical industries. This allows us to offer a wide range of solutions that can be tailored to specific applications and needs. Beyond the initial solution, we also provide comprehensive service and support, including maintenance, modernization, and spare parts management. This ensures that clients can continue to operate their systems efficiently and reliably, even as their needs evolve.

Q What do you see as the biggest growth opportunities for MAAG Group in the next five years, particularly in the polymer, chemical and recycling sectors?

The rise of chemical recycling offers a significant opportunity for MAAG to expand its portfolio beyond traditional polymer processing. MAAG can leverage its expertise in filtration and processing to develop and integrate chemical recycling technologies into existing petrochemical workflows. MAAG's recycling systems can play a crucial role in closing the loop on plastic waste and supporting the circular economy in both chemical and petrochemical sectors.

MAAG's focus on optimizing energy consumption in its chemical pump can lead to significant savings for customers and contribute to broader sustainability goals. MAAG can tailor its solutions to meet the specific needs of different chemical and petrochemical applications, such as specialty chemicals, plastics, and pharmaceuticals. By focusing on these key areas, MAAG can position itself as a leading provider of solutions for the chemical and petrochemical industries, driving growth and innovation in a rapidly evolving market

INVESTING CONTINUOUSLY IN BUSINESS AND LOOKING FOR ORGANIC AND INORGANIC GROWTH

Our investment on agro product registration continues to ensure we strengthen our portfolio and crop diversification drive



KOSHAL BISEN
Head - Growth Office
Indofil Industries

How would you explain the emerging trends in agrochemicals in India and globally?

The Indian agrochemical industry faced several headwinds in the past three years. The industry struggled to sustain, rather several business houses showed a declining trend. Similar is the case with the global market. Severe challenges in supply and demand led to raw material price fluctuations throughout the year. Still several companies, including Indofil have shown growth and turned these problems to opportunities. It's observed that the demand for off-patented molecules remains strong and growing year by year, along with new solutions being added to support the farming fraternity.

Three main challenges faced by the Indian agrochemicals sector and what are the suggested solutions?

The key challenges Indian industry faces are: Cash crunch across the value chain - We should look at options like channel financing via financial institutions. It helps in mitigating the short-term cash issues with minimal cost; Supply & Demand – Indian industry is severely dependent on China supplies and looking at ongoing geopolitical issues, it's important that we find ways to backward integrate key product lines and find solutions by coming together instead of competing; and End to end solution for farmers – Though everyone is trying hard in this aspect however still the success is not as expected. It's important now for the agrochemical industry to think of not only providing input chemicals, rather prepare to provide end to end solutions, from seed to harvest. It's only possible by collaboration if all participating industries come together and offer solutions based on the strengths in a collaborative way.

How has the performance been for Indofil in the first 9 months of FY 2024-25? Could you elaborate on the factors that contributed to this strong performance?

For Indofil, the first quarter was quite challenging because of weak demand, however in quarter 2 and 3, we revived our strategy and as a result, we could regain the momentum. Overall, for nine months, Indofil could record the desired growth on topline as well as profitability. We kept a close eye on competition and the changing environment. We were very particular on our pricing strategy, cost control measures, and balanced approach for market share gain.

How have different product segments contributed to the overall revenue, and which segments have shown highest growth?

Indofil is known for its fungicide portfolio. This year has been one of the best years for our fungicide portfolio and we recorded strong growth. We worked on our legacy products and with revised strategy and were able to outperform. Our journey continued for the growth in insecticide portfolio and we continue to strengthen our herbicide product line. Overall, our approach towards crop diversification and growth



> **We are channelising our actions towards paperless operation. Our several digital initiatives are going to help the organization to be more efficient and will follow the philosophy of "delivering More with Less"**

helped in growing our market share across the country.

How has Indofil's diverse product range contributed to its market leadership in both agricultural and specialty chemicals?

Now, Indofil has products for all important crops and this is possible because of our continuous efforts to include new products for the last 3-5 years. Indofil has products to offer for almost all key crops in India. Similarly, our specialty division is continuously adding new product lines to support our customers. Our R&D strengths are increasing year on year and investment continues to support growth.

What were the primary areas of capital expenditure in 2024, and how do these investments align with Indofil's strategic objectives?

Indofil is continuously investing on manufacturing capabilities, by adding new equipment for volume growth, to bring efficiency and productivity enhancement. These investments are helping us to offer products at competitive prices. Our investment on agro product registration continues to ensure we strengthen our portfolio and crop diversification drive. All our Capex are planned to support our mid-long term growth strategy.

Indofil repaid Rs. 200 crores of debt in FY24. How has this debt reduction impacted the company's financial health and future investment plans?

Indofil is continuously working towards strengthening our cash flow situation. Our financial control measures are the key driver to pay off the debt. Indofil' s management keeps a close eye on profitable volume growth by strengthening our cash flow situation to ensure we are ready for future investments.

Can you outline any upcoming capital projects or expansions planned for the next fiscal year?

As said earlier, Indofil is investing continuously in business and will continue to look for opportunities for organic and inorganic growth.

With exports comprising around 40 - 45 per cent of revenues over the past three fiscal years, how is Indofil expanding its global footprint and entering new markets?

We are very focused on our international business growth. In the past 2-3 years, we have taken several strategic calls to expand our reach across the globe by investing in registration for new products/mixtures beyond mancozeb. We are now ready with products to offer in the Europe and Brazil market which will help us for future growth in this market. Indofil is

also continuously investing to expand its innovative solution business reach across the globe.

How is Indofil integrating sustainable solutions into its product development and operations to address environmental concerns?
Indofil is very focused towards sustainable growth. We have recently invested in hybrid power and as a result, from next year onwards our manufacturing plant will use at least 50 per cent of the power generated via wind and solar source. Similarly, our new product development team works to ensure new products or processes are eco-friendly and to help in reducing carbon footprint. We have recently received Responsible Care accreditation from Indian Chemical Council. Our Ecovadis score is also improving year on year. All our manufacturing sites are working on zero discharge operations. Our efforts towards reducing carbon emission continue by streamlining our supply chain.

Indofil introduced insecticides like Hokori and herbicides such as Gadget, Tembofil, and Smack in 2024. How have these products impacted the company's growth?
Indofil is proud to launch these products within one year which are surely going to help the farmers to improve their productivity. These products significantly contributed to the growth this year and we have a robust marketing plan to take these products to greater heights in future. As said earlier, Indofil is committed to provide new products and solutions year on year to our customers.

Indofil launched 'IndoLife Super Specialities' to enhance farmers' return on investments through research-based solutions. How has this initiative impacted the agricultural community?
Our IndoLife business reached a significant mark in the past 6-7 years and surely helped the farming community with its innovative biological based products. Indofil is reviving Indolife business strategy to offer much better products and solutions with new faces in near future and new announcements will follow soon.

What are the primary goals behind Indofil's digital transformation efforts, and how do they align with the company's overall business strategy?
In the past three years, Indofil has significantly invested in digital transformation and it's continued. We are channelising our actions towards paperless operation. Our several digital initiatives are going to help the organization to be more efficient and will follow the philosophy of "delivering More with Less". These digitization efforts are bringing data transparency which is helping us to take quick and fact-based decisions. Each action and investment are aligned to our mid-long-term strategy.

The company has received the 'Responsible Care' certification in 2024. The significance of this accreditation and the initiatives undertaken by the company to achieve it?
Indofil is proud to share that we got Responsible Care certification in the first attempt and for all codes. Every Indofilian was involved and worked to make it happen. It also demonstrates our commitment towards sustainability. Indofil's management is committed to provide a safe working place to all our employees and contractors. Our efforts are not limited within our own site or operation, rather we are collaborating with our customer and supplier to ensure we eliminate waste across the value chain and create an ecosystem for sustainable operation.

Indofil aims to transition from a product-based to a solution-based company within five years. What steps were taken in 2024 towards this goal?
Indofil is always seen as a solution provider rather than just selling products. We are continuously investing in our field marketing activities by deploying our team at ground to help farmers in providing need-based solutions. We are also working to find solutions by inventing a digital tool to provide support to our farmers for soil testing, monsoon forecasting etc. Since Indian farming industry is continuously evolving, acceptance to these new technologies and solutions take more time than usual, however our government's efforts for smart farming help the farmers fraternity to improve their productivity. Our investment in innovative solutions, by developing technical service teams, continues to provide solutions

> **We have recently received Responsible Care accreditation from Indian Chemical Council. Our Ecovadis score is also improving year on year and all our manufacturing sites are working on zero discharge operations**



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"Prioritizing Safety is
the first step to success."

Safety is not just a concept for us. It is a core value & culture at Silox India. This is imbibed in all the processes that we follow and is aimed at creating Safe and Sustainable Solutions at our end while catering to customer needs. Our manufacturing facilities at Atladara, Ekalbara, and Silvassa are ISO 14001:2004 and OHSAS 18001 Certified, and follows contemporary EHS (Environment, Health, and Safety) Practices.

"Silox India is an Indo-Belgian JV Company with a history of more than 5 decades. We are the largest manufacturers of Sodium Hydrosulphite (SHS) in Asia (outside China) and Sodium Formladehyde Sulphoxylate (Safolite^) and Zinc Formaldehyde Sulphoxylate (Safolin^) in the world. Other products in our portfolio include Zinc Oxide, Zinc Dust, Zinc Phosphate, Zinc Oxide (Active), Zinc Oxide (HAS) and Textile Auxiliaries. We have in-house capabilities for recovery of value added Metal Salts from Secondary Metals through Hydrometallurgy. Silox India is a market leader in India for most of our products and has a strong global presence through exports to more than 65 countries spread across six continents of the world."

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TECHNOLOGICAL REFINEMENTS ARE IMPROVING EFFICIENCY OF CHEMICALS AND PETROCHEMICALS



DR. V. N. RAJASEKHARAN PILLAI
Professor of Polymer Science &
Vice Chancellor
Somaiya Vidyavihar University

In 2025, companies are diversifying away from traditional crude oil and natural gas toward alternative feedstocks to enhance resilience and sustainability

The chemicals, petrochemicals, and energy sectors are interconnected pillars of the global economy, underpinning industries from manufacturing to agriculture and transportation. In 2025, these sectors are navigating a transformative landscape shaped by technological innovation, sustainability imperatives, geopolitical dynamics, and evolving market demands. This analysis tries to explore the current trends driving efficiency and growth, highlighting key developments, challenges, and opportunities.

Sustainability: The Core Driver of Efficiency

One of the most prominent recent trends is the accelerated push toward sustainability, driven by regulatory pressures, consumer expectations, and economic incentives. The chemicals and petrochemicals industries, historically significant contributors to global emissions, are under scrutiny to reduce their environmental footprint. Companies are investing heavily in decarbonization, circular economy practices, and eco-friendly alternatives to traditional products. Major players like BASF, Dow, and LyondellBasell have committed to ambitious carbon neutrality goals by 2050, with interim targets for 2030. BASF aims for a 25% reduction in Scope 1 and 2 emissions by 2025 compared to 2018, while Dow targets a 15% reduction by 2030 from 2020 levels. These commitments are driving investments in energy-efficient processes, carbon capture, utilization, and storage (CCUS), and renewable energy integration. However, the high capital costs of transitioning to low-carbon technologies remain a challenge, particularly for smaller firms.

Major players like BASF, Dow, and LyondellBasell have committed to ambitious carbon neutrality goals by 2050, with interim targets for 2030. BASF aims for a 25% reduction in Scope 1 and 2 emissions by 2025 compared to 2018, while Dow targets a 15% reduction by 2030 from 2020 levels

The focus on circularity is reshaping petrochemical production, especially in plastics. In 2025, companies are scaling up chemical recycling technologies to break down plastics into their molecular components for reuse, reducing reliance on virgin feedstocks. For example, SABIC has introduced PCR-based (post-consumer recycled) products like NORYLTM, incorporating bio-based and recycled materials. In India,



government initiatives like plastic parks and recycling mandates are fostering sustainable practices, though logistical and infrastructural gaps persist.

The shift toward bio-based alternative materials is gaining traction. Sumitomo Chemical, for instance, is developing a method to produce propylene from ethanol, with a pilot plant set for commercialization within the next one year. Bio-based plastics and chemicals derived from renewable feedstocks like corn starch or agricultural waste are reducing dependence on fossil fuels, but scalability and cost-competitiveness remain hurdles.

Trends in bio-based plastics showcase a dynamic and rapidly evolving field driven by increasing environmental awareness and the need for sustainable alternatives to conventional petroleum-based plastics. One significant trend is the growing production capacity of bioplastics, with projections indicating a substantial increase from 2.18 million tonnes in 2023 to a potential 7.43 million tonnes by 2028. This surge is fueled by rising demand across various applications, including packaging, consumer goods, electronics, automotive, and textiles, with packaging currently holding the largest market share.

Material innovation and diversification are also key trends. While polylactic acid (PLA) and starch-based plastics remain prominent, there's increasing development and commercialization of other biopolymers like polyhydroxyalkanoates (PHAs), polybutylene succinate (PBS), and cellulose-based plastics. Notably, PHAs are gaining attention due to their biodegradability in diverse environments, including marine settings, offering a potential solution to plastic pollution in oceans.

Innovations are also focusing on enhancing the properties of bioplastics, such as mechanical strength, heat resistance, and flexibility, often through blending different biopolymers or incorporating additives. In addition, there is a growing emphasis on utilizing waste streams as feedstock for bioplastic production, aligning with circular economy principles.

Technologies are emerging to convert agricultural residues, food waste, and even carbon dioxide into valuable biopolymers through microbial fermentation and chemical catalysis. This not only reduces reliance on dedicated crops but also addresses waste management challenges. In terms of applications, bio-based plastics are finding increasing use in niche and high-value areas, such as medical devices (e.g., drug delivery systems, tissue engineering scaffolds), cosmetics packaging, and even 3D printing filaments.

The development of bio-based and biodegradable polymers for agricultural applications, like mulch films and seed coatings that can decompose in the soil, is also a notable trend.

Despite the advancements, challenges remain, including the higher production costs compared to conventional plastics, limited availability of sustainable feedstocks that do not compete with food production or contribute to deforestation, and the need for improved end-of-life management, including better composting infrastructure and ensuring compatibility with existing recycling streams.

Ongoing research and development are crucial to overcome these hurdles and unlock the full potential of bio-based plastics as a mainstream sustainable material.

The U.S. chemical industry anticipates a 1.9% output growth in 2025, supported by consumer spending and industrial recovery. However, Europe's high energy costs and Asia's uneven demand recovery create uncertainty

Technological Innovation and Digitalization Driving Productivity

Technological refinements are improving efficiency in the chemicals, petrochemicals, and energy sectors. In 2025, digitalization, artificial intelligence (AI), and process optimization are at the forefront of driving productivity and cost savings.

AI and Machine Learning: AI is transforming research and development (R&D) and operations. Machine learning algorithms analyze vast datasets from patents, scientific literature, and market trends to accelerate materials discovery and process optimization. For instance, AI-driven predictive maintenance is reducing downtime in petrochemical plants, while intelligent R&D is enabling faster development of high-margin specialty chemicals. However, the industry lags behind sectors like tech in AI adoption, presenting untapped potential.

The integration of Internet of Things (IoT) devices and smart sensors is enhancing operational efficiency. Real-time monitoring of equipment and supply chains allows companies to optimize production, reduce energy consumption, and mitigate risks. In the U.S., shale gas producers leverage 3D seismic imaging and IoT to streamline extraction, maintaining a competitive edge in alkane-based petrochemicals.

Process Optimization: Advanced catalysis, refining techniques, and modular plant designs are improving yield and reducing energy intensity. For example, modular refineries in the Middle East are enabling faster, more cost-effective capacity expansions. Yet, the high upfront costs of adopting these technologies can deter smaller players, potentially widening the gap between industry leaders and laggards.

Digitalisation enhances efficiency but raises concerns about cybersecurity and data privacy. As plants become more connected, the risk of cyberattacks grows, necessitating robust safeguards that add to operational costs.

Region- specific Dynamics and Market Growth

The global chemicals and petrochemicals market is experiencing robust growth, projected to reach US$ 681.06 billion in 2025 and US$ 1045.21 billion by 2033, with a CAGR of 5.50%. Regional dynamics play a critical role in shaping this growth, with Asia-Pacific, particularly China and India, leading the charge.

China's petrochemical surge, driven by self-sufficiency policies, is reshaping global markets. Between 2019 and 2024, China added ethylene and propylene capacity equivalent to Europe, Japan, and Korea combined, making it the largest petrochemical market.

India, meanwhile, is leveraging policy reforms like the Production Linked Incentive (PLI) scheme and Petroleum, Chemicals, and Petrochemical Investment Regions (PCPIRs) to attract US$ 87 billion in investments over the next decade. These investments aim to double India's global market share to 6% by 2030, though import dependence for raw materials remains a bottleneck.

The Middle East continues to dominate as a low-cost producer, leveraging abundant feedstock and strategic trade routes. Saudi Aramco's US$ 50 billion investment plan through 2028 underscores the region's ambition.

In North America, the shale gas revolution has revitalized the U.S. as a petrochemical hub, with companies like ExxonMobil investing US$ 10 billion to expand ethylene and propylene production.

However, excess capacity and softening demand from China are pressuring margins. Europe faces high energy costs and stringent regulations, leading to stagnant growth in petrochemicals. Initiatives like the EU Green Deal and potential Chemical Industrial Act aim to bolster sustainability, but rising feedstock prices and competition from Asia threaten competitiveness.

While emerging markets drive growth, oversupply risks and trade disruptions, such as potential U.S. tariffs under a new administration, could destabilize global markets, highlighting the need for diversified supply chains.

Feedstock Shifts and Energy Transition

The energy transition is reshaping feedstock dynamics in the chemicals and petrochemicals sectors. In 2025, companies are diversifying away from traditional crude oil and natural gas toward alternative feedstocks to enhance resilience and sustainability. The U.S. leads in leveraging shale gas and natural gas liquids (NGLs) like ethane and propane, which account for 40% of global ethane-based petrochemical capacity. This has lowered production costs but increased dependence on exports to China, creating vulnerabilities amid geopolitical tensions.

Biomass, waste plastics, and carbon dioxide are emerging as viable

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feedstocks. Projects like Dow's US$ 8.9 billion net-zero petrochemical plant in Canada, set to produce low-emission ethylene by 2029, highlight the shift toward sustainable feedstocks. However, these technologies are not yet cost-competitive at scale.

Green hydrogen and electrification are gaining traction for high-energy processes like steam cracking. In Europe, pilot projects are testing hydrogen-based ammonia production, but high costs and limited renewable energy infrastructure slow adoption.

The energy transition offers long-term efficiency gains but requires significant upfront investment and policy support. Without global coordination, disparities in adoption could exacerbate competitive imbalances.



High-Value Products and Specialty Chemicals

The shift toward specialty chemicals is a key growth driver in 2025, as companies seek higher margins amid commoditization pressures in basic petrochemicals. Specialty chemicals, including high-performance polymers, biodegradable plastics, and agrochemicals, are seeing strong demand in automotive, electronics, and agriculture. India's chemicals sector, valued at US$ 250 billion, aims to reach US$ 383 billion by 2030, driven by cost advantages and R&D investments.

Globally, demand for bioplastics and sustainable packaging is rising, with companies like BASF and Formosa Plastics expanding portfolios. R&D is critical for developing customized solutions, such as lightweight materials for electric vehicles (EVs) and durable coatings for renewable energy infrastructure. By 2025, EVs are projected to account for 30% of new car sales, boosting demand for polypropylene and other petrochemicals. Intense competition and the need for continuous innovation strain R&D budgets, particularly for mid-sized firms. Intellectual property protection in emerging markets remains a concern. Specialty chemicals offer growth opportunities but require agility to meet rapidly evolving customer needs and regulatory standards.

Geopolitical Disruptions and Economic Uncertainties

Geopolitical disruptions and economic volatility are shaping the sector's trajectory in 2025. Trade tensions, particularly between the U.S. and China, threaten supply chains, while inflation and fluctuating energy prices impact profitability. Potential U.S. tariffs could reduce global trade growth by 2.4%, affecting chemical exports. Europe's reliance on imported feedstocks exacerbates vulnerability to price shocks.

The U.S. chemical industry anticipates a 1.9% output growth in 2025, supported by consumer spending and industrial recovery. However, Europe's high energy costs and Asia's uneven demand recovery create uncertainty. Companies are diversifying suppliers and localizing production to mitigate risks, but these strategies increase costs, challenging efficiency goals. Geopolitical resilience requires strategic foresight, but short-term economic pressures may divert focus from long-term investments.

In 2025, the chemicals, petrochemicals, and energy sectors are at crossroads, balancing efficiency and growth with sustainability and resilience. Sustainability initiatives, technological innovation, and regional growth are driving progress, while feedstock shifts and specialty chemicals open new avenues for value creation. However, challenges like high transition costs, geopolitical risks, and uneven global adoption underscore the complexity of this transformation. By embracing collaboration, innovation, and adaptive strategies, the sector can navigate these challenges to deliver sustainable growth and efficiency, shaping a resilient future for the global economy

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INDIA: POISED TO LEAD THE NEXT ERA OF SYNTHETIC CHEMISTRY



BURJIS GODREJ
Executive Director, Godrej Agrovet and Managing Director
Astec LifeSciences

> We need to shatter the silos between policy, industry, and academia to be at the forefront

India stands at a scientific inflection point. As we envision a future powered by indigenous innovation, one discipline is emerging as a silent architect of transformative change: Synthetic Chemistry. The ability to translate conceptual frameworks into complex molecular realities is no longer a niche capability – it is foundational to India's aspirations in health, energy, agriculture, and sustainability.

But this isn't just a matter of producing molecules. This is about engineering precision, scale, and intention into the actual substance of chemical design. It is about restating what being a knowledge economy means.

Catalyzing a Global Leadership Role

Synthetic chemistry has long been the foundation for scientific progress, but now, in the contemporary era, it is experiencing a renaissance. Computation, green chemistry, automation, and sustainability mandates have catapulted the molecule from a lab product to a strategic driver of global progress. With the global specialty chemicals market projected to grow from US $1.3 trillion to US $1.7 trillion by 2029, India must not remain a consumer of this knowledge. We must be its creator. We must build molecular solutions that align with our unique demographic, ecological, and economic realities.

Redefining India's Pharmaceutical Independence

The traditional obsession with speed and yield in synthetic reactions is giving way to a more responsible ambition: selectivity with sustainability. Organocatalysis embodies this shift. By harnessing small, metal-free catalysts, we not only reduce toxic load but unlock reaction pathways previously deemed impractical. In Indian research labs, Organocatalysis is now more than a theoretical exercise. It is yielding industrially relevant solutions, particularly in asymmetric synthesis—a vital ability for pharmaceuticals as well as agrochemicals. This approach is allowing us to design chiral molecules with elegance, avoiding the heavy metal footprint of previous decades.

Automation Brings Molecules to Masses

The future chemist is as much a coder as a bench scientist. Automation in synthesis is dismantling traditional notions of chemical creativity, replacing intuition with data-driven design. The result? Molecules that took months now take days. Failures are predicted before they occur. Success becomes repeatable. At Astec LifeSciences, we view automation not just as a tool for efficiency, but as a means to democratize molecular innovation. Our goal is to make complexity accessible—not just in high-end pharma, but in the hands of farmers, energy scientists, and material engineers.

Rapid Scalability

Flow chemistry is revolutionizing the way molecules are synthesized, enabling us to condense time, scale, and cost into a one continuous reaction stream. This is not evolution—it's revolution. Having the capability of accurately controlling reaction parameters in real-time has enabled safer, more sustainable, and efficient manufacturing platforms. For India, this presents an opportunity to bypass legacy batch systems and create nimble chemical ecosystems based on sustainability.

Molecular Sovereignty: India's Strategic Science



Imperative

Think about it: India is the world's largest manufacturer of generic drugs but imports its APIs. We are among the world's leading producers of agricultural products but depend significantly on imported agri-inputs. This irony has to end. We can achieve atma nirbharta.

Wary of this, Godrej Agrovet has placed synthetic chemistry at the very heart of our strategy. Our pioneering in Homobrassinolide is only the starting point. These bio-stimulants, serving Indian farmers by offering different bio-stimulants as per their crop requirement, are a molecular answer to climate uncertainty and soil exhaustion. They are a new vocabulary of productivity—scribed not in hectares but in atoms. As we grow our green oleochemical hubs in 40+ countries, we reassert our dedication to molecular solutions that are ethical, environmentally responsible, and economically scalable. Godrej Chemicals is dedicated to integrating green chemistry principles into surfactant and oleochemical production, emphasizing sustainable practices, using vegetable oil instead of petrochemical feedstocks, and minimizing environmental impact.

Overcoming Challenges in Synthesis

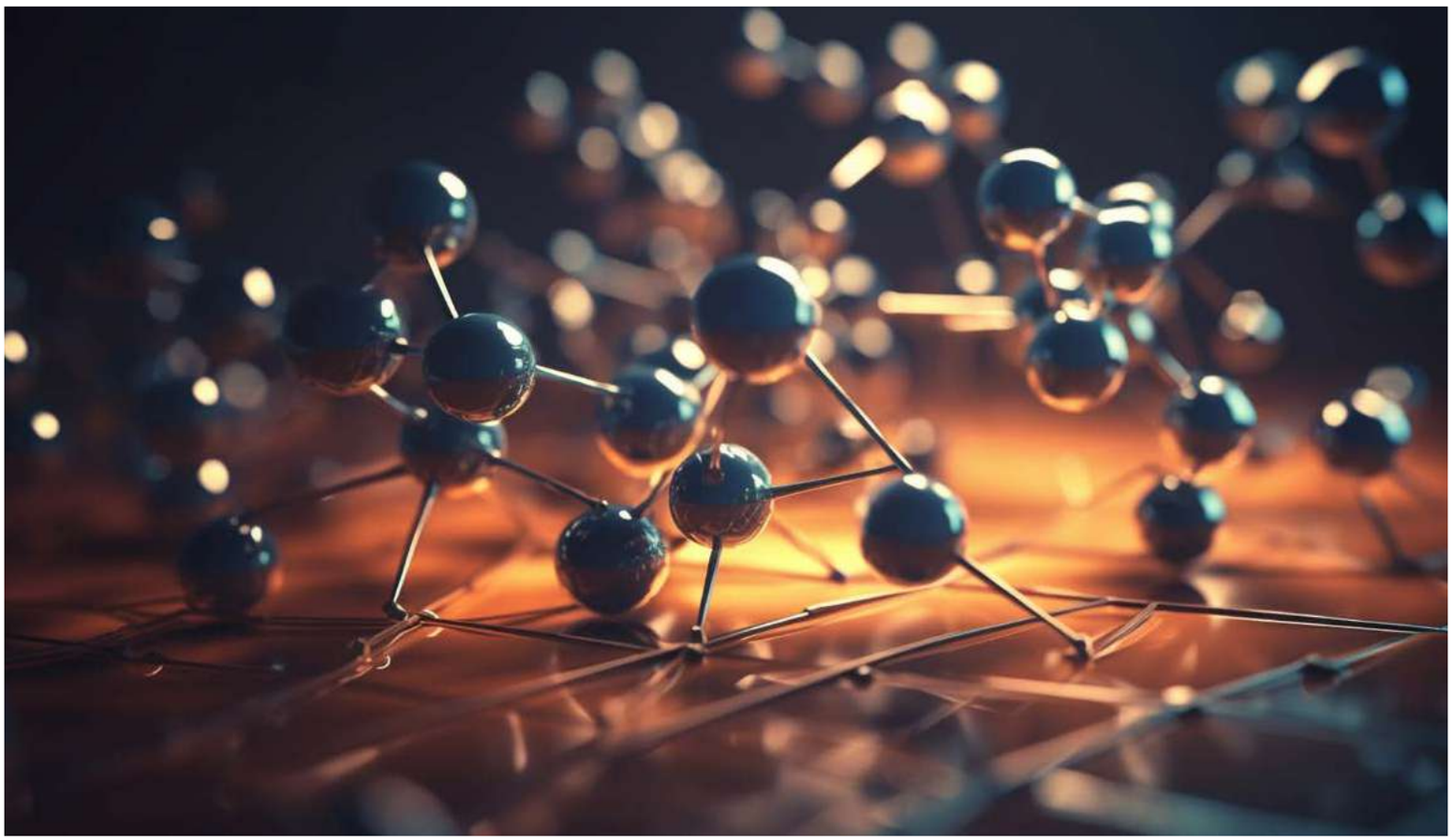
Mastery of the synthesis of complex molecules is a layered challenge—varying from structural complexity and stereochemical accuracy to selectivity of reactions and resource availability.

Planning routes for multifunctional molecules requires profound chemical acumen, particularly when more than one functional group and stereocenters are present. Supramolecular chemistry and novel catalysts such as iron-based systems are facilitating streamlining such routes. In pharma, stereochemistry directly affects therapeutic efficacy, making predictive computational models crucial for guiding synthesis.

Process selection remains vital to minimize waste and cost, with techniques like continuous flow and solid-phase synthesis offering elegant solutions. India's challenges are amplified by resource limitations such as lack of domestic oil, gas and rare earth minerals.

With the global specialty chemicals market projected to grow from US $1.3 trillion to US $1.7 trillion by 2029, India must not remain a consumer of this knowledge

However, industries are addressing these by investing in scalable infrastructure, embracing automation, and using our own resources as



substitutes (abundant biomass) and cultivating academia-industry partnerships. With growing pharma demand, supportive policies, and international partnerships, India is poised to lead the next era of synthetic chemistry.

Catalysts of Change

The glory of synthetic chemistry is its universality. It nourishes our crops, fuels our cars, cures our bodies, and safeguards our planet. But such glory is at risk without the proper intent and plans of execution. In healthcare, advanced synthetic tools are crafting targeted therapies for complex diseases while in energy, catalysts born in labs are enabling breakthroughs in hydrogen storage and organic photovoltaics. Novel polymers with controlled degradation timelines are paving the way for sustainable packaging alternatives to synthetic plastics.

With a projected US $1 trillion chemical industry in sight, the question is not whether we can lead—but whether we will choose to

Invent, Integrate, Impact

For India to be at the forefront, we need to shatter the silos between policy, industry, and academia. We need to invest in deep science with patient capital. We need to educate chemists to think like engineers, entrepreneurs, and ecologists. We need, first and foremost, to transcend incrementalism. The true opportunity is not to make better molecules—but to construct entirely new classes of function that have no precedent. Molecules that are memory-based, which can learn and adjust. Molecules that communicate in the language of the challenges of tomorrow.

The Future is Elemental

This is India's molecular moment. With a projected US $1 trillion chemical industry in sight, the question is not whether we can lead—but whether we will choose to.

By investing in synthetic chemistry, we invest in self-sufficiency, sustainability, and societal progress. As an industry, we are not merely reacting to this future. We are shaping it and building towards it—one molecule at a time. The lab bench is our launch pad. The molecule, our medium. The mission? Transformational impact on a global scale

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PLANT-BASED CHEMISTRY ESSENTIAL FOR HOME AND PERSONAL CARE PRODUCTS



VISHAL SHARMA
Executive Director and Chief Executive Officer (Chemicals)
Godrej Industries

Plant-based chemistries have an outsized role to play for the HPC sector by meeting demand for good, gentle, and green products

In the next four years, India's growing appetite for organic personal care products is expected to reach over Rs. 236 billion with a CAGR of nearly 24 per cent according to India Organic Personal Care Market Analysis Report 2024-2029 by ResearchAndMarkets. To address these challenges, the Indian government introduced the Indian Chemicals (Management & Safety) Rules (ICMSR). These rules aim to establish a unified, risk-based framework for the management of chemicals throughout their lifecycle - from manufacture to disposal. The ICMSR underwent five rounds of public consultation between 2020 and 2021, reflecting the government's efforts to balance industry concerns with public health priorities.

Sustainability is a catalytic trend shaping the Home and Personal Care (HPC) industry, unlocking significant growth and enabling vital innovation. One reason for this is that sustainability is not restricted to operations or manufacturing; it's a core feature of the product itself. Rising demand for organic products, which are gentler for use compared to their petro-based counterparts, underscores how sustainability is not secondary to business growth, but is a deciding factor for it.

A sharpened focus on greener practices is driven not only by manufacturers' internal commitment to sustainability for a healthier planet and business, but equally shaped by consumer preferences for eco-friendly, sustainable products. Home and personal care products require a strong sustainability proposition to attract

To make the adoption of plant-based chemistry feasible, an industry-wide commitment through R&D and collaborative action is essential

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consumer trust and loyalty.

Consumers today want products that are not only environmentally friendly but also safer for personal and home use. This marked shift is evident all around us, from organic gulaal (colours) for Holi, herbal pest repellents instead of insecticides, to sulphate-free shampoos. Plant-based chemistries have an outsized role to play for the HPC sector by meeting demand for good, gentle, and green products.

Plant-based chemistry makes use of renewable sources like plant biomass, derived from agricultural and forestry products and waste, as raw material for chemicals in place of fossil fuels. While this can help to make products much more sustainable and better for the environment, achieving this switch comes with various challenges. To make the adoption of plant-based chemistry feasible, an industry-wide commitment through R&D and collaborative action is essential.

Driving the Wave of Sustainability

Firstly, it's critical to understand why plant-based chemistry in particular is an essential reform for the HPC industry. End-consumers are looking for products that are organic, eco-conscious and sustainable. This is viewed as not only being healthier for the environment, but also healthier for use on skin, hair and home needs.

Rising consumer awareness, particularly among Gen-Z, means that consumers are becoming more conscious of the ingredient list of not only food items but also any products they use, especially for personal care. Authenticity and naturalness of products is emerging as a key factor in deciding consumer preferences for beauty and personal care products. Creating value for this growing segment of consumers through high-quality, sustainable products can propel further growth for HPC brands, especially when catering to a younger generation who are now entering the workforce and spending more.

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Crucially, sustainability has become a way to enhance differentiation in a competitive market. Gaining market share requires brands to constantly deepen their sustainability efforts through innovation and consistency. This cannot be limited to packaging or marketing efforts. Sustainability must be deepened across the value chain, from the very beginning during the formulation of ingredients used in creating the final product.

Sustainability must be deepened across the value chain, from the very beginning during the formulation of ingredients used in creating final product



Pressing Challenges

Despite the abundant and renewable nature of plant biomass in India, it is not yet efficiently collected and processed in India. This drives up costs and reduces the viability of plant-based chemical production at scale. This is a challenge that must be addressed collectively and collaboratively, allowing manufacturers across the sector to procure feedstock easily and efficiently.

Making plant-based chemistry cost-effective requires robust infrastructure for processing, storage and transporting. One reason why fossil fuels are seen as cheaper is that they enjoy an infrastructural advantage over emerging technologies, but it is precisely investing in new infrastructure that can help make sustainable technologies cost-efficient and easier to adopt at scale. Additionally, processing the feedstock can often be energy-intensive, which again requires infrastructure investments for renewable energy. However, despite these initial high capital costs, bio-based chemicals can unlock not only growth in domestic markets but also significant opportunities for India as a global manufacturing hub for green chemicals.

Lastly, while consumers are more aware of the need for sustainability than ever before, awareness of the need for bio-based chemicals as a critical enabler of sustainability is still comparatively low. This requires strong efforts by chemical manufacturers to highlight the value-add of plant-based chemistry to brands and end-consumers alike.

Road Ahead

India's HPC brands and manufacturers can chart a path of sustainable growth, but this requires proactive efforts. Firstly, the importance of Research & Development cannot be understated. This serves to increase the sector's green capabilities at large, innovate cost-effective methods of production, and improve the efficiency and standardisation of bio-based chemicals. Successful products and innovations aren't accidents, they are most often the result of continuous, dedicated R&D.

Strengthening partnerships with stakeholders is also a vital next step. This involves close coordination between government agencies to ensure compliance, plant biomass collectors and distributors to overcome logistical hurdles, and research bodies to explore context-specific solutions, working together with the Home and Personal Care industry for stronger adoption. This will ensure that plant-based chemistries become a national strength that is visible across the industry, allowing India to flourish as a global leader in bio-based chemicals

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SHAPING CHEMISTRY FOR TOMORROW: DRIVING EFFICIENCY AND GROWTH



SIDDHARTHA GHOSAL
CEO and Country President
Dow India

> By embedding efficiency across manufacturing, product innovation, organizational culture, and sustainability, India's chemical industry is poised to meet global benchmarks, and drive growth towards becoming a $1 trillion chemical economy by 2040

India's chemical industry stands at a pivotal juncture. With the government's emphasis on "Aatmanirbharta" and "Make in India", the sector is poised to become a linchpin of economic growth. Efficiency is no longer a buzzword but a strategic imperative, spanning manufacturing, customer-centricity, product innovation, organizational culture, sustainability, and community development. Sustainability is a catalytic trend shaping the Home and Personal Care (HPC) industry, unlocking significant growth, and enabling vital innovation. Sustainability is not just restricted to operations or manufacturing. Rising demand for sustainable raw materials is not secondary to business growth but is becoming a key enabler for decision making.

By embedding its principles across operations at a holistic level, the industry is primed to meet global quality benchmarks, optimum efficiency, align with India's ambition to grow into a $1 trillion chemical economy by 2040. This growth-conscious approach needs to be balanced with long-term resilience, thus enabling businesses to navigate market volatility and manage geopolitical headwinds, all the while contributing to the nation's growth.

Technology as the Catalyst for Global Leadership

India's aspiration to become a global manufacturing powerhouse hinges on adopting cutting-edge technologies. Artificial Intelligence (AI), IoT-enabled predictive maintenance, and advanced data analytics are revolutionizing plant operations in the sector. For instance, AI-driven demand forecasting minimizes inventory waste, and digital twins of production lines improve performance and efficiency. Such innovations enable manufacturers to scale rapidly, meet stringent timelines, and deliver high-quality products that compete globally.

Further, the integration of automation in manufacturing processes not only enhances safety but also boosts output consistency and maintains quality. As the sector strives to increase investments in smart factories and digital supply chains, it strengthens its own position as a reliable partner for global markets.

Materials Science Powering Sustainable Innovation

Modern consumers now demand products which are high performing yet environmentally responsible, and materials science is meeting this challenge head-on. For instance, advanced silicone formulations in construction enable energy-efficient glass facades that reduce building cooling costs considerably, aligning with India's green infrastructure goals. Similarly, innovative solutions in the household segment, such as mattress recycling by converting polyurethane



foam waste into new raw materials, support product and environmental stewardship. Another apt example in today's hyper-connected markets is the use of post-consumer recycled (PCR) resins for non-food applications, in packaging. These resins offer durable and sustainable alternatives while reducing dependency on virgin plastic. We see that these innovations underscore the broader role of chemistry in driving sustainable solutions across industries while preserving an efficient use of resources, and the need for such solutions is only rising as we pursue growth.

Diversity as the Engine of Innovation

At the people level, the chemical industry, once male-dominated, is transforming rapidly. Today, increased women participation in the sector is bringing fresh perspectives to R&D, operations, and leadership. Diverse teams drive creativity, while inclusive hiring practices have unlocked talent in underserved communities.

It is now more than ever that the industry needs to cultivate a culture of diversity and inclusion (DEI) that in turn fosters resilience. Diverse perspectives and needs drive the development of policies that lead to breakthroughs, promoting both equity and equality in the workplace. Companies embracing DEI culture have seen higher employee retention. As India's demographic dividend unfolds, nurturing an inclusive workforce will be critical to sustaining innovation and maintaining a competitive edge.

Elevating Industry's Role in Sustainable Growth

Beyond increasing the global footprint, the chemical sector, often perceived as resource-intensive, is now redefining its relationship with the planet. As a foundational industry enabling infrastructure, mobility, electronics, and cutting-edge technologies, we bear a dual responsibility: driving economic progress while preserving our planet.

Circular economy and sustainability principles now require being embedded in product life cycles while preserving the quality of the product's design. We see excellent examples in this regard, from bio-based polymers to recyclable chemistries that are reducing dependency on virgin resources. Inducting carbon capture technologies into operations are slashing emissions in ethylene crackers, and usage of green hydrogen is decarbonizing ammonia production, aligning the sector with India's clean energy transition.

As India's demographic dividend unfolds, nurturing an inclusive workforce will be critical to sustaining innovation and maintaining a competitive edge

Further, operational initiatives like adopting solar-powered plants demonstrates how clean tech integration can scale manufacturing productivity without compromising sustainability. The Government's schemes such as the National Green

As the sector strives to increase investments in smart factories and digital supply chains, it strengthens its own position as a reliable partner for global markets

Hydrogen Mission further amplify these efforts. This approach positions the sector as a crucial enabler of India's growth across various domains—from durable construction materials that minimize waste to lightweight automotive components that improve fuel efficiency.

CSR as a Catalyst for Holistic Efficiency

By investing in communities, organizations cultivate trust, strengthen community relations, and ensure their contribution to social causes in and around the areas of its operations. Over time, these initiatives build talent pools, increase community resilience, and aid in enhancing the sector's ability to meet global standards, proving that societal progress and industrial efficiency are mutually reinforcing.

At the community level, initiatives that aim at empowering women, such as through mentored entrepreneurship programs and empowerment drives, unlock their immense economic potential while addressing gender disparities at a granular level. Similarly, promoting STEM education among underprivileged youth nurtures a strong and enabled workforce. Igniting an early interest in science, ensures a pipeline of future-ready and skilled young professionals, ready for the industry's evolving growth demands.



Collaborating for a Shared Vision

India's chemical industry is not just a contributor to the economy but a catalyst for sustainable development. By embracing efficiency in manufacturing, product design, organizational culture, and environmental stewardship, the sector can drive inclusive growth while positioning India as a global leader. Success hinges on collaboration to foster innovation-friendly policies, skill development, and infrastructure.

At Dow India, we believe that progress is not a solitary pursuit but a collective journey. We are "Building Chemistry for Tomorrow", guided by our ambition to innovation, customer-centricity, inclusivity, and sustainability, we are championing solutions that empower industries, communities, and ecosystems to thrive in harmony in a common pursuit of growing excellence. By partnering with policymakers, academia, startups, and civil society, we are co-creating value chains that prioritize responsible and efficient growth at a holistic level.

The chemical industry's role is not only to respond to shifts in efficiency and growth drivers but to actively spearhead them with responsibility, equity, and a steadfast commitment to progress. By harnessing our collective efficiencies, we can unlock innovative solutions that drive sustainable growth and create shared value for all stakeholders. Let us seize this opportunity as partners, united in our mission to foster a dynamic and prosperous India, where the benefits of our collaboration resonate for generations to come

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RISE OF BIO-BASED CHEMICALS: HYPE OR GAME-CHANGER?



DR. SANGEETA SRIVASTAVA
Executive Director
Godavari Biorefineries

> The latest BioE3 policy builds the framework for high-performance biomanufacturing to propel the development and production

The global and Indian bio-based chemicals market has enormous growth potential driven by a multitude of factors. The production of such chemicals depends on the availability of feedstock, and it is incumbent upon the stakeholders to manage all such components and ensure smooth processes to transition in a sustainable future.

COP 29 saw crucial strides in advancing climate action for developing countries but significant gaps remain. Issues like the scale of financing, the integrity of carbon markets, and concrete support for adaptation efforts require urgent attention and more decisive action. With Brazil hosting COP 30 this year, there is a critical opportunity to translate commitments into impactful solutions. As COP 30 approaches, the world will be watching to see whether this vital decade for climate action can deliver the results needed to protect the most vulnerable and secure a sustainable future for all.

With a global market size of over US $73 billion and a CAGR of 9.6% between 2024 and 2032, the popularity of bio-based chemicals is expected to increase further

The accelerated transformation towards a net zero circular economy is only feasible with a joint holistic approach to value chain collaboration. It became clear that alternative feedstocks, such as bio-based, CO2 -based and recycled feedstocks, are the key levers to enable this transformation.

The rise of bio-based chemicals is a game changer, and we do not have any other choice. We see slower growth towards adoption, but it is happening. We can adopt cleaner energy and recycling, but net zero will not be possible without de-fossilization. An integrated biorefinery is a step towards achieving this goal.

Defining Bio-based Chemicals

Such chemicals are usually produced through fermentation, enzymatic processes, chemical conversion, or biomass. They can be crops (including sugarcane, corn, and soybeans), wood chips, lignin, algae, microbes, and organic waste.

Current State of the Market

With a global market size of over US $73 billion and a CAGR of 9.6% between 2024 and 2032, the popularity of





bio-based chemicals is expected to increase further. Volatility in petrol and diesel prices, consumer preferences shifting to sustainable products, and depleting stock of non-renewables have fuelled the interest in these products. From the Indian perspective, the sector is also witnessing steady and robust growth with a strong CAGR and growth estimates.

Bio-based Chemicals and Biofuels

In the global economy, biotechnology has begun taking on a significant role. Bio-based chemicals and biofuels are connected through their shared feedstock use, standard processing techniques, and circular economy potential. However, the essential linkage is the role of integrated biorefineries in this process. For a biorefinery, it is necessary to be economical and to produce products at a price that customers would be keen to buy, which is the biggest challenge in the real world.

Each serves a different angle regarding ensuring sustainability across the value chain. Renewable fuels produce drastically less pollution compared to fossil fuels. At the same time, products developed from biochemicals help manage the waste generated from the process, help de-fossilization, and channel it into something productive.

Integrated Biorefinery Concept for Tomorrow

Integrated biorefinery processes are efficient for producing bio-based products and secondary energy carriers such as fuel, power, and heat, along with oil refineries. The pilot projects in India indicate that both conventional (biodiesel and ethanol) and advanced biofuels (of lignocellulosic origin) are yet to be produced profitably to create a sustainable market without implementing government policies and subsidies.

The integrated biorefinery concept enables the conversion of waste to high-value streams in economically attractive pathways by focusing on the key aspects: availability, affordability, sustainability, and productivity. As the world is going towards net zero, there should be a general (global) accepted policy of biogenic CO2 uptake calculation of different biomass crops. So, a biorefinery approach applied to different biomass crops will be more valued within climate policy.

Policies Pushing the Agenda

The Indian government, in a bid to accelerate the integrated bio-refinery agenda, has begun the Mission Integrated Bio-refineries Policy to also design innovative solutions in the sector. Ongoing bio-based innovations with enzymes would only foster and bolster these growth estimates.

In August 2024, the government launched the BioE3 Policy, which aims to channel the trickle-down impact of biotechnology on the economy, environment, and employment. This policy builds the framework for high-performance biomanufacturing, which will propel the development and production at the scale of bioproducts within the nation. With the nation's vast agricultural resources and burgeoning demand for fuel appropriately implemented, such a policy shift could radically change the economy.

The focus must be on strategies to manage the most potential source, i.e., agricultural residues. Some critical issues remain: deployment of existing technologies in agriculture, better agronomic and breeding technologies, proper supply chain, adequate policy framework, effective financing mechanism, and practical information dissemination. However, a policy like BioE3 could be instrumental in sparking sectors to tackle such obstacles.

Biofuels in India are crucial as they align with government initiatives such as Make in India, Swachh Bharat Abhiyan, Self-Reliant India, and skill development. They also offer opportunities to reduce imports, increase farmers' incomes, transform waste into wealth, and create employment.



Circular Economy and Biorefineries

In a broad future circular economy, biomass-originated chemicals will play a critical role. The products and processes to generate them from such materials are usually safe by design. Biorefinery systems will be vital to greater recycling and chemical and polymer production. To ensure a continuous fuel supply and to supplant the huge demand for emerging economies, economies have to be sustainable and circular - on one hand, manufacturing bio-based chemicals that have a wider use in products and bio-fuels that can reduce the dependency on fossil fuels. With both ranges of products, there can be a strong validation of the importance of bio-based products, possibly leading to production at scale.

Challenges Hindering Growth

Despite a promising scenario, there are some pertinent challenges that the industry needs to come together.

Feedstock Cost: Sugarcane molasses and other bio-based feedstocks compete with food production for land and resources. For countries with large populations like India, there are concerns that if the transition is rapid and sudden to bio-based feedstock cultivation, it could lead to price rise and adversely impact food security. Storing and transporting diverse feedstocks like cellulosic biomass could require substantial development and investment. In such cases, ensuring sustainable sourcing and proper resource utilization could be critical in elevating production and minimizing environmental impact.

Biofuels in India are crucial as they align with government initiatives such as Make in India, Swachh Bharat Abhiyan, Self-Reliant India, and skill development

Technology Constraints: Bio-based chemical manufacturers need to scale up rapidly to scale up rapidly and maintain cost-effectiveness. One way to do that would be through innovation and rapid advances. For production, efficient and affordable downstream processing is vital.

Management Issues: Transitioning to a bio-based future would require a skilled workforce with biotechnological experience. Proper waste management efforts are also essential in shoring up efficiencies in the bio-based production chain. These objectives would require close collaboration with multiple external stakeholders, government agencies, leading tech institutes, and private enterprises.

The Future of Chemicals is Green

Looking at the current state of affairs and the rise of biobased chemicals in the short term may seem like hype, but it is a game changer in the mid and long term. Countries and companies are sticking to their net zero and decarbonization goals. The global energy mix is observing a rapid transition to renewable fuels. While in its early stages, the market for bio-based chemicals in India shows genuine promise. Key stakeholders must come together to develop innovative alternatives that are marketable to the general public.

The sector needs better long-term planning and policies and technological solutions that are practical and effective in an actual life scenario. Lastly, while aim and vision should be high, the same can be done by taking small but concrete steps. It allows the ecosystem to grow while ensuring the penetration of fuel and technologies



NEED FOR TECHNICAL STANDARDS IN INDIA'S CHEMICAL: REFLECTIONS ON ICMSR AND ROLE OF GHS



SHISHER KUMRA
Executive Director and Founder
Global Product Compliance Group

India's chemical industry is a driving force of the national economy, contributing significantly to manufacturing output and export revenue. However, the growth of the sector has outpaced the development of a centralized regulatory framework for chemicals. Chemical safety in India is currently governed by a patchwork of legislation, including the Environment (Protection) Act, the Factories Act, and sector-specific laws, each of which operates in isolation. This fragmented system often results in compliance ambiguity, regulatory inefficiencies, and risks to human and environmental health.

The proposed Indian Chemicals (Management & Safety) Rules (ICMSR) aim to align India's regulatory framework with global standards

To address these challenges, the Indian government introduced the Indian Chemicals (Management & Safety) Rules (ICMSR). These rules aim to establish a unified, risk-based framework for the management of chemicals throughout their lifecycle - from manufacture to disposal. The ICMSR underwent five rounds of public consultation between 2020 and 2021, reflecting the government's efforts to balance industry concerns with public health priorities.

Overview of ICMSR

The ICMSR framework is based on global best practices including the European Union's REACH regulation. It introduces obligations for all stakeholders involved in the manufacture, import, and handling of chemicals. These obligations include:

- Notification of Substances: Companies handling more than one tonne of a chemical per year must notify the authorities with basic data.
- Registration of Priority Substances: Certain hazardous substances must be registered with detailed safety information.
- Chemical Safety Assessments (CSA): For registered substances, companies must conduct and submit risk assessments.
- Authorization and Restriction: Continued use of high-risk chemicals will require special authorization.

India's chemical sector is one of the fastest growing in the world, yet it continues to be governed by fragmented regulations



- Import and Trade Controls: Stricter import regulations will ensure conformity with international safety standards.
- Supply Chain Communication: Industries must share safety data and handling guidelines throughout the supply chain.

These measures are designed to promote transparency, accountability, and long-term sustainability in India's chemical industry.

Industry Perspectives: ICMSR Survey Findings (March 2025)

In March 2025, a survey was conducted to assess industry perspectives on ICMSR. The survey received 127 responses from 101 organizations, including manufacturing companies, consultancies, and institutions.

Key Findings:

- 79.5% (101 respondents) support the ICMSR framework.
- 7.1% (9 respondents) were opposed.
- 13.4% (17 respondents) expressed uncertainty or conditional support.

Sectoral and Professional Insights: Multinational corporations and large domestic manufacturers were more likely to support the regulation, seeing it as a way to improve global competitiveness. Conversely, small and medium-sized enterprises (SMEs) expressed concerns about compliance costs and administrative complexity. Regulatory professionals and senior technical staff were largely supportive of ICMSR, recognizing its alignment with international standards and its potential to improve chemical safety in India.

These findings highlight widespread support for ICMSR, but also point to the need for targeted capacity building efforts, especially for SMEs, as they navigate the regulatory transition.



Survey Findings on the Globally Harmonized System (GHS)

The same survey also explored industry perspectives on the adoption of the Globally Harmonized System (GHS) of classification and labelling of chemicals.

Key Findings:

- 66.1% (84 respondents) support the implementation of GHS.
- 6.3% (8 respondents) were opposed.
- 27.6% (35 respondents) were undecided or expressed conditional support.

While support for GHS was slightly lower than for ICMSR, the majority of stakeholders recognized the benefits of harmonizing chemical hazard communication. Many respondents, particularly smaller companies, indicated a need for additional guidance on compliance requirements, documentation formats, and implementation timelines.

Sectoral trends mirrored the ICMSR responses: larger companies and professionals with regulatory expertise were more supportive, while SMEs emphasized practical implementation challenges. These findings point to the need for phased implementation, training programs, and financial assistance to promote widespread and effective GHS compliance.

Why India Needs ICMSR

The case for ICMSR is based on four main considerations: regulatory clarity, environmental protection, trade competitiveness, and innovation.

First, India's current regulatory fragmentation creates uncertainty for both regulators and businesses. A single, coherent framework such as ICMSR can eliminate overlap, reduce compliance ambiguity, and improve enforcement consistency.

Second, ICMSR is essential to protect human health and the environment. Mismanaged hazardous chemicals can lead to industrial accidents, water and air pollution, and long-term ecological damage. ICMSR introduces systematic risk evaluation mechanisms to address these issues at their source.

Third, the regulation enhances India's standing in international markets. Global buyers are increasingly demanding safety documentation aligned with international regulations. ICMSR will enable Indian exporters to meet these expectations, thereby improving

market access and strengthening trade partnerships.

Finally, ICMSR encourages sustainable innovation. By identifying and restricting substances of very high concern (SVHCs), it encourages the development of safer alternatives and the adoption of green chemistry practices. Over time, this shift supports long-term industrial resilience, reduced liability, and environmental responsibility.

Role of GHS

The Globally Harmonized System (GHS) plays a complementary role to ICMSR by standardizing how chemical hazards are classified and communicated.

Developed by the United Nations, GHS ensures that everyone - from chemical handlers to regulators and consumers - receives consistent and understandable hazard information.

In India, full adoption of GHS would bring numerous benefits. First, it would improve workplace safety by ensuring that all users can identify hazards through internationally recognized pictograms, signal words, and safety instructions. This is especially important for workers who may not be familiar with complex technical terminology.

Second, GHS enhances India's export capability. Many countries require GHS-compliant labelling and Safety Data Sheets (SDS) for imports. Without harmonized standards, Indian manufacturers face delays, additional costs, or even rejection of shipments.

Third, GHS reinforces the broader goals of ICMSR. By requiring a common language for hazard communication, it enables better coordination across the supply chain and strengthens regulatory enforcement. Information from GHS-compliant SDSs will be instrumental for chemical risk assessments, decision-making, and training.

Currently, India's implementation of GHS is partial, relying on sector-specific guidelines. Mandating full adoption under ICMSR will fill critical gaps, ensure consistency, and support seamless integration into global markets.



Currently, India's implementation of GHS is partial, relying on sector-specific guidelines. Mandating full adoption under ICMSR will fill critical gaps, ensure consistency, and support seamless integration into global markets

Conclusion

India's chemical sector is poised for continued growth and global integration. However, this growth must be accompanied by a modern regulatory framework that ensures chemical safety, promotes transparency, and encourages innovation. The Indian Chemicals (Management & Safety) Rules (ICMSR), along with full-scale adoption of the Globally Harmonized System (GHS), provide a strong foundation for achieving these goals.

Survey data shows that most industry stakeholders support both ICMSR and GHS, particularly those in larger companies and regulatory roles. However, successful implementation will depend on inclusive strategies that provide training, financial support, and phased timelines - especially for SMEs.

By embracing ICMSR and GHS, India can not only reduce chemical-related risks but also enhance its reputation as a responsible, sustainable, and globally competitive industrial hub

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ROLE OF CHEMICAL INDUSTRIAL PARKS IN INDIA'S MANUFACTURING AMBITIONS

The industrial clusters place Indian chemical sector in a strong position to capitalize on the huge growth potential and make India competitive in the global market

India's aspiration to become a global manufacturing center has picked up strong pace over the past few years, fueled by policy planning strategies, surging world demand, and changing industrial landscapes. Central to this change is a pivotal but relatively lesser-known segment—chemical industrial parks. These specially designed complexes are not only drivers of chemical production; they are catalysts for change, allowing India to scale the heights of global manufacturing.

Backbone for Industrial Growth

The chemical sector is the foundation of many high-growth industries such as pharmaceuticals, textiles, agrochemicals, construction, and automotive. Being one of the most diversified sectors, it accounts for more than 7 per cent of India's GDP (Source: Department of Chemicals and Petrochemicals, Ministry of Chemicals & Fertilizers) and is expected to grow to US$ 300 billion (Source: Invest India). Chemical industrial parks function as coherent and coordinated ensembles that conglomerate chemical factories, ancillary establishments, research and development establishments, and supporting suppliers in an organised and coordinated setup. Shared resources of infrastructure, collective effluent treatment plants, well-entrenched logistics, and waste processing networks, and shared service centers like banking and commerce make the economic system cost-reduced and process-intensified. For a high-compliance-based industry that expects to run processes under great constraint from environmentally benign norms as well as from protection-of-human-life-saving provisions, such location centers have definite benefits. India's cluster-based industrial development strategy has fructified in clusters such as Dahej PCPIR in Gujarat, Paradip in Odisha, and Cuddalore in Tamil Nadu—each with intense backward and forward linkages (Source: PCPIR Policy Report, Ministry of Chemicals & Fertilizers).

India's cluster-based industrial development strategy has fructified in clusters such as Dahej PCPIR in Gujarat, Paradip in Odisha, and Cuddalore in Tamil Nadu—each with intense backward and forward linkages

Infrastructure that Drives Sustainability

This vision was reiterated at the recent conclave organized by Arete Group to commemorate the launch of Phase 2 of Payal Industrial Park (PIP) at Dahej, Gujarat. The conclave was attended by more than 250 industry captains,





The CETP is more than a treatment plant; it reflects PIP's dedication to circular economy and optimization of resources

policymakers, and sustainability champions, highlighting the pivotal role that composite infrastructure such as CETPs (Common Effluent Treatment Plants) has to play in supporting growth with a conscience. At the core of this is the commissioning of PIP's cutting-edge 2.5 MLD Common Effluent Treatment Plant (CETP), part of a total permitted capacity of 50 MLD. Designed for high-COD effluent (5,000 ppm COD and 1,800 ppm BOD), the CETP enables industrial units to reduce their investment in separate treatment plants. With plug-and-play capabilities, the facility enables firms to acquire faster environmental clearances, reduce upfront Capex, and maintain compliance through a Ministry of Environment, Forest and Climate Change (MoEFCC) approved deep-sea discharge mechanism. The CETP is more than a treatment plant; it reflects PIP's dedication to circular economy and optimization of resources. With other future plans such as a solar power plant, hydrogen production, and intelligent utility corridors, the park is setting the stage for a net-zero industrial ecosystem.

Platform for Competitiveness and Innovation

Apart from compliance, such chemical parks are also crucibles of collaboration. Their design allows for synergies between units, allowing sharing of resources, optimal inventory, and reduced logistics costs—factors of prime importance in enhancing global competitiveness. Through promoting innovation and minimizing operational friction, such industrial clusters place Indian firms in a position to react more quickly to market needs and grow sustainably.

Augmenting Export Potential

India is already one of Asia's leading three chemical manufacturers (Source: IBEF) and exports to over 175 nations (Source: Ministry of Commerce & Industry, EXIM Data). Chemical industrial parks leverage this potential by aggregating production capacities, rationalizing supply chains, and referencing quality to global standards. With increasing focus on specialty and green chemicals, these parks are assisting India in grabbing high-value export markets.

Attracting Investments through Policy Support

The Indian government has played an important role in driving the sector forward with initiatives such as Production Linked Incentives (PLI), Make in India, and PCPIR policy. These initiatives have greatly enhanced the ease of doing business and enabled more than US$ 20 billion in FDI from April 2000 to March 2023 (Source: DPIIT). A lot of this investment has been routed through chemical parks that provide scale, predictability, and regulatory certainty. Centralized environmental control, as provided by CETPs, also adds to investor confidence by making compliance easier and ensuring sustainability in operations.

Road Ahead

As international industries look to diversify out of China-led supply chain, India has a singular window of opportunity to emerge as a trusted and resilient manufacturing partner. The modernization and strategic development of chemical industrial parks will unlock this potential. Through green technology investments, digital infrastructure investments, and skill upgradation, these parks are upgrading to future-ready manufacturing parks in line with Industry 4.0 and international ESG standards.

(Source: NITI Aayog & FICCI Reports)



COMBATING CORROSION IN CHEMICALS: FLUOROPOLYMER-LINED EQUIPMENT SOLUTIONS



PRASHANT PATIL
Managing Director
Resistotech Industries

> Over the past 50 years, the major challenges in fluoropolymer-lined process equipment has been the limited understanding of proper raw material selection and ensuring consistency in quality

India has a large chemical industry in Asia pacific region with a steady growth rate of 7-9 per cent in chemicals, pharmaceuticals and specialty chemicals. With an overall market size of > US$ 300 billion, India is the 6th largest chemical manufacturer in the world.

Larger domestic demand along with growing exports from India brings a lot of new capital investment to India which is expected to hit the US$ 500 billion mark in the next 4-5 years. Building new chemical plants requires a large amount of investment in fixed capital and process equipment. The growth comes along with multiple challenges including key raw material availability, new technologies, digitization, safety concerns and equipment compatibility to handle corrosion and hazardous chemicals at optimized cost.

There are multiple solutions to corrosion mitigation practiced in the chemical industry & every solution has its own Pros and Cons. Fluoropolymers like PTFE, PFA, and PVDF etc. as barrier lining material (3 mm to 12 mm thickness) have been used in chemical process equipment manufacturing for corrosion management for more than 10 years. Key applications include Fluoropolymers, Lined Pipes, Fittings, Valves, Pumps, Columns and Tanks etc. whereas premature failure leads to increased downtime and production losses.

There are a handful of quality fluoropolymers lined equipment manufacturers in India and others are catching up. In the last 50 years, among the key challenges observed in fluoropolymers lined process equipment is limited knowledge on right selection of quality raw materials and consistency. Also, the wrong fluoropolymers grades selection without understanding of exposed chemicals & process conditions like Pressure, Vacuum, temperature, permeation performance etc. The limited knowledge on manufacturing technologies and many unorganized players besides the lack of adequate and accurate tooling and skilled manpower are also few elusive challenges. Lack of testing facilities as per international quality standards and manufacturing limitation on larger size fluoropolymers lined equipment and dependency of imported lined equipment at very heavy cost. For example, large Diameter PTFE lined Columns > 400 NB (16 inch) under full vacuum condition and other equipment like tank, vessels, basket filters with no maintenance and zero operational cost.

In the recent past there have been multiple efforts taken by key value chain players in chemical industry to upgrade overall quality performance and reliability of fluoropolymers lined equipment

Tech Disruption: Redefining what's Possible

In the recent past there have been multiple efforts taken by key value chain players in the chemical industry to upgrade overall quality performance and reliability of fluoropolymers lined equipment. Some key corrective actions taken include end user education and awareness from equipment manufacturers via focused seminars, conferences and exhibitions for global information sharing. Active involvement from fluoropolymers material manufacturers and engineering process consultants has significant contribution in successful implementation of lined equipment.

All above efforts have brought new positive drive and helped equipment manufacturers to understand tough challenges mentioned above and brought new solutions. These include newer manufacturing technologies, lager sized seamless PTFE liner manufacturing > 400 NB to 2,000 NB (16 inch to 80 inch) for heavy process equipment like columns, vessels, scrubbers columns, tanks, basket filters, etc. which is proud moment for India to become import independent and develop substitutes with high quality Fluoropolymers lined equipment at reasonable cost and minimum delivery time to serve industry replacing exotic metals.

Resistotech Industries has a state of the art manufacturing facility near Nashik (200 km from Mumbai) for fluoropolymers like PTFE, PFA, PVDF processing and lining facility spread across 9,000 square meter area dedicated to offer corrosion protection solutions. Accepting one of the toughest challenges in the chemical industry, after continuous trials and developments efforts, the company successfully developed India's largest diameter seamless extruded PTFE Liner up to 1,800 NB (72 inch which was successfully lined inside a carbon steel column for handling corrosive chemicals under vacuum conditions. The whole project got over in just 24 months. This successful case has built significant confidence for Resistotech and helped them to showcase our products at many chemical manufacturers in India and abroad. The company started receiving firmed orders from many reputed local and international process equipment manufacturers, end users and engineering consultants for larger diameter seamless PTFE lined columns, vessels and equipment. Also, elaborated that there are around 30+ process parameters needs to be controlled for larger diameter PTFE Liners and 10 of them are most critical to get desired level of quality performance as per international quality standards like ASTM D 4895 & testing as per ASTM F1545-15 for few PTFE Lined products.

Accepting one of the toughest challenges in the chemical industry, Resistotech Industries has successfully developed India's largest diameter seamless extruded PTFE Liner up to 1,800 NB in just 24 months

A Promising Path Ahead

Resistotech is gaining a lot of appreciation from end customers and engineering consultants for addressing their specific application based needs



and becoming one of the preferred partners for development and supply of complicated & quality Fluoropolymers Lined products in India. Through differentiated and unique offerings, the company has achieved excellent growth in the last 5 years which is remarkable. Resistotech is currently focusing on complex challenges faced by aggressive chemical handling in industries like Paper & Pulp, Specialty Chemical and Fluorochemicals, Refineries, Pharma API, Chlor Alkali, Steel processing, Pickling, Agrochemical & pesticides manufacturers to find alternative solutions to expensive import substitutes & exotic metals like Titanium, Tantalum and Hastelloy for selective process equipment within range of fluoropolymers.

We now plan to grow aggressively in the coming 5 years with significant investment in new facilities for production, development and quality control for lined equipment near Nashik. Company is also planning to expand in the international market by partnering with global players to spread their technological advancement for the larger benefit of the chemical industry in corrosion management solutions

FRIENDSHORING PRODUCTION TO INDIA: SHIFT TOWARDS LOCALIZED MANUFACTURING



AASHISH KASAD
Senior Partner
Ernst & Young and National Leader – Chemicals and Agri sector

India has emerged as a stable and trusted global business partner, ranking as the third most preferred manufacturing destination, with the potential to achieve US$ 1 trillion in exports by 2030

The global chemical industry has long been characterized by its reliance on extensive supply chains that span continents, with concentrated production in certain regions having lower labor costs, such as China and Southeast Asia. However, the COVID-19 pandemic exposed the fragility of being highly reliant on one country only, leading to shortages of essential chemicals and raw materials, coupled with escalating geopolitical tensions including the Russia-Ukraine crisis, the Israel-Hamas conflict, and the Red Sea shipping crisis have created significant business disruptions and intensified various risks, prompting companies to reevaluate their supply chains and manufacturing strategies.

Interestingly, almost all, if not all, of



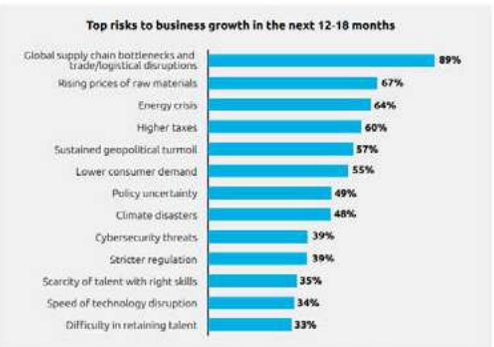
the top risks to business growth for organisations, identified in 2022 for the next 12-18 months, continue to exist even now. Hence, companies are increasingly considering "friendshoring" or "allyshoring" as a viable strategy to mitigate risks and enhance supply chain resilience. As per the World Economic Forum, "friendshoring" essentially refers to the rerouting of supply chains to countries perceived as politically and economically safe or low-risk, to avoid disruption to the flow of business.

India, being a reliable partner, with its growing manufacturing capabilities, large pool of English-speaking skilled workforce, stable government and favorable macro-stability influenced policies, sustainable practices including use of green energy, strong technology capabilities etc, has emerged as a prime candidate for friendshoring chemical production.

Indian chemicals industry, one of the fastest-growing sunrise sectors in the country, growing at approximately 9 per cent CAGR, driven by increasing domestic demand, government initiatives, and a focus on sustainability, is highly diversified, covering >80,000 products and employing >2 million people

Moreover, the Indian chemicals industry, one of the fastest-growing sunrise sectors in the country, growing at approx. 9 per cent CAGR, driven by increasing domestic demand,

FIGURE 05
Supply-chain disruption is the biggest short-term risk for organizations



Source: Capgemini Research Institute, Global Investment Research, November–December 2022. N=2,000 respondents from unique organizations

government initiatives, and a focus on sustainability, is highly diversified, covering over 80,000 products and employing more than 2 million people. It is ranking 6th in the world and 3rd in Asia in global chemical sales. These factors position India as an attractive destination for friendshoring chemical production, to ensure impactful productivity, operational gains and reduce business disruptions.

This article explores the motivations behind friendshoring chemical manufacturing to India to diversify the global supply chain, the benefits it offers, and the models that companies may explore in this transition.

Motivations for Friendshoring to India



Geopolitical Stability: The geopolitical landscape has become increasingly unpredictable, with trade wars and sanctions affecting global supply chains. Friendshoring to India allows companies to reduce their dependence on politically unstable regions and maintain greater control over their operations. India has proven to be not only a stable but reliable business partner to the globe, making India the third most sought-after manufacturing destination in the world, having the potential to export goods worth US$ 1 trillion by 2030.

Supply Chain Resilience: The pandemic highlighted the importance of supply chain resilience. By establishing manufacturing facilities in India, companies can create more localized supply chains, reducing lead times and enhancing their ability to respond to disruptions.

Cost-Effectiveness: While labor costs in India are rising, they remain competitive compared to developed countries. Additionally, the Indian government offers various incentives for manufacturing, making it a cost-effective option for companies looking to offshore.

Skilled Workforce: India boasts a large pool of skilled labor, particularly in engineering and technical fields. This workforce is essential for the chemical industry, where specialized knowledge is required for production processes and quality control. Moreover, India's median age (28 years) is one of the lowest globally and the working-age population for India expected to grow till as late as 2050. There is also an aspirational movement from low-wage agricultural jobs to manufacturing jobs, providing a large pool of resources that can be deployed at factory sites.

Sustainability Goals: Many companies are increasingly focused on sustainability and reducing their carbon footprints. Year 2023-24 saw 45.4 per cent of India's electricity from non-fossil sources, insulating firms from natural gas price hikes and potentially increasing orders, market share and shifting production to India. Friendshoring to India can facilitate the adoption of greener manufacturing practices and enable companies to leverage renewable energy sources.

Benefits of Friendshoring Chemical Production to India

Enhanced Control and Flexibility: Friendshoring to India provides companies with greater control over their manufacturing processes. This flexibility allows for quicker adjustments to production schedules, enabling organizations to respond rapidly to dynamic market demands.

Reduced Lead Times: Manufacturing in India can significantly reduce lead times for product delivery, given India's



unique geographic position enabling faster delivery across various continents. This is particularly important in the chemical industry, where timely access to materials can impact production schedules and customer satisfaction.

Access to Emerging Markets: India is not only a manufacturing hub but also a rapidly growing market for chemical products, swiftly enhancing its production capabilities in fine chemicals, agrochemicals, and specialty chemicals. By establishing production facilities in India, companies can tap into this burgeoning market and cater to local demand.

Government Support: The Indian government has implemented various initiatives to promote manufacturing such as the Public Procurement (Preference to Make in India) Policy, the creation of plastic parks and centers of excellence, the Chemicals Promotion and Development Scheme, and the Proposed New Petroleum, Chemicals and Petrochemicals Investment Region Policy 2020-35, along with Production Linked Incentives and Remission of

Duties or Taxes on Export Products, apart from tax incentives, subsidies, and infrastructure development. These supportive policies can ease the transition for companies looking to reshore. Several states such as Gujarat, Maharashtra, Karnataka, Orissa, and Rajasthan are also offering various incentives such as tax exemptions, land subsidies, infrastructure support, research and development incentives, making them especially appealing to both domestic and foreign investors,



thereby enhance India's attractiveness for manufacturing investments.

Expanding Network of Free Trade Agreements (FTAs): India has entered into 14 FTAs, including four with the European Free Trade Association (EFTA), which comprises Iceland, Liechtenstein, Norway, and Switzerland. Additionally, recent agreements have been made with Mauritius, the United Arab Emirates, and Australia, while ongoing negotiations may lead to over 120 preferential trade relationships through FTAs with the United Kingdom and the European Union (EU). These FTAs facilitate in reducing tariffs on imported raw materials and components thereby lowering production costs which enable chemical players to leverage on these local advantages while accessing global



markets more effectively. India and the United States have also initiated sectoral discussions under the proposed Bilateral Trade Agreement, aiming to finalise the first phase by fall 2025. The agreement seeks to enhance economic cooperation by expanding market access, reducing trade barriers, and deepening supply chain integration between the two nations

Focus on Alternative Feedstocks: Green hydrogen has emerged as a promising alternative feedstock for the chemical industry. The Indian Government is offering schemes to subsidize the production and export of green hydrogen and ammonia. As a result, India's chemical sector is increasingly shifting towards sustainability by utilizing alternative feedstocks and adopting low-carbon energy sources such as biomass, hydrogen, and bio-CNG. The Indian chemical sector is making significant strides, particularly among ammonia and methanol producers, in moving away from fossil fuel reliance towards sustainable production methods.



Innovation and Collaboration: Friendshoring to India can foster closer collaboration between manufacturers,

As per the World Economic Forum, "friendshoring" essentially refers to the rerouting of supply chains to countries perceived as politically and economically safe or low-risk, to avoid disruption to the flow of business

suppliers, and customers. This collaboration can lead to innovation and the development of new products that meet evolving market needs, given India's large talent pool of scientists for research and development.

Models for Friendshoring to India

Several companies have successfully offshored their chemical production to India, across various models, demonstrating the viability of this strategy:

Establishing wholly owned subsidiaries: Given that 100 per cent foreign direct investment is permitted under the automatic route by India in chemical manufacturing, several companies have set up their own entities in India and made significant investments over the years in establishing production facilities that leverage advanced technologies to cater to local markets and export from India. A raft of companies such as Archroma, BASF, Bayer, Callisons, Celanese, Clariant, Corteva, Covestro, Croda, Dow, Evonik,

Firmenich, FMC, Givaudan, Huntsman, IFF, Johnson Matthey, LANXESS, Linde, LG Chemicals, PolyOne, Solvay, Syngenta, Takasago, Yara, etc. represent the above model.

Establishing JVs: Some companies have preferred to establish a joint venture in India to enable them to have control over their operations and yet avail local market access and also benefit from the knowledge of the local JV Partner. For example

- Lubrizol-IOC JV for additives
- Lubrizol-Grasim JV for CPVC resin
- PPG – Asian Paints JV for paints and coatings solutions
- Solvay – MP Birla group JV (Hindustan Gum) produce guar gum
- Solvay – Anthea JV(CatàSynth) produce catechol derivatives
- Wacker Chemie AG - Metroark Chemicals JV produce silicone chemicals
- Givaudan - Privi JV (Prigiv) focuses on manufacturing complex fragrance ingredients using advanced chemical synthesis processes
- Kumiai Chemicals with PI Industries produce agrochemicals
- Mitsui and Nisso Jointly Alliance With Bharat Insecticides for crop protection products
- OAT Agrio Co and Insecticides India JV for researching and inventing new chemical entities in agrochemicals for India and the world

Contract Manufacturing through Local Partners: Select companies who prefer an asset-light model, have chosen to tie-up with local Indian chemical manufacturers under a tolling/contract manufacturing arrangement for varied timeframes. Some of the Indian contract manufacturers having long term contracts with global companies include Deccan Chemicals, Saraswati Agro, PI Industries, UPL, Anupam Rasayan etc.

Conclusion

In a fast changing and unpredictable global economy, friendshoring chemical production to India represents a strategic shift toward localized manufacturing that can help companies mitigate geopolitical risks and enhance supply chain resilience. While such arrangements need careful consideration, the benefits of offshoring chemical manufacturing to India—such as derisking the supply chain through high quality offshore manufacturing, improved control, reduced lead times, and access to emerging markets—make it an attractive option for many organizations.

As the global landscape continues to evolve, companies that embrace offshoring manufacturing to India may find themselves better positioned to navigate uncertainties and capitalize on new opportunities in the chemical industry. The future of manufacturing lies in a balanced approach that combines the advantages of globalization with the resilience of localized production, and India stands at the forefront of this transformation



EMERGING INVESTMENT SCENARIO IN INDIAN CHEMICAL INDUSTRY



MAHESH SINGHI
Founder & Managing Director
Singhi Advisors

> Indian chemical companies are actively pursuing outbound transactions and partnerships to accelerate strategic growth

The global chemical industry is witnessing a prolonged downturn, primarily driven by supply side pressures impacting profitability and reinvestment economics. Significant overcapacity in key building blocks, high energy and feedstock costs, coupled with slowing demand across multiple end-use sectors, have significantly compressed margins over the last few quarters. Geopolitical uncertainties, supply chain disruptions (such as the Red Sea and containers crisis), inflationary pressures, and a sluggish recovery in major economies have further exacerbated the situation.

Today, high-cost chemical assets worldwide are facing immense pressure, and India is no exception. Companies are prioritizing cost efficiency, and assets burdened with high operating expenses, whether due to energy costs, feedstock disadvantages, or aging infrastructure, are prime candidates for rationalization. Many global players are restructuring their portfolios, shutting down unviable plants, or shifting focus to lower-cost production hubs such as India.

Riding on the boom in the chemical sector during the Covid period, most Indian chemical companies immensely benefited and expanded capacities and margins. The Indian chemical industry has been a strong performer, delivering impressive returns over the past five years. However, profitability has flattened in the last two years due to global headwinds, domestic challenges, and a cyclical downturn, including a slowdown in end-user industries. While India's domestic market remains a bright spot for demand growth and operating costs being amongst the lowest in the world, they still face challenges due to surplus capacity, technology gaps, and feedstock pricing. Additionally, competition from cheaper imports, particularly from China is intensifying. From here on, how does the industry at large generate demand to absorb the significant overcapacity in key building blocks and still balance the markets thereby protecting profitability and long-term industry viability is something industry must be watchful of.

Long-Term Promise

Despite these challenges, India is well-positioned for a long term growth in the chemical sector, supported by sustained domestic demand, regulatory expertise in global compliance standards, cost competitiveness, and increasing R&D investments in custom formulations and green chemistry. Nevertheless, issues such as infrastructure limitations, the need for technology partnerships, and sustainability mandates must be addressed. Expanding production capacity, fostering global collaborations, and focusing on eco-friendly innovations will be crucial in strengthening India's role in the global supply chain

India has significant latent domestic demand across the C1 to C9 value chains, spanning derivatives used in pharmaceuticals, agrochemicals, polymers, coatings, and specialty chemicals. However, several internal and external factors have hindered the global competitiveness of Indian chemical companies, causing them to lag in the global positioning. Indian chemical Industry bases its foundation on core segments and continues to see significant investments in core chemistry, green chemistry and mineral-based chemicals.

Core chemistry, particularly cluster-based segments like Chlor-Alkali are the foundation of India's chemical industry. Leading players such as DCM Shriram, Grasim, Atul, Aarti, and Epigral are expanding into downstream and sub-stream chemical value chains to enhance integration and value addition. Additionally, large conglomerates, including Adani and Reliance, are entering the Chlor-Alkali

space, signalling the sector's strategic importance. Likewise, the Aditya Birla Group has partnered with Lubrizol to strengthen its presence in the PVC value chain, further reflecting the growing interest in scaling up and specializing in foundational chemistries.

Green chemistry is gaining traction as Indian chemical companies shift towards sustainable, plant-based alternatives. Leveraging India's rich agricultural base, the industry is investing in bio-based chemicals for pharma, healthcare, and specialty additives. Global awareness and preference for natural over synthetic materials are placing immense importance on sustainable inputs for all end products.

Mineral-based chemicals are vital to India's chemical industry, serving as key feedstocks for fertilizers, pharmaceuticals, construction, and specialty chemicals. Despite abundant mineral reserves, India remains import-dependent in critical segments such as phosphates, soda ash, titanium dioxide, rare earths, and lithium due to limited local processing and refining capacity. Strengthening beneficiation, backward integration, and advanced purification can enhance self-sufficiency. Sustainability efforts and global partnerships will be essential in building a resilient domestic supply chain and reducing import reliance.

Government initiatives such as the Production Linked Incentive (PLI) scheme and "Make in India," along with backward integration efforts and global partnerships, are driving self-sufficiency. The government's focus on infrastructure development and industry support, and development of large-scale chemical industry zones such as Dahej and Vizag, will further accelerate targeted growth tapping into global markets, making India an increasingly attractive destination for chemical manufacturing and exports.

India's Chemicals Play: Emerging as a Global Investment Hotspot



As global supply chains diversify under the China Plus One strategy, India has emerged as a strong contender due to its cost advantages, skilled workforce, and a growing domestic market. Formulation-based chemicals, which involves blending active ingredients with excipients or additives, presents a significant opportunity for India as they are critical across industries such as pharmaceuticals, agrochemicals, coatings, adhesives, and personal care.

Additionally, India faces tough competition from European chemical giants, which have extensive global subsidiaries and joint ventures, enabling them to meet rising global demand more efficiently. However, to fully capitalize on this shift and remain globally competitive, Indian chemical companies must scale up capacity, enhance infrastructure, and invest in R&D to meet global quality and regulatory standards.

To attract global demand, exports must be treated as a dedicated business vertical, ensuring that international firms have confidence in India's scalability and quality standards. The Indian chemical industry's pivotal role within the global value chain has ignited significant interest from both strategic and financial investors worldwide.

Expanding production capacity, fostering global collaborations, and focusing on eco-friendly innovations will be crucial in strengthening India's role in the global supply chain

This surge in investment is driven by a confluence of factors, including the pursuit of direct market access, portfolio expansion, cost-effective manufacturing capabilities, robust distribution network enhancement, and the potential for substantial financial returns within a high-growth market.

Notable transactions include the International Chemical Investors Group (ICIG) acquiring a majority stake in Hyderabad-based Vasant Chemicals,

a manufacturer of specialty chemicals and pharmaceutical intermediates. Likewise, private equity firm Bain Capital made a financial investment by acquiring Porus Labs, a Hyderabad-based specialty chemicals company operating in segments such as specialty polymers, electronic chemicals, and agrochemicals. This move seeks to establish a platform in the specialty chemicals contract development and manufacturing sector, leveraging Porus Labs' existing position.

Several global chemical distribution companies, including IMCD, Brenntag, and Azelis, continue to pursue acquisitions in the Indian chemical distribution unorganized market to gain access to key markets, products, and customers.

R&D to RoI: Feuling the Innovation-Led Investment Wave

To accelerate strategic growth, Indian chemical companies are actively pursuing outbound transactions and partnerships, aiming to acquire advanced technology and R&D capabilities, expand their global footprint, fortify supply chains, and diversify their product portfolios with innovative chemistries. Prominent transactions include UPL's acquisition of Arysta LifeScience and ChrysCapital-backed Safex Chemicals' acquisition of UK-based Briar Chemicals to expand its global footprint. Additionally, large Indian corporations such as Reliance Industries Limited (RIL), Pidilite, and DCM have formed partnerships to gain access to advanced technologies.

Indian companies have made strategic and ambitious moves by acquiring renowned global businesses from German family-owned enterprises. Remarkable examples include the Murugappa Group's landmark acquisition of Huber and Sudarshan Chemicals' transformative acquisition of Heubach, strengthening their international footprint and industry leadership.

Domestic PE funds have also been



Indian chemical Industry bases its foundation on core segments and continues to see significant investments in core chemistry, green chemistry, and mineral-based chemicals

focusing on high-growth chemical businesses, undertaking control transactions, and executing bolt-on acquisitions such as IndiaRF's acquisition of Anthea Aromatics, Premji's investment in Best Value Chem, and Motilal PE's investment in Megafine. Advent, after acquiring RA Chem, further expanded through the bolt-on acquisitions of ZCL and Avra and integrated them into the Cohance platform.

Future-proofing India's chemical industry and enhancing its global competitiveness demands a multi-faceted approach. This includes: bolstering value chain integration by investing in domestic production and strategic global technology partnerships, scaling operations through targeted M&A to expand market share and access advanced chemistries, integrating decarbonization principles via ESG initiatives, green chemistry, and circular economy practices, and optimizing supply chains and leveraging trade policies to maintain cost competitiveness in a dynamic global market.

The Indian chemical industry must also consider upcycling from 'volume to value', to help balance out supply-demand, protect margins and allow for sustained reinvestment economics

SUSTAINABLE CHEMISTRY AS A PILLAR OF VIKSIT BHARAT @2047

By designing and promoting sustainability, we can build a future free of hazardous waste and environmental degradation while achieving the goals of Vikshit Bharat



DR. K. NAGAIAH
Chief Scientist
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PHANI RAJ G.
IT Professional

The Indian chemical industry is experiencing remarkable growth and is on track to achieve the $1 trillion target by 2040. As India takes a stride toward "Vikshit Bharat" (a developed India) and aims for self-reliance, it is imperative that the chemical industry adopt sustainable practices that balance the triple bottom line of people, planet, and profits with that of sustainable chemistry. Although it is certainly agreeable that the chemical industry is required for various applications, it is vital to understand its drawbacks relative to areas such as safety and greenhouse gas emissions. Sustainable chemistry is gaining global prominence, particularly in alignment with the United Nations' Sustainable Development Goals (SDGs), which aim to improve quality of health, reduce consumption, address gender inequality, protect biodiversity, and safeguard land and marine ecosystems, which are goals to which India is committed. The chemical industry remains a crucial sector due to its impact on the environment, society, and the economy. We will be highlighting some aspects of sustainable chemistry the Indian chemical industry should explore.

Addressing Key Challenges

Toxic Waste and Hazardous Materials: The chemical industry has a bad reputation for causing pollution, hazardous waste generation, and chemical disasters, often due to human error or system malfunctions. Sustainable chemistry greatly differs in this aspect, as it aims to create a minimal amount of waste byproduct. As production scales up and new chemicals are introduced, safety and environmental pollution must remain top priorities. The Bhopal, Visakhapatnam, Love Canal, Lake Erie tragedies all serve as tales of unsustainable practices to be avoided. Further there are many toxic belts across where people are suffering from effects of hazardous substances. Consequently, toxic chemicals can cause significant effects on agriculture, threatening food security.

The research should focus on benign molecule design to facilitate reduction of hazardous ingredients, reagents, additives, solvents, catalysts, wastage, and byproducts. Alternative to toxic chemicals that can potentially cause death, health problems during production, end use and those that persist in the environment for a long time should be explored.

To mitigate such risks, research must focus on planning industries to study the chemical processes from reactions perspective and figure out sustainable manufacturing processes emphasizing safety from the planning



India needs to introduce regulations similar to the EU's REACH and US EPA regulated TSCA (Toxic Substances Control Act) to ensure that all chemicals produced, imported, or traded in India are registered, with information about them easily accessible

stage and throughout the construction and production, transportation phases. For instance, assessing the need for large chemical storage tanks, especially near urban areas, is essential for preventing future disasters and training of the workers handling the chemical processes. Protocols have to be developed to ensure the safe transportation of chemicals to prevent spills or leaks on the road.

Effluent treatment plants must be tailored to treat hazardous chemicals, preventing pollution of rivers and lakes, which have been reported to contain heavy metals and other contaminants, leading to health crises such as rise of cancers. We must also prioritize saving the oceans and marine environments.

Renewable Energy and Bio-feedstocks: While transitioning from fossil fuels to renewable energy and bio-feedstocks is essential, several challenges must be addressed. The use of bio-feedstocks like sugarcane and ethanol raises concerns about food security and biodiversity. The risk of monoculture crops threatening ecological balance also exists. Further cultivation of these crops may involve application of pesticides and fertilizers that threaten the environment and defeat the purpose. Sustainability is the key aspect. Life Cycle Assessments should be conducted to evaluate these issues.

Food and Food Additives: As the processed food industry grows, usage of flavoring agents, anti-caking agents, preservatives, similarly grows. Some of these additives are known to be unsafe therefore need to be regulated comprehensively and stricter labeling should be enforced. Consumers should be made aware of the product they are consuming, helping them make better informed choices. The databases on lines of FDA GRAS and Codex Alimentarius should be made available for the Indian foods in English and vernacular languages.

Textile Industry: According to a Swedish Chemical Agency report, around 10 per cent of chemicals found in clothing products may contain harmful chemicals which may even disrupt endocrine. Furthermore, landfills are flooded with textile waste, and runoff can reach waterways and fields. We should aim to minimize use of formaldehyde, PFAS, and phthalate-based leveling agents, and instead find potential replacements for these substances, so that they can be used in sustainable textile production.

Electronic Waste: Flame retardants, lead, and other heavy metals are some toxic substances typically found in waste of electronics. Safe disposal of e-waste needs to be stressed by the government; proper disposal is needed, as oftentimes inappropriate disposal can lead to exposure of aforementioned chemicals. Safer alternatives for the harmful substances used in the electronics need to be rigorously studied.

Plastics: Although cheaper to produce, plastic products—especially single-use plastics and multi-layered packaging, are difficult to recycle and often contain harmful additives. The chemical industry should focus on Life Cycle Assessment studies for plastics, and initiatives to reduce dependence on plastics. Bioplastics, while reducing carbon footprints, are also not easily biodegradable. Industry practices must focus on eco-friendly alternatives in labeling and packaging.

Micro Plastics: There are two types of microplastics: those produced for use in cosmetics and pharmaceuticals, and those that occur from the degradation of plastics. The construction industry's demand for paints, varnishes, and coatings containing microplastics is rising. Special filtration devices should be employed to prevent these microplastics from entering waterways.

Talent Development and Gender Inclusivity

The chemical industry faces a decline in enrollment and interest. Fields like Computer Science are perceived as more lucrative than Chemistry and Chemical Engineering, which are often considered difficult. To change this, it is essential to host various outreach programs and posting on social media to attract youth towards the opportunities of chemistry and chemical engineering. Additionally, promoting diversity and inclusion, representing all sections of society, should also be prioritized to ensure various perspectives in research and innovation.

Advancing Research in Sustainable Chemistry

As India progresses towards Vikshit Bharat, emerging technologies such as nanotechnology and electric vehicles require careful consideration of the environmental and resource extraction costs. Basic research in chemistry and chemical engineering should be prioritized in research institutions to find sustainable solutions.

The conversion of feedstock such as bioproducts, solid municipal waste, industrial waste, agricultural waste to organic chemicals and energy should be explored. BioE3 initiatives of the Government of India should fund research into fermentation, composting and organic waste management.

Research in sustainable chemistry explores alternatives, such as abundant metals for catalysis, and investigates organocatalysis, bio catalysis, and hybrid bio catalysis leveraging synthetic biology and photocatalysis. Bioprospecting can help identify enzymes for industrial-scale processes that address challenges such as plastic waste and support fermentation pathways for synthetic chemical processes.

Artificial Intelligence also holds potential in sustainable chemistry. Learning models and technologies can aid in molecule discovery and can enhance safety systems. However, AI implementation must be carefully analyzed to avoid operational issues. For example, gas pipelines across the country could be fitted with sensors monitored by AI to ensure safety. The industry must also prioritize cybersecurity to safeguard safety protocols and intellectual property.

The government should introduce a national sustainable chemistry policy, akin to the proposed Sustainable Chemistry Act in the US, to provide the necessary framework for progress

Regulations and Safety Measures

India needs to introduce regulations similar to the EU's REACH (Registration, Evaluation, Authorization, and Restriction of Chemicals) and US EPA regulated TSCA (Toxic Substances Control Act) to ensure that all chemicals produced, imported, or traded in India are registered, with information about them easily accessible. Information about these materials should be made available on smartphones and web portals, similar to the Ask REACH and ToxFox tools used in Europe. Regulations and customer awareness would spur innovation in the chemical industry, promoting a shift toward less toxic substances.

Material Safety Data Sheets (MSDS) should be strictly mandated. These important sheets contain information on properties and any hazardous impacts associated with certain chemicals, along with precautionary measures when working with the chemical. SDSs must be available to factory personnel, surrounding industries, emergency responders, and the public. Staff members working in chemical plants or in lab environments should be trained regarding the interpretation and application of safety data sheets. Public education campaigns, including in schools and colleges, should aim to teach locals, school children, and the youth how to interpret these safety sheets and therefore respond to emergencies.

Additionally, a web/mobile portal should be developed to make chemical safety information accessible. Industries should conduct fire drills, distribute safety masks to residents near industrial areas, and install siren systems to alert the public in case of emergencies.

Collective Efforts and Strong Policy Push

As we move toward Vikshit Bharat, sustainable chemistry offers the key to addressing challenges in the chemical industry. With cutting-edge research and active support from the government, India can build a sustainable and resilient chemical industry that contributes to environmental protection and societal well-being. The government should introduce a national sustainable chemistry policy, akin to the proposed Sustainable Chemistry Act in the US, to provide the necessary framework for progress. Similarly, the government should also take action to consider sustainability-linked incentives akin to PLI to encourage the concept.

By designing and promoting sustainability, we can build a future free of hazardous waste and environmental degradation while achieving the goals of Vikshit Bharat. This is only possible with the collective effort of the diverse nation of India, the Chemistry community, and the Chemical Industry. India can harness the potential of sustainable chemistry, which can lead to a great degree of improvement in scientific innovation and societal change ICN

FUTURE OF PESTICIDE FORMULATIONS LIES IN LOW-COST, INTERDISCIPLINARY INNOVATIONS

IPFT made significant advancements from conventional to next-generation technologies, including nano-enabled and botanical-based formulations



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Traditional pesticide formulations often face limitations such as low solubility, unintended toxicity to non-target species, and prolonged environmental persistence. In contrast, specialized pesticide formulations overcome these challenges by improving bioavailability, enabling controlled release, and increasing target specificity. These innovations are aligned with the principles of ecological sustainability and integrated pest management. Advanced formulations—including controlled-release, combination, and biopesticide variants—offer significant advantages over conventional pesticides. They are engineered for higher efficacy with broad-spectrum pest control, allowing for reduced application doses and minimizing the risk of resistance development in pest populations.

The increasing demand for food production and the spread of vector-borne diseases necessitate efficient pest control strategies. Moreover, the disease-carrying vectors cause life-threatening diseases and impose a social and economic burden. The dependence on conventional agrochemical formulations to manage agricultural pests and disease vectors may further harm the environment and consumers.

Role and Relevance of IPFT

Institute of Pesticide Formulation Technology (IPFT), is an autonomous institute under Department of

Chemicals & Petrochemicals (DCPC), Ministry of Chemicals & Fertilizers, Government of India is one of its kind institute in India with a focus to develop user and environment-friendly new generation pesticide formulations, bio-botanical formulations, analytical services, bioefficacy & phytotoxicity studies since its inception.

IPFT designs formulations with improved solubility, stability, leaf adhesion, and controlled release properties and targeted delivery to combat both agricultural pests and disease vectors. The institute has the latest and advanced state-of-the-art infrastructure to develop pesticide formulations, their analytical characterization, bioefficacy & phytotoxicity evaluation through lab and field trials with a facility to optimize pilot scale demonstrations of the developed pesticide formulations.

The analytical facility of IPFT has been certified by NGCMA as per OECD-GLP principles and accredited by NABL as per ISO/IEC – 17025: 2017 and also recognized by Central Insecticide Board & Registration Committee (CIB & RC) for data generation for household and crop protection product registration related to bioefficacy, phytotoxicity, and residue studies.

IPFT is contributing to the industry by developing highly specialized formulations, including green formulations based on biological and botanicals for crop protection and public health applications. To date, 95 formulation technologies have been developed and successfully transferred to various industries, with 15 of these technologies secured through patents. Additionally, over 100 research papers have been published in esteemed national and international journals. Today, IPFT has a strong presence in the Indian agrochemical industries and support them through formulation development and pilot scale demonstration, bio-evaluation and analytical chemistry data generation. IPFT conducts farmers' awareness programs to make them aware about the safe and judicious use of pesticides, integrated pest management and good agricultural practices and utilize the locally available plants for pesticide extract preparation for agricultural applications etc. Further it also conducts industry interaction meets to brief about the advancements in pesticide formulations, analytical and bio-evaluation studies and regulatory requirements etc.

As an initiative to create safer alternatives to DDT, IPFT developed a range of biopesticide formulations based on neem and Bacillus thuringiensis. These include neem-based repellent coils, creams, suspension concentrates, surface-spreading agents, and tablet formulations



Figure 1: Pictorial representation of IPFT facilities and activities

IPFT Initiatives in Improved Conventional Formulations

Initial efforts were focused on the development of conventional pesticide formulations such as dustable powder (DP), wettable powder (WP), emulsifiable concentrate (EC), soluble liquids (SL) and these had limitations as dust inhalation and solvent toxicity etc. IPFT has transitioned to green solvents and bio-based adjuvants, reducing the active ingredient dose and environmental impact.

Sustainable alternatives such as green EC and SL formulations have been explored. These were possessed to have limitations like presence of petroleum-based solvents (EC formulation) and dust inhalation with the use of DP and WP; in addition, these are difficult to mix in spray tanks and, have poor compatibility, and sometimes toxic to crops and non-target organisms, resulting in environmental contamination. Later on, IPFT made efforts to modify the EC formulations by replacing petroleum distillates with green solvent which helped to reduce the environmental impact by using more sustainable and eco-friendly alternatives. This change aligns with the commitment to promote green chemistry practices in the agrochemical industry. The use of bio-based adjuvant reduced the required dose of pesticide active ingredient, which led to make advances in SL formulation, and then green solvent-based EC formulations are being explored as a sustainable alternative to petroleum solvent based EC.

New Generation Technologies: A Transition from Conventional Formulation Technologies

New-generation formulation technologies have been introduced to overcome challenges associated with conventional technologies. With advancements in pesticide formulation technologies, IPFT has developed new-generation formulations, including EW (Emulsion-in-water), SC (Suspension Concentrate), and WDG (Water-dispersible granules). The new generation formulations offered several technologies like SC, WDG as safer alternatives to WP, DP, and EC. The efforts at IPFT continue to advance new-generation formulations of synthetic and botanical-based pesticides, aiming for a safe and smart delivery systems of pesticides that can reduce the adverse effects associated with conventional formulations. The most recent trends in formulation technologies, emphasizing botanical pesticides and combination formulations, including bio-waste reuse and controlled release technology, are currently trending. Examples include SC formulation for controlling parasitic weeds, WDG formulation of biopesticide etc.



Figure 2: Different types of formulations developed at IPFT

To date, 95 formulation technologies have been developed and successfully transferred to various industries, with 15 of these technologies secured through patents. Additionally, over 100 research papers have been published in esteemed national and international journals

Nanopesticides Formulations

Nanopesticides involve tiny particles of a pesticide's active ingredient (a.i.) with at least one size dimension in the range of 1-100 nm. The advantages of nanoparticle-based pesticide formulations include enhanced water solubility, wettability, bioavailability and increased stability of an active pesticide, the capacity to delay the release of active ingredients, and the ability to prevent pesticide degradation from environmental factors, as well as increased insecticidal activity due to smaller particle size and greater surface area. IPFT developed nanotechnology-based formulations, including nanosuspension, nanoencapsulation and nanoemulsions for pesticide delivery, which has advantages as outline above resulting in improved pest control and contributing to the progress of agrochemicals delivery, which can become a potential breakthrough in crop protection and pest management.

Our recent research has focused on nanoemulsions of synthetic as well as biopesticides to control agricultural

pests and vectors that can transmit deadly diseases. IPFT investigated the effectiveness of water-insoluble resin derived from the tree of Pinaceae family, served as the biopesticide, and loaded into stable nano-micelles. In a field bioassay, a single spray treatment of resin-loaded nanoemulsion provided at least nine days of protection against aphid infestation. Further, grape pomace-derived extract to develop nano formulation, which was effective against whiteflies, the potential of botanical nanoemulsion as a biopesticide, namely castor oil, and biowaste, cashew nut shell liquid nanoemulsion, orange peel derived nanoemulsion as a larvicide against mosquito vectors were also investigated.

Biopesticide Formulations: Botanicals, Microbial & Waste Valorization

In a move to develop safer alternatives to DDT under the United Nations Industrial Development Organization sponsored project, IPFT developed neem and Bacillus thuringiensis-based biopesticide formulations such as neem-based repellent coil, cream, suspension concentrate, surface spreading, and tablet formulations against mosquito vectors and were transferred to Hindustan Insecticide Limited for commercialization. Water-based SC formulation of Verticillium lecanii and oil dispersion of Sisham leaf extract have been developed against aphids of seed spice crops.

The herbicide formulation for the management of orobanche weed was developed in collaboration with ICAR-DRMR, Bharatpur. Bioefficacy field trial results indicate good control of target weed. Bio-botanical formulations may be effectively used as safer alternatives to synthetic pesticides and have potential applications in minimizing pesticide residue in crops and promoting organic farming. A botanical-based oil dispersion system has been



Figure 3: Different biopesticides formulation developed at IPFT

developed considering the above facts, which showed good bioefficacy against aphids of spice crops.

Combination Pesticide Formulations

Due to the high operational costs associated with agrochemical usage in agriculture, pesticides are combined in formulations to prevent tank mixing; as a result, combination applications of various products are prevalent and trending in agriculture. Water formulation technologies are commonly employed in combination formulations. The combination formulations include Suspo-emulsions (SE), ZW (combination of CS + EW), and ZC (combination of CS + SC).

These types of formulations have advantage because of the combination of two pesticides and their individual formulations in one formulation to have broad-spectrum activity, i.e., in EW formulation, which is available for quick action. In contrast, encapsulated lambda-cyhalothrin CS was retained for controlled release effects. Thus, it helps to maintain the effectiveness for an extended period of time with long-term pest control. The combination formulation can be used for different pesticides with a good compatibility index. ZC is the stable aqueous suspension of CS and SC, where one pesticide is encapsulated in a polymeric matrix producing microcapsules, and the other is suspended as fine particles in a water medium. The ZC formulation of thiamethoxam and lambda-cyhalothrin has been effective against soybean aphids, Japanese beetles, grasshoppers, stink bugs, etc. IPFT has developed Lambda cyhalothrin 14 per cent CS and Diflubenzuron 10 per cent SC. This ZC formulation is effective against the early and adult stages of the pest.

Future Outlook

With the current developments in pesticide formulation technology, it is expected that advancements in formulation technology will play a crucial role in the future of agriculture and global food production, contributing to sustainable crop protection. The innovative formulation technologies, including nano-enabled, controlled release, and biopesticide formulation technologies, should be based upon simplicity-in-development approaches and be considered efficient and viable only if created by considering the principal areas like chemistry, agronomy, material science, toxicity, and plant physiology. The cooperation between the public and private sectors is required to allow the design of an improved and environmentally sustainable alternative.

Communication with the public is also essential to promote technological acceptance and combat misconceptions about new technologies. Formulation costs are necessary for developed technology; therefore, minimizing formulation costs while maintaining product quality is crucial. Beyond crop production, other areas, like the public health sector burdened by disease vectors (mosquitoes, ticks, mites, etc.), can profit from these cutting-edge technologies and will be given more consideration in the future. The future of pesticide formulations lies in low-cost, interdisciplinary innovations that ensure sustainability and public acceptance. IPFT aims to support global food security and public health through continued R&D in nano-enabled, biopesticide, and controlled-release technologies

BUILDING VIKSIT BHARAT & VIKSIT GUJARAT 2047: STRATEGIC ROLE OF CHEMICAL SECTOR



DR. JAIMIN VASA
President
Gujarat Chemical Association

> By 2047, the sector is expected to be even more critical in driving both the Indian and global economies

India is on the cusp of monumental transformation, with aspirations of becoming a "Viksit Bharat" by 2047, marking a century of independence. A significant player in this ambitious goal is the chemical sector, which has long been a cornerstone of industrial growth, economic development, and technological advancement. In this context, the chemical sector will play an increasingly vital role in driving the nation's overall progress. Similarly, Gujarat, often referred to as the "chemical hub" of India, will be at the forefront of shaping the vision of "Viksit Gujarat" by 2047, contributing substantially to the national vision.

Current Landscape of Chemical Sector in India

India is the 6th largest producer of chemicals in the world and, contributing 7 per cent to the country's GDP. The Indian chemical industry is currently valued at US$ 220 billion and is expected to reach US$ 300 billion by 2030 and US$ 1.5 trillion by 2047. The industry includes the production of a wide range of chemicals, from petrochemicals, and paints to agrochemicals, pharmaceuticals, and specialty chemicals. The chemical sector not only provides raw materials for various industries but also enables innovation across multiple fields like agriculture, manufacturing, healthcare, and energy.

India's chemical sector is integral to India's growing export capabilities. In recent years, the sector has witnessed substantial growth in exports, positioning India as a significant exporter of chemicals globally. By 2047, this sector is expected to be even more critical in driving both the Indian and global economies.

Key Contributions of Chemical Sector to a Viksit Bharat

Driving Industrial Growth: The chemical sector is essential to the growth of India's industrial base. As the nation moves towards industrialization and modernization, chemicals provide the necessary raw materials for key industries such as textiles, automotive, construction, and electronics. Advancements in petrochemicals, for example, will fuel the country's automobile and infrastructure sectors, contributing to sustainable urbanization.

Sustainability and Green Chemistry: One of the key goals for India by 2047 is achieving environmental sustainability while maintaining economic growth. The chemical industry is already making strides toward sustainable practices through green chemistry. The development and adoption of green technologies such as biodegradable polymers, water treatment chemicals, and eco-friendly pesticides are essential for India to achieve its sustainability goals.

The growing emphasis on renewable energy and cleaner fuels will also see the chemical sector's active role in developing energy storage solutions, battery technology, and carbon capture technologies. The Indian chemical industry's ability to innovate in this space will ensure that India meets its climate commitments and establishes itself as a global leader in sustainability by 2047.

Gujarat's well-developed infrastructure, robust industrial ecosystem, and progressive policies have made it a favoured destination for chemical industries. Gujarat's contribution to the national goal of "Viksit Bharat" will be crucial in shaping India's future



Improving Agriculture and Food Security: India's agricultural sector is a critical component of the nation's economy, providing livelihoods to millions. The chemical sector plays a vital role in improving agricultural productivity through the production of fertilizers, crop protection chemicals, and soil health enhancers. By 2047, with the integration of smart farming technologies, the chemical industry will be a key enabler in ensuring food security for India's growing population.

Innovations such as bio-based fertilizers, integrated pest management solutions, and the reduction of chemical residues in food will not only boost agricultural yields but also ensure that India becomes a leader in sustainable agriculture, thereby addressing both food security and environmental concerns.

Technological Innovation and R&D: By 2047, India's chemical sector will likely be characterized by a high degree of technological sophistication. Research and Development (R&D) in the chemical industry will be pivotal in driving innovation. Breakthroughs in materials science, nanotechnology, and pharmaceutical chemistry will improve the quality of life for millions. For instance, the chemical sector's advancements in the production of new, high-performance materials will contribute to the country's growing aerospace, defence, and electronics industries.

The chemical sector will also be integral to the pharmaceutical industry's global standing, with India being known as the "pharmacy of the world." By 2047, the sector's innovation will help India become a hub for biopharmaceuticals and personalized medicine.

Gujarat's Role in Building Viksit Bharat

Gujarat has long been recognized as the chemical capital of India. The state accounts for a substantial share of India's chemical production, export, and industrial growth. The state's well-developed infrastructure, robust industrial ecosystem, and progressive policies have made it a favoured destination for chemical industries. Gujarat's contribution to the national goal of "Viksit Bharat" will be crucial in shaping India's future through the chemical sector.

Industrial Ecosystem and Infrastructure: Gujarat is home to some of India's largest chemical plants, and its proximity to key ports such as Mundra and Kandla makes it a major player in the export of chemicals. The state boasts world-class infrastructure, including dedicated industrial zones, well-connected roads, and ports. This infrastructure will be pivotal in ensuring the efficient production and distribution of chemicals, making Gujarat a critical



part of the national supply chain for chemical products.

The state's focus on developing industrial clusters such as the Dahej, Vapi, and Ankleshwar industrial zones has established Gujarat as a hub for chemicals, petrochemicals, and fertilizers. By 2047, Gujarat will continue to lead India's chemical industry by enhancing production capacities and ensuring the integration of emerging technologies in the sector.

Fostering Innovation through R&D: Gujarat's chemical industry is also heavily invested in R&D, and by 2047, the state will be a leader in technological innovations within the chemical sector. Research institutions such as the DDU, IIT and PSU like GSFC, GNFC will collaborate with global players to push the boundaries of chemical engineering, biotechnology, and material science.

Gujarat's emphasis on innovation will facilitate the creation of high-value, high-performance chemical products in sectors like pharmaceuticals, specialty chemicals, and agrochemicals. These advancements will contribute to the nation's economic growth and help make India a global leader in chemical manufacturing.

Sustainable Practices and Green Chemistry: Gujarat has also been a forerunner in promoting sustainable practices within the chemical industry. In line with national goals for sustainability, the state has encouraged businesses to adopt green chemistry and waste management techniques. Gujarat's commitment to renewable energy, including solar and wind, will reduce the chemical sector's carbon footprint, and its emphasis on water conservation and recycling will ensure the sector's sustainability. The state's large-scale adoption of solar energy for industrial use, alongside its push for clean technologies, will support India's broader goals of reducing emissions and combating climate change, contributing to the vision of a sustainable "Viksit Bharat."

Export and Global Leadership: Gujarat's chemical industry is one of the largest contributors to India's chemical exports. By 2047, Gujarat's chemical products—ranging from industrial chemicals, agrochemicals, and petrochemicals to pharmaceutical products—will play an even more critical role in the global market. The state's dominance in the chemical export sector will be integral to India's goal of becoming a $5 trillion economy.

The development and adoption of green technologies such as biodegradable polymers, water treatment chemicals, and eco-friendly pesticides are essential for India to achieve its sustainability goals

Bright Outlook

The chemical sector will be a pivotal contributor to realizing the vision of Viksit Bharat and Viksit Gujarat by 2047. With innovation, sustainability, and technological advancements at its core, the chemical industry will help India achieve economic self-sufficiency, environmental sustainability, and global competitiveness. Gujarat, with its robust infrastructure, R&D capabilities, and progressive policies, will continue to serve as the nation's chemical powerhouse, leading the way in achieving these ambitious goals.

In this journey toward becoming a developed India and Gujarat, the chemical sector's role will be multifaceted—driving industrial growth, ensuring food and energy security, fostering technological advancements, and contributing to global sustainability goals. With the right investments in infrastructure, R&D, and sustainability practices, the chemical sector will be one of the central pillars upon which India's and Gujarat's future success will be built ICN

INDIA'S ANTIDUMPING DUTY SAGA CONTINUES WITH LAB

Domestic demand for LAB stood at an estimated 751 KT last fiscal, of which 34 per cent was fulfilled through imports **CRISIL INTELLIGENCE**

The Directorate General of Trade Remedies on 26th March 2025 imposed anti-dumping duty (ADD) on linear alkyl benzene (LAB) imports from Qatar and Iran for five years. The levy will range from $14 to $62 per kiloton (KT) depending on the country of origin and exporter. The move follows a request from two of the major domestic manufacturers, which had claimed imports from Qatar and Iran were being dumped at low prices, affecting profitability of domestic manufacturers.

The impact on domestic industry will be moderate as it will prevent sudden volatility and decline in prices for domestic manufacturers and a mere $14 to $62 per kiloton rise in LAB prices won't impact the large downstream players. At the same time there will be considerable imports from Middle Eastern regions on account of stable demand and no domestic capacity addition.

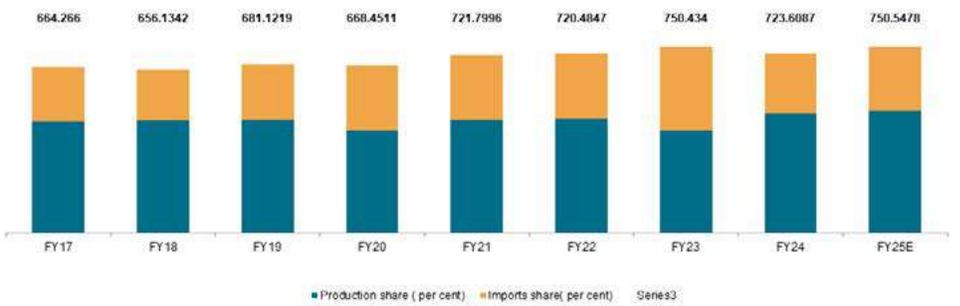
Domestic Demand Met by Both Imports and Local Production

India relies heavily on imports for its LAB requirements. Domestic demand for LAB stood at an estimated 751 KT last fiscal, of which 34 per cent was fulfilled through imports.

As of last fiscal, domestic manufacturers had an estimated capacity of 547 KT, with an utilisation rate at 90 per cent.

Domestic utilisation had plummeted to 79 per cent in fiscal 2023 due to a 29 per cent surge in imports. The increase in imports resulted from a supply crunch due to de-bottlenecking at one of the top domestic manufacturing plants and a 9,000 per cent spike in dumping from Iran, highlighting the domestic industry's vulnerability to external factors.

Share of domestic production vs imports



All units in KT

Note: E – estimated
Source: Company Reports, Ministry of Commerce and Industry, Crisil Intelligence

Share of Domestic Production vs Imports

The mid-term outlook for the next five years indicates a considerable amount of LAB imports from Middle Eastern countries, as there have been no major capacity additions planned in India.

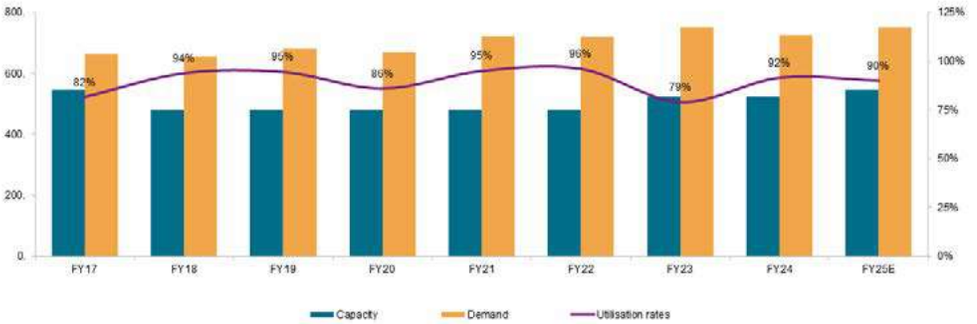
Domestic players will be able to maintain an average utilisation rate of ~95 per cent in the next five years despite imports.

Saudi Arabia, Qatar and Thailand collectively accounted for an estimated ~94 per cent of India's LAB imports last fiscal. The easy availability of raw materials, such as paraffin, in these countries makes them a preferred source for Indian imports.

India relies heavily on imports for its LAB requirements. Domestic demand for LAB stood at an estimated 751 KT last fiscal, of which 34 per cent was fulfilled through imports

In fiscal 2023, India's LAB imports had surged by 29 per cent. However, implementation of the Bureau of Indian Standards (BIS) requirements in June

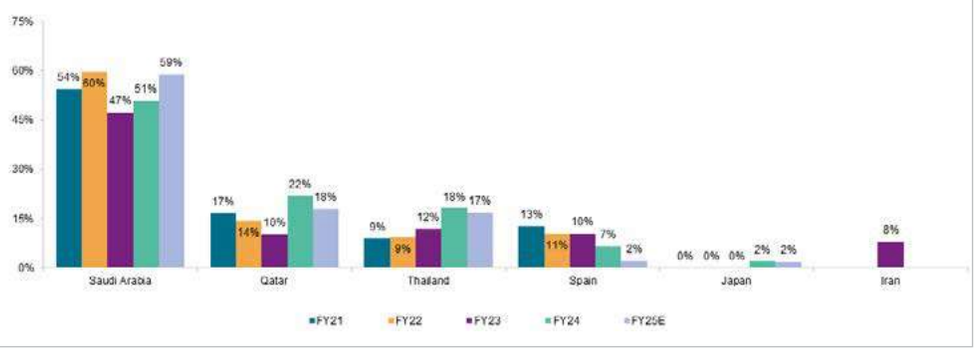
Capacity and utilisation trends



All units in KT

Source: Company Reports, Crisil Intelligence

Share of LAB imports by country



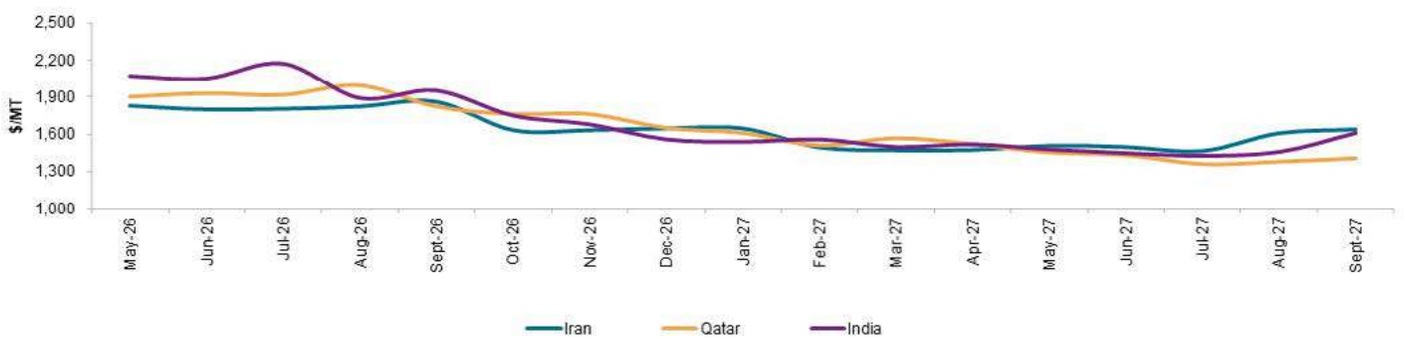
Source: Ministry of Commerce and Industry, Crisil Intelligence

The mid-term outlook for the next five years indicates a considerable amount of LAB imports from Middle Eastern countries, as there have been no major capacity additions planned in India

2023 led to zero imports from Iran in fiscals 2024 and 2025. Imports of LAB, a crucial ingredient in the production of detergents and washing liquids, are expected to clock a compound annual growth rate of 8-10 per cent between fiscals 2026 and 2030.

The production costs in Iran and Qatar are influenced by their favourable access to raw materials, which is partly a result of the integrated nature of

Import realisations for LAB from Iran and Qatar vs Indian prices



Note:
1. Import realisations for LAB from Iran and Qatar = Value of imports/volume of imports
2. Indian prices were based on actuals sourced from manufacturers
3. Prices were provided for the ADD investigation period and for the four months following the cessation of imports from Iran on account of the implementation of BIS standards on LAB products

Source: Industry sources, Crisil Intelligence

The table outlines the applicable duties on imports from these countries

HS code	Description	Country of origin	Country of export	Producer	Amount	Unit	Currency
38170011	LAB	Iran	Iran	Iran Chemical Industries Investment Co.	14	MT	$
38170011	LAB	Iran	Any country, including Iran	Any other than (1)	54	MT	$
38170011	LAB	Any country other than Iran and Qatar	Iran	Any	54	MT	$
38170011	LAB	Qatar	Qatar	SEEF Ltd	31	MT	$
38170011	LAB	Qatar	Any country, including Qatar	Any other than (4)	62	MT	$
38170011	LAB	Any country other than Qatar and Iran	Qatar	Any	62	MT	$

Source: Directorate General of Trade Remedies, Ministry of Commerce and Industry

their manufacturing facilities and their ties to government-affiliated entities. Furthermore, the dumping by Iran, coupled with a supply glut, led to a decline in domestic LAB prices between August 2022 and July 2023.

The market dynamics during the investigation period, marked by a surge in low-priced LAB imports, led to a challenging environment for domestic manufacturers, with both integrated and non-integrated producers facing difficulties in maintaining viable profit margins.

In response to the surge in imports from Iran and Qatar, India imposed Anti-Dumping Duties (ADD) to protect its domestic industry. The ADD is not imposed on major countries such as Saudi Arabia and Thailand, including excluding few companies from Qatar which constitutes major chunk of India's LAB import basket.

The ADD is imposed to prevent rampant dumping from Iran and at the same prevent the cash margins for domestic players

Impact of ADD on India's Downstream Industry

As per the DGTR ADD document on LAB, the imposition of a 5 per cent ADD on LAB would increase costs for Indian downstream users, including detergents and home cleaning liquids, by a mere 0.58 per cent.

Assuming the cost of detergent at Rs 140 per kilogram (kg) and a consumption factor of 0.12, the impact of the ADD on the domestic downstream industry appears minimal. However, the situation becomes complex when considering the impact on micro, small and medium enterprises (MSMEs) operating in the downstream industry.

For MSMEs, assuming the cost of the downstream product at Rs 60-70 per kg and a consumption factor of 0.12, a 10 per cent ADD would result in the actual impact exceeding 3.8 per cent on the final product cost. That could render operational challenges for smaller manufacturers

Disclaimer:

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BATTERY & SEMICON

Powering India’s Future





POWERING PROGRESS: EVOLVING LANDSCAPE OF EV, SEMICONDUCTOR & BATTERY

India's electric vehicle sector is gaining momentum amidst growing consumer interest yet with challenges in infrastructure, affordability, and supply chains TEAM ICN

As the world races toward decarbonization and digital transformation, the electric vehicle (EV) ecosystem has emerged as a focal point of innovation, investment, and policy reform. The backbone of this transformation lies not just in the vehicles themselves, but in the critical building blocks that power them: advanced semiconductors and battery chemicals. Together, these industries form a complex and interdependent value chain that is rapidly evolving under the pressures of global demand, supply chain shifts, and technological breakthroughs.

EV adoption is scaling rapidly across major global markets, driven by climate goals, rising fuel prices, and government mandates. In 2025, global EV sales are projected to surpass 17 million units, with key growth markets like China, Europe, and increasingly, India and Southeast Asia, expanding their EV infrastructure.

In 2024, India's passenger EV production surged by 22.5 per cent year-over-year, reaching approximately 125,500 units. This growth is primarily attributed to the rising demand for electric two-wheelers, which dominated the market with sales of around one million units in the financial year 2024. In India, ambitious initiatives like the FAME II scheme, PLI programs, and state-level EV policies are pushing both demand and manufacturing capacity. Major OEMs and startups alike are developing two-wheelers, three-wheelers, and passenger EVs, supported by growing investments in charging infrastructure and fleet electrification.

Semiconductor: Critical yet Constrained

Semiconductors are the digital brains of EVs, enabling everything from battery management systems to autonomous driving capabilities. However, global chip shortages that began in the post-pandemic recovery continue to affect production cycles and cost structures.

> To meet the escalating demand, India's lithium-ion battery manufacturing capacity is projected to expand from 18 GWh in 2023 to 145 GWh by 2030

EVs require far more chips than ICE vehicles—nearly 2-3 times more—putting additional pressure on an already strained supply chain.

India is currently the world's second-largest consumer of semiconductors, with demand expected to reach US$ 110 billion by 2030, up from around US$ 24 billion in 2022. This growth is driven by the rapid expansion of smartphones, automotive electronics, EVs, industrial IoT, telecom equipment (especially 5G), consumer appliances, and defense electronics. Despite this surging demand, India has historically had no commercial-grade semiconductor fabs, relying heavily on imports from Taiwan, South Korea, China, and the U.S.—a vulnerability highlighted during the global chip shortages of 2020–2022.

India is actively trying to localize part of this supply chain through the Semicon India initiative, attracting partnerships from global giants to build fabrication and ATMP (Assembly, Testing, Marking, and Packaging) units. The challenge lies in balancing capital-intensive chip manufacturing with long-term demand certainty.

While fabrication is nascent, India is already a global leader in semiconductor design, with over 20 per cent of the world's chip design engineers based in the country. Nearly all major semiconductor companies—including Intel, Qualcomm, MediaTek, AMD, and Texas Instruments—have R&D and design centers in India. In terms of early movers in the segment, Micron Technology is setting up a $2.75 billion ATMP plant in Gujarat, marking the first significant foreign investment in India's semiconductor ecosystem. Tata Electronics has signed a MoU with Powerchip Semiconductor Manufacturing Corp (Taiwan) to establish a semiconductor fab in Dholera, Gujarat, with an estimated investment of over $11 billion. Vedanta-

Key Opportunities

Growing Market Demand	Rapid increase in EV adoption across 2W, 3W, and 4W segments boosting demand for battery chemicals
Policy Support	FAME-II, PLI for ACC battery storage, and state-level EV policies encouraging local manufacturing
Abundant Raw Materials	Availability of key materials like graphite and aluminum; ongoing initiatives for lithium sourcing
Strategic Investments	Over Rs. 35,000 crore pledged by companies like Ola Electric, Amara Raja, Exide, and Reliance Industries
Localization Focus	Rising push to develop domestic battery supply chains and reduce import dependence
Innovation Ecosystem	Active R&D in battery chemistries (Li-ion, LFP, Na-ion), recycling technologies, and energy storage solutions
Export Potential	India's potential to become a global hub for battery chemicals and cell manufacturing

Foxconn had initially announced plans for a large-scale fab, but the deal was restructured after Foxconn exited the joint venture. Sahasra Semiconductors has already begun chip packaging operations in Rajasthan. ISRO and DRDO are also pushing for indigenous chip development for defense and aerospace applications.

Battery Chemicals: The Supply Chain Hotspot

Battery chemicals, particularly lithium, cobalt, nickel, and manganese, have become geopolitically sensitive and commercially critical. Prices of key materials have seen significant volatility, impacting cell manufacturing economics. At the same time, there's an urgent push toward developing alternative chemistries, such as sodium-ion and solid-state batteries, to overcome sourcing and safety limitations.

The battery chemicals market, valued at approximately $1.2 billion in 2022, is expected to grow at a compound annual growth rate (CAGR) of 13-15 per cent from 2023 to 2030, driven by the increasing adoption of EVs. However, challenges persist, including reliance on imported raw materials and the need for technological advancements in battery production. Addressing these challenges is crucial for India to establish a robust and self-reliant EV and battery ecosystem.

India is investing in domestic refining capacity for battery materials and exploring overseas mining partnerships, particularly with countries in South America and Africa. To meet the escalating demand, India's lithium-ion battery manufacturing capacity is projected to expand from 18 GWh in 2023 to 145 GWh by 2030. This expansion is bolstered by the government's Production-Linked Incentive (PLI) scheme, which aims to establish 50 GWh of battery cell capacity by 2026. Notable corporate initiatives include Reliance Industries securing a bid to produce up to 10 GWh of advanced chemistry cells under the PLI scheme, and Amara Raja Energy and Mobility's licensing agreement with China's Gotion High Tech Co. to produce lithium-ion batteries in India.

Fast Paced Dynamic Deals

Tata Motors, India's leading EV manufacturer, is focusing on locally produced EV batteries to maintain its competitive edge amid intensifying competition. The company's EV market share declined to 62 per cent in 2024 from 73 per cent in 2023 as competitors like JSW MG Motor gained ground. Other automakers, including Mahindra & Mahindra, Hyundai, Maruti Suzuki, and Tesla, are also entering the Indian EV market. Tata Group plans a $1.5 billion investment in a battery gigafactory in India, expected to start production by 2026, to integrate its supply chain further. This move aims to secure the

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India is currently the world's second-largest consumer of semiconductors, with demand expected to reach US$ 110 billion by 2030, up from around US$ 24 billion in 2022

supply of the most costly component of EVs—lithium-ion battery cells—by 2028. Tata Motors is leveraging funding from U.S. private equity firm TPG and India's EV incentive program to support its investments.

In a significant joint venture, India's largest steel producer, JSW, and Chinese carmaker SAIC Motor have established a $1.5 billion partnership to produce and market MG-brand electric vehicles in India, with plans to invest $5 billion by 2030. They aim to reduce costs by sourcing locally, including batteries from a new plant in Odisha. JSW will hold 51 per cent of the joint venture, with SAIC holding 49 per cent. The venture, JSW MG Motor India, plans to release new models every three to six months starting in October. This partnership highlights the shift towards electric vehicles in India, despite challenges such as higher costs compared to combustion-engine cars. Amid regulatory hurdles due to geopolitical tensions, Indian partnerships like this are crucial for Chinese companies. India's EV market, currently led by Tata, is gradually expanding with new entrants like VinFast, Tesla, and Suzuki. The Indian government recently reduced import tariffs on EVs for companies investing in local production, further encouraging market growth.

Amara Raja Energy and Mobility has entered into a licensing agreement with Gotion-InoBat-Batteries, a unit of China-based Gotion High Tech Co., to produce lithium-ion batteries in India. Under this agreement, Amara Raja will access Gotion's lithium iron phosphate technology and receive support to establish gigafactory facilities, integrating into Gotion's global supply chain. Gotion, with German automaker Volkswagen as its largest shareholder, specializes in lithium-ion batteries for new energy vehicles. Indian automakers currently import batteries mainly from China and South Korea but are increasingly investing in domestic lithium-ion battery production. Amara Raja's competitor, Exide Energy Solutions, partnered with SVOLT to build a lithium-ion battery plant expected to start operations this year. Additionally, Hyundai and Kia signed an MOU with Exide to supply batteries for their electric vehicles. Earlier this year, Amara Raja, Reliance Industries, and JSW Neo Energy were among companies that submitted bids to set up battery manufacturing gigafactories in India.

Reliance Industries has secured a bid under India's incentive program to produce EV batteries. The company will manufacture up to 10 gigawatts of advanced chemistry cells (ACCs), essential for EV production, in order to support the country's goal of increasing electric car usage. The production-linked incentive (PLI) scheme, aimed to enhance local battery manufacturing, has allocated $434.4 million.

Hyundai Motor Group has announced a partnership with three premier Indian Institutes of Technology (IITs)—IIT Delhi, IIT Bombay, and IIT Madras—to establish a collaborative research framework focused on batteries and electrification. This initiative aims to revolutionize the development of electric vehicle (EV) technologies tailored for the Indian market. The partnership's centerpiece, the Hyundai Center of Excellence (CoE), will be established at IIT Delhi and will operate with sponsorships from Hyundai Motor Group. The CoE will spearhead advancements in battery technology and electrification while also fostering talent development and academic-industrial cooperation. Hyundai Motor Group plans to invest US$ 7 million over five years (2025-2029) to conduct research in battery technology, electrification, and future technologies, including software and hydrogen fuel cells.

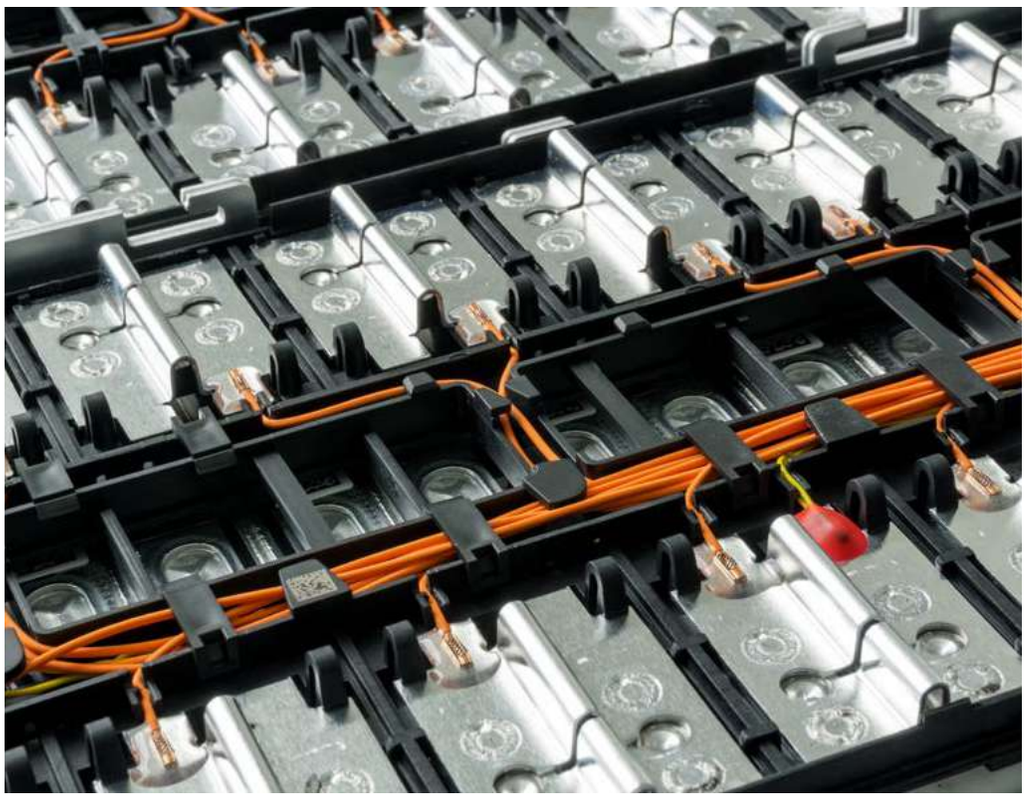
Overcoming Challenges

A major hurdle is the heavy dependence on imports for critical battery materials such as lithium, cobalt, and nickel. Despite the government's efforts to secure overseas lithium blocks, over 70 per cent of India's lithium-ion cell requirements were met through imports in 2024, primarily from China, South Korea, and Japan. This dependence exposes the industry to global price fluctuations and geopolitical risks.

Another significant challenge is the lack of a well-developed domestic battery manufacturing ecosystem. While India has announced plans to reach 145 GWh of battery manufacturing capacity by 2030, the current operational capacity in 2024 stood at less than 20 GWh. Most of this capacity is in the early stages of setup, and delays in land acquisition, infrastructure, and technology transfer are common.

Cost is also a major barrier, with EVs priced 20 per cent to 40 per cent higher than their internal combustion engine counterparts. Battery costs, which constitute 35 per cent to 45 per cent of an EV's total cost, remain a key contributor to this price differential. The slow pace of technology indigenization further aggravates this cost disparity, making EVs less attractive in the mass market despite subsidies under the FAME II scheme and state-level incentives.

Charging infrastructure remains sparse and unevenly distributed. As of mid-2024, India had around 12,000 public charging stations, with more than 60 per cent concentrated in urban centers. This inadequacy in infrastructure hampers EV adoption in Tier 2 and Tier 3 cities, where growth potential is significant.



On the environmental front, concerns are growing over the future disposal and recycling of used batteries. India lacks a comprehensive battery recycling policy and has limited recycling capacity for lithium-ion batteries, posing a potential ecological risk as volumes grow. Additionally, the energy-intensive nature of battery production raises questions about the overall sustainability of the supply chain, particularly when reliant on coal-powered grids.

Workforce skill gaps and limited R&D capacity also hinder industry innovation. While global automakers and battery makers are entering the Indian market, domestic firms are still catching up on advanced cell chemistries such as solid-state batteries and lithium iron phosphate (LFP) technologies. Without robust investments in research, partnerships with global technology providers, and upskilling of the technical workforce, India risks lagging in the global EV transition.

Building Synergy for a Sustainable Tech Future

India's EV industry is poised for significant expansion in 2025 and beyond. In 2025, production of battery-powered passenger vehicles in India is projected to increase by 140.2 per cent year-over-year, reaching approximately 301,400 units, which would constitute about 6 per cent of the estimated 5.16 million passenger vehicles produced that year. This surge is attributed to heightened consumer awareness, favorable government incentives, and advancements in EV technology. Major industry players are making significant investments to strengthen the domestic supply chain. For instance, Tata Group plans to invest $1.5 billion in a battery gigafactory in India, expected to commence production by 2026, aiming to secure the supply of lithium-ion battery cells by 2028.

India is actively seeking technical assistance from countries such as Australia, the United States, and Bolivia to develop domestic lithium processing capabilities and reduce reliance on imports. Additionally, companies like Vedanta are expanding nickel sulfate production to meet the growing demand for battery materials.

With strong government backing, private sector investments, and increasing global interest in a China+1 strategy, India has the opportunity to carve out a significant role—especially in chip packaging (OSAT), legacy node fabrication (28nm+), compound semiconductors, and automotive-grade chips. The real inflection point will come when the first fabs begin operations and India can demonstrate reliability, scalability, and cost-effectiveness. As the world seeks resilient semiconductor supply chains, India is positioning itself as not just a market, but a maker.

The transformation of transportation is not happening in silos. The EV industry's growth is critically dependent on robust semiconductor supply chains and reliable access to battery-grade materials. Governments and companies are now working more collaboratively across these sectors to ensure long-term competitiveness and sustainability. For India and other emerging markets, the opportunity lies in creating integrated ecosystems where innovation, policy, and manufacturing capabilities converge. Cross-sector synergy will be the defining force that determines who leads the next phase of the global mobility and clean energy transition.

Strategic investments, international collaborations, and supportive policies are expected to drive substantial growth, positioning India as a significant player in the global EV market in the coming years ICN



INVESTING RS. 15,350 CRORE IN KARNATAKA TO BUILD EV BATTERY MANUFACTURING AND R&D HUB

Investments in sustainability-linked projects and R&D played a crucial role in enhancing the company's long-term positioning



VIKRAM HANDA
Managing Director
Epsilon Carbon

Q How has Epsilon Carbon performed financially in FY 2024-25? Key growth drivers that influenced company's revenue and profitability?

Epsilon Carbon's financial performance in FY 2024-25 shows a period of strategic investment and market adjustments. While revenue and profitability saw a dip compared to the previous year, this was largely due to ongoing expansions and shifts in market demand. The company is focused on strengthening its asset base, increasing fixed assets to support future growth, and optimizing working capital for better efficiency.

We are working on a few high-value specialty carbon products that are currently 100 per cent imported into India. Our new product line will serve as an import substitution for these products. Investments in sustainability-linked projects and R&D played a crucial role in enhancing the company's long-term positioning. Despite short-term fluctuations, the company remains focused on leveraging its investments to drive sustained growth, particularly in specialty chemicals, advanced materials for EV batteries.

Q Epsilon plans to invest about Rs. 8,000 crores in India and USA during the next three years. Which business areas are expected to get the highest Capex allocation in terms of capacity expansion and new manufacturing plants?

Our investments focus is on specialty carbon capacity expansion by 300,000 tons in Jharsuguda, Odisha and setting up a 30,000 graphite anode manufacturing facility in Karnataka. This also includes a 30,000 tons graphite anode manufacturing plant in North Carolina, USA. Both the India and US graphite anode facilities are currently in the permitting phase, with engineering work progressing, and construction is expected to begin early next year. The specialty carbon plant in Jharsuguda will be operational by Q3 2026.

Q How is Epsilon Carbon leveraging R&D to develop advanced carbon materials for emerging industries like EV batteries and specialty chemicals? Do you also plan to invest in bio-based or circular economy-driven R&D projects?

We are continuously innovating to meet evolving market demands while enhancing performance, efficiency, and sustainability for all our products. For Epsilon Carbon, our R&D is focused on developing sustainable carbon black solutions, and we recently launched Terrablack, which is transforming the carbon black industry for both tyre and non-tyre sectors. By utilizing recovered carbon black (rCB) and tyre-derived oil as key raw materials, we will support tire circular economy by reducing dependency on fresh feedstock while delivering high-quality solutions for tyres, rubber, and coatings. We are also researching on developing customized carbon black paste and creosote oil tailored for specific industrial applications to enhance processing efficiency and product performance. Additionally, we are also working on custom high-performance carbon black grades to meet the evolving

needs of the tyre industry, focusing on sustainability, durability, and efficiency.

In Epsilon Advanced Materials, we are focusing on developing graphite-silicon composite anodes, which can significantly improve the energy density and range of lithium-ion batteries. Our Joint Development Agreement (JDA) with Daejoo, Korea will strengthen our expertise in next-generation battery materials.

Our R&D facility in Vijayanagar focuses on innovation in battery material research, pilot production, cell fabrication, and testing while continuously exploring new materials, techniques, and designs. Additionally, our Germany based Cathode Research Centre is pioneering in cathode material research, pilot production, and cell testing, expanding our capabilities in advanced battery technologies.

Q Can you provide details on Epsilon Carbon's Rs 15,350 crore investment in Karnataka? Expected timeline for the project and its strategic importance for the company?

We are investing Rs 15,350 crores in Karnataka to set up a manufacturing and research facility focused on EV battery ecosystem. The project includes setting up a Rs 9,000 crore graphite anode manufacturing facility, a Rs 6,000 crore lithium iron phosphate (LFP) cathode plant, and a Rs 350 crore Research and Development Centre for battery material development, testing and training. These facilities will be developed by Epsilon Advanced Materials, Epsilon CAM Pvt. Ltd., and Inspire Energy Research Centre. Our goal is to provide Domestic Value Addition (DVA) of 100 per cent for anode material and 60 per cent for cathode material to Indian cell manufacturers which will enable them to become class -1 "Make in India" producer.

These investments are expected to create over 2,000 jobs in Karnataka, contributing to regional economic growth and positioning India as a key player in the global battery materials supply chain.



Q Epsilon Carbon has committed to investing Rs. 8,000 crore to develop an Integrated Carbon Complex in Odisha. Could you provide insights into the key features of this complex, its expected production capacities, and the projected impact on both local and global markets?

Last year, we announced the Integrated Carbon Complex in Jharsuguda, Odisha, with an investment of Rs 8,000 crores spread over the next 10 years. As phase-1, we will build a 300,000-ton Coal Tar Distillation Plant by 2026. From this facility, we are set to produce several specialty oils like Anthraquinone, Carbazole & Cresols that are currently 100 per cent imported. We aim to make India more self-reliant and reduce import dependence.

This plant will support nearby aluminium smelters while also exporting to the Middle East from our planned port in Gopalpur. Over time, we plan to build a carbon black plant and an advanced materials unit, making this one of the largest integrated carbon complexes in the world. Through this project, Epsilon Carbon aims to boost domestic production, create jobs, and contribute to India's industrial growth while expanding our global presence.

Q The Karnataka manufacturing plant recently received the ISCC PLUS certification. How does this certification influence your operations, and what benefits do you anticipate in terms of market reach and customer trust?

ISCC PLUS certification is a significant milestone in our commitment to sustainability and responsible production. This certification shows our efforts in using sustainable raw materials, lowering our carbon footprint, and ensuring full traceability across our supply chain. By meeting global environmental standards, we are strengthening our position as a leader in sustainable carbon solutions.

This certification also allows us to expand into markets that prioritize responsible sourcing, particularly in sectors like specialty chemicals and advanced carbon materials. As sustainability becomes a key focus for global brands, our certification enhances customer confidence and positions us as a preferred supplier for companies committed to reducing their environmental impact. It also gives us an edge in regulatory compliance, helping us meet evolving industry standards and unlocking new business opportunities.

Q With a Rs. 550 crore investment to expand the Vijayanagar unit's capacity by an additional

100,000 metric tons, what are the expected outcomes in terms of production efficiency and market share?

Our carbon black capacity expansion to 100,000 metric tons is a strategic move to strengthen the production capabilities and global market position. This will increase our total carbon black capacity to 215,000 metric tons annually, enhancing supply for both tire and non-tire applications. This growth will enable us to capture a large share of the domestic and international markets, potentially increasing market share from 7 per cent to approximately 14 per cent, positioning us as the third-largest carbon black producer in India to serve the growing demand for high-quality carbon black in industries such as automotive, plastics, and specialty chemicals.

Q Epsilon Carbon's 2023-24 sustainability report indicates a 10 per cent reduction in greenhouse gas emission intensity, a 3.3 per cent decrease in energy intensity, and a 6 per cent reduction in water use intensity compared to the previous fiscal year. Could you elaborate on the specific strategies and technologies implemented to achieve these environmental milestones?

One of our key initiatives was to set-up a waste heat recovery system which captures and reuses excess heat from industrial processes. These waste hot gases run a 17 MW captive power plant that powers our entire carbon complex in Vijayanagar. This has led to a 15.7 per cent reduction in Scope-1 emissions and a 14 per cent reduction in Scope-2 emissions. We also introduced the Digital Analytics for Resource and Technology (DART) Program, a digital initiative that leverages data analytics to improve operational and environmental efficiencies. By integrating digital tools into manufacturing and resource management, we have been able to monitor and optimize resource utilization more effectively.

These sustainability-driven efforts align with India's broader climate goals and reinforce our commitment to responsible industrial practices.



Introducing 5 electric trucks into our logistics operations was a big step towards our sustainability journey. By shifting from diesel to electric, we expect to cut CO_2 emissions by around 127 metric tons per year

Q Epsilon Carbon secured Rs. 100 crore in sustainability-linked funding from Standard Chartered Bank. How will these funds be allocated to further the company's sustainability goals, and what specific projects are prioritized under this funding?

The sustainability-linked funding from Standard Chartered Bank is a big step towards strengthening our ESG commitments. This funding is mainly focused on making our operations more sustainable by reducing greenhouse gas emissions, optimizing water and energy use and improving overall efficiency. One key requirement is a third-party audit to ensure we are meeting our ESG targets, which helps keep our approach structured and transparent.

The funds are being used for working capital and specific projects that make a real impact. For example, we are working on improving energy efficiency by monitoring steam traps to reduce energy losses. We are also investing in technology and processes that help lower our carbon footprint while maintaining high operational standards.

Beyond the immediate impact, this funding has helped us set a clear sustainability roadmap for the next one, three and five years. It has also strengthened our collaboration with financial institutions on ESG-driven projects and opened up opportunities for more sustainability-linked financing in the future. Overall, we see this as a great step toward creating long-term environmental and economic value.

Q Being the first Indian carbon black manufacturer to receive the SA8000 certification, how has

this recognition influenced your company's internal policies and stakeholder relationships?

Getting SA8000 certification is a big milestone for us, making us the first Indian carbon black manufacturer to earn this recognition. It shows our commitment to ethical business practices and worker welfare, leading to positive changes within the company and in our relationships with stakeholders.

Inside the company, we have strengthened policies to ensure fair wages, safe working conditions, and better living facilities for our employees. Our Vijayanagar township now provides housing for over 1,800 workers and their families, creating a clean and healthy living environment. We have also taken steps to support migrant workers by helping them settle in smoothly and access essential services.

Earning this recognition is just the beginning. We're committed to continuously improving our policies and workplace environment, ensuring that social responsibility stays at the core of our growth.

Q How is Epsilon Carbon leveraging digital transformation to enhance efficiency across its operations? Are you implementing AI, IoT, and Big Data analytics in manufacturing to optimize production processes?

Our digital transformation journey, "DART," began two years ago with an aim to enhance efficiency, automation, and innovation. We started by digitising data handling with SAP ERP, streamlining operations across key functions, and implementing a Master Data Management tool to improve data accuracy.

In the second year, we focused on automation in Finance with enterprise asset management, auto invoicing & treasury, and tax intelligence. We improved supply chain and shop floor operations with an Energy Management System, real-time shipment tracking, and compliance management. Upgrading to SAP RISE improved integration, while analytical tools enhanced decision-making and sustainability tracking.

This year, we are enhancing shop floor efficiency and customer experience by extending energy management, implementing a Laboratory Information Management System (LIMS), and using IoT and AI for predictive maintenance. Looking ahead, we aim to integrate AI into daily operations with Microsoft Copilot and SAP Joule while developing a data lake to leverage AI and Machine Learning for greater operational efficiency.

> **Expanding carbon black capacity to 100,000 MT strengthens our production and global position, raising total capacity to 215,000 MT annually**

Q Epsilon Carbon introduced a fleet of five electric trucks to its logistics operations. What has been the impact of this initiative on the company's carbon footprint, and are there plans to expand the use of electric vehicles in the future?

Introducing 5 electric trucks into our logistics operations was a big step towards our sustainability journey. By shifting from diesel to electric, we expect to cut CO_2 emissions by around 127 metric tons per year, showing our continued effort to reduce our impact on the environment. Each of these heavy-duty electric trucks comes with a 258-kWh battery, providing a range of 185 Kms which is perfect for transporting raw materials like coal tar efficiently. With this move, we have become the first company in India's carbon sector to use electric trucks for raw material logistics, setting a new benchmark for sustainable practices in the industry.

We are actively looking at ways to expand our Electric Vehicle fleet across different parts of our operations. This is all part of our larger strategy to integrate greener technologies throughout our value chain, contributing to India's goal of achieving net-zero emissions by 2070.

Q The company's 'Sustainable Livelihood Interventions for Women' project in Sripura Village received the 'Best CSR Project of the Year 2024' award. How has this initiative impacted the local community, and are there plans to replicate similar projects in other regions?

The 'Sustainable Livelihood Interventions for Women' project in Sripura Village, Odisha, has empowered over 200 women through Self-Help Groups (SHGs). By providing vocational training in phenyl manufacturing, tailoring, and agarbatti production, the initiative has helped women achieve financial independence.

A key success story is the 'Maa Parbati SHG,' where women have successfully produced and sold phenyl bottles across Jharsuguda, boosting their confidence and economic stability. Beyond financial support, the project has encouraged leadership and community participation.

Building on this success, we plan to expand similar programs in other direct impact regions, reinforcing our commitment to women's empowerment and social sustainability

AIMING TO PLAY PIVOTAL ROLE IN INDUSTRY'S EVOLVING MATERIALS ECOSYSTEM

GFL stands apart in the highly specialized fluoropolymer market through a combination of deep technical capabilities, forward looking investments, and a strategic global outlook



KAPIL MALHOTRA
Global Business Unit Head - Fluoropolymers
Gujarat Fluorochemicals

Q How do you see the industry dynamics, particularly in the automotive, semiconductors, EV and ESS industries, to provide large scale opportunities for value-added fluoropolymers, which should translate into higher revenues and margins for GFL?

In the automotive industry, there has been a growing shift towards electric vehicles (EVs), increasing the demand for durable and high-performance materials. GFL's fluoropolymers play a vital role in this particular application for wire and cable insulations, seals, gaskets, hoses and membranes. This indicates that with the strong and growing demand for EV, the volume demand for fluoropolymers will also grow substantially. The EV batteries and Energy Storage Systems (ESS) also use advanced fluoropolymers as coatings for separators, electrolyte additives and liners. With large players looking for safety and durability, we are highly optimistic about the future as GFL's fluoropolymers have an excellent track record in both areas.

In the semiconductor segment, GFL has already seen a great demand for fluoropolymer parts made out of PTFE, PFA and PVDF. With the global expansion of AI, IoT, and 5G/6G, and multi-billion-dollar investments by companies like TEL, Intel, Samsung, Tata, Adani, the semiconductor industry is most likely to require ultra-pure chemical handling systems. GFL's fluoropolymers, especially PFA, PVDF, and PTFE are and will be witnessing demand for applications like CMP, etching system parts, wet systems, tubes, and lining equipment.

Q What specific role do fluoropolymers play in semiconductor manufacturing and why are they essential?

In the semiconductor manufacturing industry, fluoropolymers are critical as the processes involve extreme purity, high temperatures and aggressive chemicals.

Some specific roles of fluoropolymers include chemical handling where PTFE, PFA, PVDF pipes, tubes, valves, and tanks are used in processes that involve high corrosive chemicals. Another is wafer processing, with exposure to acids and plasma, fluoropolymer coatings are used to protect chambers and parts from degradation, extending equipment life and preventing contamination. Chemical Mechanical Planarization where CMP slurries used to polish





wafers require slurry delivery lines made of fluoropolymers to eradicate contamination. Gas Delivery Systems has specialty gases like CF4 used in etching that require fluoropolymer-lined gas tubings to prevent chemical reactions and particle shredding. Filtration Systems have fluoropolymer membranes being used in filters that remove ultra-fine particles from chemicals and gases.

How do you foresee the demand for fluoropolymers evolving in the semiconductor market over the next five years?

With continued fab expansions by TSMC, Intel, Samsung, Hynix, Micron in the US, Europe, Japan, Korea, Taiwan and new players like Tata expanding in India, there is an estimated US$ 700+ billion of fab Capex planned worldwide, by 2030.

As process nodes shrink (5nm, 3nm, 2nm), purity and material performance requirements skyrocket. This sets a very strong background for material consumption, including fluoropolymers. The demand for fluoropolymers in semiconductors is expected to grow at a CAGR of over 8-12 per cent (with the overall semiconductor volume growth expected at 6 per cent). PFA and UHP PFA, will see even higher growth of about 12-15 per cent because of the advanced chip sizes.

> **Our efforts are anchored in long-term thinking, responsible practices, and a strong belief in building value for our customers, stakeholders, and environment**

How is GFL gearing to cater to the growing demand of fluoropolymers - PTFE, PFA, FEP, FKM, PVDF and Additives?

GFL has been very active in capitalizing on the fluoropolymer demand surge. With heavy investments in expanding the production capacity, new facilities, testing equipment and R&D centers, GFL's expansion is targeted at high-margin applications. GFL has also been broadening its product basket beyond PTFE, to cater to the demand in EV, SC, UPW and battery segments. The company is also focusing on actively expanding sales in US, Europe, and Japan markets, critical for semiconductor fabs, EV battery manufacturers and high-end industries. GFL is also focusing on targeting stringent certifications and regulatory approvals to qualify for the highest value supply chains.

What are the emerging trends or technologies in fluoropolymers that GFL believes will redefine their use in the semiconductor industry?

Some of the emerging trends and technologies which will define the use of fluoropolymers in the semiconductor industry include Ultra-High Pure (UHP) grades; next-gen plasma-resistant materials, tailored melt-processable materials; high purity PFA, PVDF; surface modified fluoropolymer coating material; environmentally safer fluoropolymers; specialty compounding facilities; and regulatory preparedness.

How does GFL contribute to innovation in fluoropolymer production or application for semiconductors?

GFL is in constant touch with end customers and equipment manufacturers to understand their requirements in terms of quality, purity and technical specifications. We are equipped with state-of-the-art R&D setup to develop grades and products for the semicon industry.

How do geopolitical factors and supply chain issues affect the production and distribution of fluoropolymers in the semiconductor

sector?

The production and distribution of fluoropolymers in the semiconductor industry are increasingly influenced by a combination of geopolitical and supply chain dynamics. A major factor is the sector's heavy dependence on China for critical raw materials and processing capabilities, which makes it vulnerable to shifts in global political relationships. The rise of export controls and trade restrictions, particularly between major economies, has further complicated cross-border movement of specialized materials. Additionally, persistent supply chain bottlenecks, such as limited transportation infrastructure and port congestion, have strained timelines and inventories across regions. Compounding these issues are evolving regulatory pressures, especially concerning environmental compliance and product stewardship, which vary significantly across jurisdictions.

Q In light of increasing environmental regulations, how is GFL adapting its fluoropolymer solutions to meet sustainability standards?

GFL has taken a proactive and leadership-driven approach to evolving environmental regulations, positioning itself as a global front-runner in regulatory compliance within the fluoropolymer industry. We have consistently anticipated changes in sustainability standards and have developed products that not only meet but often exceed these regulatory requirements. Our R&D teams work closely with global stakeholders to ensure that our fluoropolymer solutions are aligned with the latest environmental expectations, ensuring both performance and responsibility go hand in hand.

Q How do you see the competitive landscape in the fluoropolymer space, particularly regarding their application in semiconductors?

> **The demand for fluoropolymers in semiconductors is expected to grow at a CAGR of over 8-12 per cent, with the overall semiconductor volume growth expected at 6 per cent**

The global fluoropolymer market for semiconductors has historically been dominated by a handful of high-end players. However, recent structural shifts — including geopolitical decoupling and tightening regulatory frameworks — have disrupted this equilibrium, creating clear gaps and new opportunities in the market. GFL is strategically positioned to fill this void and emerge as a formidable challenger across a broad spectrum of applications. In the semiconductor space, success is defined not merely by scale or cost competitiveness, but by a deep command of technical sophistication, an area where GFL continues to demonstrate strong capabilities and innovation.

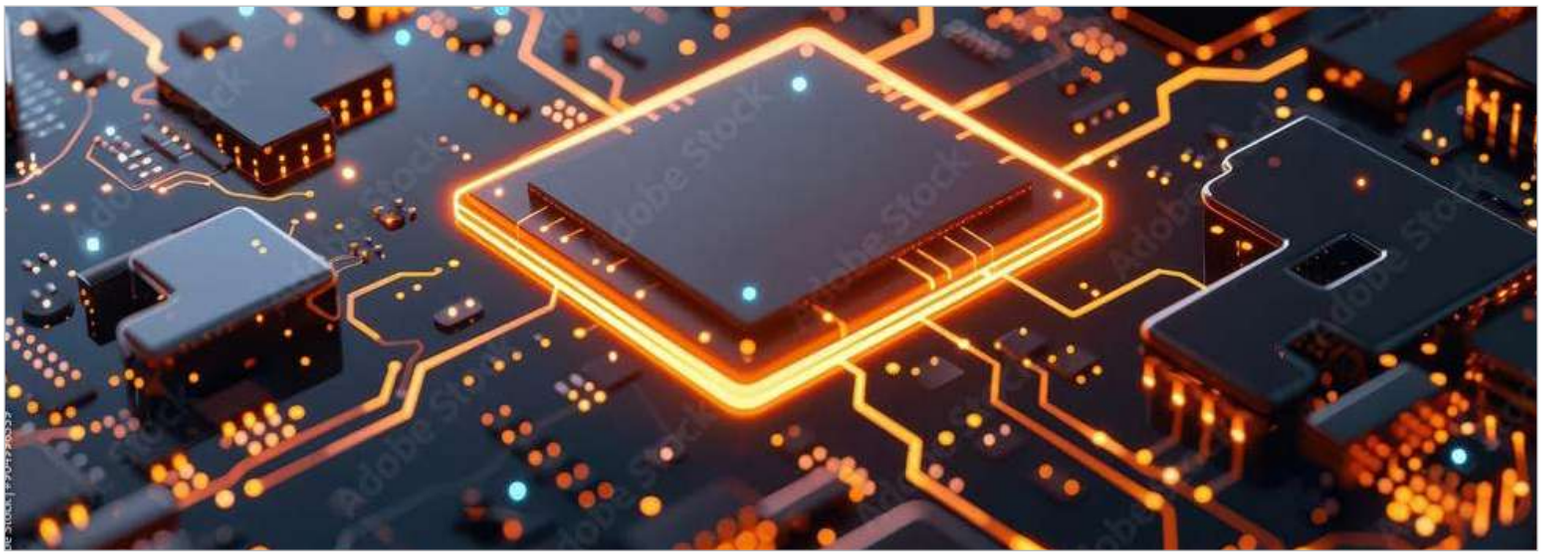
Q What differentiates GFL's products or services from those offered by competitors in this niche market?

GFL stands apart in the highly specialized fluoropolymer market through a combination of deep technical capabilities, forward-looking investments, and a strategic global outlook. Our key differentiators include backward integration in raw materials, aggressive capacity expansion, focused new product development, strategic global expansion, and proactive regulatory compliance. As the first major Indian player in ultra-high-purity (UHP) fluoropolymers, GFL is now one of the few globally trusted fluoropolymer sources of Indian origin.

Q How closely GFL works with semiconductor manufacturers to develop tailor made fluoropolymer solutions?

GFL is evolving beyond the traditional supplier role to become a true materials co-development partner for the semiconductor industry. Our collaboration begins early, often during fab design cycles, allowing us to tailor fluoropolymer solutions at





the molecular level to meet precise performance demands. We actively participate in global qualification programs, ensuring our materials meet stringent international standards. Additionally, our model includes near-customer technical support, enabling faster iterations, quicker issue resolution, and deeper alignment with customer roadmaps. This integrated approach positions GFL as not just a vendor, but a strategic innovation partner in the semiconductor value chain.

Q What are the key challenges GFL faces in supplying fluoropolymers for semiconductor applications?

While GFL is well-positioned in the semiconductor fluoropolymer space, operating in this high-stakes, innovation-driven segment comes with its own set of complex challenges. These include lengthy qualification timelines, high technical entry barriers, continuous innovation for evolving processes, and navigating regulatory compliance.

Q How do you envision the role of fluoropolymers in emerging technologies like AI, IoT, and Quantum Computing?

Emerging technologies such as AI, IoT, and Quantum Computing are driving the evolution of next-generation semiconductor chips, demanding higher performance, greater miniaturization, and extreme reliability. This directly translates to increased usage of fluoropolymers, given their unmatched chemical resistance, thermal stability, and ultra-high purity characteristics. As chip designs become more complex and process environments more aggressive, fluoropolymers are playing an increasingly critical role in enabling the materials infrastructure that powers these technologies.

Q What are GFL's long-term strategic goals in the fluoropolymer segment of the semiconductor industry?

GFL's long-term vision is to establish itself as a globally trusted and technologically advanced partner for the semiconductor industry. Our primary goal is to consistently meet and exceed the stringent quality and purity standards demanded by this sector. We are committed to scaling our capacities in alignment with global market requirements, investing in advanced R&D, and continuously enhancing our material performance to support future technology nodes. By aligning closely with semiconductor roadmaps, GFL aims to play a pivotal role in the industry's evolving materials ecosystem.

Q What role do sustainability and corporate social responsibility play in your company's strategy regarding fluoropolymers?

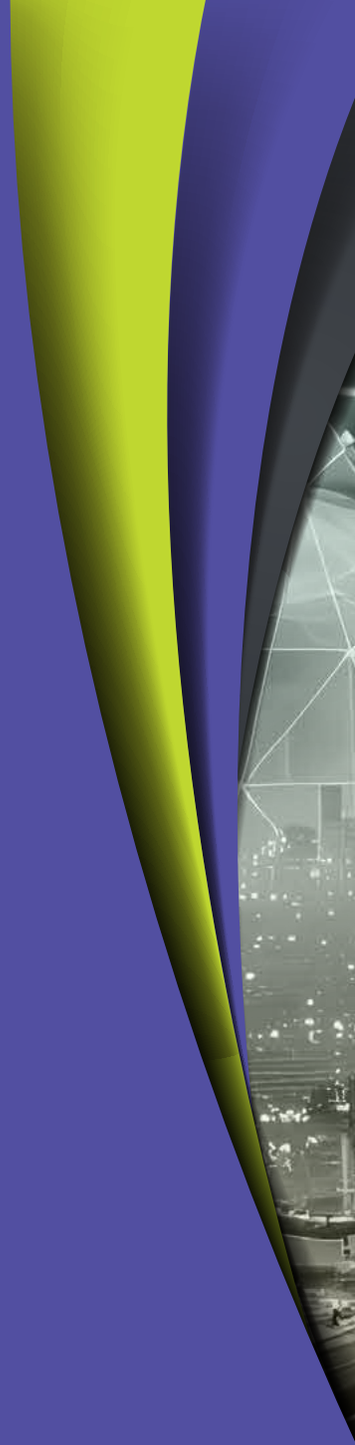
Sustainability and corporate social responsibility are integral to GFL's long-term strategy, especially within the fluoropolymer business. We have a dedicated ESG team that oversees all aspects of environmental stewardship, corporate governance, and community engagement. Our approach goes beyond compliance — we actively embed sustainability into product development, operations, and stakeholder relationships. GFL publishes an Integrated Annual Report along with a Business Responsibility and Sustainability Report (BRSR) in line with SEBI guidelines, transparently outlining our ESG initiatives and performance. This structured focus ensures that our growth in high-tech sectors like fluoropolymers is both responsible and future-ready.

Q What is the long term vision of the company and how do your efforts align with it?

At GFL, we remain deeply committed to advancing the fluoropolymer business with a clear focus on sustainability, innovation, and global relevance. As the industry evolves rapidly, driven by breakthroughs in semiconductors, clean energy, and advanced manufacturing, we are positioning ourselves not just as a supplier, but as a strategic, future-ready partner. Our efforts are anchored in long-term thinking, responsible practices, and a strong belief in building value for our customers, stakeholders, and the environment ICN

SUPPLY CHAIN

Shifting Towards Agile and Resilient Model





SMART LOGISTICS: THE CHEMICALS INDUSTRY'S NEW LOGISTICS PLAYBOOK

Companies are investing in smart logistics, automation, and resilient sourcing strategies to ensure safety, compliance, and continuity amid global disruptions

TEAM ICN

The supply chain and logistics landscape within the chemicals industry is undergoing a profound transformation, fueled by a confluence of global disruptions, regulatory demands, and the push for digital innovation. As a sector deeply dependent on complex global trade routes and strict safety regulations, chemical companies are increasingly re-evaluating their logistics and supply chain models to build resilience, agility, and sustainability.

One of the key challenges the industry faces is managing volatility in raw material availability and transportation costs. The Russia-Ukraine conflict, for instance, disrupted the supply of key feedstocks and fertilizers, while shipping bottlenecks in the Red Sea and Panama Canal caused delays and cost surges across global trade lanes.

To mitigate such risks, chemical manufacturers are diversifying their supplier base and adopting nearshoring strategies. A BASF executive recently noted that the company is increasingly exploring regional production hubs to reduce reliance on single-source suppliers and minimize cross-border friction. This approach is being supported by significant investment in digital supply chain tools. The global market for supply chain analytics in chemicals is expected to reach US$4.3 billion by 2027, growing at a CAGR of 15%, according to MarketsandMarkets.

Digitization is at the heart of the industry's logistics overhaul. Companies are deploying advanced technologies like digital twins, predictive analytics, and real-time shipment tracking to gain visibility across their operations. For instance, Dow Chemical has implemented AI-powered demand forecasting tools that have improved forecast accuracy by over 20 per cent, resulting in reduced inventory costs and faster customer deliveries. Additionally, chemical logistics providers are leveraging automation in warehousing and using blockchain for more secure and compliant documentation processes, especially when handling hazardous materials.

Environmental and safety regulations are also shaping logistics strategies. With increasing pressure to meet ESG goals, companies are rethinking transportation modes and packaging materials. Rail and intermodal transport are being preferred over trucking to cut carbon emissions. Moreover, the implementation of 'Responsible Care' logistics standards by many global players ensures adherence to safe transport and handling practices.

Ultimately, the future of supply chain and logistics in the chemicals sector lies in building systems that are not only efficient and transparent but also adaptable to a rapidly changing world.

> The chemical logistics market is poised for substantial growth, with projections indicating an increase of US$ 67.7 billion from 2024 to 2028. This growth is driven by the expanding chemical industry and the adoption of advanced technologies such as smart sensors, robotics, AI, and blockchain

While challenges remain, particularly in balancing cost efficiency with regulatory compliance and sustainability, the ongoing transformation promises a more resilient and digitally empowered chemicals industry.

Key Developments

In 2024, the Indian chemicals industry witnessed significant advancements in supply chain and logistics, driven by government initiatives, technological integration, and a heightened focus on sustainability.

A pivotal development was the release of the "Logistics Ease Across Different States (LEADS) 2024" report by the Indian Ministry of Commerce & Industry. This report emphasized the

Chemicals without Borders: Logistics in an Era of Disruption and Demand

Market Size & Growth	Indian chemicals industry projected to reach US$ 300 billion by 2029
Logistics Cost	Current logistics cost is 13–14% of GDP, targeted to reduce to below 10% via reforms
Key Government Initiatives	PM Gati Shakti, Multi-Modal Logistics Parks (MMLPs), and LEADS 2024 Report to improve infrastructure and efficiency
Digital Adoption	60% of companies plan to invest in real-time tracking, AI forecasting, and blockchain by 2026
Sustainability Trends	Growing adoption of LNG-powered trucks, focus on green logistics, and alignment with ESG norms
Infrastructure Bottlenecks	Challenges remain in last-mile connectivity, hazardous material handling, and trained workforce availability
Technology Integration	IoT, AI, and smart sensors are enabling visibility, predictive maintenance, and risk reduction
Geopolitical & Raw Material Risks	Over 40% feedstock imports from China/Middle East; volatility impacts production and costs
Regional Logistics Growth	Clusters like Dahej, Vizag, and Cuddalore emerging as new hubs due to decentralization and regional manufacturing
Future Outlook	Emphasis on resilience, digitization, and sustainable freight modes to meet global benchmarks

necessity for states to devise action plans aimed at enhancing logistics infrastructure to attract investments. Key recommendations included promoting green logistics, fostering workforce inclusivity, and facilitating central government projects. The report highlighted the importance of adopting technologies such as Artificial Intelligence, Machine Learning, and Data Analytics to boost efficiency in the logistics sector. Additionally, it underscored the need for skill development and greater participation of women in the workforce to drive the sector forward.

Technological advancements have played a crucial role in reshaping the chemical logistics landscape. The integration of Internet of Things (IoT) technology has enabled real-time tracking and monitoring of goods, providing valuable data on shipment conditions, locations, and transit times. This digital shift has led to reduced operational costs, improved accuracy, and enhanced agility within supply chains.

Furthermore, the Indian government's focus on developing Multi-Modal Logistics Parks (MMLPs) has been instrumental in improving the country's freight logistics sector. These parks aim to lower overall freight costs and time, cut warehousing expenses, and reduce vehicular pollution and congestion. The Govt. of India has approved 35 MMLPs for development of MMLPs. These parks are designed to provide integrated storage and warehousing, mechanized material handling, and inter-modal transfer facilities, thereby enhancing the efficiency of chemical logistics.

Globally, the chemical logistics market is poised for substantial growth, with projections indicating an increase of US$ 67.7 billion from 2024 to 2028. This growth is driven by the expanding chemical industry and the adoption of advanced technologies such as smart sensors, robotics, AI, and blockchain. These innovations are expected to enhance operational efficiency, ensure compliance with safety regulations, and promote sustainable practices within the industry.

Challenges

The Indian chemicals industry, while rapidly growing, continues to face several critical challenges in its supply chain and logistics operations, many of which were further intensified in 2024. One of the primary issues is infrastructural inefficiency. Despite efforts like the PM Gati Shakti National Master Plan, the

fragmented transport networks, poor last-mile connectivity, and insufficient storage infrastructure continue to hinder smooth movement of hazardous and non-hazardous chemical goods. According to the Logistics Performance Index (LPI) 2023 by the World Bank, India ranked 38th globally—an improvement, but still reflective of logistical bottlenecks that hamper sectoral growth.

Compliance and safety remain a significant concern, particularly in the storage and transportation of hazardous chemicals. As per data from the National Disaster Management Authority, incidents involving chemical mishandling during transit increased by 11 per cent in 2023 compared to the previous year. This reflects gaps in workforce training, standard operating procedures, and real-time monitoring. The lack of specialized chemical logistics providers and trained personnel contributes to the high operational risk and safety non-compliance.

Another key challenge is the volatile pricing and availability of raw materials, which severely disrupt supply chain predictability. India imports over 40 per cent of its chemical feedstock, primarily from China and the Middle East. In 2023–24, geopolitical tensions and increased freight costs led to a 12 per cent rise in the landed cost of raw materials, according to data from the Ministry of Chemicals and Fertilizers. These fluctuations complicate procurement planning and impact production schedules, especially for MSMEs that lack deep inventory buffers.

Technology adoption, though progressing, remains uneven across the sector. While large players have begun implementing advanced digital supply chain platforms, a significant portion of small and mid-sized enterprises still operate manually or with outdated ERP systems. A 2024 industry survey by FICCI found that only 35 per cent of Indian chemical manufacturers have adopted real-time tracking systems, and fewer than 20 per cent use predictive analytics to manage inventory and demand.

Environmental compliance is also a growing challenge. With stricter ESG regulations coming into effect, companies are under pressure to reduce emissions from logistics operations and adopt sustainable transport modes. However, the transition to greener logistics, such as LNG trucks or rail freight, is slowed by the limited availability of infrastructure and the high cost of transition. For instance, LNG fueling stations are concentrated mainly in western and southern India, making cross-regional adoption difficult.

Outlook

The future outlook for supply chain and logistics within the Indian chemicals industry is poised for significant transformation, driven by a combination of policy reforms, technological advancements, and increasing global demand. As the sector aims to reach a projected market size of US$ 300 billion by 2029 robust and agile supply chain mechanisms will become critical to sustaining this growth. The Indian government's initiatives, particularly the PM Gati Shakti National Master Plan and the development of Multi-Modal Logistics Parks (MMLPs), are expected to drastically improve the country's freight infrastructure. These projects are designed to lower logistics costs, currently estimated at around 13–14 per cent of GDP, to below 10 per cent, aligning India with global standards.

Technological integration is set to play a pivotal role in future supply chain modernization. According to a 2024 Deloitte India survey, over 60 per cent of Indian chemical companies plan to invest in supply chain digitization by 2026, focusing on real-time tracking, AI-based demand forecasting, and blockchain for compliance and traceability. These technologies will enhance visibility, reduce waste, and improve the overall responsiveness of chemical logistics networks, which are traditionally prone to delays and inventory challenges.

The Indian government's initiatives, particularly the PM Gati Shakti National Master Plan and the development of Multi-Modal Logistics Parks (MMLPs), are expected to drastically improve the country's freight infrastructure

Sustainability will be another defining feature of the future landscape. With India committing to net-zero emissions by 2070 and tightening ESG regulations, chemical logistics providers are expected to transition to greener fuels and optimize freight modes. The market for LNG-powered logistics, for instance, is projected to grow by 20% annually over the next five years.

Furthermore, the ongoing shift toward regionalized and decentralized manufacturing—driven by global supply chain diversification trends—will lead to more distributed logistics networks across India. This decentralization is expected to benefit Tier-2 and Tier-3 cities, especially in chemical clusters like Dahej, Cuddalore, and Vizag, leading to increased demand for localized warehousing and just-in-time delivery systems. The Indian Chemical Council predicts that by 2030, over 40 per cent of the country's chemical logistics flows will originate outside the traditional industrial corridors.

The future of supply chain and logistics in the Indian chemicals industry is anchored in modernization, resilience, and sustainability. With continued investment in infrastructure, digitization, and green technologies, the sector is well-positioned to overcome longstanding inefficiencies and emerge as a globally competitive and environmentally responsible supply chain hub

EXPECT TO HANDLE 50 MILLION TONNES OF CARGO, TARGETING 20% OVERALL GROWTH

VOC Port is working on implementing AI and IoT technologies to create a smart, green, and secured port



Susanta Kumar Purohit
Chairperson
V.O.C Port Authority

Q Could you please tell us about VOC Port?

Strategically located close to the East West International Sea Route, the V.O. Chidambaranar (VOC) Port is considered as the gateway port of Southern Tamil Nadu. It is an all-weather port with 24x 7 operations and is well connected by road and rail. The port is congestion free and provides seamless cargo evacuation through National Highways 38 connecting Madurai and 138 connecting Tirunelveli. Moreover, all the 16 Container Freight Stations and an Inland Container Depot are located at proximity of 5 Kilometres from the port providing easy access to the EXIM community.This exposure will not be sector specific but will encompass manufacturing, services and agriculture sectors. These three sectors are the pillars of Indian economy.

Q How was the cargo and financial performance of the VOC Port in FY24-25?

In FY 2024-25, despite capacity constraints, VOC Port delivered a robust performance, handling 41.72 million tonnes of cargo, a significant increase from the 41.40 million tonnes in the previous fiscal year. The Container handling reached a record 7, 95,222 TEUs (Twenty-foot Equivalent Units) registering an impressive growth of 6.41 per cent.

For FY 2025-26, we expect to handle 50 million tonnes of cargo, targeting a 20 per cent overall growth in throughput and Container volumes are projected to exceed 8, 50,000 TEUs. VOC Port has achieved the highest ever Total Revenue of Rs. 1209.19 crore in the FY 2024-25 as compared to Rs. 1121.92 crore of previous FY 2023-24, registering a growth of 7.78 per cent. The net surplus after tax for FY 2024-25 is Rs. 534.90 crore as against Rs. 460.08 crore in FY 2023-24, registering a record growth of 16.26 per cent and the Operating Ratio of 29.05 per cent, is one of the least among the Indian major ports.

வ.உ.சி துறைமுக ஆணையம்
वी.ओ.सी पत्तन प्राधिकरण
V.O.C Port Authority
Global Connect

Q What sort of infrastructure was added last year and what are the planned capacity augmentation initiatives of the VOC Port?

VOC Port has adapted to rising cargo volumes and global trade demands through various initiatives. We have enhanced our container handling infrastructure, by commissioning Tuticorin International Container Terminal operated by JM Baxi, with a capacity of 6 lakh TEUS. Along with the existing DBGT Container terminal, the port has a container handling capacity of 1.2 million TEUs.

To cater the bulk cargo needs, the NCB-II has been operationalized with Harbour Mobile Cranes. The North Cargo Berth-III has been dredged to 14.2 mt draft and shall be operational in a few days with Harbour Mobile Cranes,



> **VOC Port has earmarked 765 acres of land under the Coastal Employment Unit for setting up various port based industries under the Sagarmala initiative of Ministry of Ports, Shipping, and Waterways**

accommodating 95,000 DWT vessels. Further, the fully mechanized North Cargo Berth-III shall be operated by JSW by the end of March 2027. An innovative solution to use the spare capacity available at the berth, a link conveyor with 2000 TPH capacity, linking Coal Jetty I conveyor with Port Coal Yard for handling coal has been developed.

The turning circle of the Port and the entrance channel is also being upgraded. The mouth of the entrance channel will be widened from 153 mt to 230 mt. Further, the diameter of the turning circle will be widened from 480m to 550m facilitating the Port to berth 14.20 mt draft container vessels with ease. Plans are also in place to construct a 440 mt multi-cargo Berth no. 10 and a 470 mt exclusive windmill blade terminal to boost offshore wind exports through VOC Port. On completion of the planned inner harbour capacity augmentation projects, the port will be able to attract regular mainline vessels.

Moreover, the Outer Harbour project of VOC Port with two container terminals, draft of 16 metres and capacity to handle 4 million TEUs of containers shall transform VOC Port as the Transshipment Hub of the East coast of India.

Q How do you see port-led industrialization around VOC Port?

VOC Port has earmarked 765 acres of land under the Coastal Employment Unit for setting up various port-based industries under the Sagarmala initiative of the Ministry of Ports, Shipping, and Waterways. Many industries like green hydrogen manufacturing, chemicals, food processing, edible oil manufacturing and warehousing are already operating their facilities at the port.



> **The newly commissioned Direct Port Entry (DPE) facility enables factories and exporters to deliver containers directly to the port terminal instead of routing through container freight stations (CFS)**

Q What sort of green hydrogen and renewable energy projects are coming at VOC Port?

An investment of Rs. 41,860 crore has been committed by leading global firms such as ACME Green Hydrogen & Chemicals, Green Infra Renewable Energy Farms (Sembcorp), Amplus Ganges Solar, and ReNew E-Fuels. The commencement of green hydrogen is expected by the year 2028. To infuse confidence in the investors, the pilot project for installation of green hydrogen production plant of 10 nm3 capacity, along with 10 KW power generation using fuel cell for EV charging and powering street lights in port colony is nearing completion. In addition, the port is set to undertake a pilot project for green hydrogen and green methanol bunkering which will demonstrate bunkering and refueling facilities at VOC Port.

Q How is VOC Port positioning itself as a smart port?

India's first indigenously developed Vessel Traffic System to optimize vessel movements, minimizing congestion and berthing delays has been commissioned at the port. The RFID based port gate management has facilitated real time gate monitoring and seamless movement of trucks. The newly commissioned Direct Port Entry (DPE) facility enables factories and exporters to deliver containers directly to the port terminal instead of routing through container freight stations (CFS). Port's drive through container scanner can scan 100 vehicles per hour, capable of detecting suspicious material at ease, thereby improving the evacuation efficiency.

VOC Port is working on implementing AI and IoT technologies to create a smart, green, and secured port. The port is set to commission an IoT-based street lighting system and water sprinkler system in the coal yard. The port is also exploring various avenues of automation, AI and IoT, Digital twin, and 5G technology with IIT Chennai.

ACCELERATING GROWTH IN INDIA BY EXPANDING PRODUCT PORTFOLIO AND DIGITAL CAPABILITIES

Caldic India aims to capitalize on its expansion by leveraging its global expertise, deep local presence, and strong relationships with both principals and customers



VISHAL JAWALE
Managing Director - India &
Regional Director - South Asia
Caldic India

Q Emerging trends in the speciality chemicals distribution market in India and globally?

The specialty chemicals distribution market is evolving with key trends like sustainability, digitalization, and demand for customized solutions. In India, growth is fuelled by rising demand from the personal care, pharma, and food sectors, while globally, the focus is on bio-based, eco-friendly ingredients, and stricter regulations.

Q Caldic India has expanded its operations in key markets, including the acquisition of a majority stake in a specialty chemicals distributor in Asia. How is this going to benefit its India operation?

Caldic's expansion in Asia-Pacific supports India operations by making our portfolio of unique, value-added products, and services more accessible to a broader customer base. With Asia being a high-growth region, the move strengthens our ability to support key markets such as food and nutrition, (bio) pharma, personal care, and industrial formulations.

The expertise and expanded capabilities resulting from our regional presence allows us to deliver customized solutions that align with evolving industry demands. By redefining the benchmarks for added value in specialty chemicals and ingredients distribution, we aim to help both existing and new customers seize emerging opportunities and foster innovation. Ultimately, this expansion positions us to create a larger positive impact across life sciences and material sciences sectors in India through sustainable business growth.

Q Caldic India has been appointed as official distribution solutions partner for Stratachem's specialty chemicals in India. What synergies do you anticipate from this partnership and how will it enhance product offerings in the Indian market?

The strategic partnership with Stratachem strengthens our ability to meet the growing demand for specialty additives and surfactants in India. Stratachem's expertise in antifoams, defoamers, wetting agents, pigment dispersants, and acetylenic diols, combined with their in-house R&D capabilities, allows them to offer high-performance, cost-effective formulations that meet global standards. This collaboration enhances our product portfolio, particularly in sectors like paints, inks, adhesives, and construction chemicals.

CALDIC
Empowering innovation with specialty chemicals and ingredients as your trusted partner in life and material sciences distribution.
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> **Recent strategic partnerships have enhanced the company's product portfolio and distribution network, enabling broader access to innovative, high-demand solutions in sectors like personal care, food, and specialty chemicals**

With India's chemicals sector expected to triple its global market share by 2040 due to rising domestic demand and global supply chain diversification, this partnership positions us to capitalize on emerging opportunities and deliver innovative, value-generating solutions to our customers. By leveraging Caldic's extensive global distribution network and Stratachem's deep expertise, we aim to expand our reach and enhance customer satisfaction both locally and globally.

Q Collaboration with Laviosa aims to distribute rheology additives and organoclays in India. How do these products meet evolving demands of industries such as coatings, plastics, and construction in the region?

Our partnership with Laviosa, a 100-year-old, family-owned Italian company and one of the world's largest producers of bentonites and organoclays, brings tremendous value to the Indian market. Laviosa's rheological additives and organoclays are essential for improving performance and stability of solvent coatings, paints, grease lubricants, and inks. These solutions address the evolving demands of industries such as coatings, plastics, and construction, which are witnessing significant growth in India.

By leveraging Caldic's extensive distribution network and portfolio of value-added solutions, this partnership aims to increase awareness and accessibility of Laviosa's high-performance products in India. Together, we are well-positioned to capitalize on emerging opportunities and drive sustainable business growth in this key market.

Q Acquisition of Chemhouse Marketing and Brink Chemicals strengthens Caldic India's position in the personal care sector. How does this acquisition align with Cadic's strategy to offer customized value-added solutions in the Indian market?

The acquisition of Chemhouse Marketing and Brink Chemicals strengthens Caldic India's foothold in the high-growth personal care market in India. With Chemhouse's expertise in premium and plant-based ingredients, tailored formulations, and value-added services like product testing and regulatory guidance, this move aligns perfectly with our focus on delivering innovative and customized solutions. By integrating Chemhouse's capabilities, we aim to further inspire innovation, enhance our product portfolio, and create new opportunities for our customers and partners in India's evolving personal care landscape.

Q Caldic has been appointed as distribution solutions partner for Michelman's products in Japan and the Indian Subcontinent. What opportunities does this present for expanding the company's reach in these regions, particularly in the coatings sector?

The expanded partnership with Michelman represents a significant opportunity for Caldic to strengthen its presence in Japan and the Indian Subcontinent. Michelman's extensive portfolio, which includes surface additives, polymeric binders, barrier and functional coatings, and digital printing-press primers and OPVs, serves diverse applications in industrial packaging, consumer packaging, paper products, and commercial printed materials.

With India being a high-growth market for the global coatings and industrial sectors, this strategic collaboration enables us to leverage Michelman's high-performance solutions and Caldic's end-to-end distribution capabilities. Together, we are well-positioned to address the rising demand for advanced coatings while developing sustainable and thriving business opportunities. This partnership reinforces our shared commitment to delivering innovative, high-quality products that meet and exceed customer expectations across both regions.

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Q Given the projected growth of India's chemicals sector, how does Caldic India plan to capitalize on this expansion and what role do these recent partnerships play in your long-term strategy?

With India's chemical sector poised for significant growth, Caldic India aims to capitalize on this expansion by leveraging its global expertise, deep local presence, and strong relationships with both principals and customers. Recent strategic partnerships have enhanced the company's product portfolio and distribution network, enabling broader access to innovative, high-demand solutions in sectors like personal care, food, and specialty chemicals. By focusing on sustainability, innovation, and customized value-added services, Caldic seeks to strengthen industry relationships, address evolving market needs, and drive long-term growth and diversification in the Indian chemicals sector.

Q The company has expanded its product portfolio to include bio-based alternatives to traditional petrochemical products. What challenges have been encountered in this transition, and how does the company educate customers about the benefits of these alternatives?

The transition to bio-based alternatives brings challenges like addressing market perceptions, performance concerns, and supply chain complexities. Caldic India tackles these by offering technical support, performance data, and hands-on demonstrations at its application center, helping customers experience the benefits of bio-based solutions. By aligning with global sustainability trends, the company aims to drive adoption and support a greener, more sustainable future.

Q The company has invested in digitization efforts, including the implementation of an advanced supply chain management system. How has it improved operational efficiency and customer satisfaction?

Caldic is advancing toward digital leadership in the ingredients and specialty chemical distribution sector with a strategic roadmap designed to enhance the digital customer journey. Recognizing the growing importance of digitization for sustainable business growth, we seek to deliver impactful and relevant digital solutions to customers, principals, and stakeholders while addressing evolving business needs.

With increased investments in digital platforms in the last few years, Caldic is accelerating its transformation to strengthen operational efficiency, optimize processes, and improve customer satisfaction. This digital strategy is aimed at driving innovation, enhancing competitiveness, and creating incremental value that differentiates the company in the market.



Q Looking ahead, what are Caldic India's strategic priorities for the Indian market? How do you envision Caldic India's role in supporting the growth and diversification of India's chemical industry?

Caldic India aims to accelerate growth in India by expanding product portfolio, digital capabilities, and driving sustainable innovation across key sectors of personal care, food and nutrition, pharma, and industrial formulations.

Sustainability remains central, with a focus on reducing carbon footprint through bio-based products, green solvents, and circular economy initiatives. Investments in digital tools further enhance customer engagement, operational efficiency, and market differentiation.

With a long and deep presence in the Indian market, we are committed to leveraging our extensive distribution network, comprehensive portfolio of value-added solutions, and global expertise combined with local insights to foster innovation, strengthen partnerships, and unlock long-term growth to support India's diverse and growing chemical industry ICN

With increased investments in digital platforms in the last few years, Caldic is accelerating its transformation to strengthen operational efficiency, optimize processes, and improve customer satisfaction

FUTURE OF DISTRIBUTION LIES IN INNOVATION, DIGITALIZATION, AND SUSTAINABILITY

Larger players are acquiring regional distributors to strengthen their market position, improve efficiencies, and offer a broader range of solutions



NARENDRA VARDE
Managing Director
IMCD India & Bangladesh

Q Emerging trends in the chemical distribution segment?

The chemical distribution industry is evolving along two major trends. First, we see a shift from commodity-based sales to high-value specialities. The market is moving away from low-margin commodity sales towards high-value, specialised products. Customers today expect more than just a supplier. They seek partners who can provide quality, service, digitalization, and value-added solutions. Distributors are no longer just intermediaries; they play a vital role in helping customers scale, innovate, and improve efficiency.

Principals are also raising their expectations, selecting distribution partners who can support innovation through product development and co-creation. Sustainability is another decisive factor, with principals looking for distributors who align with their ESG goals and drive sustainable growth across the supply chain.

The second key trend is consolidation. Larger players are acquiring regional distributors to strengthen their market position, improve efficiencies, and offer a broader range of solutions. This consolidation helps address the challenges of shifting from commodity sales to high-value specialities, ensuring distributors can meet increasing customer and principal expectations.

In this evolving landscape, distributors must go beyond transactions and become value chain enablers. The future of chemical distribution lies in scale, innovation, digitalization, and sustainability - ensuring long-term success for both customers and principals.

Q The company has been on acquisition spree in FY 2024-25. How are these acquisitions benefiting IMCD India?

At IMCD, our acquisitions are driven by a strategic intent: to continuously review our portfolio and identify gaps that, when addressed, enable us to offer a more complete and differentiated value proposition to our customers. We proactively scout for acquisition targets that align with our priorities, both directly and in collaboration with trusted M&A partners.

Over the last few years, we acquired five entities in India: Parkash Dyechem that increased our presence in the construction and ink segments; Tradeimpex Polymers that enhanced our presence in the automotive sector; two business lines from CJ Shah for bolstering our coatings and adhesives segment; Valuetree Ingredients for strengthening our Beauty & Personal Care business, and Signet Excipients for augmenting the Pharmaceuticals business.

We are delighted that the talent acquired through these acquisitions plays a crucial role with IMCD and in some cases have joined the leadership team within our organisation.



Key factors that have contributed to IMCD India's growth?

The chemical industry has experienced a challenging period over the past couple of years, marked by market volatility, supply chain disruptions, and a shift in customer expectations. Despite this backdrop, IMCD India has delivered performance that has outpaced the broader market, reflecting our strategic focus, operational agility, and customer-centric approach. We have garnered market leadership in several key industry sectors, reinforcing our reputation as a preferred distribution partner for both customers and suppliers.

As a company without manufacturing assets, our people and talent drive our growth. We focus on attracting and nurturing the right talent. To support this, we have launched leadership development programs in partnership with top B-schools and introduced recognition programs for high performers. Our entrepreneurial culture fosters empowerment and accountability, ensuring sustained and consistent growth.

To support our expansion in India, we have taken measures to strengthen our supply chain. We have consolidated sampling operations into a centralised fulfilment centre that caters to all our businesses. The third party-managed facility underscores our commitment to customer-centric solutions and strengthens partnerships by ensuring quicker access to product samples. In addition, the Authorised Economic Operator (AEO) T2 accreditation strengthens our supply chain resilience and ensures greater efficiency in logistics and trade operations.

What's your strategy to maintain/grow your market share in the India region?

Continuous improvement, the new IMCD corporate value, is the cornerstone of all our efforts. Portfolio expansion remains a key strategic focus, achieved both organically by onboarding new principals and inorganically through mergers and acquisitions. Additionally, we emphasize operational excellence, positioning ourselves not just as a distributor but as a formulation development expert.

Our supply chain excellence has been recognised through multiple



awards in 2024, including: 'Value-Added Distribution Service' by the Institute of Supply Chain Management (ISCM); Recognition at Fi India Awards 2024 for outstanding practices in logistics, supply chain management, and warehousing services; and Winner in the Supply Chain Management category at the Rosefield Conference.

By continuously optimising our supply chain, enhancing our service portfolio, and leveraging digital tools, we ensure sustained growth and a competitive edge in the Indian market.

Q How has IMCD India ensured sustainability in its operations and what new initiatives are planned on the sustainability front?

Sustainability is embedded in our operations through a multi-faceted approach such as warehouse selection, sourcing vendor screening, formulation development, operational efficiency, community engagement, and regulatory compliance.

Warehouse selection: We have partnered with a sustainability-focused warehouse that exemplifies our commitment to greener logistics and operations. The facility includes solar power generation, green logistics through electric vehicles, wastewater treatment systems, and eco-board flooring.

Sourcing vendor screening: Partnering with suppliers who prioritise eco-friendlier chemistry and solutions.

Formulation development: We help customers develop prototypes using safer and more sustainable ingredients.

Operational efficiency: We prioritise optimising energy consumption, minimising waste, and reducing our carbon footprint. For instance, we have moved to a paperless transaction system.

Community engagement: Aligning CSR initiatives with the UN Sustainable Development Goals, particularly in education and gender equality, to create lasting social impact.

Regulatory compliance: Recently IMCD India renewed its ISO 9001:2015 certification, assuring our customers of our service through continual improvement. Our dedicated teams from the Global Regulatory Questionnaire Center and the newly established Item Creation Centre/ Master Data Management function, both of which are based in India, support regulatory standards for IMCD India as well as globally for the IMCD Group.

Q In the rapidly changing and competitive market landscape, how does IMCD India stay ahead by anticipating customer needs and market trends?

In a recently concluded survey, IMCD India achieved outstanding customer satisfaction ratings. Customers rated us with high scores for supply chain performance, reliability and trustworthiness, and ease of doing business.

IMCD's strength lies in its ability to deliver hyper-local solutions while leveraging its global expertise. Through our application centres, we provide formulation support tailored to local market needs, helping customers innovate and optimise their products. Additionally, by leveraging deep market insights, we differentiate ourselves by offering value-driven solutions that address the specific challenges of our partners and customers.

We actively track market trends through intelligence studies and analyses, ensuring a proactive approach. Leveraging our global network, we introduce cutting-edge solutions in India ahead of market demand.

By continuously optimising our supply chain, enhancing our service portfolio, and leveraging digital tools, we ensure sustained growth and a competitive edge in the Indian market

Regular engagement with customers via technical seminars, collaborative projects, and digital outreach are a few initiatives that have built our relationship with customers.

Q What are the major challenges/ opportunities facing the specialty chemicals industry? Suggestions to navigate through them?

The specialty chemicals industry is navigating a complex environment shaped by both pressing challenges and emerging opportunities. Among the most immediate concerns is the Red Sea crisis, which has disrupted one of the world's key maritime trade routes. This has resulted in longer shipping times, increased freight costs, and unpredictable delivery schedules, creating bottlenecks in the supply of critical raw materials. For a sector that



relies heavily on timely imports and exports, such disruptions directly impact manufacturing timelines, working capital cycles, and customer service levels.

In parallel, shifting global trade policies and tariffs are further complicating the operating environment. As countries reassess their trade dependencies, tariffs and counter-tariffs have introduced cost volatility and altered traditional sourcing patterns. Deglobalisation and shifting trade policies have disrupted traditional supply chains, while geopolitical developments have led to increased volatility in logistics and raw material availability. At the same time, an influx of Chinese imports into India, as manufacturers seek alternate markets, is intensifying competitive pressures and creating pricing challenges. However, domestic consumption and supply chain realignments present significant growth opportunities. The Indian chemical industry has been expanding at a CAGR of 10.5% since 2018, outpacing GDP growth.

To thrive in this environment, companies must strike a strategic balance between localising their supply chains and leveraging India's growing importance in global value chains. Investing in digitalization, enhancing logistics resilience, co-developing sustainable solutions with partners, and nurturing technically skilled talent will be essential to remaining competitive.

Ultimately, companies who, like IMCD, embrace innovation, agility, and collaboration will be best positioned to lead in the next phase of growth for the specialty chemicals sector.

Q How is IMCD India planning to leverage digital technologies for optimizing its processes and improving overall operational performance?

We are advancing digital capabilities through a unified global IT platform, AI-driven tools, integrated ERP, and CRM systems. Our MyIMCD platform enables customers to access technical documentation, track orders, and request samples seamlessly. By integrating supplier, customer, and third-party data, we enhance operational efficiency, reduce manual interventions, and ensure seamless digital interactions across the value chain.

Our omnichannel distribution model, which includes our 24/7 e-commerce portal MyIMCD and Customer Care 360 support service, ensures we offer a seamless customer experience across



all interaction points. These platforms have further enhanced flexibility and accessibility, contributing to high customer satisfaction and loyalty.

IMCD India has recently inaugurated a new Sample Fulfilment Centre near Mumbai for diverse business segments. How will this Centre help in enhancing efficiency and effectiveness of its operations?

We indeed recently inaugurated IMCD India's dedicated Sample Fulfilment Centre near Mumbai, established through a strategic third-party partnership. This initiative underscores our commitment to commercial and operational excellence while significantly elevating the customer experience. Serving across all our business segments, the Centre plays a pivotal role in streamlining our sampling process. By consolidating all sampling operations into a centralised location, we are now equipped to handle large volumes with greater efficiency, improved accuracy, and faster response times. This third-party-managed facility reflects our focus on delivering innovative, customer-centric solutions and reinforces our commitment to strengthening partnerships across the value chain, while maintaining an asset-light model that allows greater flexibility. It is a key enabler of our growth strategy, supporting scale, consistency, and agility in meeting customer needs across India's dynamic and expanding market landscape.

Where does India stand in IMCD's global scheme of things? How do you see the growth trends from India?

As one of the largest and most promising emerging economies, India offers immense opportunities for value creation across a broad spectrum of industries from life sciences to industrial. India presents immense opportunities for growth, driven by industrialisation, regulatory advancements, and evolving customer needs.

Our mantra for growth in India is centred on combining deep local knowledge with global expertise to deliver tailor-made, technically driven solutions. By leveraging our extensive distribution network, formulation labs, market insights, and highly skilled teams, we are building long-term partnerships that go beyond distribution. With continued investments in talent, digitalization, supply chain infrastructure, and strategic acquisitions, we are well-positioned to capitalize on India's momentum and drive sustained, scalable growth in the specialty chemicals space for years to come. Our growth is supported by an expanding customer and principal base.

IMCD India has received Authorized Economic Operator (AEO) L2 status. How will this status help the company in the long run?

IMCD India has received AEO Level 2 status, following a comprehensive evaluation process and thorough inspection of our premises by the authorities. This recognition is a significant milestone in our journey towards operational excellence. The AEO L2 status enables us to serve our customers more efficiently by facilitating expedited customs clearance, reducing physical inspections, ensuring faster release of shipments, and enhancing overall supply chain security. It also strengthens our ability to mitigate risks and respond with greater agility in a dynamic trade environment. This achievement is one of the many steps in our ongoing commitment to customer centricity, enhancing reliability, responsiveness, and resilience across our logistics operations to deliver superior value to our partners.

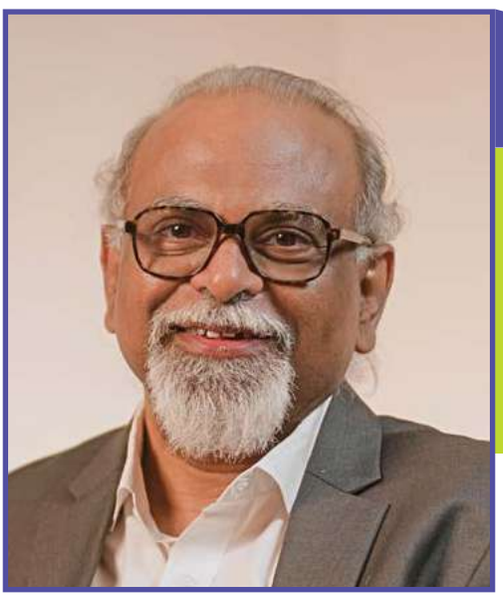
Where do you see IMCD India five years down the line?

Five years down the line, we envision IMCD India as a leading force in the specialty chemicals space, recognized not just as a distributor, but as a true value-adding partner for all our stakeholders. Our goal is to deliver meaningful impact across the value chain. Our commitment to sustainability, digital transformation, and operational excellence will continue to shape our long-term success, positioning us at the forefront of India's dynamic and evolving specialty chemicals market. With a focus on talent, customer-centricity, and strategic expansion, we are building a future-ready organization equipped to lead and grow with confidence

> **Investing in digitalization, enhancing logistics resilience, co-developing sustainable solutions with partners, and nurturing technically skilled talent will be essential to remain competitive**

THERE ARE NO HALF MEASURES IN DANGEROUS GOODS TRANSPORTATION

Our goal is to establish a dedicated Dangerous Goods handling warehouse that will serve as a central hub for the long-term storage of dangerous goods



RADHARAMANAN PANICKER
Managing Director
Dangerous Goods Management India

Q What is the core mission of Dangerous Goods Management India (DGMI) in ensuring safety and compliance in the transportation of hazardous materials?

Our approach is centered on delivering defect-free services while maintaining competitive pricing, positioning ourselves as the most reliable service provider in the hazardous goods sector. We take a proactive, people-driven approach to customer service, with a team that is fully dedicated to ensuring quality and efficiency in every aspect of our operations.

We aim to foster collaboration to promote trade and act as trusted advisors, not just to our customers and partners, but also to regulatory authorities. Our expansion strategy is carefully managed to ensure our commitment to providing quality services, while ensuring seamless continuity for our clients.

Ultimately, we believe that success is not something we take for granted; it must be earned. We maintain success through constant dedication, innovation, and continuous investment in both our people and systems to ensure we are always improving and meeting the evolving needs of the industry.

Q India's chemical sector is a significant contributor to GDP. How does DGMI address the unique risks associated with transporting dangerous goods in this market?

We take a thoughtful and consultative approach to the market, rather than employing a blind, aggressive sales strategy. Initially, our focus was solely on providing compliance services—such as packing, marking, labeling, and preparing Dangerous Goods (DG) declarations—catering to a critical need within the DG transportation sector. This was not only our core competency but also a significant pain point for many businesses in the industry. To ensure the highest level of service, we made it a priority to thoroughly train every member of our team before they were entrusted with handling shipments. Establishing our own DG Training Institute has proven to be a significant advantage. However, we also identified considerable gaps in the industry's understanding of regulatory requirements. To address this, we began collaborating with industry bodies like Indian Chemical Council (ICC) and CHEMEXCIL hosting webinars throughout the year to raise awareness about various aspects of Dangerous





Goods transportation. Through these efforts, we recognized that promoting understanding of the regulations is just as essential as ordering compliance services.

Q DGMI offers training in dangerous goods regulations. How do you ensure your programs remain cutting-edge and relevant to industry needs?

Our biggest advantage in training is the hands-on experience our instructors bring. Together, they have over 50 years of experience in air cargo, logistics, and the chemical industry. Our training programs strictly follow regulatory requirements. To enhance it further, we have introduced innovations like real-time quizzes through Mentimeter to engage participants during sessions. Currently, we are developing a learning management system that combines classroom training with online microlearning modules, enhancing knowledge retention. We also intend to use this system to track participants' learning progress, as DG training is a continuous journey—recurrent training is required every two years.

Q How do you navigate the complexities of regulatory frameworks like the IMDG Code and ICAO TI, and what role does DGMI play in shaping industry standards?

IMDG and ICAO Technical Instructions are not just regulatory frameworks. They represent the global standard for the safe transportation of dangerous goods. If universally followed, they ensure that the fundamental objective of safety in DG transport is fully achieved.

At DGM India, we actively promote awareness and adherence to these regulations through various initiatives. We conduct free public webinars in collaboration with industry bodies, particularly CHEMEXCIL, to educate stakeholders across the supply chain. Additionally, I regularly participate as a speaker at national and international conferences to advocate for best practices and compliance in DG handling. Our advertisements and outreach efforts further reinforce the importance of regulatory compliance and the adoption of robust safety management principles when dealing with hazardous materials. Raising

awareness and building a safety-first mindset is a continuous effort we are deeply committed to.

Q With safety being paramount, what measures does DGMI take to mitigate risks during the transportation of hazardous materials by air and sea?

At DGMI, our core philosophy for mitigating risk is rooted in one word: packaging. Packaging is the first and most critical line of defense. All modal regulations emphasize the use of standard UN specification-tested packaging for the safe transport of dangerous goods. We not only ensure that we use the correct packaging ourselves, but we also hold our customers to the same standard. A properly packaged shipment can be the key difference between a routine transit and a potential safety incident.

Beyond packaging, we strictly enforce the application of accurate hazard markings and labelling on all packages and containers, as required by regulation. The final piece of the puzzle is documentation— specifically, the Shipper's Declaration for Dangerous Goods. We believe in zero compromise when it comes to compliance. In DG transportation, there are no half measures—you're either fully compliant or you're not. And we ensure that every shipment we handle meets the full compliance requirements, every single time.

Q Piracy and security threats are concerns in global shipping. How do you address these risks, particularly in the Indian context? Dangerous goods transportation is highly regulated. What are the biggest challenges in ensuring compliance with national and international standards in India?

The biggest challenge we face in ensuring compliance is the quality and consistency of trained personnel at the acceptance check points, particularly in air cargo complexes. Earlier, this function was handled by airline staff who were thoroughly trained in Dangerous Goods regulations. However, with the outsourcing of cargo handling to third-party terminal operators, we now see inconsistent interpretations of the rules. At times, partially trained staff, when questioned or corrected on specific regulatory points, tend to respond defensively—often rejecting shipments on questionable grounds thereafter.

Let me illustrate with an example: In the case of radioactive materials, packages weighing over 50 kg are required to display the "permissible gross mass." This figure represents the maximum allowable total weight (including both the packaging and the radioactive content) that the package has been tested and approved for, as per IAEA and IATA DGR standards. If a package is marked with a permissible gross mass of 190 kg, that simply means it must not exceed 190 kg— not that it must weigh exactly 190 kg. Yet, we've had instances where staff have rejected shipments solely because the actual weight was less than the permissible limit—a clear misunderstanding of the regulation.

A similar challenge exists in ocean freight. The Shipper's Declaration for Dangerous Goods, mandated by the IMDG Code, has a specified format and sequence that must be followed. It clearly outlines what information is required—and what is not. For example, details about inner packaging in combination packs are often unnecessary. Despite this, some shipping lines continue to insist on outdated formats and irrelevant data, which creates confusion among logistics staff who have been trained to follow the current, correct procedures. So, while we invest significant effort in training people to understand and apply the right standards, they often find themselves caught between compliance and legacy expectations from other stakeholders.

> **The biggest challenge we face in ensuring compliance is quality and consistency of trained personnel at the acceptance check points, particularly in air cargo complexes**

Q How is DGMI preparing for emerging trends such as sustainability and digitalization in logistics and dangerous goods?

We are actively working towards incorporating sustainable materials into our packaging operations. However, the cost factor remains a significant challenge, as many customers are still reluctant to pay a premium for



environmentally friendly alternatives. That said, we've made strong progress in digitization. Our IT systems are equipped to generate digital shipper's declarations, which we can transmit directly to airlines and shipping lines—streamlining documentation and reducing paper use. Additionally, one of our top priorities is to ensure that all packages are handled in a way that prevents any damage or leakage of dangerous goods. I'm proud to say we have a strong track record on that front, with minimal incidents over the years.

Q Where do you see DGMI in the next five years, especially with the growing demand for safe hazardous materials transportation?

Our goal is to establish a dedicated DG handling warehouse that will serve as a central hub for the long-term storage of dangerous goods, as well as for managing DG cargo related to ocean freight EXIM operations. We are actively exploring leasing opportunities for such a facility, either as a standalone venture or through strategic partnerships with interested parties.

Q What advice would you give to young professionals aspiring to build a career in dangerous goods management or logistics in India?

Handling, storing, and transporting dangerous goods—be it chemicals, explosives, or radioactive materials—demands precision, a deep sense of responsibility, and strict compliance. It's a high-stakes field where safety and environmental impact are always on the line. To build a career in this space, mastering regulatory compliance is essential, and that begins with pursuing the right certifications. Courses like the IATA DGR and IMDG Code are Foundational; they're not one-time qualifications but continuing education programs that keep you updated with evolving global standards. If you're looking to deepen your expertise, consider specialized international certifications offered by the Institute of Hazardous Materials Management (IHMM) in the US. Programs such as the Certified Professional in Dangerous Goods Management or Certified Hazardous Materials Manager/Practitioner carry strong global recognition. Even broader safety management certifications like NEBOSH, while challenging, open doors to career paths in industrial and environmental safety.

That said, there's no substitute for hands-on experience. Work with a couple of solid companies in the chemical or logistics sectors and gain ground-up exposure to every facet of the job. Learn the ropes thoroughly before thinking of your next move. This is a field that's constantly evolving and gaining relevance worldwide. In fact, it won't be long before every organization involved in DG transport, especially by road, is required to have a dedicated safety advisor on board. While this mandate currently applies in Europe under the ADR (European Agreement concerning the International Carriage of Dangerous Goods by Road), India is a signatory to the IRU and will likely adopt similar norms soon. However, ADR-certified courses are currently only offered in Europe, making them a valuable addition for those thinking long-term



> **We began collaborating with industry bodies like ICC and CHEMEXCIL, hosting webinars throughout the year to raise awareness about various aspects of dangerous goods transportation**

EVERYTHING YOU NEED TO KNOW ABOUT MOVING TO AN AUTOMATED BAGGING MACHINE



Yogesh Malani
Managing Director
Chronos Richardson India
(Premier Tech Systems and Automation)

Automated bagging machines increase production speed, allowing faster throughput without sacrificing accuracy



Automated systems are like shortcuts for manufacturers nowadays. Moving from human resources to automatic machines increases production, fulfills market needs, and controls the budget and expenses to achieve long-term goals. But before stepping in, preparation is needed. Here, Premier Tech shares valuable guidelines & tips based on the true experiences of experts in various industries to help our customers make practical use of the automated bagging machine and understand how the automated system works.

Change Problems to Productivity with an Automated Bagging Machine

Premier Tech has experience taking care of customers from various industries such as sugar, tapioca starch, chemical fertilizer, or even baby formula milk powder and animal feed companies. Over the years, many manufacturers have shared the stories and production line problems that caused them to move from manual process to an automated process, switching to an automated bagging machine which helps improve their productivity with applications such as product packing and product sealing.

The implementation of automatic bagging machines increases efficiency and quality in every step, from packing until the bag is closed. For example, in a sugar factory, a complication that many manufacturers have encountered (even those with good control of the process)

There must be a collaboration between the manufacturers and the suppliers who procure the machines and systems, and workers must be ready for the change and to learn new things

is the sugar becoming caked due to moisture being absorbed during the manual bagging process. This reduces the quality of the product and may lead to customer complaints.

Furthermore, there are also problems with the workforce; absence, annual leave, lateness, and shortage which happen repeatedly. These problems disrupt the production line and often become the reason they cannot reach the target number of units each day.

Many think long and hard before implementing an automatic bagging process. But for others, it's a no-brainer. For example, moving the sugar bagging process to a machine prevented the sugar from clumping together. In addition, the by-product from the implementation of automatic bagging machines is less contamination of the bag, which occurred back when the bagging process was done manually.

8 Things to do Before Moving to an Automated System:

1. Create a vision and long-term plan
2. Understand the long-term investment and return
3. Recruit the right personnel
4. Get ready to adjust to the new working system
5. Have a solid maintenance plan
6. Improve the knowledge and skills of personnel
7. Adjust the current team structure
8. Communicate and gain acceptance within the organization



Things to Understand Before Moving to an Automated System

From the 8 things to do list that was mentioned above, the two most important thing before switching from manual to automated, is Firstly, to improve the knowledge and skills of workers. There must be a collaboration between the manufacturers and the suppliers who procure the machines and systems, and workers must be ready for the change and to learn new things. Secondly, we highly suggest our partners to have a solid maintenance plan, including how the automatic bagging machine works and how to maintain it to prevent mistakes and prolong the machine's lifespan.

You should consider:

- An organized schedule of preventive maintenance.
- Regular training to provide knowledge on the machine for existing personnel and newcomers.
- Machine control operating software.
- Sourcing authentic parts to ensure the long-term running of the machine.

Daily preventive maintenance will keep the machines and bagging machine stable in the long-run and reduce unnecessary costs in the future, which could occur without a proper maintenance.

There's Always a Reward for Taking the First Step

So, what are the differences after moving the bagging process to



Even though introducing the machines costs time and money, you will find that the payback makes it worth it

an automated system? Since the bagging machine works faster and can substitute human resources, of course, the results are positive. Whether in terms of Total Cost of Ownership (TCO), Return on Investment (RoI), manufacturing quality or system security. Because the automated system keeps the manufacturing line going, it supports the smooth running of the factory.

Another obvious benefit would be that a factory could reduce the manpower on its production line, e.g., from 15 people per shift scooping, bag opening, sealing etc., to 3-4 people per shift controlling the automatic bagging machine. Even though introducing the machines costs time and money, you will find that the payback makes it worth it. Moreover, you will gain long-term value and a production standard on par or even above your competitors.

Another reward for revolutionizing your production line is the welfare and safety of your staff. Using automatic bagging machines instead of people reduces the number of accidents as the machine itself has a security system and stop mode and a controlling to preventive dust system.

Find More Than A Business Partner



Changing to an automated bagging machine will certainly improve the efficiency and security of your production line. But if you choose the right business partner or supplier, this new relationship will also be one of the driving factors for your success. Because a good supplier should be a partner who guides you, shares experiences, knowledge, and the perspective of an outsider that a business owner may not be able to see. When choosing a bustiness partner or supplier, it's important to ensure they:

- Have a production base, installation team and after-sales services within your country or region and are able to communicate in your native language.
- Are familiar with bagging machines, both manual and automatic, since they will need to understand and work with an organization that is changing to an automated system and support those changes.
- Are reliable by seeing some past projects that showcase their experience in the industry.

To summarize, when you find the right partner, you will benefit from increased production quality and reduced costs and expenses. Problems during the manual bagging process will lessen, both in the short-term and long-term, including security and safety issues. There will even be indirect benefits of the new production line, for instance, better use of floor space. Furthermore, it will improve the skills and knowledge of personnel within your organization, strengthening your ability to compete with other companies in the field.

Premier Tech is the right partner to guide you through the automation process. Get in touch with our Expert today to find out more, please send your inquiry to info@premiertech.com







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DIGITALIZATION & AUTOMATION

Reshaping Industries



AUTOMATION AND AI DRIVE NEXT-GEN GROWTH IN INDIAN CHEMICAL INDUSTRY

The Indian chemical industry is rapidly embracing digitalization and automation to enhance operational efficiency, safety, and global competitiveness TEAM ICN

India's chemical industry is rapidly transforming through digitalization and automation, aligning with global Industry 4.0 benchmarks. Under pressure to boost efficiency, ensure compliance, and meet global standards for safety and sustainability, leading chemical manufacturers across India are investing heavily in technologies such as artificial intelligence (AI), machine learning, industrial IoT (IIoT), robotics, and advanced process control systems. These tools are enabling real-time monitoring of plant operations, predictive maintenance, automated quality control, and data-driven decision-making, significantly reducing downtime and production costs. One of the key challenges the industry faces is managing volatility in raw material availability and transportation costs.

Digitalization is also reshaping the supply chain landscape in the chemical sector. Companies are deploying end-to-end visibility platforms and predictive analytics to manage inventory, forecast demand, and mitigate supply disruptions—critical improvements in a sector heavily reliant on imported feedstocks and vulnerable to global price volatility. For example, firms leveraging AI-driven supply chain optimization tools have reported up to 25 per cent improvement in forecast accuracy and 15–20 per cent cost savings in logistics.

Automation is streamlining manufacturing workflows, with robotics and process integration improving throughput and reducing human error in hazardous environments. According to industry estimates, digitally enabled chemical plants in India have seen productivity gains of 20–30 per cent, with some achieving 10–15 per cent improvements in energy efficiency as well.

Regulatory compliance and safety, long-standing concerns in chemical manufacturing, are being strengthened through digital interventions. Automated environmental monitoring systems, digital twins, and blockchain-based traceability tools are helping companies adhere to increasingly stringent ESG and regulatory standards. Additionally, cloud platforms and centralized data systems are enhancing audit readiness and transparency. Training and workforce upskilling are also becoming central to digital success, with industry bodies like the Indian Chemical Council and FICCI launching digital capability-building programs to support this transition.

AI-driven systems are now being used to analyze real-time data from reactors, distillation columns, and mixing units, leading to faster decision-making and reduced human error in critical environments

Technology dynamics Driving Digital Leap

A rapid shift toward digitalization and automation is fueled by emerging technologies that are transforming operations, supply chains, and compliance frameworks across the sector. At the forefront of this transformation is the integration of artificial intelligence and machine learning, which are enabling chemical manufacturers to optimize production processes, predict maintenance needs, and reduce energy consumption. AI-driven systems are now being used to analyze real-time data from reactors, distillation columns, and mixing units, leading to faster decision-making and reduced human error in critical environments.

The adoption of industrial IoT (IIoT) is another significant trend that



is reshaping how chemical plants operate. Smart sensors and connected devices are being deployed to monitor temperature, pressure, humidity, and emissions continuously, allowing for more precise control and enhanced safety. This connectivity is improving overall equipment effectiveness and enabling predictive maintenance strategies that minimize unplanned downtime. At the same time, digital twins—virtual replicas of physical assets—are being used by leading Indian firms to simulate and test plant operations under various scenarios, improving design accuracy and reducing time-to-market for new chemical products.

Cloud computing and advanced data analytics are playing a vital role in centralizing operations, especially for companies with multiple plants across the country. Centralized digital control rooms and data lakes are giving decision-makers a bird's-eye view of operations, empowering them to make strategic adjustments across locations in real time. Blockchain is gradually gaining ground in the industry as well, particularly in areas like raw material sourcing, product traceability, and export documentation, helping enhance transparency and build trust across global value chains.

> According to industry estimates, digitally enabled chemical plants in India have seen productivity gains of 20–30%, with some achieving 10–15% improvements in energy efficiency as well

Additionally, robotic process automation (RPA) and autonomous systems are being deployed in warehousing, hazardous material handling, and quality control functions, reducing exposure to risks and improving turnaround times. Low-code and no-code platforms are also emerging as tools for rapid digital solution development, enabling plant managers and engineers to build custom dashboards and workflows without heavy reliance on IT teams.

These technology trends are collectively enabling Indian chemical companies to enhance productivity, improve environmental compliance, reduce operational costs, and position themselves as global leaders in smart manufacturing. As the sector continues to evolve, the convergence of these technologies promises to redefine the contours of competitiveness and innovation in India's chemical landscape.

Automation Reshaping Future of Chemical Manufacturing

Key industry players like Reliance Industries, UPL, and Aarti Industries have launched large-scale automation programs in their manufacturing units, focusing on predictive maintenance, process optimization, and real-time monitoring of chemical reactions and equipment performance. These systems are helping to reduce unplanned downtime by as much as 30 per cent while improving plant throughput and product quality.

One of the standout developments has been the integration of digital twins in process-intensive operations. For instance, Tata Chemicals has

Automation Ignites a New Era for India's Chemical Industry

Industry Value	Projected to reach US$ 300 billion by 2030, driving demand for advanced digital and automated systems
Technology Adoption	Increasing integration of AI, IoT, digital twins, blockchain, and advanced analytics
Efficiency Gains	Companies report up to 30% reduction in downtime and 20–25% improvement in process efficiency
Supply Chain Transformation	Real-time visibility, predictive planning, and blockchain-enabled traceability becoming more common
Digital Divide	Large enterprises lead in adoption, while SMEs face capital and capability constraints
Workforce Readiness	Shortage of skilled digital talent remains a key barrier; upskilling initiatives are gaining momentum
Government Support	PM Gati Shakti, PLI schemes, and Digital India are encouraging sector-wide digital transformation
Cybersecurity Concerns	Data protection, IP security, and legacy system integration present operational risks
Future Outlook	Sector moving toward integrated digital operating models with emphasis on scalability and sustainability

implemented digital twin technology in its Mithapur facility to simulate plant performance, optimize energy usage, and reduce emissions, contributing to a broader ESG compliance strategy. Additionally, smart manufacturing platforms powered by AI are being used to analyze historical process data and optimize batch performance, enabling consistent yields and reduced waste.

Companies are also adopting blockchain for supply chain traceability, particularly in export-focused segments like specialty and agrochemicals, where compliance with international quality and safety standards is critical. These solutions are allowing manufacturers to track product movement from plant to port, ensuring greater transparency and efficiency in trade logistics.

In the logistics and warehousing domain, automation is gaining traction with the deployment of smart sensors, autonomous guided vehicles (AGVs), and AI-based route planning tools. These systems are streamlining the storage and distribution of hazardous and non-hazardous chemicals while minimizing risk and human error. Furthermore, digital procurement platforms are helping firms manage vendor relationships and control input costs in a volatile raw material market. On the shop floor, robotics and distributed control systems (DCS) are improving safety by minimizing human intervention in high-risk zones and ensuring consistent operation in temperature- and pressure-sensitive environments.

The government has also played a catalytic role in accelerating digital transformation. Through schemes like PM Gati Shakti, the PLI scheme for specialty chemicals, and initiatives under Digital India, policymakers are encouraging adoption of Industry 4.0 technologies in chemical manufacturing. The Department of Chemicals and Petrochemicals has also collaborated with industry associations to facilitate the development of digital standards and frameworks, aiming to bring uniformity and interoperability across digital systems used in the sector.

However, the journey is not without challenges. Small and mid-sized enterprises, which make up a significant portion of India's chemical ecosystem, often lack the financial resources and technical expertise to adopt these advanced solutions at scale. To bridge this gap, digital technology providers and industry bodies are exploring plug-and-play platforms and cloud-based services tailored for SMEs, with a focus on affordability and ease of implementation. Upskilling the workforce is another area receiving attention, with major companies partnering with academic institutions and digital training platforms to equip employees with the skills needed to work in data-driven environments.

Bottlenecks

Digitalization and automation within the Indian chemical industry face several structural and operational challenges that hinder widespread adoption, particularly among small and mid-sized enterprises. One of the primary obstacles is the high capital expenditure required to implement advanced technologies such as AI, IoT, digital twins, and robotics. While large enterprises may have the financial flexibility to invest in such infrastructure, smaller players often struggle to justify the upfront costs without clear short-term returns. This creates a digital divide within the industry, slowing the pace of uniform transformation.

Another critical challenge is the shortage of skilled professionals who can operate, manage, and maintain digital systems. The chemical sector traditionally relies on mechanical and process engineering expertise, but digitalization demands proficiency in data science, cybersecurity, software integration, and automation technologies. The lack of interdisciplinary talent limits the ability of firms to fully leverage digital investments and extract value from new tools. Moreover, the integration of digital platforms with legacy systems is complex and can cause operational disruptions if not managed carefully. Many chemical plants still operate with outdated control systems and fragmented data architecture, which complicates the process of digitizing end-to-end operations.

Data security and intellectual property protection also remain concerns, especially as companies begin sharing sensitive production and logistics data with cloud-based platforms and external partners. The fear of cyberattacks, industrial espionage, and data misuse makes firms cautious in adopting open digital ecosystems. Regulatory ambiguity around digital compliance and data privacy in the industrial context further adds to the uncertainty, especially for companies operating across multiple jurisdictions.



Additionally, resistance to change at the organizational level can impede digital adoption. In many legacy-driven firms, decision-makers and operational staff may be hesitant to trust automated systems or alter existing workflows that have functioned for decades. The lack of clear digital roadmaps and measurable KPIs often leads to fragmented or underutilized digital projects, resulting in limited RoI and low stakeholder buy-in. Finally, while government initiatives like Digital India and PM Gati Shakti are supportive in principle, the chemical industry lacks tailored policy incentives, digital infrastructure standards, and sector-specific guidance to accelerate transformation in a coordinated and scalable manner.

Global Push Fueling Rapid Adoption

The future outlook for digitalization and automation within the Indian chemical industry is increasingly optimistic, driven by the sector's need to enhance productivity, ensure regulatory compliance, and meet the demands of a competitive global market. As the industry moves towards its projected valuation of US$ 300 billion by 2030, digital transformation is expected to be a critical enabler of sustainable and scalable growth.

Emerging technologies such as AI-powered process optimization, IoT-enabled equipment monitoring, blockchain-based traceability, and digital twins are set to become mainstream, particularly among large enterprises and export-oriented firms aiming to meet stringent global standards. Investments in cloud platforms and advanced analytics will further enhance real-time visibility across production and supply chain operations, reducing waste, improving yield, and enabling agile decision-making.

As the government continues to promote initiatives like the PLI scheme, PM Gati Shakti, and Industry 4.0 adoption under the Digital India framework, chemical manufacturers are likely to benefit from enhanced infrastructure, digital policy support, and collaborative R&D ecosystems. The increasing availability of affordable, cloud-based digital solutions tailored for SMEs is expected to gradually bridge the digital divide, allowing mid-sized players to automate critical functions without massive capital outlay. Workforce upskilling and the integration of digital curricula in technical education will also play a vital role in equipping the next generation of professionals with cross-disciplinary expertise needed in data-driven environments.

Over the next five to seven years, the Indian chemical industry is poised to transition from selective adoption of digital tools to a more integrated, end-to-end digital operating model, positioning it as a globally competitive, efficient, and innovation-led sector

AIMING GLOBAL LEADERSHIP IN CHEMICALS AND AI-DRIVEN PROCESS ENGINEERING BY 2030

Our strategy focuses on sustainability by cutting carbon emissions, enabling companies to scale their process technologies, and reducing carbon footprints through digital solutions



DR. PRATAP NAIR
Founder, President & CEO
Ingenero

Q The Indian chemical industry aims to achieve a US $2 trillion market size by 2047. How does Ingenero plan to align its strategic goals to contribute to and capitalize on this growth?

Ingenero recognizes the Indian chemical industry's potential to reach a US $2 trillion market by 2047 and plans to align its strategic goals with this growth through several key initiatives. We will enhance our investment in sustainable chemical processes and products, focusing on areas like Carbon Capture and Utilization and Waste-to-Value solutions, to meet market demands while minimizing environmental impact.

We will be establishing collaborations with academic institutions, research organizations, and industry leaders that will facilitate knowledge exchange and access to cutting-edge technology, keeping us at the forefront of industry advancements. We aim to diversify our offerings by developing specialized Applied AI applications for process manufacturing, building on our existing solutions.

Our strategy will prioritize sustainability by reducing carbon emissions and supporting companies in scaling their process technologies, while also helping to lower carbon footprints through our digital solutions. We will implement digital technologies to enhance process manufacturing and supply chain operations, improving efficiency and decision-making to quickly respond to market changes. We will invest in training programs to cultivate a skilled workforce, driving innovation and maintaining competitiveness in a rapidly evolving market.

Q The company emphasizes its expertise in process improvement consulting and chemical and process engineering. What new markets or industries did Ingenero venture into during FY 2024-25 and what strategies were employed to ensure successful entry?

In FY 2024-25, Ingenero successfully ventured into new markets by leveraging its expertise in process improvement consulting and chemical engineering. In terms of ssustainable solutions expansion, we focused on Carbon Capture and Utilization (CCU) and waste-to-fuels and chemicals, optimizing production processes to enhance efficiency and reduce costs. We expanded our Applied AI solutions to address client needs in HR and procurement, in addition to manufacturing operations and supply chain. We improved our solutions in design engineering, safety, and operations performance by integrating advanced AI applications and co-enabling technologies.

In terms of our strategies for successful market entry, we conducted thorough market analysis and client discussions to identify growth opportunities and tailor our offerings. We also entered into collaborations



with key players in new sectors, and developed client-centric solutions to address specific challenges. We also adopted advanced technologies and AI-based tools to enhance decision-making and service offerings.

Q How did Ingenero perform financially during FY 2024-25? Key revenue drivers and which segments have shown the most growth?

Ingenero has continued to maintain its robust average double-digit growth rate, over the past five years. Key revenue drivers included AI-Driven digital solutions that experienced the highest growth, as our AI-based solutions significantly improved efficiency, reliability, safety, and sustainability for our clients. There was continued demand for safety enhancements, in the USA and in other geographies, contributed positively to our revenue. Design engineering projects also saw substantial growth, driven by our innovative approaches and expertise, to support process development and design optimization. In terms of specialized engineering support, we expanded our services in optimizing process design and scaling up sustainable technologies, which further boosted our performance.

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Q What were the major areas of investment for the company in FY 2024-25 and what is the investment plan for FY 2025-26?

Ingenero made significant investments in several key areas such as Applied AI Solutions where we focused on enhancing our offerings by leveraging rapidly evolving AI technologies, including Generative AI, Agentic RAG, advanced traditional algorithms, and workflow agents. Under Sustainable Process Technologies, we invested in the development of sustainable technologies in collaboration with research institutes, aiming to drive innovation in this critical area. We also made additional investments into safety and efficiency tools to improve safety, production yields, efficiency, and reliability across our operations.

For FY 2025-26, we plan to continue these investment strategies, further expanding our Applied AI capabilities and enhancing our commitment to sustainable technologies. We will also prioritize the development of advanced tools that support operational excellence and safety in the process manufacturing sector.

Q Ingenero emphasizes the importance of R&D in developing innovative solutions for process optimization. What were the key focus areas of your R&D efforts in FY 2024-25 and what advancements have resulted from these initiatives?

In FY 2024-25, Ingenero focused its R&D efforts on several key areas to enhance process optimization. Utilizing our Hybrid Modeling approaches, we successfully combined fundamental models with data-driven techniques, leveraging the strengths of both and our deep and vast experience with



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both, for more robust and effective optimization solutions. By incorporating Generative AI techniques and existing Foundation models, we enhanced our capabilities in predictive and prescriptive analysis, adding content generation to it. This integration allowed us to better utilize our extensive historical data and knowledge gained over two decades of supporting process operations. Our R&D initiatives also focused on enhancing the human-machine interface, making it more intuitive and effective for users, which in turn facilitates better decision-making and innovation.

Q Ingenero has been deploying AI-based digital solutions across multiple processes and diverse domain use cases. Could you elaborate on the new AI-driven solutions introduced in FY 2024-25 and how they have enhanced your service offerings?

In FY 2024-25, Ingenero continued to advance its AI-based digital solutions, building on over a decade of expertise across various domains, including failure prediction, anomaly detection, process efficiency, energy optimization, emissions management, and reliability management. This year, we introduced several innovative AI-driven solutions that significantly enhanced our service offerings such as Enhanced Safety Management Solutions, Diverse Data Handling, Intuitive Human-Machine Interfaces and Autonomous Work Processes.

These advancements have not only strengthened our service offerings but also positioned Ingenero as a leader in delivering cutting-edge AI-driven solutions tailored to meet the evolving needs of our clients.

Q The company has developed tools like IPOGware for automatic analysis and interpretation of plant and equipment data. How has IPOGware evolved over time, and what impact has it had on operational efficiency and decision-making processes?

Originally developed over 15 years ago, IPOGware began as Ingenero's platform for detailed time-series plant data analysis. It has since evolved into IngeneroX—a more advanced solution leveraging modern data processing technologies and serving as the backbone for several no-code data platforms in the market. Today, IngeneroX serves as a specialized platform tailored specifically for the process manufacturing industry. This evolution has enabled users to perform automatic analysis and interpretation of plant and equipment data more efficiently and robustly.

The impact of IngeneroX on operational efficiency has been profound, wherever it has been used. By streamlining data analysis, it has empowered decision-makers with real-time insights, facilitating quicker responses to operational challenges.

Q Ingenero offers an Enterprise Energy Management System (EEMS) aimed at promoting sustainable manufacturing. Can you discuss how EEMS has been adopted by clients and the measurable outcomes in terms of energy efficiency and sustainability?

Ingenero's EEMS has been successfully adopted by several clients, including major crude oil refineries in the USA and multiple sites of a leading petrochemical company in both the USA and the Middle East. The implementation of EEMS has yielded impressive measurable outcomes. For instance, one client achieved a 4 per cent reduction in steam requirements across their facilities. Additionally, our Applied AI-driven solutions delivered significant energy savings, amounting to 2,475 GBTU, and reduced greenhouse gas emissions by 3 per cent in the first year of implementation at the petrochemical sites in the Middle East. These results not only reflect tangible improvements in energy efficiency but also demonstrate a commitment to sustainability, enhancing production reliability and overall operational performance for our clients.

> **In 2024, Ingenero has made significant strides in promoting sustainability within the process industry by actively supporting clients' sustainability initiatives**

Q The company has been focusing on sustainability in the process industry. Any new business models or partnerships formed in 2024 aimed at promoting sustainable manufacturing practices?

In 2024, Ingenero has made significant strides in promoting sustainability within the process industry by actively supporting our clients' sustainability initiatives. Our commitment has reflected in the development of Applied AI-based digital solutions and our expertise in design engineering, in the past few years, both at the conceptual and scale-up stages for various process technology providers. Notable projects include our work with BEP on a plasma-based

process for waste-to-energy conversion, as well as bio-based processes for transforming waste into ethanol and advancing green hydrogen production.

Additionally, we are forging strategic partnerships with research laboratories to co-develop cutting-edge technologies in critical sustainable areas such as Carbon Capture Utilization (CCU) and green hydrogen. These collaborations are aimed at accelerating the adoption of sustainable manufacturing practices and fostering innovation that aligns with our vision for a greener future. Through these efforts, Ingenero is not only enhancing its portfolio but also contributing to a more sustainable process industry.

For FY 2025-26, we plan to continue with our investment strategies, further expanding our Applied AI capabilities and enhancing our commitment to sustainable technologies

Q The integration of sustainability into business strategies has become a necessity for future growth. What specific CSR initiatives did Ingenero launch in 2024 to address environmental challenges, and what measurable impacts have they had?

In 2024, Ingenero reaffirmed its commitment to corporate social responsibility (CSR) with a vision to "Help Improve Lives by Partnering with Communities to Deliver Lasting Solutions." This vision is anchored in four core value pillars: Improving Lives, Sustainable Development, Partnerships, and Care and Concern.

Our CSR initiatives are designed to foster economic development while minimizing our resource footprint and maximizing positive impacts on society, the environment, and our stakeholders. In this spirit, we launched several specific initiatives aimed at addressing pressing environmental challenges including support for research at IIT Mumbai focused on green hydrogen production, early fault detection and diagnostics for rotating equipment and technology for fertilizers from air.

Q Ingenero emphasizes a balanced work environment, as evidenced by events like the Ingenero Cricket Tournament (ICT) 2024. How do such initiatives contribute to employee morale and productivity, and are there plans for similar events in the future?

Our mission is clear: to design and deliver a holistic employee experience that attracts, engages, and maximizes the potential of our people. Every initiative we undertake is grounded in fostering human connection, creating a workplace where individuals not only perform but thrive. Events like the Ingenero Cricket Tournament (ICT) are more than just recreational activities; they represent strategic investments in our organizational culture.

We structure our employee experience strategy around several key focus areas such as Social Capital, Listening, Recognition, and Well-being. Looking ahead, we are excited about the future. We are committed to curating more experiences that blend fun, wellness, learning, and engagement, all aimed at deepening connections and energizing our organizational culture. By continually fostering a vibrant and supportive work environment, we aim to enhance both employee satisfaction and productivity.

Q Where do you see Ingenero in 2030?

By 2030, Ingenero envisions itself as a leading global player in sustainable chemical and AI-driven process engineering, distinguished by our commitment to innovation, sustainability, and transformative technologies. Our vision encompasses several key pillars such as industry leadership in actionable sustainability, digital transformation, collaboration and partnerships, and commitment to community and social responsibility.

Through these strategic initiatives, Ingenero is poised for significant growth while making a positive contribution to the environment and society. Our vision for 2030 is not just about being a leader in our field; it's about being a catalyst for change, driving sustainability, and enhancing the quality of life for generations to come



CULTURE FOSTERS INNOVATION & AGILITY FOR DIGITAL INITIATIVES



Gaurav Vyas
Lead Strategy - Director's office/AVP
Reliance Industries

> Technologies are transformative but organization culture is essential ingredient of transformation to drive productivity

The industrial landscape is undergoing a transformative shift as Industry 4.0 technologies redefine how we approach efficiency, sustainability, and growth. Refining and petrochemicals assets are closely linked to global energy and production chains. Particularly in refining and petrochemicals we observe multidimensional shifts with the intersection of lower cracks era, focus on recycling, unfolding energy transition and lower operations staff experience. This evolution makes digital transformation a necessity and not an option to remain competitive.

The integration of technologies such as IoT, AI, machine learning (ML), robotics, and digital twins is reshaping the world of manufacturing enabling operators to optimize processes, improve on yield, productivity and safety at unprecedented scales. However, to unlock the full potential of these innovations, organizations must address technological, cultural, and operational challenges.

Convergence of two worlds: digital and oil & gas has led to increased focus in data driven decision making, breaking of silos, increased cross functional collaboration and increased productivity. Use of IR 40 technologies in processes such as feedstock management, video surveillance, predictive maintenance, energy management and emissions control are some of the examples which are new normal for the oil and gas industry.

Though the overarching goal remains the same for everyone in the industry, what differentiates is how one applies, at what cost, at what scale, governance framework, what derived benefits are and how much they are. More than the technology itself, it is the organization and its culture determines digital transformation and ensures transformation that sticks.

Organizational Culture: A Catalyst for Digital Transformation

Convergence of two worlds: digital and oil & gas has led to increased focus in data driven decision making, breaking of silos, increased cross functional collaboration, and increased productivity

The adoption of Industry 4.0 technologies is as much about culture as it is about technology. A strong organizational culture fosters innovation, agility, and collaboration, which are essential for scaling digital initiatives.

Leadership Vision: Leadership must champion digital transformation,



aligning technological goals with broader strategic objectives. Transparent communication and a commitment to long-term investments are critical. At Reliance, our visionary top leadership leads from the front to bring IR 4.0 technologies to everyone from boardroom to shop floor.

Prepare for Change that lasts: Continuous learning programs and upskilling initiatives ensure employees are prepared to operate advanced systems. It is difficult to have data scientists and digital experts who know the oil & gas domain so it is the upskilling and cross-skilling that works. With digital Literacy facilitation, opportunities to grow into digital translators allow domain experts to turn into digital experts. Encouraging a culture of innovation also helps teams embrace change and contribute ideas. With Reliance fostering opportunities in digital space and enormous learning opportunities there is a workforce which sees literacy as a way of life.

Collaboration across Sectors within a group: Cross-functional collaboration accelerates problem-solving and drives holistic improvements. In my experience, partnerships value delivery and benefit realization in one industry can be adopted in another. Increased collaboration within the group entities on the successful PoCs enables implementation at low cost and benefit from other's learnings to shape new do and don'ts.

Institutionalization of Knowledge: People to platform is the way organizations should approach digital transformation roll out. People come and they go but the knowledge and experience should remain in the organization for eternity. Therefore, All PoCs should have closure and learning reports. All implemented initiatives should mandatorily have a playbook that not just ensures standardization across organization but also helps in faster implementation and avoiding of pitfalls which some other asset experienced in first implementation.

Governance Framework: Robust governance design sets the ground rules to reach Autonomous but intelligent operations. Art is not to use AI/ML but to know when not to follow AI/ML recommendations. Data analytics is the cornerstone of decision-making in Industry 4.0, but one should make governance frameworks to have checks and balances, mechanisms to check and audit AI, and system and frameworks designed to clearly state when not to follow AI recommendations. The ability to monitor, predict, and optimize processes reduces energy consumption, operational downtime, and resource wastage but autopilot doesn't mean unmanned and unsafe. For example, IoT-enabled sensors in a refinery can identify inefficiencies in heat exchangers, determine which exchanger cleaning will bring more energy gain but how exchanger would be taken offline for cleaning would require all process and procedure adherence with or without AI.

Supply Chain Transparency and Integration with Manufacturing: Organizations leveraging Industry 4.0 can respond swiftly to market demands, offering customized solutions, faster delivery times, and higher product quality. blockchain enhances supply chain integrity by providing traceability and ensuring compliance. From tracking crude oil shipments to verifying raw material sources, this technology builds trust and efficiency. IR 4.0 technologies bring real time window on feedstock availability and prices, IIOT tools bring visibility into pipeline disruptions before they can hamper product evacuation. This all real time information adds to the bottom line but puts another layer



of pressure on operating assets to adjust operations in real time. Industry leaders embrace change and transform the way we work but they also set the governance and processes in the place that 'Human in the loop' and 'The Plant' is not stressed to comply with real time optimization.

Need for Holistic View: Overall digitization strategy is central to digital transformation. It is important to know beforehand how one piece of puzzle fits into another. This avoids duplication, envisages obsoletion requirements and cannibalization between tools and applications, and in process saves from redundant investment. Further to deliver effective digital transformation it requires to have the right organizational structure in place and dedicated value realization cell to keep track of investment and benefits.

It is easy to deliver use cases but changes that last for eternity and 'digital transformation that stick' require organization structure to own the platform, and continually develop and add value to delivered use cases. Platform ownership also ensures effective and seamless radiation of PoC/ delivered use cases from one asset to another.

Industry 4.0 technologies are no longer a futuristic vision; they are the present reality driving efficiency and growth across refining, petrochemicals, and all over manufacturing

Other Challenges to Scaling Industry 4.0

Apart from culture and people part, scaling technological advancement to deliver benefits is not without challenges, it will require to surmount below barriers as well

Integration with Legacy Systems: Many facilities rely on aging infrastructure, making integration complex and resource-intensive.

IT/OT integration & Cybersecurity Risks: Increased connectivity heightens the need for robust security frameworks. Integrating IT-OT data will bring operational agility, single source of truth but it also exposes operating infrastructure to cyber threats and sabotage.

Initial Capital Investments: While ROI is significant, upfront costs, cost overrun can be a barrier, particularly without value tracking and strong value realization office/governance in place.

Current Context and Road Ahead

Industry 4.0 technologies are no longer a futuristic vision; they are the present reality driving efficiency and growth across refining, petrochemicals, and all over manufacturing. Organizations that successfully implement these technologies will lead their industries, setting new benchmarks for performance, sustainability, and innovation. However, success requires more than just technological prowess.

A robust organizational culture that values innovation, collaboration, and acontinuous improvement is the true enabler of transformation. By embracing both the technological and human aspects of Industry 4.0, the refining, petrochemical, and manufacturing sectors can unlock unprecedented opportunities and shape a more efficient and sustainable future. While the technologies themselves are transformative, their success hinges on the culture within an organization. In my experience, fostering a culture that embraces change, prioritizes innovation, and invests in continuous learning is essential for scaling Industry 4.0 initiative

POLYMATHIC PERSPECTIVE ON CHEMICAL INDUSTRY IN GEN AI AGE



Partha Sur
Senior General Manager
Haldia Petrochemicals

The AI technology led interventions are set to disrupt chemicals business, calling for a systematic adoption of AI technologies in mainstream, recasting ways of doing business

We all know that Covid-19 pandemic gave birth to many digital technologies and it has created many new business entities of growth, but their adoption into mainstream chemical manufacturing business is yet to gain momentum in the likes of mobile & telecommunication, financial services, banking, transportation and retail e-commerce. Whether we like it or not, sooner or later this order of low adoption of digital technologies in core chemicals business will transition into a rapid growth phase in less than a decade.

We are going to realize soon that human intelligence is no longer supreme, rather we need to borrow more and more from machines for our own progress, to thrive and to compete in the new business setting. With the advent of communication technology post internet era, assimilation of knowledge has become easier and faster. Now, human intelligence is no longer confined only to the capacity of the human brain but it is residing more on the air or in electromagnetic waves available at a speed that the current hardware system can handle, streaming online for anybody's consumption. This so-called human intelligence got multiplied many times if not more with the advent of Artificial Intelligence.

It is logical to say that no force on earth can undermine the AI's potential that every individual can readily access emerging technologies like Open AI, Chat GPT, LLMs, DeepSeek etc. We can possibly coin this phase of AI 'Democratization of Intelligence' for humans residing on the web, thereby we humans will be the largest beneficiary.

AI in Era of Polymath

Given the dragon of super intelligent avatar of emergent AI, set to surpass individual human intelligence, will attain the cognitive capabilities that humans perform. When we equate 'human IQ' against the 'machine IQ', it is proved that machines have far exceeded humans in most cases but when we equate with other humans' complimentary quotients like 'EQ' & 'SQ', machines may not match. But very soon with maturity from rapid growth of machine intelligence backed by development of ultrafast communication networks and a

Convergence of two worlds: digital and oil & gas has led to increased focus in data driven decision making, breaking of silos, increased cross functional collaboration, and increased productivity



leap in quantum computing technology, AI machines will reach there. Therefore, a machine's intelligence when equated one-to-one with humans, will far exceed human intelligence and the pride that humans inherited over generations will be under big question, it will be embarrassing too if not defeated fully. Moreover, machines do not fatigue but humans do. The most defining limitation out of many that the future is going to witness is rapid infrastructural scale-up needs on capacity build-up, data center creation, building new communication networks and finally the physical power supply to run them up to store and to do streaming of machine intelligence to billions of users simultaneously.

The rapid advancement of AI suggests that, in the future, it will be the polymathic mind—driven by deep curiosity and cross-disciplinary thinking—that will be most valued, rather than the traditional model of narrow specialization we are accustomed to today. As AI systems grow more versatile, humans may increasingly feel outpaced or even obsolete in comparison. We typically derive our intelligence from experience—gathered through observation, experimentation, literature, and reasoning—allowing us to create theories and apply them in familiar, relatable ways. This shared cognitive framework makes human-to-human understanding intuitive.

So far chemical sector AI adoption is confined only to low hanging fruits and in non-core peripheral functions like Admin-HR, Safety & security, automated production, accounting, monitoring of plant performances, monitoring supply chain logistics, and financial reporting

In contrast, machines can access and learn from the vast global knowledge base humans have built over centuries—doing so continuously, at speeds approaching that of electromagnetic waves. As AI accelerates, the pace of knowledge expansion will outstrip traditional human learning models. We are now entering an era where entirely new forms of computational reasoning and pragmatic problem-solving may emerge—capabilities that lie beyond our current sensory perception or intellectual reach.

Now let us draw our parallel to 'Business of Chemistry & Chemicals' which owns a share of 25 per cent of GDP estimates made and published by one wing of the US federal department. Hence it has a strong place in the economy, gives employment to its citizens, raises the standard of living to people, provides sovereignty of the nation etc. Hence, it occupies top ministerial people of the federal government and becomes the agenda of top growth to any nation. So far chemical sector AI adoption is confined only to low hanging fruits and in non-core peripheral functions like Admin-HR, safety & security, statutory compliances, automated production accounting, monitoring of plant performances, supply chain and logistics



and financial reporting. No doubt, these are significant productivity improvement needs without which no organization can function.

AI to Redefine Chemical Industry Operations

Let us explore systems that are fundamental to chemical industries functioning where AI may predict alteration in scientific techniques to attain next level of efficiency improvement, cost reduction, process simplification, enhance productivity and availability in operation etc. Humans can infer better with use of AI computational power and accrue significant benefit and hence it is worth trying. Some common examples could be exploit advanced convergence science in industrial cooling tower fills design for intimate heat and mass transfer to bring the approach of tower further closer, develop new technique to recover and recycle water from saturated vapor from tower top and finally bring down lifecycle cost; redesign gas turbine combustion chamber, alter heat wave flow profile in stationary and rotating components, internal cooling system, upgrade materials alloy compositions to enhance service life to bring down lifecycle cost; Engineer efficient clean coal combustion system design for CFBC boiler to enhance efficiency and raise onstream hours between two maintenance cycle to bring down the lifecycle cost.

Take up optimization work on compacting/downsizing complex steam and water footprint for any large chemical complex to enhance energy efficiency and attain cost competitiveness. Next constraining operational area where AI can work is to redesign cooling water treatment chemistry to minimize corrosion in process equipment, remove capacity bottlenecks to increase run length between turnarounds and stretch plant operation between turnarounds.

Similarly for large power generation company, AI may bring fundamental change in a major way especially super critical power generation plant starting with new flowsheet design, apply advanced know-hows to attain the high-end Rankine cycle efficiency closer to Carnot cycle (Carnot efficiency- 54 per cent) as opposed to actual Rankine operating between 35-37 per cent efficiency point.

Does this mean that AI technology is an 'Aladdin's lamp or owning a Midas blessing power turning into gold wherever applied? It is a double-edged sword for humans who need to weigh and take a call on a case-to-case basis, build systematically for improving every aspect of business and deploy gainfully where the need of humans and their judgment will be binding, decision science of business will be by humans with augmented intelligence.

I will not be surprised that in the coming decade humans are trying out to build artificial humans from scratch using augmented AI intelligence using both artificial and earthly materials giving life to anatomy resembling humans created from artificially designed limbs. While citing limitations of human intelligence in the current context, let us not undermine what humanity has attained so far and it is also vividly true that the need for humans in the AI age will not go away but will get enriched. On the contrary, humans need to weigh every outcome, validate and revalidate outcome properly, apply regulatory mechanisms, enforce security protocol and finally apply judgement while maximizing economic and social metrics without bias.

AI transition is expected to transform the basic fabric of our current material discovery, food security, energy security, drug discovery, education and health, uphold sovereignty and territorial integrity of nations by building new technology portfolios together by a new set of cohesively collaborative forward-looking individual scientists and engineers or their pool from various corner of the globe, will build new needs; compete and thrive, turns and shine as new entrepreneurs aiming, addressing global call on climate change and environmental

SUSTAINABILITY

Empowering Greener Future



INDUSTRY SHIFTS GEAR TOWARDS SUSTAINABILITY AND CIRCULAR ECONOMY

Industry is steadily embracing sustainability and circular economy principles, driven by regulatory mandates, ESG investments, and growing demand for green products TEAM ICN

The Indian chemical industry is now actively adopting circular economy principles, signalling a major shift towards sustainability. In response to growing environmental concerns and stricter global regulations, companies are prioritizing green chemistry, resource efficiency, waste reduction, and the use of renewable inputs.

Digitalization is also reshaping the supply chain landscape in the chemical sector. Companies are deploying end-to-end visibility platforms and predictive analytics to manage inventory, forecast demand, and mitigate supply disruptions—critical improvements in a sector heavily reliant on imported feedstocks and vulnerable to global price volatility. For example, firms leveraging AI-driven supply chain optimization tools have reported up to 25 per cent improvement in forecast accuracy and 15–20 per cent cost savings in logistics.

A key development in the pursuit of sustainability has been the adoption of circular economy models that emphasize reducing resource consumption and reusing materials through closed-loop systems. Leading Indian chemical firms are investing in technologies that enable recycling of industrial effluents, recovery of solvents, and reprocessing of byproducts into value-added chemicals. For example, companies like UPL, Aarti Industries, and Atul have made significant strides in implementing zero-liquid discharge (ZLD) systems and improving water-use efficiency, with some reporting up to 80-90 per cent wastewater recycling rates. Moreover, the Indian government's support for green hydrogen and bio-based chemicals under the National Green Hydrogen Mission and the Biomass Conversion Program is further catalyzing a shift toward cleaner inputs in chemical manufacturing.

CLARIANT

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India's plastic waste crisis, generating over 3.5 million tonnes annually, has accelerated efforts within the chemical and petrochemical sector to innovate in polymer recycling and biodegradable materials. Reliance Industries and Indian Oil Corporation have committed to scaling up chemical recycling plants, with projected capacities of over 25,000 tonnes per annum in the next few years. Additionally, specialty chemical producers are exploring sustainable surfactants, green solvents, and bio-based additives, aligning their product portfolios with global ESG expectations. The demand for green-certified products from export markets, especially Europe and North America, is also propelling this transition.

Energy efficiency and carbon reduction are critical pillars of the sustainability agenda in the Indian chemical sector. According to the Department of Chemicals and Petrochemicals, the industry accounts for around 13 per cent of total industrial energy consumption and approximately 6 per cent of India's total greenhouse gas emissions. To mitigate this, companies are adopting cleaner fuels, electrification of processes, and carbon capture technologies. Gujarat and Maharashtra-based chemical clusters are witnessing significant investments in captive renewable energy generation, with solar and wind installations supporting decarbonization goals. Firms like Deepak Nitrite and SRF have disclosed plans to reduce carbon intensity by over 20 per cent in the next five years through such measures.

> AI-driven systems are now being used to analyze real-time data from reactors, distillation columns, and mixing units, leading to faster decision-making and reduced human error in critical environments

The circular economy approach is evident in increased resource efficiency and recycling initiatives. Indian chemical firms are investing



in plastic recycling and reprocessing technologies, with Reliance Industries, for example, targeting 5 billion PET bottles for recycling annually by 2025 through its 'Circular Economy Initiative'. Additionally, Indian Oil Corporation is setting up a chemical recycling plant with an initial capacity of 20,000 tonnes per annum to convert waste plastics into fuel and chemicals.
On the specialty chemicals front, manufacturers are developing green solvents, biodegradable surfactants, and bio-based polymers, with the green chemicals market in India estimated to grow at a CAGR of over 10 per cent and projected to surpass US$ 15 billion by 2027.

Policy support is accelerating adoption through fiscal incentives and regulatory mandates. Under India's Production Linked Incentive (PLI) scheme for the chemical sector, several projects qualifying for incentives are aligned with green chemistry and low-carbon technologies. The Ministry of Environment, Forest and Climate Change (MoEFCC) has tightened norms around hazardous chemical management and waste disposal, prompting a shift toward safer and recyclable inputs. The government's push for Extended Producer Responsibility (EPR) in the plastics and packaging industry has further incentivized chemical companies to rethink design and end-of-life reuse of their products.

Innovation at Core

In recent years, significant R&D investments have been directed toward developing low-carbon production techniques, green solvents, bio-based polymers, and recyclable specialty chemicals. Leading companies like UPL, PI Industries, and Aarti Industries have set up dedicated innovation centers focused on sustainable product development and process optimization. UPL, for instance, has introduced nature-based solutions and regenerative agricultural inputs as part of its sustainability agenda. Similarly, Atul and SRF are investing in R&D to replace fossil-derived raw materials with renewable alternatives, reducing dependency on non-renewable resources while aligning with global sustainability goals.

The shift toward circular economy models is also being accelerated by technological innovations such as chemical recycling, carbon capture and utilization (CCU), and solvent recovery systems. In Gujarat and Maharashtra, pilot plants have been commissioned to convert plastic waste into high-value chemicals through depolymerization and pyrolysis technologies. These solutions not only help in waste reduction but also enable the recovery of valuable feedstocks, closing the loop in industrial resource use. Advanced oxidation processes (AOPs) and membrane bioreactor systems are also being implemented to achieve zero liquid discharge, particularly in high-pollution industrial clusters.

Digital technologies are playing a pivotal role in optimizing sustainable operations. The adoption of IoT-based emission monitoring, AI-enabled predictive maintenance, and blockchain for traceability in raw material sourcing is gaining momentum. Such digital integration helps companies ensure compliance, reduce resource wastage, and create transparent, sustainable supply chains.

Government and academic collaborations are further fueling R&D in this domain. Institutions like the National Chemical Laboratory (NCL), IITs, and CSIR labs are partnering with industry to co-develop eco-friendly formulations, enzymatic catalysts, and biodegradable surfactants.
The Department of Chemicals and Petrochemicals has initiated support programs for technology incubation and commercialization of green innovations under the Chemicals Promotion and Development Scheme (CPDS).

Despite progress, the scale of R&D adoption varies across the industry, with large corporations leading the way while small and medium enterprises often face challenges due to limited technical and financial capacity. Nevertheless, the broader ecosystem is gradually aligning, with sustainability-linked loans, ESG-focused investors, and global supply chain requirements incentivizing innovation at every level.

Challenges

As the industry strives to align with global environmental benchmarks and India's own net-zero targets by 2070,



the path toward greener operations is fraught with financial, infrastructural, and regulatory hurdles, particularly for small and mid-sized enterprises. The Indian chemical sector, which contributes around 3 per cent to the global chemical industry and was valued at approximately US$ 220 billion in 2024, is undergoing a gradual transition toward sustainable production models. However, the scale and complexity of the transformation present formidable roadblocks.

One of the most critical barriers is the high capital expenditure associated with implementing sustainable technologies. Zero Liquid Discharge (ZLD) systems, solvent recovery units, green hydrogen generation, and effluent treatment plants require upfront investments ranging from Rs. 50 crore to over Rs. 200 crore for medium- to large-scale setups. For example, while big companies have invested collectively in sustainable infrastructure, many small and medium-sized manufacturers in clusters like Ankleshwar, Vapi, and Ludhiana lack the financial bandwidth to follow suit. This disparity creates a fragmented adoption landscape, where sustainability remains concentrated among larger corporates.

Technological and knowledge gaps also hamper progress, particularly in the development and deployment of circular solutions such as chemical recycling, biodegradable polymers, and process integration. Many players lack access to global best practices or advanced R&D capabilities, leading to slower innovation cycles. The mid-sized companies have inadequate in-house expertise to evaluate or implement circular economy frameworks effectively. Furthermore, the ecosystem for industrial symbiosis, where one firm's waste serves as another's input, is still nascent in India, owing to poor logistical linkages and lack of digital traceability platforms.

Infrastructural limitations remain a serious impediment. India's hazardous waste treatment and recycling facilities are still underdeveloped in many industrial regions. The chemical industry generates a large volume of hazardous byproducts, and without adequate centralized facilities, companies are often forced to incur high transportation and treatment costs or face compliance violations. In 2024, the Central Pollution Control Board reported that only about 40 per cent of hazardous waste in chemical manufacturing clusters was being scientifically treated or co-processed, highlighting the pressing need for more robust waste management systems.

The supply chain also presents a bottleneck, especially in sourcing sustainable raw materials and packaging. The availability of bio-based feedstocks, green solvents, and recyclable inputs is still limited and often costlier than conventional alternatives. Imported green intermediates attract higher duties, and domestic production remains insufficient to meet demand, leading to higher operational costs for companies trying to switch to sustainable alternatives.

Promising Technologies

Green Chemistry Innovations: Development of non-toxic, biodegradable, and renewable chemical formulations

Bio-based Feedstocks: Substitution of petrochemical inputs with agricultural and biomass-based alternatives

Chemical Recycling: Advanced depolymerization and pyrolysis technologies for converting plastic waste into raw materials

Carbon Capture and Utilization (CCU): Capturing industrial CO_2 emissions and converting them into useful chemicals and fuels

Zero Liquid Discharge (ZLD) Systems: Advanced wastewater treatment and recovery technologies to eliminate effluent discharge

Catalyst Optimization: Use of nano-catalysts and enzyme-based catalysts for cleaner, high-yield reactions

Waste-to-Value Technologies: Converting industrial byproducts into high-value chemicals and energy

IoT and AI in Process Efficiency: Real-time monitoring and AI-based control for minimizing emissions and resource wastage

Way Forward

The future outlook for the adoption of sustainability and circular economy within the Indian chemical industry is increasingly optimistic, underpinned by a combination of regulatory pressure, investor expectations, evolving consumer preferences, and industry-led innovation. As India moves toward its net-zero emissions target by 2070 and global markets continue to demand greener supply chains, the chemical sector—valued at over US$ 220 billion—is poised to play a pivotal role in enabling sustainable industrial growth.

Commitment to Sustainable Manufacturing

Industry Size (2024)	Approx. US$ 220 billion; contributes ~7 per cent to India's GDP
Green Investment by Top Firms	Over Rs. 1,500 crore invested collectively by UPL, Aarti Industries, and Deepak Nitrite in sustainable technologies
Wastewater Recycling	Leading companies recycle over 80 per cent of wastewater; ZLD systems widely implemented in Gujarat & Maharashtra
Renewable Energy Use	Up to 30 per cent of power sourced from renewables by top players; green hydrogen pilot projects initiated
Circular Economy Initiatives	Reliance targets recycling of 5 billion PET bottles annually; IOCL building 20,000 TPA chemical recycling plant
Green Chemicals Market Size (Projected)	Expected to grow at a CAGR of 10 per cent+, reaching over US$ 15 billion by 2027
Policy Support	PLI schemes, Extended Producer Responsibility (EPR), and Green Energy Corridors backing sustainability efforts
R&D Focus Areas	Green solvents, biodegradable surfactants, bio-based polymers, and carbon-neutral processes

In the coming years, the adoption of green manufacturing processes, waste minimization strategies, and closed-loop production systems is expected to accelerate, particularly among large and export-oriented players. Companies will increasingly invest in renewable energy, zero-liquid discharge (ZLD) infrastructure, and advanced effluent treatment technologies to meet both compliance requirements and ESG commitments. The green chemicals market, including bio-based solvents, biodegradable polymers, and specialty ingredients, is projected to grow at a CAGR of over 10 per cent, crossing US$ 15 billion by 2027.

Circular economy principles are set to become more deeply embedded in product design, supply chain integration, and end-of-life resource recovery. Industry leaders are likely to develop industrial ecosystems where waste from one process becomes input for another, while digital traceability, blockchain, and AI-powered material tracking will enable real-time monitoring of sustainability performance. As Extended Producer Responsibility (EPR) and plastic recycling mandates tighten, both chemical and downstream industries will innovate in packaging and waste management.

Government policies are expected to be more targeted and supportive, with fiscal incentives, public-private R&D initiatives, and stricter enforcement of environmental norms acting as key enablers. Meanwhile, small and medium enterprises—currently lagging in adoption—will increasingly benefit from shared infrastructure, technology transfer hubs, and green financing tools designed to bridge capability gaps.

The Indian chemical industry's shift toward sustainability and circularity is not just a regulatory response but an emerging business imperative. By 2030, a substantial portion of the sector is expected to operate on circular principles, with decarbonization,



resource efficiency, and ecosystem stewardship at the core of its growth strategy, positioning India as a regional leader in sustainable chemical manufacturing



CCUS, LIGNIN AS RENEWABLE RAW MATERIAL FOR POLYURETHANE PRODUCTION



Padma Shri Professor Ganapati D. Yadav
Former Vice Chancellor
Institute of Chemical Technology
Mumbai

In order to reduce dependence on fossil chemicals and to achieve net zero targets, lignin based polyurethanes (LPU) are most desirable

Achieving net zero emissions by mid-century necessitates the deployment of Carbon Capture, Utilization, and Storage (CCUS) technologies across industrial sectors, particularly those with inherently high process emissions such as cement, chemicals, and steel. CCUS enables the direct removal of CO_2 from point sources or the atmosphere and its subsequent sequestration or conversion into value-added products.

In the chemical and polymer industries, a parallel shift toward renewable feedstocks is underway, with biomass emerging as a viable and sustainable alternative to fossil-derived raw materials. Renewable biomass, when processed into platform chemicals like bio-ethylene, succinic acid, and lactic acid, can serve as the basis for producing bio-polymers such as polyethylene, polybutylene succinate, and polylactic acid. Integrating biomass valorization with CCUS technologies offers a synergistic route to not only sequester carbon but also to create polymers with inherently lower life-cycle greenhouse gas emissions. Moreover, this integration supports the broader development of a circular carbon economy, wherein carbon is continuously recycled and reused, thus minimizing net atmospheric additions. By coupling CCUS, renewable energy, and bio-based feedstocks, the polymer sector can significantly contribute to decarbonization targets while fostering sustainable material innovation.

Recent advancements allow captured CO2 to be chemically incorporated into polyol structures through catalytic processes, producing CO2-based polyols that can replace up to 20–40 per cent of the conventional fossil-derived content

CCUS AND Polyurethanes

CCUS is increasingly being integrated into the production of polyurethanes by utilizing captured CO_2 as a raw material for polymer synthesis. Traditionally, polyurethanes are manufactured by reacting polyols (compounds with multiple hydroxyl groups) with isocyanates. Recent advancements allow captured CO_2 to be chemically incorporated into polyol structures through catalytic processes, producing CO_2 -based polyols that can replace up to 20–40 per cent of the conventional fossil-derived content. Companies such as Covestro have commercialized such technologies, developing CO_2 -containing polyether carbonate polyols that maintain desirable polyurethane properties for use in foams, coatings, adhesives, and elastomers. This

approach not only reduces the carbon footprint of polyurethane products but also transforms captured CO_2 into durable materials, embodying the principles of carbon circularity and advancing net zero goals.

Importance of Polyurethane

Polyurethane (PU), renowned for its exceptional versatility, is a well-known polymer widely utilized in elastomers, foams, sealants, coatings, fibres, adhesives, and a myriad of other applications, spanning automotive parts, clothing, biocompatible medical products, and interior/exterior finishing materials for housing. Polyurethanes (PUs) are characterized by urethane linkages (–NH–(C=O)–O–), formed through the polyaddition reaction of a polyol with di- or poly-isocyanate (–N=C=O) compounds. PUs can be tailored to various densities, morphologies, and stiffnesses, making them ideal for applications in several industries. Within the PU product spectrum, foams dominate, categorized as rigid, semi-rigid, or flexible based on core densities, stiffness, and mechanical properties. The global polyurethane foams market is anticipated to grow at a 7.6 per cent CAGR, from US$ 42.4 billion in 2023 to US$ 62.5 billion by 2030 during the forecast period 2025-2030 as per the report of Vynz Research.

Polyol, a primary component of PU foams, typically constitutes 30–70 wt. per cent depending on the foam's intended use. Presently, most PU foams rely on fossil-fuel-based polyols for production. Polyurethanes (PUs) are synthesized through the addition reaction of polyols with terminal OH groups and diisocyanates (or polyisocyanates), forming PU (carbamate) groups within the polymer backbone, as depicted in Scheme 1.

In the context of depleting fossil fuel reserves and the net zero emissions of carbon dioxide by 2050, the use of biomass for production of chemicals, fuels, polymers and materials assumes great significance. Since lignin contains

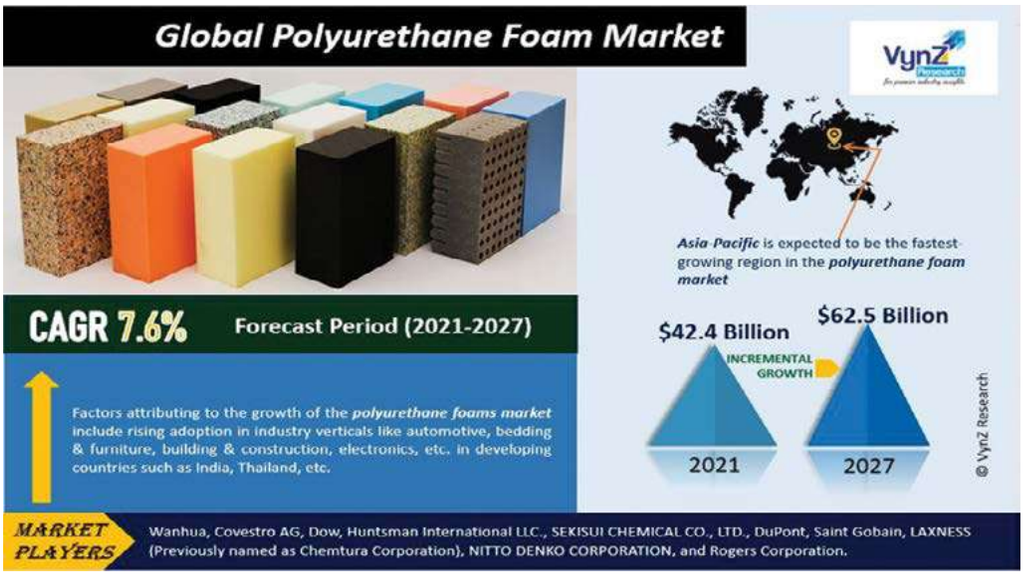
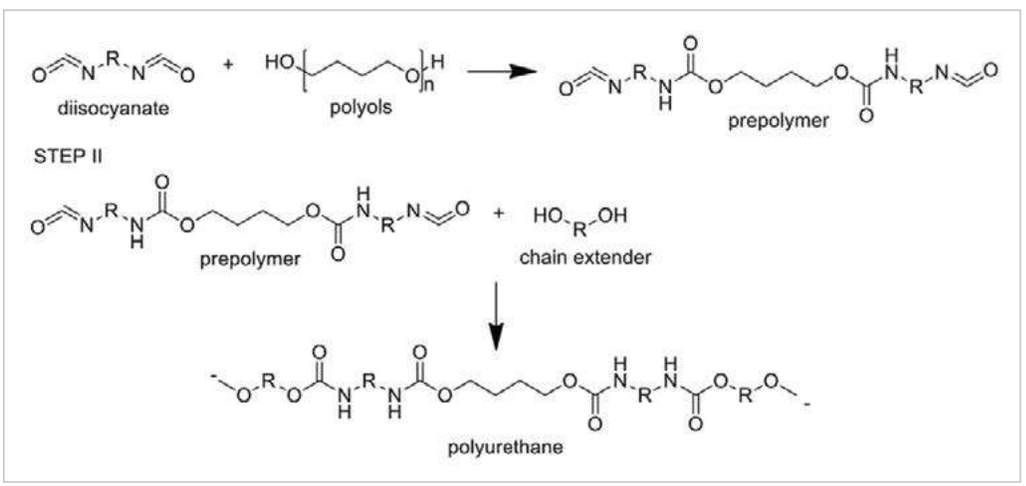


Figure 1: PU market (Source: Vynz Research market survey)

several hydroxyl groups, it can be used to substitute the petroleum derived polyols. The utilization of natural and renewable resources such as lignin, predominantly comprising phenylpropanoid with abundant hydroxyl (OH) groups, phenols, and carbonyls, holds promising potential for



Scheme 1: Synthesis of PU

replacing petroleum-based polyols in PU synthesis.

Lignin as a Feedstock

Roughly 2 per cent of the 70 million tons of lignin produced annually is incinerated to substitute fossil resources and generate heat in pulping mills. However, given its inherent traits such as low toxicity, eco-friendliness, biocompatibility, and susceptibility to enzymatic breakdown, lignin presents itself as a promising candidate for the production of high-value goods rather than mere combustion. Traditionally relegated to low-value fuel, lignin exhibits tremendous resistance to digestion compared to other naturally occurring substances. Nonetheless, lignin and its derivatives are increasingly recognized for their potential as value-added products in various large-scale applications.

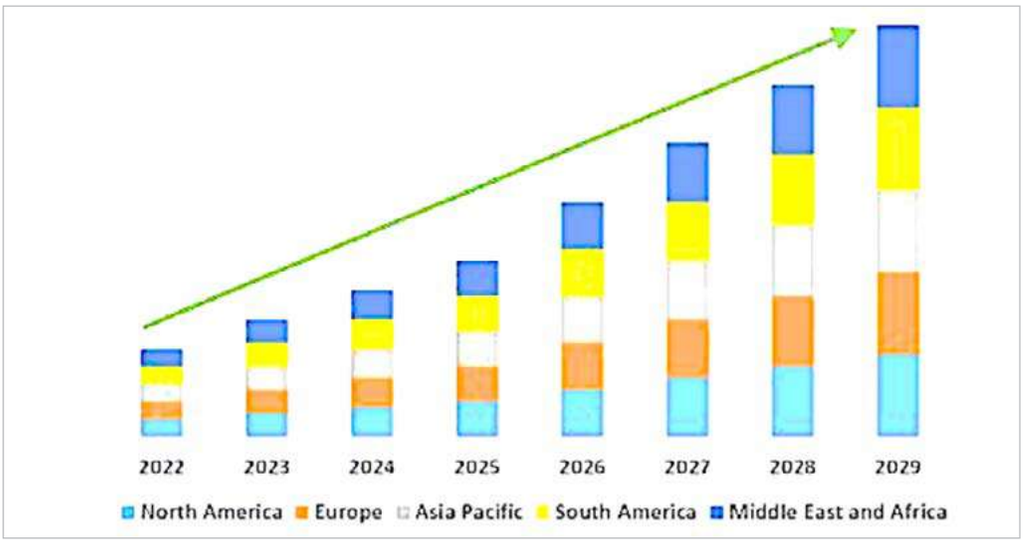


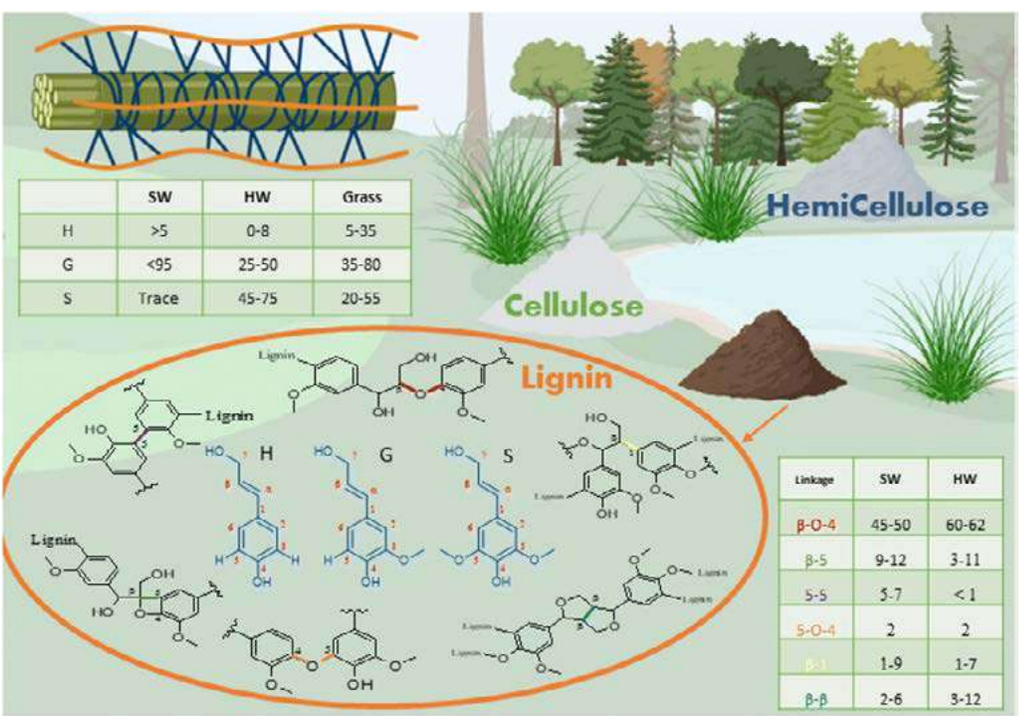
Figure 2: Global lignin market from 2022-2029. Lignin market is expected to be 2.88 billion US$ by 2029
(Source: https://www.databridgemarketresearch.com/reports/global-lignin-market)

Isolated lignin presents promising potential for the production of high-value goods, including low-cost carbon fibre, engineering plastics, thermoplastic elastomers, polymeric foams, membranes, and a spectrum of fuels and chemicals currently sourced from petroleum (Figure 2). However, to be viable, these lignin-derived coproducts must offer competitive pricing while meeting the performance standards of their petroleum-based counterparts. Each product category poses its own unique set of challenges.

As the most abundant aromatic biopolymer, lignin's structure is rich in carbon, comprising over 60 per cent of its composition. The advancement of renewable lignin-based polymers hinges on the enhancement of processing technologies and the integration of tailored bioenergy crops that yield lignin with desired chemical and physical attributes. In the realm of fuels and chemicals, various approaches for lignin depolymerization and upgrading have emerged, encompassing thermochemical treatments, as well as homogeneous and heterogeneous catalysis. Lignin serves to bind cellulose and hemicellulose fibres together, providing structural support and shielding plants from microbial degradation. The proportion of lignin varies depending on the plant source, with softwood (SW) containing approximately 25–39 per cent lignin, hardwood (HW) about 20–25 per cent, and grasses typically ranging from 15–25 per cent

Variations in physical properties arise from differences in synthesis methods and constituent materials. Given its abundance of aliphatic and phenolic hydroxyl functionalities, lignin can readily substitute the macropolyol component of PUs. Moreover, PU derived from petroleum-based polyols exhibits lower biodegradability compared to lignin-based counterparts.

The biologically enhanced properties of chemically modified lignin exhibit superior antibacterial, antioxidant, biocompatible, flame-retardant, hydrophobic, and UV-blocking attributes, likely attributable to the introduction of new functionalities. In recent years, there has been a significant shift towards utilizing renewable resources in the development of polymeric materials. This movement has garnered considerable attention as an alternative to petroleum-based products, with a focus on plastics and biodegradable polymers sourced from natural and renewable origins. The adverse environmental impact of conventional fossil fuels has prompted a transition towards renewable resources, among which lignin and its derivatives play a prominent role. This strategic



	SW	HW	Grass
H	>5	0-8	5-35
G	<95	25-50	35-80
S	Trace	45-75	20-55

Linkage	SW	HW
β-O-4	45-50	60-62
β-5	9-12	3-11
5-5	5-7	< 1
5-O-4	2	2
β-1	1-9	1-7
β-β	2-6	3-12

Figure 3: Lignin as a source of chemicals and materials (source: DOI: 10.1039/D2GC02724K, Green Chem., 2022, 24, 8193-8226). SW=soft wood, HW=hard wood, Different constituent structures H, G, and S in lignin

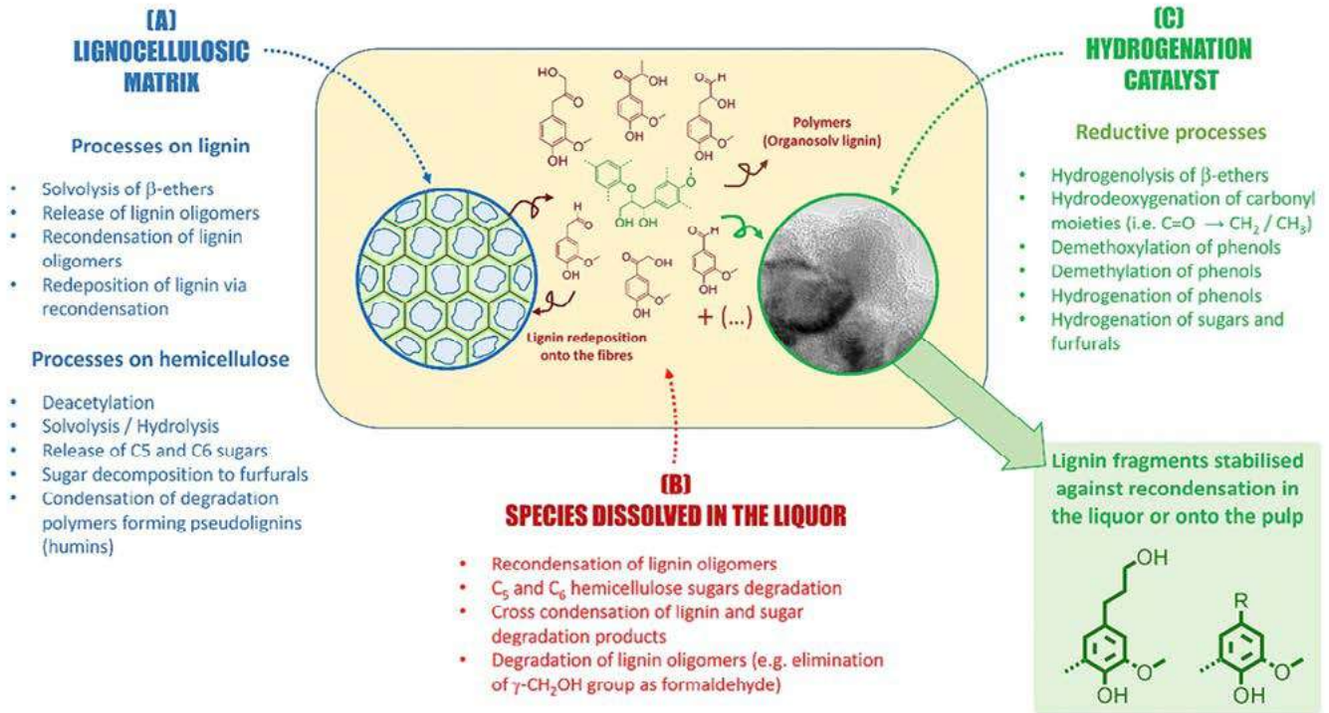


Figure 4: Lignin biorefinery
(Source: DOI:https://doi.org/10.1016/j.joule.2017.11.001)

shift not only fosters environmental sustainability but also promotes national security, rural economic development, and the mitigation of environmental challenges. Because of the presence of several functionalities in lignin, it is a great source of chemicals, fuels and materials (Figure 4).

Hydrogenation/hydrogenolysis and oxidation will play a great role in conversion of lignin to a variety of products (Figure 6).

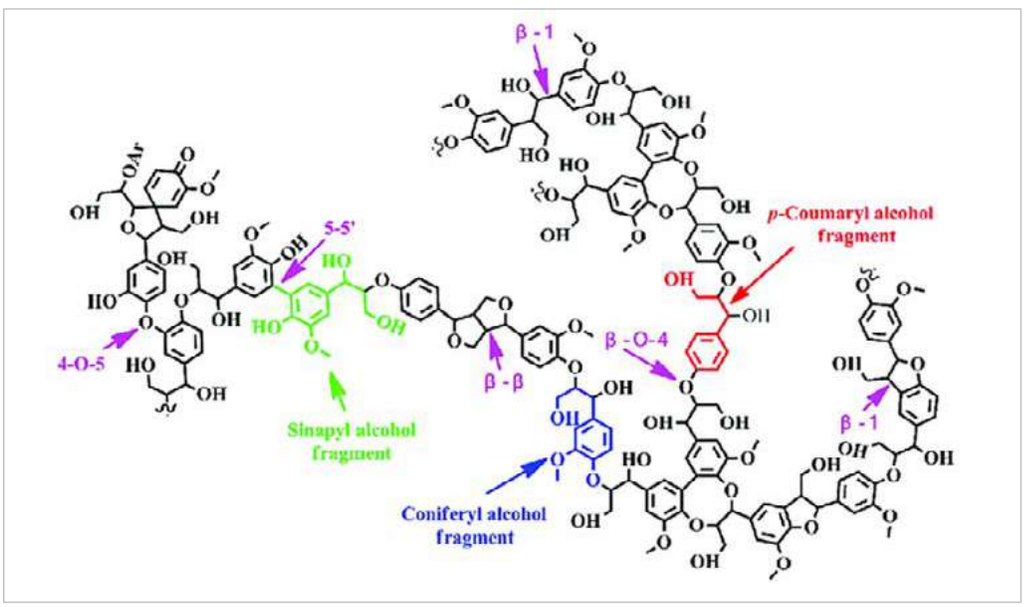


Figure 5: Schematic model of lignin structure and its major constituents/ fragments (sinapyl alcohol, coniferyl alcohol, and p-coumaryl alcohol)

LIGNIN PROCESSING

Advancements in wood processing, papermaking, and textile technologies have facilitated the production of lignin and its derivative polymers. These polymers find application in bio-refineries, where they contribute to the generation of a diverse range of products including power, chemicals, materials, and fuel. The majority of lignin and its derivative polyols are sourced from vegetable oils. Vegetable oil, a triglyceride resulting from the combination of glycerol with unsaturated or saturated fatty acids, serves as the primary precursor. A variety of vegetable oils, such as soybean oil, castor oil, rapeseed oil, and bio-glycerol, find application in PU production. Moreover, there exist diverse methodologies for modifying

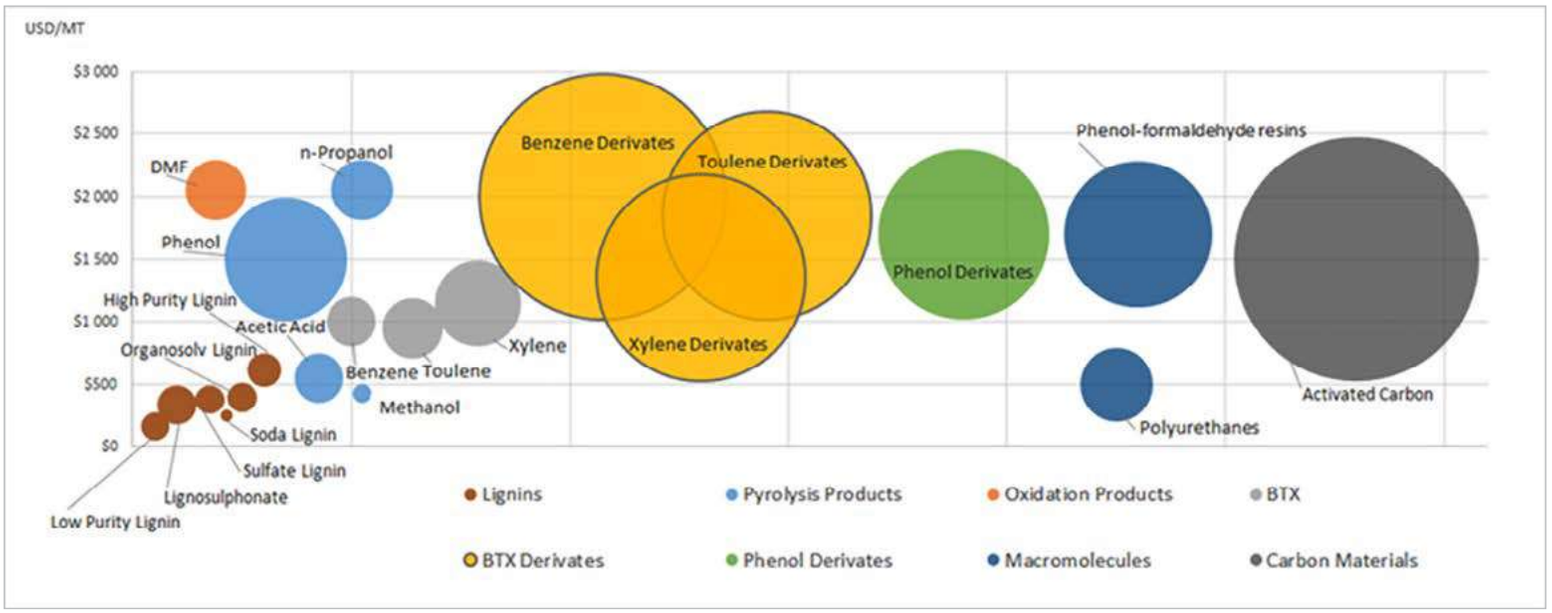


Figure 6: Lignin to chemicals
(Source: Wood Research 60(6):973-986 (Dec 2015)) 7, 11, 1831-1837)

vegetable oils, including oxypropylation, ring-opening, epoxidation, catalytic hydrogenation, and thiolene reaction (also known as alkene hydrothiolation). However, it is worth noting that vegetable oil (excluding castor oil) is also utilized in this regard.

Lignin has long been recognized as a promising source of aromatic compounds; however, traditional lignin depolymerization methods often yield complex mixtures of products. An alkaline aerobic oxidation technique efficiently converts lignin extracted from poplar wood into a range of oxygenated aromatics, including commercially valuable compounds like vanillin and p-hydroxybenzoic acid. The use of centrifugal partition chromatography (CPC) proves effective in isolating individual compounds from the intricate product mixture (Figure 6).

Delignification

For industrial applications, the isolation of lignin from lignocellulosic raw materials can be achieved through both chemical and mechanical methods. These processes fall into two main categories: (i) techniques that involve the removal or solubilization of hemicellulose and cellulose, leaving lignin as an insoluble residue; (ii) methods that target the removal or dissolution of lignin, leaving behind the polysaccharides.

The lignin obtained from these processes exhibits variations in size, structure, molecular weight, and physical or chemical properties, influenced by the diverse plant species used and the range of delignification techniques available. Among the most common delignification methods are (a) kraft, (b) sulfite, and (c) organosolv processes, while alternative approaches such as (d) pyrolysis, (e) enzymatic hydrolysis, (f) steam explosion, (g) alkaline hydrolysis, and (h) acidolysis offer less commercial but viable options. Key system parameters such as pH, chemical concentration, temperature, and pressure play critical roles in determining lignin functionality, extraction yield, solubility, and molecular weight, etc.

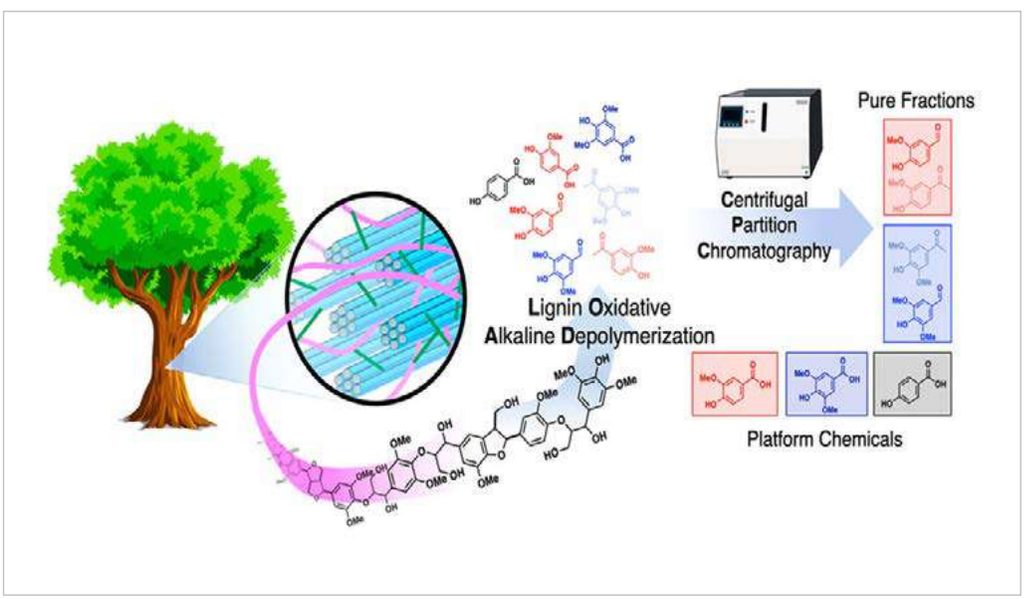
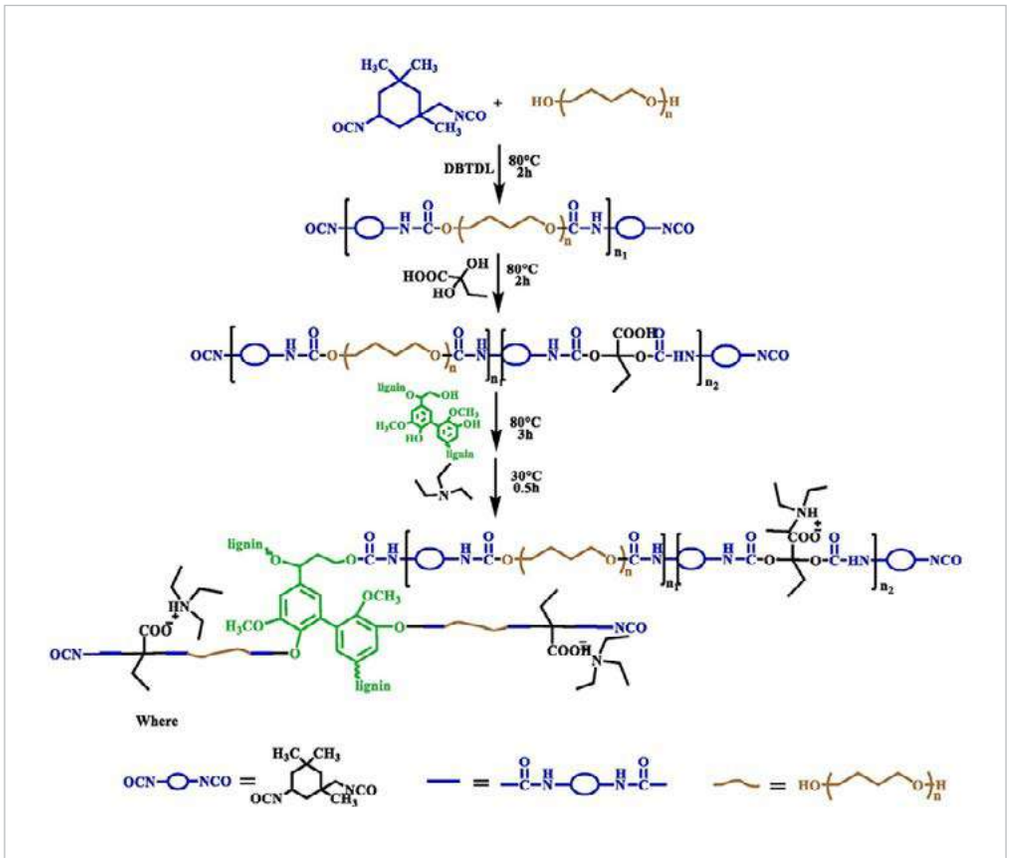


Figure 7: Lignin oxidative alkaline depolymerization
(Source: ACS Cent. Sci. 2021, 7, 11, 1831–1837)



Scheme 2: Lignin-based polyurethane elastomer synthesis

Lignin based PU

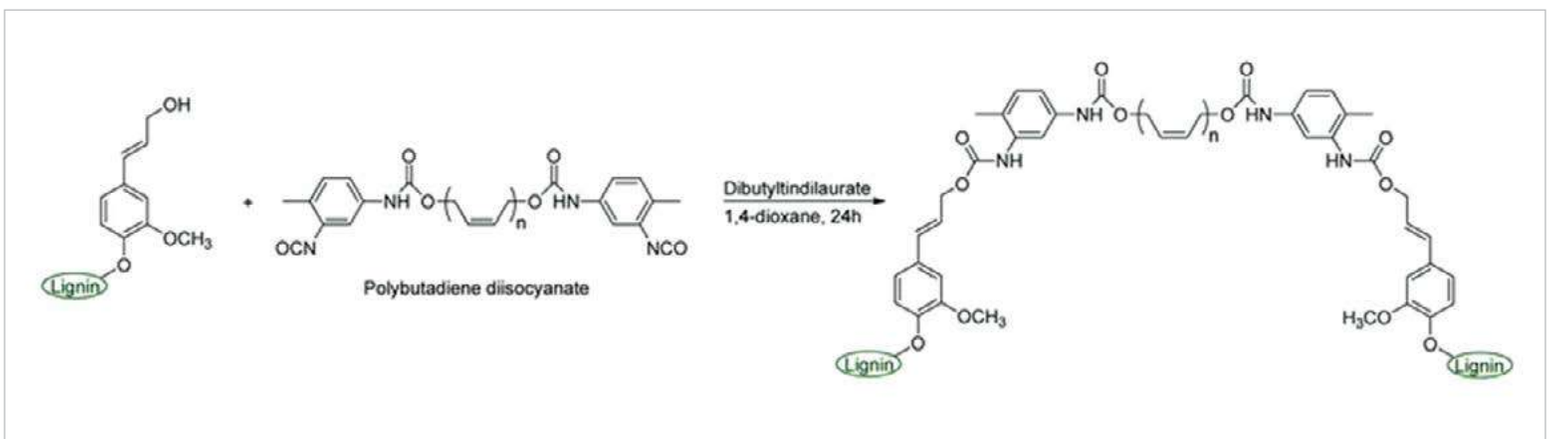
Various methodologies for manufacturing lignin-based polyurethane (LPU), including alkali treatment, oxidation methods, prepolymer techniques, haloalkane modification, and alkane depolymerization, are elucidated in literature. Presently, lignin-based polyurethanes exhibit promising applications across diverse sectors including construction, automotive industries, packaging, textiles, footwear, sporting goods, automobiles, printing rollers, sealants, and binders (Scheme 2).

The inherently multifaceted nature of lignin historically necessitates intricate separation and purification processes to isolate distinct product streams. However, engineering plant feedstocks to achieve greater structural uniformity and tailored functionality holds promise for mitigating these challenges.

Moreover, carbohydrates derived from lignin and its derivatives offer a wide array of applications. These include the synthesis of polyols, polyurethanes (PUs), acrylics, esters, epoxy resins, and phenolic resins featuring aromatic structures, methoxy, alcoholic hydroxyl, phenolic hydroxyl, and other active functional groups. Incorporating lignin into PU production not only reduces reliance on fossil reserves but also enhances the mechanical properties of PU and introduces additional functional characteristics such as flame retardancy, UV protection, and hydrophobicity (Scheme 3).

Polyurethane Synthesis

Thermoplastic polyester can be made by reacting lignin with carboxyl-terminated polybutadiene. Lignin interacts with diisocyanate-terminated polybutadiene to create PU after being cross-linked with formaldehyde to increase uniformity. The soft segment is made of polybutadiene, and the cross-linking point is made of lignin. This leads to the formation of a two-phase network structure and consequently, a thermoplastic polyurethane (TPU) material is developed. TPU elastomer is a material with a lot of applications since it can be manufactured and utilized repeatedly



Scheme 3: Lignin-based PU thermoplastic (Source: RSC Adv., 2013,3, 21832-21840).

With approximately 75 million tonnes of lignin generated annually as a byproduct of the pulp and paper industry, its utilization is expected to increase significantly in the future, particularly with the projected rise in renewable chemicals and fuels derived from lignocellulosic materials

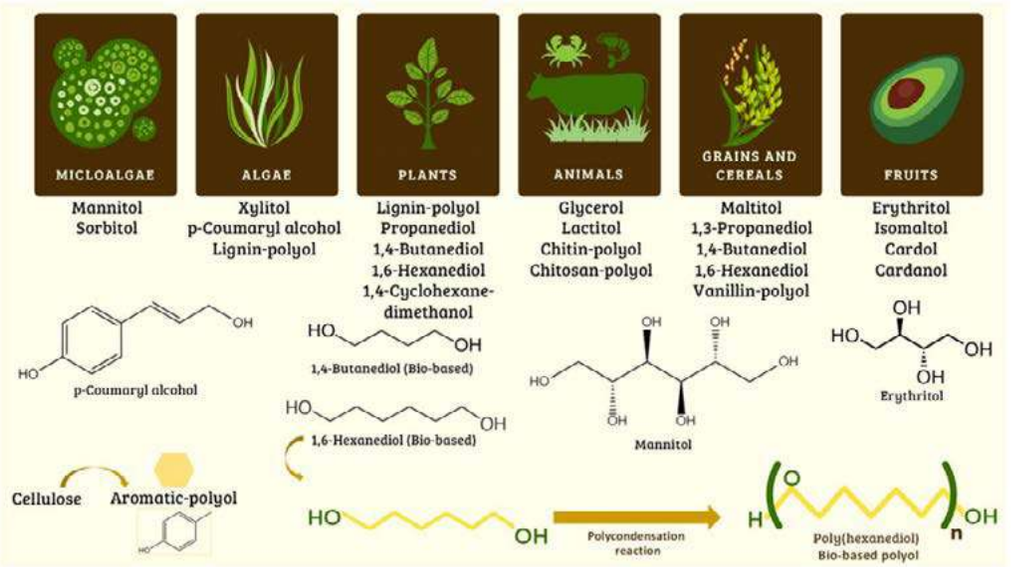


Figure 8: Synthesis of bio-based diols and polyols from natural and renewable resources used to synthesize polyurethanes.(Source: Molecules. 2024 Jan; 29(2): 387.)

with no environmental impact. Dynamic covalent bonds are also discovered to be useful for recycling cross-linked polymers. Trans-esterification reactions occur with DBTDL as the catalyst, allowing the elastomer to reconstruct at 160◦ C under hot pressing. The trans-esterification reaction is slower than usual dynamic bonding and demands the use of a catalyst. Although thermoplasticity achieved through molecular chain motion doesn't need a catalyst, it can only modify the shape of a material but not repair it. As a result, it would be more beneficial if we could integrate the two mechanisms.

Thermoplastic Lignin-based Polyurethane Elastomer (TLPUE):

Thermoplastic polyester can be synthesized by combining lignin with carboxyl-terminated polybutadiene. The interaction of lignin with diisocyanate-terminated polybutadiene, followed by cross-linking with formaldehyde to enhance uniformity, results in the formation of polyurethane (PU). In this formulation, the soft segment comprises polybutadiene, while lignin serves as the cross-linking point, leading to the development of a two-phase network structure and the creation of a thermoplastic polyurethane (TPU) material.

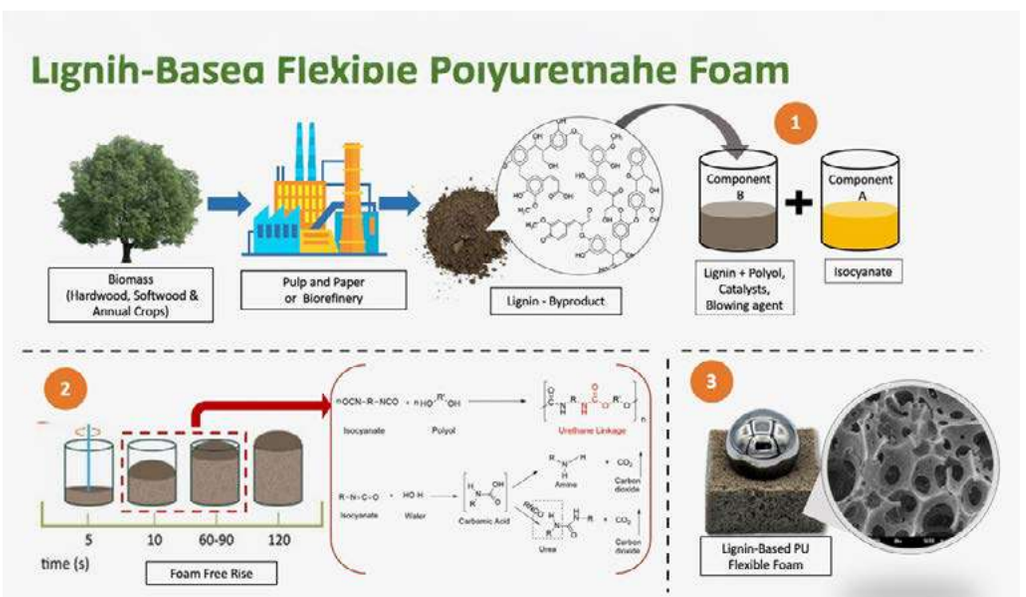


Figure 9: Lignin-based flexible PU foam (Source: ACS Cent. Sci. 2021, 7, 11, 1831–1837)

Lignin-based polyurethane biofoam dressing:

Silver nanoparticles have garnered considerable attention for their commercial use as essential biomedical materials. However, their widespread application poses a threat to both environmental ecosystems and human health. To address this concern, silver nanoparticles in material formulations have been partially replaced with naturally occurring antibacterial polylysine (PL). Consequently, a variety of lignin-based polyurethane (LPU) composite biofilms with different formulations have been devised. These biofilms

demonstrate rapid development, exhibiting antimicrobial activity against both gram-positive and gram-negative bacteria.

Flame retardant lignin-based PU foam: A three-step procedure to modify lignin with phosphorus, a flame-retardant component, has been reported resulting in the creation of halogen-free, flame-retardant hard PU foam. Flexible PU foams with flame-retardant characteristics have been created by combining phosphorus-containing polyols, lignin, or layered double hydroxide (LDH). Combining lignin, phosphorus-containing polyol, and LDHs resulted in high-viscosity melts that prevented dripping during combustion.

Flame-retarding PU composites (FLPU films): This process lays the groundwork for developing lignin-based flame retardants. The condensation reaction between the hydroxyl (OH) groups of lignin, PEG 2000, polyol 204, or NCO in methyl diisocyanate (MDI) effectively yields polyurethanes (PUs). Additionally, PEG2000 serves to modulate the flexibility of PU segments, further enhancing the versatility of the resulting materials.

Lignin-containing polyurethane adhesives: Their appeal lies in their low toxicity, excellent thermo-stability, rapid curing, superior mechanical properties, and resistance to chemicals and moisture. DBTDL serves as a catalyst in the hydroxymethylation and copolymerization of tolune diisocyanate (TDI) or lignin to produce LPU adhesives.

Lignin-based composites and 3D printing: Thermoplastic materials, including polyhydroxy butyrate (PHBs), polylactic acid (PLA), polyethylene (PE), and acrylonitrile butadiene styrene (ABS), are key components in enhancing antimicrobial, antioxidant, and biodegradable properties, as well as UV radiation stabilization, in the synthesis of composites or bio-composites through 3D printing.

Synthesis of lignin based polyurethane elastomers and films: The conventional methods of synthesizing LPUes often involve the use of hazardous or carcinogenic solvents, posing challenges in their removal. A solvent-free (SF) synthesis approach to produce lignin-containing polyurethane elastomers (SF-LPUs) exhibits remarkable toughness, elasticity, and strength. LPU elastomers derived from low molecular weight alkali lignin demonstrate exceptional elongation, good tensile strength, and a high elastic recovery ratio of 98.7 per cent.

Non-isocyanate-based polyurethane films (NIPU): A series of environmentally friendly non-isocyanate-based polyurethane films (NIPU) have been developed via a polycondensation reaction between diamine derivatives and biscyclic carbonate. The synthesis of biscyclic carbonate was achieved through the thiolene click and transcarbonation reactions of polyethylene glycol diacrylate and 1-thioglycerol.

Sustainable bio-PU: Fully harnessing the potential of high-performance lignin-based PU remains challenging, particularly in achieving a balance between reprocessability and excellent mechanical properties. A novel approach involving the reaction of phenolic lignin (PL) with isocyanate to create dynamic phenolic-carbamates, aiming to produce robust and reprocessable bio-PU elastomers is reported.

Self-healing LPU Elastomer: Self-healing coatings materials have a wide application in various fields, but achieving a high self-healing property and efficiency at ambient temperature without any additional power is still a big challenge. Since lignin contains a variety of active functional groups, such as aromatic groups, alcoholic hydroxyl groups, phenolic hydroxyl groups, etc., it can participate in chemical reactions such as esterification, oxidation, and reduction, which determines that it can replace polyols to prepare various types of polymers. LPUE was successfully prepared via partially substituting reactive raw material, chain extender, and filler with lignin.

Biological Potential of Chemically Modified Lignin

The use of natural and renewable raw materials such as lignin, which is primarily composed of phenylpropanoid that possesses a huge number of hydroxyl (OH) groups, phenols, and carbonyls has a potential to replace petroleum-based polyols in PU synthesis. The biological potential of chemically modified lignin shows better antibacterial, antioxidant, biocompatibility, flame retardancy, hydrophobicity, and UV-blocking properties. Lignin based polyurethanes have potential applications in construction, automated industries, packaging, textiles, footwear, supporting goods, automobiles, printing rollers, sealants, and binders.

With approximately 75 million tonnes of lignin generated annually as a byproduct of the pulp and paper industry, its utilization is expected to increase significantly in the future, particularly with the projected rise in renewable chemicals and fuels derived from lignocellulosic materials. Lignin, a naturally occurring polymer rich in reactive groups such as aromatic and aliphatic carbonyls, phenols, and hydroxyls, can be further enhanced through chemical modifications like depolymerization and oxyalkylation to improve the hydrophobic and thermal properties of PUs.

LPU synthesis predominantly employs the pre-polymerization method, involving polyester polyols or polyethers, chain extenders, polyisocyanates, functional additives, and crosslinking agents in preparation. Additionally, the use of polyols derived from lignocellulosic chain extenders can minimize PU fracture toughness, with lignin concentration significantly impacting PU characteristics CN

SUSTAINABILITY CRISIS AND INNOVATVE TECHNOLOGIES ARE INDIA'S OPPORTUNITY



Rupark Sarswat
Chief Executive Officer
India Glycols

> Biological processes involve the most complex, integrated chemistry working with physics and intelligence in perfectly sustainable manner

The world stands at the cusp of a radical transformation driven by three main factors: sustainability challenges that are not only a matter of survival but rather urgent; phenomenal advancements in technology; and significant geopolitical shifts in a rapidly evolving world order. I explore how India's chemical industry can seize this opportunity to lead the transformation through innovation and sustainable models. If India does the right things, it is in a great position to leverage amazing new technologies, deliver sustainable models, build upon India's strengths, and fulfil India's aspirations and provide value and solutions to the world.

The chemical industry is integral to and intertwined with all human activity. It is thus bound to see a transformation that would drastically alter the shape of global manufacturing as well as global supply chains.

We will see radical change over the next decade and beyond. It's both a necessity and an opportunity. We need those products and conveniences. The chemical industry must not only reduce the negative environmental impact but must also play an important role in providing solutions to the world to help solve issues and remedy the ecological damage. This will drive innovation enabled by technological advancements happening now and even greater ones to come.

India's chemical industry is the sixth largest globally and third largest in Asia, contributing over 7 per cent to GDP and 13 per cent of exports. With current market value exceeding $220 billion and projected to reach $ 1 trillion by 2040, it has a crucial role to play in India's sustainable economic development.

The transformative shifts, rising domestic demand, solid talent pool, focus on green energy and molecules, export potential, and demographic tailwinds augur well for India. But turning that promise into real progress will depend on how well we align industrial policy, R&D investment, infrastructure, sustainability goals, and talent development — to leapfrog from volume & cost-based growth to sustainable growth through value-driven innovation.

> **Recent advancements allow captured CO2 to be chemically incorporated into polyol structures through catalytic processes, producing CO2-based polyols that can replace up to 20–40 per cent of the conventional fossil-derived content**

Sunset to Sunrise

The chemical industry contributed to human progress and the first wave of innovation around the world wars and going upto 1980s transformed human life. From polyester and nylon to petrochemicals, plastics, medicines, and synthetic rubber — the chemical



revolution enabled the convenient world we live in. Today, it's nearly impossible to identify a human activity untouched by chemicals. Beyond the 1990, however it began to be perceived as a sunset industry. Other areas like IT, electronics, automotive, and pharma were capturing the imagination while chemicals was seen as mature, less innovative, stagnating and less value creating.

Most significantly with rising awareness about environmental degradation, pollution, and climate change, chemicals came to be associated with harm - to the planet, health, and ecological balance.

We stand at a pivotal point — a time of extraordinary change where the path we choose will shape the future for our industry and for our generations to come. We need those products or their benefits. Demand for convenience and performance is only increasing, but we realize we can't sustain the ecological costs. Either we must change products or processes or both. We need a new kind of chemistry: green, safe, circular, and efficient.

Necessity is the mother of invention. I am confident we're entering a new era we will see a second wave of innovation. Where previous decades innovation focussed on new products using fossil-based feedstocks and emphasized scale and cost reduction, the new era prioritizes sustainability, circularity, and regenerative impact.

Let us not forget that the chemical industry is a mother industry — a foundational layer upon which countless other industries depend automobiles, electronics, construction, textiles, consumer goods, renewable energy, and more and innovations here cascade into many more.

We don't have to grow like China or developed countries as they did decades ago. We can leapfrog with advanced technologies to deliver sustainable solutions without incurring the ecological costs they did.

Far from being a sunset sector, I firmly believe the chemical industry is re-emerging as a sunrise industry with India being in a great position to gain. Those who innovate and deliver solutions the world needs will build the next generation of businesses. Those who cling to the old ways — what I call the 'karkhana mindset' — risk fading away.

Three Drivers of Radical Change

We face complex challenges that seem impossible to solve — yet solving them is essential and urgent. At the same time, technological advancement offers hope and the power to tackle what once seemed unsolvable. Despite the gravity of challenges, I remain optimistic. The spirit of human endeavour will prevail.

The Sustainability Imperative

The most pressing issue is the planet's escalating sustainability crisis. Climate change, resource depletion, biodiversity loss, water scarcity, and toxic load are real threats and intensifying.

Highlighting urgency: climate scientists estimate oceans are absorbing excess heat equivalent to four to six Hiroshima-sized atomic bombs every second. This thermal load is disrupting weather patterns, accelerating glacial melt, and triggering oceanic die-offs — destabilizing entire ecological systems.

However, climate change is only one side. The other, less talked-about but more worrying, is toxic overload. A quiet catastrophe spreads across our air, soil, water, food, and bodies of living beings. We're often asked if people will pay for "greener solutions." A study indicates Delhi residents could lose up to 11.9 years of life expectancy due to pollution. Are we not already paying a very large cost?

Considering indicators: Phytoplankton populations — responsible for 50-70 per cent of Earth's oxygen — have declined 40 per cent in 70 years. We've lost 24-28 billion tonnes of annual CO_2 absorption. Nearly 73 per cent of global wildlife has been wiped out in 50 years. Today, 96 per cent of

mammal biomass consists of humans and livestock; wild mammals are only 4 per cent.

The challenge isn't just carbon emissions but chemical contamination and ecological collapse. Many chemicals causing damage are slow to degrade, bioaccumulate, and spread silently. Unlike carbon dioxide with natural sinks, toxins often have no return path.

Tech Revolution

We're witnessing breath-taking acceleration in technological capability. Key disciplines — biology, chemistry, computation, cognitive science — are merging. I sometimes say the future of the chemical industry is biology. Biological processes involve the most complex, integrated chemistry working with physics and intelligence in perfectly sustainable manner.

Green Hydrogen and Carbon Capture: India generates 2.6 billion tonnes of CO_2 annually. We can capture and convert this to useful products. Moreover, India is also on track to become a leading and the most cost-effective producer green hydrogen. That gives us the two key building blocks for hydrocarbons available across the country.

India's renewable energy capacity grew from 73 GW in 2014 to 200 GW in 2024, expected to exceed 500 GW by 2030. Our solar costs are 27 per cent lower than China, 35 per cent lower than USA, 47 per cent lower than EU. India's high solar energy harvest potential — 1650 KWH/m² — is 41 per cent higher than China, 83 per cent higher than Japan.

Electrochemical Processing: This can replace heat-driven, fossil fuel-based reactions with electron-driven ones powered by renewable electricity — cleaner, safer, modular. The fascinating thing is flexibility: same reactors can be repurposed to make different molecules by changing voltage and catalysts.

AI Revolutionizing R&D: AI tools are slashing R&D timelines from years to months. Platforms like IBM RXN and DeepMind's AlphaFold predict reaction outcomes and protein structures with unprecedented accuracy. Self-driving laboratories autonomously discover molecules and optimize conditions.

Synthetic Biology: We're using engineered microbes like living factories. Companies program microbes to produce products for cosmetics, fragrances, therapeutic proteins. A fascinating example is self-healing concrete with bacteria that activate when cracks develop and help seal the crack. Microbes are also being used to capture carbon from emissions and convert it into useful products. We will see bioreactors being increasingly used and energy intensive processes will be replaced by lower energy, cleaner and greener manufacturing. In future we are talking about Biofabrication, regenerative organs, factory produced meat and leather and microorganisms that can consume plastic and clean up our water bodies.

Autonomous Robotics: Fanuc in Japan manufactures 50 robots daily with no humans entering the factory for a month. Humanoids will soon handle material, repetitive tasks, safety inspections. In chemical plants, robots will patrol shop floors detecting leaks, perform lab work 24x7, and enter unsafe zones. We can expect capex costs of plants to come down and productivity, quality, efficiency and safety to improve.

On a different note, we may think self-healing concrete is miraculous. But nature does this constantly — from bacteria to plants to animals, creating new life from single cells. Life has that knowledge; our conscious minds just lack access. Imagine possibilities when genetics, synthetic biology, human intelligence, AI, and cellular programming integrate

The transformative shifts, rising domestic demand, solid talent pool, focus on green energy and molecules, export potential, and demographic tailwinds augur well for India

Geopolitical and Supply Chain Shifts

The post-Cold War era of stable globalization is over. Rising US-China tensions, conflicts in Europe and Middle East, and emphasis on national security are reshaping the world order. We've had really VUCA times — Covid exposed supply chain vulnerabilities, followed by Russia-Ukraine war and unpredictable Trump presidency.

India stands out demographically, has a median age under 29 and expecting expects to add 140 million middle-income households by 2030, boosting demand. "China+1" strategies position India as natural alternative with large talent pool, improving infrastructure, and political stability.

These three forces — sustainability imperative, technological acceleration, and geopolitical reordering — collectively reshaping the future. India, with its unique advantages, natural endowments, demographic profile and strategic positioning has a great opportunity.

India Advantage

Resource Abundance: India's vast agriculture produces ~500 MMT of biomass annually, mostly underutilized. Converting just 20 per cent could produce 50-75 MMT of bio-based chemicals, create $25-40 billion value while provide income to 100+ million farming households.

Demographic Dividend: India produces 1.5 million STEM graduates annually, including 200,000+ chemical engineers. This talent pool enables high-quality operations and research at 30-50 per cent lower costs than developed markets. Urban consumption grows above 10 per cent annually; rural



markets show even higher potential. The capex costs in India are also substantially lower.

Import Substitution: India's chemical imports total $60+ billion annually. Key segments include specialty chemicals (40 per cent import-dependent), electronic chemicals (70 per cent import-dependent). This gives an opportunity of $25-30 billion in import substitution while building exports.

Way Forward for India

Our ambition must go beyond becoming a low-cost manufacturing alternative. The world needs a model combining efficiency, innovation, circularity, and sustainability and we must aspire to create knowledge-based companies producing differentiated products and solutions.

Planetary survival and progress are intertwined, and development must be pursued with deep ecological consciousness and global responsibility. India needs to build an industry that reflects aspirations of new India, solves problems and adds value to the world through products, sustainability, ideas, and solutions.

India needs many centres of excellence in sustainable chemistry, focusing on biocatalysis, electrochemistry, AI-driven molecular design. These should combine academic research, industry collaboration, and startup incubation.

The next decade represents a defining era for India's chemical industry. Convergence of sustainability imperatives, technological capabilities, and geopolitical realignments creates unprecedented opportunity to deliver value to domestic as well as global markets.

If India captures just 5 per cent of global sustainable chemistry market by 2040 — projected to reach $500 billion — it would add $25 billion annually to chemical exports while creating millions of jobs. More importantly, it would position India as global solution provider for sustainability challenges.

It will be time of great churn as happens with major transformation. Those who innovate and deliver solutions the world seeks will create great new businesses. Those who don't adapt and stay with old world — the 'karkhana mindset' — will fade away.

The convergence of necessity and possibility, crisis and capability, creates a unique window of opportunity for India to solve its development challenges while contributing solutions to the world. This dual value proposition — serving national interests while advancing global welfare — represents essence of enlightened leadership that is essential to make this happen

As someone said "If sustainability is a fad, it will be the last one" but I have confidence in the unprecedented technology revolution and unbeaten spirit of human endeavour to deliver and I am sure we in the Indian Chemical Industry will seize the opportunity and lead the fascinating transformation in the years to come.

Just as the first chemical revolution enabled the modern world, the second can enable a sustainable world and take the chemical industry from being a sunset to an exciting sunrise industry for the years to come.

The radical transformation of the world and the chemical industry is interconnected and inevitable. The question is whether the India will seize the unprecedented opportunity, and the strategic moment is now

PETROCHEMICALS

Building Circular Economy



BEYOND OIL: INDIA'S PETROCHEMICAL RENAISSANCE

A major trend shaping the petrochemical industry in 2024 was the shift towards specialty chemicals, with a strong emphasis on sustainability TEAM ICN

The Year 2024 was a transformative year for India's petrochemical industry, marked by aggressive investments, strategic global partnerships, and a concerted move towards sustainable practices. With a growing demand for petrochemicals fuelled by industrialization, urbanization, and an expanding consumer base, the industry has witnessed a substantial increase in capacity expansions and infrastructure development.

These developments not only strengthened India's position in the global petrochemical landscape but also set the foundation for future growth aligned with environmental considerations. This growth has been particularly evident in the rise of domestic production capacities, reducing import dependencies and enhancing India's self-reliance in petrochemicals.

A major trend shaping the industry during 2024 and continues in 2025 is the shift towards specialty chemicals. Companies are increasingly focusing on developing biodegradable materials, bio-based polymers, and high-value specialty chemicals to meet evolving environmental regulations and customer preferences. The demand for bioplastics and green chemicals has surged, aligning with India's broader commitment to decarbonisation and circular economy principles. In tandem, petrochemical refiners have integrated renewable feedstocks such as used cooking oil into their processes to produce cleaner fuels.

However, this transition has also necessitated the development of advanced catalysts and refining technologies to handle bio-feedstock impurities effectively.

Fuelling the Greener Future

Research and development have emerged as a core focus area for industry players looking to develop alternative feedstocks, innovative production techniques, and high-value petrochemical derivatives. There is a growing emphasis on chemical recycling technologies to convert plastic waste into usable petrochemical feedstocks, fostering sustainability within the sector. Collaborative efforts between government research bodies, academic institutions, and private enterprises have strengthened India's R&D ecosystem, enabling the industry to compete with global leaders in terms of innovation and technological advancements.

Digital transformation has played a pivotal role in optimizing business operations, improving efficiency, and enhancing supply chain transparency. Industry 4.0 technologies, including artificial intelligence (AI), the Internet of Things (IoT), and blockchain, have been widely adopted to facilitate predictive maintenance, process automation, and real-time tracking of petrochemical shipments. This has enabled manufacturers to reduce operational costs and improve productivity while ensuring compliance with stringent environmental and safety regulations.

The Indian petrochemical sector is undergoing a dynamic transformation characterized by accelerated growth, sustainability-driven initiatives, digital adoption, and strategic policy interventions

Substantial Investments and Expansion Plans

The petrochemicals sector plays a pivotal role in the country's industrial and economic growth, supplying essential raw materials to industries such as plastics, textiles, pharmaceuticals, and agriculture etc. With the sector poised for robust expansion, the Indian government and private enterprises have initiated several key investments and projects to strengthen domestic production, reduce dependency on imports, and enhance sustainability.

Petroleum Minister Hardeep Puri, at India Chem 2024, highlighted a projected US$ 142 billion (approx. Rs. 11.9 lakh crore) investment in India's petrochemical sector over the next decade, with FY24–25 serving as a key year for groundwork investments by major players like IndianOil, Bharat Petroleum, Hindustan Petroleum, Oil and Natural Gas Corporation, Oil India,

Haldia Petrochemicals, Reliance, Nayara Energy etc.

Bharat Petroleum Corporation Limited (BPCL), for instance, has announced US$ 11 billion (approx. Rs. 95,000 crore) refinery and petrochemical project in Andhra Pradesh. The project will feature a 9 MMTPA refinery and an ethylene cracker unit, designed to strengthen India's petrochemical supply chain and reduce dependency on imported fuels and chemicals.

Indian Oil Corporation Limited (IOCL) is progressing with expansions of its Panipat, Gujarat, and Barauni refineries, with completion targeted for December 2025. In August 2024, Indian Oil Corporation outlined plans to triple its petrochemical capacity by 2030, starting from 4.28 million tonnes/year. For FY24–25, this includes commissioning a 150,000 tonne/year butyl acrylate plant at its Gujarat refinery, part of a broader Rs. 61,000 crore investment over the next few years. The FY25 capex is estimated at Rs. 10,000–12,000 crore, aligning with refinery and petrochemical integration goals.

Hindustan Petroleum Corporation Limited (HPCL) planned a Capex of Rs. 12,000 crore for FY23–24, with a focus on refinery enhancements. For FY24–25, while no new announcement was made in 2024, the company's ongoing commitment to petrochemicals and sustainability suggests a similar or slightly higher capex, potentially Rs. 12,000–14,000 crore. HPCL's Rajasthan Refinery which is an integrated refinery and petrochemical complex, is nearing completion. With a total capacity of 9 MTPA, several units have already entered the pre-commissioning phase. HPCL recently expanded the capacity of the Vizag refinery to 300,000 barrels per day and is looking for a further increase.

Oil India Limited's (OIL) Numaligarh Refinery expansion, totaling Rs. 28,000 crore, is expected to be completed by December 2025. Post its expansion, the refinery's capacity is expected to increase to 9 million tonne per annum from the present 3 million tonne.

Oil and Natural Gas Corporation (ONGC) has proposed an investment of Rs. 1 lakh crore to set up a 12 MMTPA refinery-cum-petrochemical complex in Uttar Pradesh.

Haldia Petrochemicals Ltd (HPL) is considering a proposal to build a polycarbonate plant in Bengal, entailing an investment upward of Rs. 8,500 crore. Haldia Petrochemicals also plans a Rs. 85,000 crore oil-to-chemical project in Cuddalore, Tamil Nadu. The facility aims to convert crude oil into high-value petrochemicals, specifically ethylene and propylene, with a production capacity of approximately 3.5 million metric tonnes per year.

Nayara Energy announces plan to invest Rs. 68,000 crore to set up a 1.5 MTPA ethane cracker at its 20 MTPA refinery at Vadinar in Gujarat. The company has also strategically planned the development of its petrochemical division in phases and is in the process of setting up a 450 KTPA polypropylene plant at the same location.

Reliance Industries Limited have also announced capacity expansion projects to cater to the growing demand for petrochemicals, specialty chemicals, and polymer products. Reliance is focusing on high-value petrochemical production to support various downstream industries.

These expansions are designed to enhance refining capacity and integrate petrochemical production, supporting India's goal to increase its refinery capacity from 249 MTPA to 450 MTPA.

Such projects are designed to reduce India's reliance on imported petrochemical intermediates while catering to the growing domestic and international markets.

Demand Outlook

Styrene and Polymers: Demand for styrene is projected to grow by 15% in FY 2025-26, driven by increasing usage in plastics, rubber, and packaging industries

Specialty Chemicals: With industries shifting towards high-performance materials, specialty chemicals have emerged as a key growth driver, especially in electronics, automotive, and pharmaceuticals

Bioplastics and Sustainable Materials: Growing environmental concerns and regulatory changes are fostering demand for biodegradable and bio-based plastics

Renewable Feedstocks: Companies are integrating bio-based feedstocks, such as used cooking oil, into refining processes to produce cleaner fuels

Carbon Capture and Circular Economy: Major refineries are investing in carbon capture technologies and circular economy initiatives to reduce emissions and enhance recycling of plastic waste

Green Hydrogen Adoption: Indian oil and petrochemical firms are exploring green hydrogen as an alternative energy source for production processes, aligning with the national hydrogen mission

US Tariffs could Create Imbalance

The impending tariffs by the Trump administration on imports, particularly from China, could have significant implications for the Indian petrochemical industry. While the direct impact on India might not be as severe as on countries directly involved in the trade dispute, the broader consequences of these tariffs could reverberate throughout global supply chains, raw material pricing, and market competitiveness, posing both risks and opportunities for Indian petrochemical players.

First, the most immediate impact could stem from disruptions in the availability and pricing of key raw materials. India imports a large portion of its petrochemical feedstock, including products like polyethylene, polypropylene, ethylene, and propylene, from a variety of international sources. With US tariffs affecting Chinese exports, Indian companies might face higher costs for these materials, as Chinese suppliers look to offload surplus production onto other markets. The increased cost of raw materials could squeeze margins for Indian producers, especially in an industry where cost efficiency is critical to maintaining competitive pricing.

Furthermore, global supply chains will likely experience significant shifts as the US-China trade war intensifies. With China being one of the largest global producers of petrochemical products, its reduced access to the US market could drive the Chinese to redirect their exports to regions like Southeast Asia, Africa, and the Middle East, regions where India also competes. As a result, Indian petrochemical manufacturers could find themselves facing stiffer competition, particularly in markets that were once less crowded. The reconfiguration of supply chains could also lead to a redistribution of demand, impacting the competitiveness of Indian products globally.

In terms of export opportunities, there might be short-term benefits for Indian petrochemical producers, particularly in markets where Chinese exports become more expensive due to the tariffs. India could capture a portion of this displaced demand in regions where it traditionally has a strong presence, such as the Middle East or Southeast Asia. However, this benefit may be short-lived.



Countries like South Korea and other Middle Eastern producers could quickly fill the gap left by China, reducing the potential for India to secure lasting market share in these regions. In the US, though Indian products might become more attractive as alternatives to Chinese petrochemicals, the elevated tariffs on US-China trade could also slow overall global demand, making the US a less reliable export market for Indian companies.

> The impending tariffs by the Trump administration on imports, particularly from China, could have significant implications for the Indian petrochemical industry

The unpredictability of these trade shifts will also force Indian petrochemical firms to adapt quickly, recalibrating their supply chains and reconsidering long-term investments. Companies may need to look at diversifying their raw material sources, forging new trade partnerships, and exploring new production technologies that could offset higher costs. tionally, India's government may be compelled to introduce domestic policy adjustments to buffer the industry, such as tariff reductions on key petrochemical inputs or incentives for companies that invest in expanding local production capacities.

Outlook

Despite a global slowdown, India remained a bright spot for petrochemical demand in 2025, driven by sectors like electric vehicle components, solar panels, and consumer electronics. Companies like Bharat Petroleum and Indian Oil reported robust domestic demand, highlighting the resilience of the Indian market.

The sector is on a strong growth trajectory, driven by significant investments, capacity expansions, and sustainability initiatives. This growth is primarily driven by increasing domestic consumption, expanding industrial applications, and supportive government policies.

The expansion is focused on increasing domestic production capacity, reducing reliance on imports, and incorporating sustainable practices. As the industry moves toward self-sufficiency, investments in innovation and green technologies will play a crucial role in shaping its long-term competitiveness on the global stage

OUR REFINERY DESIGN CAPACITY WILL BE EXPANDED TO 45 MMTPA BY 2028

We are also setting up indigenous electrolyzer facility, which will be making hydrogen and providing fuel for the local hydrogen-based buses

Q Refinery capacity in India is expected to reach 310 MMTPA by 2030 and 400 MMTPA by 2047 from the current 250 MMTPA. Where do you see Bharat Petroleum Corporation Ltd. (BPCL) in this capacity expansion?

As far as BPCL share is concerned, we are having our capacity around 35 million metric ton per annum (MMTPA) as of today and going forward we plan to take it to 45 MMTPA. We will be expanding the capacity of all three refineries. In addition to this, we have decided to explore the option of having a new refinery with a petrochemical complex at the East Coast where we don't have any presence. We are working on the options of refinery with a capacity of 9 to 12 MMTPA. As of now, we have targeted the petrochemical intensity index up to 40 per cent.

Q You have recently allocated Rs. 6,100 crore for Polypropylene (PP) refinery. What's the update on that project?

We are going for the Detailed Feasibility Report through which we will be finalizing the configuration and will be going for the licenses selection. Along with this, the land has been allocated, and we will be doing some work related to land development. We are expecting that the whole job will be taking close to 18 months. By next year's end, we will be having the final decision based on all these input. Post this, the way forward for the refinery will be taking place.

Q You are also negotiating a crude oil deal with Saudi for your refinery. Is it too early for this or all things need to be considered before planning?



SANJAY KHANNA
Director (Refineries) with Additional Charge of Chairman & Managing Director BPCL

We are currently contemplating the capacity configuration. Therefore, taking anybody on board at this junction where things are very fluid, will not be right. But as things will become clearer with our configuration and the product output as well as the petrochemical plant, if companies are coming on board, we will be open to that.

Q You have signed two agreements, one with Shipping Corporation of India and another with Petrobras, and both are related to crude oil. How do you see these agreements moving forward?

With Petrobras, we have a non-binding agreement from both sides. We will be the preferred customer for them if they are having surplus crude. They will be giving us crude and similarly, it will be non-binding on their part to offer us the crude based on the fixed commitment. With Shipping Corporation of India, we are looking for a joint venture through which crude sourcing or other related facilities sourcing can be done jointly. It is quite an exciting field which we are looking forward to.

Q You have also signed a deal with SBI consortium of about Rs 3,182 crore for the Bina refinery where you are looking at an expansion from 7.8 MMTPA to 11 MMTPA and ethylene capacity of 1.2 MMTPA. What's the update on that front?

I am told this is one of the biggest project financing done by SBI and through this way we are insulating our full project in the time to come. I must say that we got a very attractive deal from the SBI.

Q And what about the remaining part of Rs. 48,296 crore?

This will be happening over the period of next five years and I am sure the company will be having strength on its



own to fund the project.

Q You plan to set up a PP unit at the Kochi refinery with an investment of Rs 5,544 crore. Any update on that? Also, when will the Bina refinery expansion project be commissioned?

The Kochi PP project is progressing well, with commissioning targeted for September 2027. The Bina refinery expansion is also set for completion by September 2027, aligned with the refinery's next turnaround. The associated petrochemicals facilities are expected to be ready by 2028.

Q By 2028, what would be your total refining capacity and chemical capacity?

Our design capacity of the refinery will be increased to 45 million metric ton per annum and our petrochemical capacity will increase from 2.3 per cent to 8 per cent.

Q What initiatives are you undertaking to enhance environmental responsibility and also sustainability within the refinery?

There are many steps taken in this direction, be it digitalization or the reliability improvement, or overall safety improvement. Let me give you a few examples. First and foremost, we are working on the reliability improvement because we believe that once reliability is better than your failure will automatically come down, leading to less unwanted emission. Second, we are also working on energy efficiency improvement and are aware that 5 per cent to 10 per cent of decarbonation can be achieved through this route. Third, we have worked on biofuels. As

“The Kochi PP project is progressing well, with commissioning targeted for September 2027. The Bina refinery expansion is also set for completion by September 2027, aligned with the refinery’s next turnaround. The associated petrochemicals facilities are expected to be ready by 2028”

we all know that 20 per cent ethanol is being added to fuels on a sustained basis now, and with time it is going to go up only. Fourth, we are also in the process of implementing our biorefinery wherein, we will be making 100 KL per day bio-ethanol from the 1G route and 100 KL per day from the 2G route. This particular unit is expected to be commissioned next quarter in the state of Odisha.

Apart from these, we are implementing three major initiatives in green hydrogen. First, we are implementing a 5 megawatt electrolyzer facility at our Bina refinery, which is expected to be commissioned next quarter. We are working on 5,000 TPA green hydrogen in our Kochi refinery and we are expecting the same to be commissioned by next year. We are also setting up indigenous electrolyzer facility, which will be making hydrogen and providing fuel for the local hydrogen-based buses in the city of Kochi. We are also planning to scale up our compressed biogas in a big way. We have already commissioned around 10 CBG plants and in the next two years, we are planning to scale it up to 26 CBG plants.

Q From kilo to mega to giga, when will it exactly happen? On the green hydrogen side, what is your forecast? Are we looking at 2029 or 2030?

It is an upcoming technology and a lot is happening in this arena. A lot of research is happening and many lab scale findings have happened already and if these get scaled up, it will make the green hydrogen quite an attractive preposition. We have to be net zero and one of the important components is the green hydrogen.



Q What is the latest update on your biorefinery project at Bargarh?

At this biorefinery, we will be making bioethanol from rice straw and bagasse. To improve its commercial viability, we are also working on the R&D and then all the byproducts and how to make more value added products out of it.

Q You have been talking about market volatility in the feedstock, land prices on the higher side and also improving energy efficiency in the refinery. How do you see these things in terms of affecting overall refinery market margins?

I think volatility is not new to our business and we are used to it. It was always there because when the majority of feedstock is getting imported, you are definitely on the vulnerable side. At the same time, all the initiatives taken in the form of alternate energy, renewable energy or green hydrogen and bioethanol will be added to reduce the volatility to some extent.

Q Any numbers in terms of deploying renewable energy across refineries? What will be the capacity at the end of the year and future plans?

Two years ago, our portfolio was in the range of 20-30 megawatt and next year it is likely to become 600 plus megawatt. Going forward, whatever green energy will be available for maximum use within the refinery production capacity, will be deployed in all facilities

(The interview was taken when he was Director (Refineries) without additional charge of CMD)

We are developing a 5,000 TPA green hydrogen facility at one of our refineries, expected to be commissioned next year. Additionally, we are expanding our compressed biogas operations—having already commissioned 10 CBG plants, with plans to scale up to 26 over the next two years

STRATEGICALLY EXPANDING TO BECOME A LEADER IN PETROCHEMICALS

With domestic demand for petrochemicals projected to triple over the next decade, the addition of PTA to product mix positions us strongly in the market



AYUSH GUPTA
Director (HR)
GAIL India &
Chairman, GMPL

Q What is the current status of GAIL Mangalore Petrochemicals Limited (GMPL) and how its collaboration with GAIL (India) influences its strategic direction and what synergies have been realized from this partnership?

The GAIL Mangalore Petrochemicals Limited (GMPL) plant was acquired through National Company Law Tribunal (NCLT), followed by a capital infusion to revive its operations. The plant had been non-operational for seven years, so we first needed to assess the extent of damage and identify components that required replacement. While feasibility reports were available, several aspects remained uncertain at the outset.

I am pleased to share that both the estimated cost and timeline are well within control. In fact, the actual costs have come in lower than initially projected, and the schedule remains largely on track. Although we had initially targeted commissioning the plant by August or September 2025, there has been a slight delay. We now expect to commission the plant by the end of December 2025 or, at the latest, early January 2026. Trial production should begin around that time. With pre-commissioning activities already underway, we have initiated the boiler revival process and are progressing in phases, with a goal to complete this by October 2025.

So far, a total capital infusion of approximately Rs. 59,691 lakh has been made, and the plant revival is progressing steadily. Of this, Rs. 39,425 lakh has been invested as equity. The majority of this capital has come from GAIL, which underpins GMPL's financial strength. GAIL's board had approved this equity investment at the time of acquiring the plant through the NCLT process, ensuring a guaranteed cash flow within the approved limits.

Two critical aspects for commissioning the plant revolve around raw material sourcing and operational readiness. One key input is paraxylene, the primary feedstock for producing purified terephthalic acid (PTA), which is essential for polyester manufacturing. Initially, we had planned to source paraxylene through an agreement with MRPL, and discussions with them are ongoing. At the same time, we are exploring the option of importing paraxylene via the sea route. Infrastructure is being developed for this purpose, including laying pipelines from the port to the plant. We are actively coordinating with port authorities, working on setting up a pumping station, and arranging temporary storage facilities at the port to ensure an uninterrupted supply chain. In the coming month, we plan to issue an Expression of Interest (EoI) to onboard additional suppliers and create a diversified, empaneled vendor base.

On the marketing front, we have already initiated outreach efforts and are in discussions with potential customers. GAIL's marketing team is providing strong support in finalizing warehousing and sales agreements, leveraging their established presence in the petrochemical sector. Both



paraxylene sourcing and PTA marketing will be managed by GAIL's marketing division.

Q How do the company's recent initiatives, such as the PTA plant revitalization, contribute to India's vision of self-reliance in petrochemicals under the Atmanirbhar Bharat initiative?

With PTA added to the product mix, GAIL's petrochemical portfolio will become fully integrated across all product segments within the next year. This positions us strongly in the market, especially as domestic demand for petrochemicals is projected to triple over the next decade. Currently, a significant share of these is imported, creating substantial opportunities for import substitution and enhancing the long-term prospects of India's petrochemical sector.

GAIL is in the early stages of planning another ethane cracker plant. While the financial structuring is yet to be finalized, this move is aligned with anticipated demand in the petrochemical sector. Meanwhile, the PTA to be produced at the GMPL plant represents a niche product with substantial demand, particularly in the textile industry. GAIL's established reputation for delivering high-quality products will be a significant advantage as we enter an already competitive market across India. This will be crucial, as a robust marketing strategy must accompany the commencement of production.

We now expect to commission the GAIL Mangalore Petrochemicals Limited (GMPL) plant by the end of December 2025 or, at the latest, early January 2026

We are also receiving strong support from our technology licensor. Notably, we successfully renegotiated the licensing agreement with INEOS, which was originally in place with JPL. Given the seven-year hiatus and the absence of returns during that period, we were able to secure a more favorable deal. This renegotiation is a key milestone, as the licensor's backing during the commissioning phase, and beyond, will help ensure consistent product quality and long-term success for GMPL.

Sustainability and social responsibility are also central to our commissioning efforts. One of the significant challenges during the plant acquisition was resolving issues related to project-displaced persons.



Out of 115 individuals identified, an initial list of 75 was prioritized for employment. Almost all of them have now been re-engaged, many of whom had worked at the plant previously, contributing valuable experience and support to the commissioning process. A few opted not to join, and the remaining are in the process of being integrated.

I must appreciate the fact that we have received support from the Port Authority and all the government departments. Besides, the Development Commissioner has been very helpful to make sure that the plant gets reviewed and commissioned soon. The Ministry of Petroleum and Natural Gas played a vital role in getting the clearances and approvals besides helping in resolving the issues at ground level.

GAIL (India) Limited

Q With your new plant getting commissioned, how do you see GAIL as a major player in the Indian petrochemical scenario?

GAIL is poised for a significant capacity expansion across its petrochemical portfolio. With the commissioning of the PTA unit at the GMPL plant, alongside the existing BCPL portfolio, and the upcoming Usar and Pata petrochemical plants, we are entering a transformative phase. Once operational, the GMPL plant will contribute 1,250 KTA of PTA, Usar will add 500 KTA, and Pata will bring in 60 KTA. These additional volumes are expected to come online within the next year, marking a major shift that will significantly impact the petrochemical landscape in India. This expansion will undoubtedly alter market dynamics and intensify competition. While it will be a challenging journey for GAIL to establish a strong market foothold, we are confident in our strengths—particularly our commitment to product quality, fair contracting practices, and reliable execution, all hallmarks of a Maharatna public sector enterprise.

Historically, GAIL lacked a diverse product portfolio, which limited our ability to scale competitively. However, with these three plants nearing commissioning targeted for late 2025 to early 2026, we will soon be in a position to serve a broad spectrum of customers across the country. The coming year promises to be exciting, as several other players are also eyeing entry into the

market. Over the next two years, we anticipate a game-changing evolution in India's petrochemical sector.

Q Why did you choose the PTA for this GMPL plant? Is it going to cater to the domestic demand or you are also looking at exporting as well?

In the initial phase, there wasn't much of a choice as the plant was originally designed for PTA production. While exploring options for portfolio expansion, we identified PTA as a missing product in GAIL's offering. This particular plant became available at the right time, and although other players were interested, GAIL emerged as the highest bidder.

We also see potential for further expansion, given the availability of additional land. Since the plant is located within a SEZ, there are certain export obligations we need to fulfill, and we are open to exploring those opportunities when they arise. For now, however, our primary focus remains on catering to the domestic market.

Q What change you brought it in your strategy to meet the tight deadline within the estimated budget?

Several critical factors contributed to the success of this project, beginning with clear and structured planning from day one. This included early and active engagement with key stakeholders such as MSEZ and the relevant ministry. Initially, there was skepticism in the market, with concerns that GAIL had overpaid for the asset. We were aware that any deviation from our profitability projections would be closely scrutinized, so we adopted a disciplined approach from the outset.

A key strategic decision was to operate with a lean team, just 50 people, but their dedication and efficiency were exceptional. They played a vital role in resolving major challenges, including settling issues with project-displaced families, renegotiating the license with INEOS, and coordinating with vendors. Their efforts ensured that all critical matters were handled professionally and on time, avoiding potential delays or cost overruns.

> **With the commissioning of the PTA unit at the GMPL plant, alongside the existing BCPL portfolio, and the upcoming Usar and Pata petrochemical plants, we are entering a transformative phase**

During the period when the licensor agreement was being renegotiated and the EPC contract was under finalization, the team proactively carried out significant groundwork. This helped us assess the plant's equipment condition and saved considerable time, boosting our confidence in the plant's readiness. The experience of GAIL's project team was instrumental, especially during maintenance activities, ensuring smooth progress. The small but highly capable team deployed at GMPL proved to be one of the best, playing a crucial role in managing risks and keeping the project firmly within both time and cost parameters.

Q Given the fluctuations in global petrochemical markets, what strategies are in place to mitigate potential risks? Five years from now, what would be the contribution of petrochemicals that you envisage because the market is huge?

The petrochemical market is inherently volatile and cyclical, making it challenging to predict price movements, especially with numerous plants operating globally. However, this very cyclicality also presents opportunities to capitalize on favorable market conditions. The upcoming five-year cycle appears to be entering an uptrend, making GAIL's entry into this space both timely and strategic.

Expanding into a broader product range at this juncture positions GAIL advantageously. The next five years are expected to be transformative for the petrochemical industry in India, and GAIL's portfolio expansion is likely to contribute significantly to its overall revenue, and we hope, to its profitability as well.

Q In terms of Corporate Social Responsibility (CSR), GAIL has been known to help the local communities. With the commissioning of plant on anvil, how do you plan to help the local community?

From a local economic perspective, the revival of the plant, which had been shut down for seven, will bring widespread benefits. Beyond the regular workforce, a significant number of contractual employees will be engaged, positively impacting nearly 500,000 families. The local community is understandably enthusiastic about the new livelihood opportunities this project will create.

In addition to directly employing members of the project-displaced families, the commissioning of the plant is expected to generate further employment needs. Opportunities will also arise through transport contracts and various support services, helping stimulate the entire local economy and surrounding ecosystem ICN

INVESTED RS. 4,200 CRORE IN BAMBOO-BASED ETHANOL PROJECT

Our production capacity includes 50,000 MT of ethanol, 18,000 MT of furfural, and 11,000 MT of acetic acid



BHASKAR JYOTI PHUKAN
Managing Director
Numaligarh Refinery

Q How have been the developments in FY 2024-25 and how are you planning to move ahead for the next two months?

Up to the Q3 of FY 2024-25, we did fairly well. Despite the fact that the margins are a bit depressed and standalone refinery companies faced a few issues, we have still registered a very reasonable profit. We are planning to put back capital into our expansion project which is also progressing very well. We have conducted a successful trial run in our bio refinery during the month of December and the product has been converted to ethanol. Currently, a few of the jobs are just in the finishing end and maybe in a couple of months time, we will do the full commissioning. For the main refinery, we will be able to start the commissioning activities from December, 2025.

Q What was the investment made for the bamboo based ethanol plant that is expected to get commissioned soon? How much will be the capacity of this plant?

Given that it is a first of its kind initiative, we have had our engineering challenges as we moved along. We found that a lot of critical areas needed to be addressed and, hence, it underwent constant modification. Therefore, the capex was little higher and currently we have spent around Rs. 4,200 crore and are now nearing the end of the project.

As far as capacity is concerned, we are going to produce around 50,000 metric tonnes of ethanol and along with that we will also produce 18,000 tonnes of furfural and 11,000 tonnes of acetic acid. Apart from that, the lignin portion will go for production of power and 5 megawatt of power can also be exported. If you look at the plan as a whole, it's an absolutely green plan. Only area where carbon dioxide (CO2) is emitted is in the fermentation section wherein we have made provision for capturing and converting it into liquid CO2 for sale.

> **We have already awarded a 17 megawatt electrolyzer to produce 2.5 KTPA of green hydrogen and it is expected to be rolled out in this calendar year**

Now with the confidence of operating the plant in two months' time, are you looking at some other projects in other regions with respect to bamboo?

We are definitely looking into the other geographical areas as we gain



We currently operate a 3 mn tonne refinery, which will scale up to 9 mn tonne. Our diesel production will rise from 2 MMTPA to 5.5 MMTPA, while gasoline output will increase from 0.6 MMTPA to 1.2 MMTPA

some more experience in operation. We just did the trials and we still have to do major optimization. We have to make the consumption of enzymes and chemicals more economical and that will be done with the experience of handling the unit a little bit more.

Q When will the refinery become operational? Once the plant will be commercialized, what would be the final output including complete cumulative refinery capacity?

By December 2025, some of the plants will be in operation mode as it has to be done in phases and gradually other plants will also be made operational soon. From a food processing point of view, we are a 3 million tonne refinery currently and we will reach 9 million ton. We have around 2 Million Metric Tonnes per Annum (MMPTA) of diesel production currently and that will go up to 5.5 MMTPA. The gasoline production which is currently 0.6 MMTPA will go to 1.2 MMTPA. We will also have flexibility of producing Aviation Turbine Fuel (ATF) just to take care in case the diesel demand falters.

We are also going to have LPG in a very major way because the northeast is pretty much deficit of LPG. We will have at least 500 million KTPA and we will also have propylene coming from the PFCC unit, which we are also trying to convert to polypropylene by having different units. It is a separate project, already approved and we will soon be on the ground there.

Q How are things shaping up for the hydrogen project? When is it expected to be commercialized?

We have already awarded a 17 megawatt electrolyzer to produce 2.5 KTPA of green hydrogen and it is expected to be rolled out in this calendar year. In terms of other major projects, we are also in the market, looking for a partner that will be producing around 10 KTPA of green hydrogen on a consistent basis. That tender is in the market and there are some discussions going up. We will be able to award the contract by the end of this year and expect it to get commissioned in either one year and a half or another two years.

Q With currently no large-scale production of hydrogen in the country, it is expected to pick up with implementation of large projects. What's your take on that?

Refinery is the best place to put up a hydrogen plant and 10 KTPA in a wider way is not a small one but a fairly large plant. This is just the beginning and once the prices come down, things will get accelerated further. When we started the journey, we were looking at a price of US$ 5 per kg and it has already come down to US$ 3.5 per kg. If the trend continues, we will go more aggressively and 10 KTPA can be doubled to 20 KTPA. When we have the new refinery coming, we will require close to 130 KTPA of hydrogen. A new refinery will roughly consume 1.5 per cent hydrogen. There is a lot of scope only in the refinery but again we have to be conscious of the cost being incurred. The delta is still very high with US$ 1 versus US$ 2.5. We will have to adopt some moderate pathway in the initial phase but if we see the prices coming down, we will immediately go for another capacity addition

NUMALIGARH REFINERY LIMITED
A GOVERNMENT OF INDIA ENTERPRISE
NRL

WORKING ON A BASKET OF PRODUCTS TO INCREASE OUR PRESENCE IN SPECIALTY CHEMICALS

We are fully committed to adopting a sustainable approach across our operations and building a more ESG-compliant business environment



NAVANIT NARAYAN
Wholetime Director & CEO
Haldia Petrochemicals

Q What role does Haldia Petrochemicals Ltd. (HPL) envision playing in the broader context of India's petrochemical industry expansion, and how does it plan to collaborate with other stakeholders to achieve these ambitious investment goals?

The growth of the Indian petrochemical industry is crucial considering it is generating raw materials for various end-use segments such as agriculture, infrastructure, pharmaceuticals, appliances, automobiles, textiles, packaging, construction etc. Integrated petrochemical complexes like HPL generate huge downstream value creation facilitating large investment and employment creation in downstream chemical and polymer processing. Growth of polymer processing in West Bengal is testimonial to success of such collaborative business models.

The large petrochemical industry landscape requires investment and collaboration at multiple levels to achieve self-sufficiency to meet growing demand from a large population base. To realize the goal of "Atmanirbhar Bharat" we need to invest in Plant, People and Processes and HPL is ready to collaborate and establish an ecosystem for our stakeholder which perpetuates the growth cycle for all. We have been very focused in our investment strategy to reduce the country's imbalance of niche chemicals and committed an investment of Rs. 5,500+ crore in India's first Integrated Phenol Complex. With our strong relationship with Lummus Technology and bonds created with technology leaders over the last 25 years, we intend to collaborate and invest to bring state-of-the art petrochemical technologies for niche applications in the Indian market.

We are dedicated to ensuring reliable and cost-effective material supply for our customers along with strong customer and business development support to facilitate large downstream investments in chemical and polymer processing. We have always been proactive in capacity building for human resources to meet growing demand of highly skilled manpower and would work closely with academia, industry bodies, government and other stakeholders to nurture and develop the talent pipeline needed to meet huge demand as we grow.

You would also appreciate that a positive policy framework is essential to achieve leapfrogging growth of the industry. We, along with industry peers, can collaborate with the government to develop an enabling policy framework which provides long-term competitiveness of Indian petrochemical industry on the global scale and thus realize the shared dreams of Atmanirbhar Bharat.

Q HPL's financial performance has experienced fluctuations, with operating profits impacted by declining tolling margins in recent years. Could you elaborate on the factors that influenced HPL's revenue performance during FY 2024-25 (so far) and what strategies were implemented to navigate these challenges?

The petrochemical industry is a typical commodity industry having cyclicity in industry performance. The current

financial performance is not typical of HPL and decline in profitability has been witnessed by almost all producers in Asia, Europe etc.

The major factor influencing current performance is significant capacity creations, especially in China whereas demand growth has been stagnant post covid in several parts of the world. Margins are squeezed globally from intense competition between global suppliers to reach the customer base. In India, we have also been adversely impacted by intense competition after commissioning of one of the largest plants in the country.

We have been very focused in our approach to manage the current downcycle. We have progressively moved to an enviable cost position for a naphtha-based producer in the country and the world. An organization-wide initiative, Project FEISTY (Focused EBITDA Improvement through Systematic Transformation) was undertaken to optimize conversion and logistics costs to ensure that the current downcycle is well managed. Apart from managing costs, we have also taken a focused approach to add new products and diversify the product basket with countercyclical margin products.

Q Can you provide an overview of HPL's capital expenditure initiatives undertaken in FY 2024-25, particularly focusing on any major projects or acquisitions? What's your plan for FY 2025-26?

We have initiated a Rs. 5,500 crore Capex plan for an integrated OCU-Phenol project, with a combined capacity of 560,000 TPA of phenol and acetone, through one of our step-down subsidiaries. We expect to complete the project in the first half of 2026. We are also evaluating several chemical downstream projects and expect to take final investment decisions soon.

Q In November 2024, HPL signed a license amendment with Lummus Technology to enhance the production capacity of its upcoming Phenol and Acetone Plant in Haldia, West Bengal. What strategic objectives does HPL aim to achieve with the expanded phenol and acetone production capacities, and how will this impact the domestic and international markets?

HPL through its subsidiary Adplus is planning to set up a state-of-the-art single location phenol manufacturing facility in India. This capacity expansion aligns with HPL's ambitious growth strategy and reflects the company's commitment to supporting India's chemicals industry. Our partnership with Lummus Technology has enabled the efficient design of India's largest integrated phenol plant. This expansion marks a major milestone for HPL, reinforcing our role in driving the nation's industrial growth and advancing its role in the production of vital



chemical intermediates.

Phenol project is an idea creating an ecosystem of phenol and acetone downstream which was not available in the eastern part of India. Now, such an ecosystem creates a lot of opportunities not only for us to grow but also for the other players to grow. We see the Phenol project to facilitate significant investment in the downstream segment, further improving the chemical industry ecosystem in West Bengal and the eastern region.

Q HPL recently entered into a significant 10-year naphtha supply agreement with QatarEnergy. What factors influenced HPL's decision to secure this long-term naphtha supply agreement with QatarEnergy, and how does it align with the company's strategic objectives?

HPL sources 50 per cent of its feedstock from the Middle East and relies on local refiners for the rest of its feedstock needs. Managing crude oil fluctuations and its impact on our feedstock prices remains a major challenge. The fluctuating crude prices due to various global factors have encouraged us to get into a strategic 10-year agreement (through its 100 per cent subsidiary, HPL Global Pte Limited, Singapore) with QatarEnergy, to secure long-term naphtha supply. Under this agreement,

"We have initiated a Rs. 5,500 crore Capex plan for an integrated OCU-Phenol project, with a combined capacity of 560,000 TPA of phenol and acetone, through one of our step-down subsidiaries"

QatarEnergy will supply a total of up to two million tons of naphtha to HPL over the next ten years, starting from the second quarter of 2024. This agreement is in line with our focused and innovative approach to secure long-term competitive advantage.

Q HPL announced plans to establish a polycarbonate production plant in West Bengal, with an estimated investment of over Rs. 8,500 crore. Could you elaborate on the factors influencing HPL's decision to venture into polycarbonate production, and what are the anticipated benefits for the company and the region?

We would like to reiterate our vision to create an ecosystem which will transform not only West Bengal but eastern and northeastern regions of India. Chemical downstream projects are one of the means to create that ecosystem. As a part of these, we are evaluating multiple opportunities including Polycarbonates which are entirely being imported in the country. These projects are synergic to our current and future chemical product basket. However, these are still in early stages of evaluation and would not like to assign any capex, timeline and benefits at this stage.

Q HPL is commissioning a specialty Low Molecular Weight (LMW) polymer project, expected to increase the topline of the specialty chemical business by about Rs. 100 crore per annum. What are the key applications and markets targeted by the LMW polymer project, and how does HPL plan to position itself as a leading player in the specialty chemicals segment?

Adplus, a step-down subsidiary of HPL inaugurated its state-of-the-art zero-waste LMW PE Wax manufacturing plant in Haldia in 2024. The products, under the brand "Polyfast", is providing benchmarked quality product to various industries such as plastics and rubber, bitumen roofing membranes, hot melt adhesives, paints, ink, toners, paper coatings, high altitude road surfacing, and even cosmetic and skin care products.

This is a small foray in the specialty chemical segment by the group. However, we are keenly evaluating and working on a basket of products to increase our presence in specialty chemical segments and expect to unveil our road map soon.

> **We, along with industry peers, can collaborate with the Government to develop an enabling policy framework which provides long-term competitiveness of Indian petrochemical industry on the global scale**

Q What digital transformation initiatives has HPL implemented recently to enhance operational efficiency and maintain a competitive edge in the petrochemical industry?

Digital transformation has played an integral role for us in building an ecosystem of trusted business stakeholders both internal and externally. HPL has adopted a multi-pronged approach for its digital journey towards process automation, reliability, troubleshooting and to improve operational efficiencies.

In a recent technological advancement initiative, we have introduced Real-Time Optimization (RTO) services for Naphtha Cracker Unit (NCU). This RTO system is supporting HPL's journey of achieving operational excellence through undertaking technology driven transformative programs aimed at process/ performance optimization.

An integrated RTO allows HPL to take full advantage of the plant's overall economic potential. The goal of RTO is to maximize the profit and excellence of the NCU functions and establish the target set points for the operating variables at which the profit is maximum.

Q How is HPL integrating sustainability into its operations and product offerings to address environmental challenges and contribute to a greener future?

We are committed to leaving no stone unturned in our endeavour of harbouring a sustainable approach in our operations and developing a more ESG (Environment, Social and Governance) compliant business environment. A dedicated ESG team is working diligently to develop and implement sustainable actions towards environmental conservation.
We have installed 1 MWp Solar Power Plant in December 2021. In terms of rainwater harvesting, we use more than 8, 74,356 m3 of rainwater (FY 23-24), thereby conserving the natural resources (fresh water). We are implementing several water recycle and reuse projects and progressing gradually towards Zero Liquid Discharge (ZLD).

With a total 1.25 Lac of trees in our greenbelt, we are planning to further increase the number of trees. In terms of clean technology, we are implementing Pipe Coal Conveyor to transport coal from port to plant to replace transfer through trucks.

India's Petrochemical Leap: The Making of a Global Powerhouse



Saugata Chaudhuri
Head - Petrochemicals
HPCL

> Over the past decade, India has strategically positioned itself for growth in both petrochemical consumption and production

Indian chemicals and petrochemicals segment contributes over 9 per cent to manufacturing Gross Value Added (GVA) and 7 per cent to total exports. It plays a catalytic role in reinforcing a country's growth. It contributes to 6 per cent of the country's GDP providing employment to over 5 million people. With the humble beginning Indian Petrochemicals industry, which started with the intention of mopping up naphtha by-products from petroleum refining, came a long way.

India's petrochemicals demand is underpinned by its accelerated economic expansion and large population. Petrochemical products are crucial in various industries such as automotive, packaging, textiles, construction, agriculture, and consumer goods. As India's middle-class segment continues to swell, the demand for plastics, synthetic fibres, and other petrochemical products is on the rise, making the domestic market an important driver for growth. India's share in the global chemical and petrochemicals market is projected to triple to 10-11 per cent by 2040. Growth is driven by rising disposable incomes, a favorable demographic dividend, change in lifestyle, Govt initiatives etc.

Building the Base: India's Roadmap to Petrochemical Leadership

For the last 10 years India has been positioning itself on a strategic platform of both consumption and production growth in the petrochemical segment. Indian Petrochemical's demand demonstrated an impressive CAGR of 6.5 per cent in the last 10 years. In addition to its ever-increasing consumption growth, India has emerged as a leading petrochemicals manufacturer also. In the last 5 years Indian Petrochemicals capacity inscribed a CAGR of 4.5 per cent. India has added considerable capacity in some of the key petrochemical products like, Polyethylene, Polypropylene and Paraxylene. With the steady capacity addition India's self-reliance on many petrochemical products are becoming more conspicuous.

The global trend, emerged in recent past in a refining ecosystem is the strategy of integration. India is no exception. Indian refineries have been expanding and diversifying into petrochemicals segments, aiming to make Refining assets more profitable, especially in a fast-changing global energy marketplace and stressed demand of traditional refined products of oil. Going forward, the philosophy of refinery integration to Petrochemicals is going to be augmented with several investment plans in place. With Diesel &

India's share in the global chemical and petrochemicals market is projected to triple to 10-11 per cent by 2040. Growth is driven by rising disposable incomes, a favorable demographic dividend, change in lifestyle, Government initiatives etc.

Petrol consumption expected to wane, maximization of crude conversion to Petrochemicals will make more economic sense in coming decades. Indian oil companies are focusing to seize on the trend. All the 22 Refineries across India are contemplating forward integration to petrochemicals through unleashing synergies between Refinery and Petrochemicals units through refinery stream sharing and utilities systems.

Close to Rs. 9-10 lakh crores (~100 bn USD) of new investments are in the pipeline in the petrochemical segment. These new investments, upon fructification, will not only meet the surging petrochemical demand in the country but will substantially contribute towards realizing India's vision of a US$ 5 trillion economy. Through these investments Indian capacity will grow from current 35 MMT to 48 MT by 2030, a stupendous 7 per cent CAGR making up more than 10 percent of global petrochemical capacity growth. Other than classical products like Polyethylene (PE), Polypropylene (PP), Polyvinyl Chloride (PVC) and Benzene these investments will feed Indian market with indigenously produced wide range of specialty products like IsoPropyl Alcohol (IPA), Phenols, Polycarbonate, Acrylic Acids, Esters etc.

Besides robust domestic demand and rapid capacity addition, other key imperatives have also been actualizing Indian growth prospects in the Petrochemicals industry. Few examples are as follows:

- **Government Initiatives:** Numerous strategic efforts, espoused by Indian Government to enhance self-sufficiency, have resulted in an unprecedented surge in the industry's market value. Policy reforms and incentive schemes like Remission of Duties and Taxes on Exported Products (RoDTEP), Production-Linked Incentive (PLI), Chemical Promotion and Development schemes (CPDS) along with initiatives like Petroleum, Chemicals and Petrochemical Investment Region (PCPIRs), setting up Plastic Parks and Centre of Excellence (CoEs) are contributing significantly towards the industry growth. The new PCPIR rule, which is to be executed by 2035, can spur on huge investments to the tune of more than Rs. 34 lakh crore (~400 Bn USD).



- **Evolving Supply Chains Infrastructure:** Supply chain is the backbone of commerce and plays a crucial role in the success of businesses across the world, irrespective of the sectors & segments. The logistics sector in India is rapidly expanding. In the 7th edition of the Logistics Performance Index (LPI 2023), India jumped 6 places to Rank 38 out of 139 nations in the World Bank's logistics ranking. The Union Budget for 2024-25 has taken a "monumental stride" towards positioning India as a global logistics powerhouse as it focuses on infrastructure development, leveraging technology and supporting MSMEs.

- **Digitalization:** It is estimated that nearly every aspect of work will be optimized by data by 2030. Digitalization is at full tilt in Indian Petrochemicals industry. Digital transformation is sweeping across Indian industries. The Indian Petrochemicals industry is embracing it swiftly for multiple purposes. Plant Reliability is one of the key imperatives of operation excellency. The ML driven Digital Twin and Predictive maintenance (PdM) are being used to provide a real-time look into the asset operation and help improve Reliability and Plant tracking by the petrochemicals industry. Various downstream industries are practicing smart manufacturing through integration of Industrial Internet of Things (IIoT) resulting in less wastage, better yields and hence better customer satisfaction.

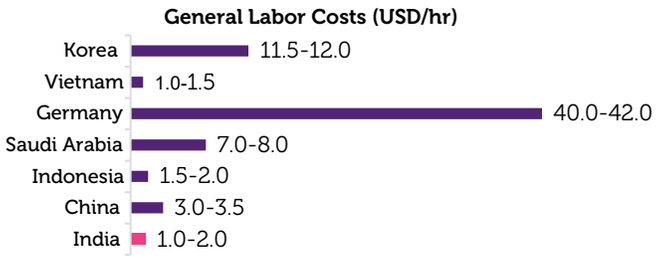
- **Easy access to cheap labour:** 1-2 USD/hr compared to 3-3.5 USD/hr in China, 11.5-2 USD/hr in South Korea and 40-42 USD/hr in Germany

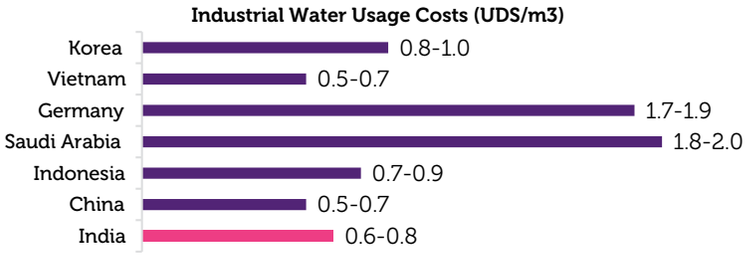
- **Competitive Utility cost:** 0.6 USD/m3 in India compared to 0.7 USD/m3 in China, 1 USD/m3 in S Korea and 1.9 USD/m3 in Germany

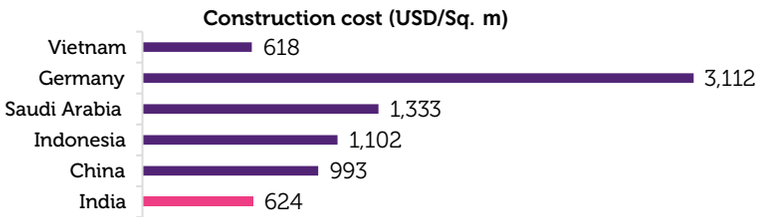
- **Construction cost:** 624 USD/Sq. m compared to 993 USD/Sq. m in China, 1,130 USD/Sq. m in S Korea and 3,112 USD/Sq. m in Germany

- **Corporate tax rate:** 25 per cent compared to 25 per cent in China, 28 per cent in S Korea and 30 per cent in Germany

- **Ease of doing business:** Prominently positioned in Protecting Minority Investors (Rank #13),









Data Source: IMF, DCPC, Turner & Townsend, World Bank and, CEIC

Getting Electricity (Rank #22), Getting Credit (Rank #25), Dealing with Construction. Permits (Rank #27)

- **Global opportunity:** With rising production cost in China and imposed higher tariff by US to China and Vietnam, India has proficiency to fill the gap, which market would look for as alternative. Buyers' China+1 strategy can be capitalized by Indian manufacturers over the medium term.

- **Sustainability and Circularity:** Responsible growth thrives on practices. Doing well and doing good are intertwined and hence successful business strategies encompass both. The cohort of Indian Petrochemicals manufacturers have the proclivity for sustainability and circular economy, the most important pathway leading to net zero contribution. These are evinced by several strategic initiatives taken by Government and Indian manufacturers. From a regularity perspective EPR & use of PCR are the obvious ones, which are already implemented. Through a high percentage of recycling, India is well placed for mechanical recycling. Few manufactures have started Chemicals recycling through Pyrolysis of flexible packaging waste. Indian Petrochemical companies are also in process of deploying blockchain technology to increase transparency to plastic recycling processes by creating a shared, secure ledger that would contribute to increasing recycling rates and promote a circular plastic economy.

Can India Seize the Global Spotlight?

India has a muscular foundation to potentially become a formidable player in the petrochemical sector. India's proliferation of domestic demand, Government initiatives, infrastructure improvement, technological advancement, digital metamorphosis, increasing production capabilities, strategic investments coupled with low manufacturing costs, skilled workforce and other favourable imperatives provide distinct advantages in the global petrochemicals value chain. All these factors brought the country at tipping point at which growth is irreversible unleashing immeasurable opportunities through building resilience and seizing the moment. Consequently, India has strengthened its position as a competitive global Petrochemicals hub creating an international heft

Over the past 5 years, India's petrochemical capacity grew at a 4.5 per cent CAGR, with significant additions in key products like polyethylene, polypropylene, and paraxylene—strengthening the country's self-reliance

FERTILIZER

Making India Self-reliant



GREEN SHOOTS: FERTILISER INDUSTRY GEARS UP FOR THE NEXT GROWTH PHASE IN INDIA

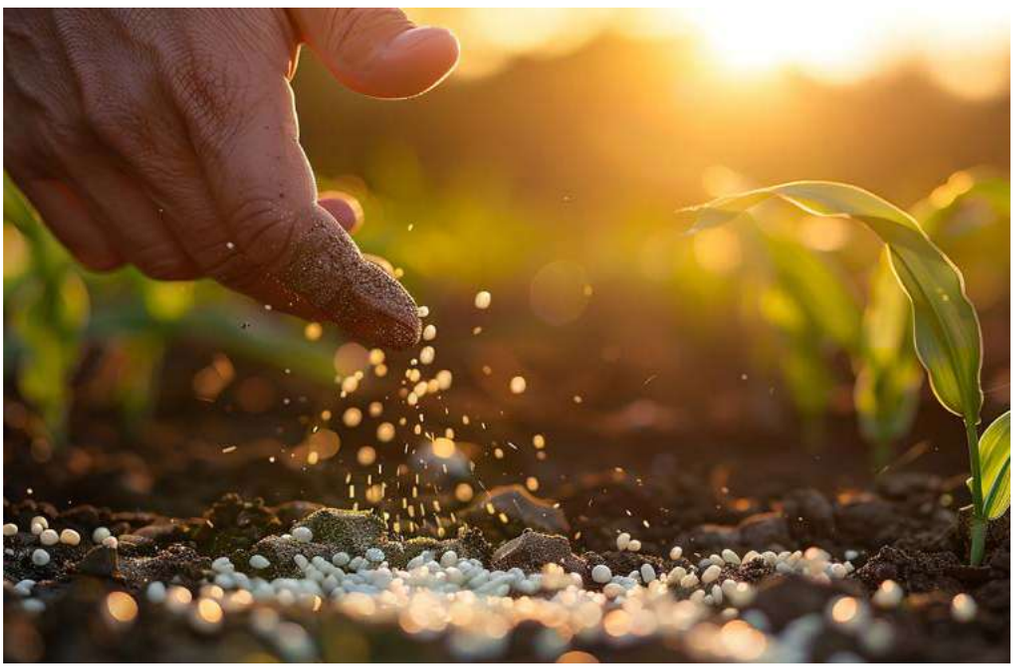
Industry's growth is driven by increasing agricultural productivity needs, and a shift towards sustainable farming practices

TEAM ICN

In India, the fertilizer industry is a key pillar supporting agriculture, an essential driver of the country's economy and food security. Valued at around US$ 10.8 billion in 2024, the sector is projected to reach US$ 14 billion by 2030, growing at a CAGR of 4.2 per cent. This growth is fueled by rising demands for higher agricultural productivity, government support for domestic fertilizer production, and a growing emphasis on sustainable farming practices, including the use of bio-fertilizers.

Consumption patterns reflected a modest growth, with total fertilizer consumption reaching 64.84 MMT, marking a 1.6 per cent increase from the previous year. Urea remained the predominant fertilizer consumed at 35.78 MMT, a slight rise of 0.2 per cent. DAP consumption increased by 3.8 per cent to 10.81 MMT, and NP/NPK complex fertilizers saw a 9.9 per cent uptick to 11.07 MMT. However, SSP consumption declined by 9.4 per cent to 4.54 MMT.

In 2024, the Indian fertilizers industry experienced several significant developments across production, consumption, imports, technological advancements, and policy initiatives. Total fertilizer production reached approximately 41.8 million metric tons (MMT), with urea production increasing by 4.7 per cent and NP/NPK complex fertilizers witnessing a substantial 20.7 per cent rise compared to the previous year. Conversely, the production of Di-Ammonium Phosphate (DAP) and Single Super Phosphate (SSP) declined by 40.9 per cent and 30.8 per cent, respectively.



On the import front, India imported fertilizers worth over Rs. 86,500 crore in the fiscal year 2024, primarily comprising manufactured fertilizers. Notably, from April to December 2024, fertilizer imports totaled 23.54 MMT, a decrease from 25.56 MMT during the same period in the previous year. Paradip Port emerged as the leading hub, handling 5.13 MMT of these imports.

Major Developments

The fertilizers industry in India has been undergoing a series of strategic developments aimed at strengthening self-reliance, improving efficiency, and ensuring sustainability. One of the key developments is the government's continued thrust on the revival of urea plants under the New Investment Policy (NIP) and the 'Atmanirbhar Bharat' initiative. Several dormant public sector fertilizer units have been revived, including the Gorakhpur and Ramagundam plants, with new projects also underway in Sindri and Barauni. These efforts aim to reduce India's dependence on urea imports, which still account for a significant portion of domestic consumption.

There has also been a strategic shift toward balanced nutrient management, with the government promoting the use of alternative fertilizers like nano urea and bio-fertilizers. IFFCO's commercial rollout of nano urea and plans for

Fertilizer Footprint Expands in India

Potential Areas	Key Highlights
Large Domestic Demand	India ranks among the top consumers of fertilizers globally Consistent agricultural activity drives year-round nutrient demand
Government Policy Support	Fertilizer subsidies ensure affordability for farmers Initiatives like DBT and NBS streamline distribution and payments
Domestic Production Growth	New and revived plants under Atmanirbhar Bharat Rising urea and NP/NPK output reduces import dependency
Technological Advancements	Launch of nano urea and nano DAP improves efficiency Adoption of automated and energy-efficient manufacturing technologies
Strong Private Sector Role	Leading companies expanding capacity and supply chains Investments in backward integration and sustainability projects
Robust Distribution Network	Over 250,000 retail outlets across rural India Mix of cooperatives, private players, and digital platforms ensures accessibility
International Collaboration	Import agreements with countries like Morocco, Russia, Jordan Joint ventures secure long-term supply of raw materials like rock phosphate
Focus on Sustainability	Growing use of bio-fertilizers and eco-friendly inputs Government and industry promoting balanced nutrient management and soil health improvement

setting up new production units have garnered significant attention. This innovation is seen as a game changer for reducing excessive urea usage, improving soil health, and cutting down subsidy costs.

On the policy front, the introduction of the Direct Benefit Transfer (DBT) system in fertilizers has improved transparency and reduced leakages in subsidy disbursement. The government has also announced the "One Nation One Fertilizer" scheme to streamline branding and prevent duplication, though it has received mixed reactions from private players.

Private sector involvement is increasing, with companies like Coromandel International and Chambal Fertilizers expanding their capacity and investing in backward integration projects to secure raw material supply. The exploration of joint ventures abroad, particularly in Morocco, Jordan, and Russia for sourcing phosphatic and potassic fertilizers, continues to be part of India's long-term strategy to secure its nutrient needs.

Digitization and automation across the supply chain, from manufacturing to retail distribution, have also gained momentum. Companies are investing in technology to ensure better demand forecasting, real-time inventory management, and improved farmer outreach through mobile platforms and digital advisory services.

In terms of environmental responsibility, there is growing emphasis on sustainable practices. The industry is aligning with global ESG norms by adopting energy-efficient technologies, reducing carbon footprints, and enhancing water management practices within fertilizer production units.

Increased R&D Push

India's fertilizers industry is experiencing a wave of innovation driven by the latest research and development efforts focused on sustainability, efficiency, and self-reliance. A major breakthrough is the commercialization of nano fertilizers, particularly nano urea and nano DAP, spearheaded by the Indian Farmers Fertiliser Cooperative Limited (IFFCO). These nano variants, delivered in liquid form, significantly enhance nutrient uptake while reducing the volume of fertilizer required per acre, thereby cutting costs and environmental load. As of mid-2024, nearly 755 million bottles of nano urea and 69 million bottles of nano DAP have been utilized by farmers across the country, reflecting growing acceptance. IFFCO has also expanded its production targets to 400 million bottles of nano urea plus and 200 million bottles of nano DAP for FY 2024-25.

Efforts to decarbonize urea production are also underway, focusing on transitioning to renewable ammonia as a feedstock. This shift aims to reduce greenhouse gas emissions associated with traditional urea manufacturing processes, aligning with global climate



goals and promoting sustainable agricultural practices. In parallel, public and private sector players are investing in R&D for bio-fertilizers, slow-release nutrient technologies, and customized soil health-based formulations. Collaborations with research institutes and agri-tech startups are also enabling the integration of AI, remote sensing, and precision farming tools to align fertilizer use with specific crop and soil needs. These developments signal a strategic shift in India's fertilizer ecosystem from volume-driven production to innovation-led efficiency and environmental responsibility.

Policy Interventions

Government policies have significantly influenced the industry, particularly through subsidies and support for domestic production. Initiatives aimed at reducing import dependency and enhancing self-sufficiency have led to investments in new urea plants and the promotion of alternative fertilizers. Additionally, the government's focus on balanced nutrient management and sustainable agriculture has encouraged the use of organic and bio-fertilizers. Subsidies for phosphatic and potassic fertilizers, along with investments in new urea plants, aim to enhance domestic production capacities and reduce import dependencies. Furthermore, the promotion of balanced nutrient management and sustainable agriculture practices is encouraging the adoption of alternative fertilizers.

Policy initiatives also played a crucial role in shaping the industry. In December 2024, the Indian government approved a subsidy of Rs. 73,100 crore (approximately $860 million) for phosphatic and potassic (P&K) fertilizers for the financial year 2024-25, aiming to ensure affordable access to these vital inputs for farmers. Additionally, the government announced plans to invest Rs. 10,000 crore to establish a new urea plant, further bolstering domestic production capacity and reducing import dependency.

Despite these positive developments, the industry faces challenges such as fluctuating raw material prices, environmental concerns related to the overuse of chemical fertilizers, and the need for infrastructure improvements in storage and distribution. Addressing these issues is crucial for ensuring the long-term sustainability and efficiency of the fertilizer sector in India.

Elusive Challenges

The fertilizers industry in India, while critical to the nation's food security and agricultural productivity, faces a number of structural and operational challenges that impact its efficiency, sustainability, and long-term growth. One of the foremost challenges is the heavy dependence on imports for

raw materials and finished fertilizers, particularly phosphatic and potassic varieties. Despite efforts to boost domestic production, India remains vulnerable to global price volatility and geopolitical disruptions in supply chains, which in turn affect pricing and availability for farmers.

Another persistent issue is the growing fiscal burden of fertilizer subsidies. While these subsidies are crucial to ensure affordability for farmers, they place a significant strain on the government's finances. In recent years, the fertilizer subsidy bill has escalated sharply, and efforts to reform the subsidy structure—such as the introduction of the Direct Benefit Transfer (DBT) system—have met with mixed success. Additionally, the pricing imbalance caused by urea being heavily subsidized compared to other nutrients has led to imbalanced fertilizer use, resulting in declining soil health and reduced agricultural efficiency.

The industry also grapples with aging infrastructure in several public sector units, which affects production efficiency and increases operational costs. Though modernization programs have been initiated, progress is often slow due to bureaucratic hurdles and regulatory delays. Technological adoption in manufacturing and distribution remains uneven across the sector, with private players moving faster on digital integration than their public counterparts.

Environmental concerns have increasingly come to the fore. Excessive and unbalanced use of chemical fertilizers, particularly urea, has led to soil degradation, water contamination, and greenhouse gas emissions. While the government is promoting the use of bio-fertilizers and introducing innovative solutions like nano urea, widespread adoption remains limited due to lack of awareness, training, and distribution infrastructure among farmers.

Another challenge is the logistics and distribution network, especially in remote rural areas. Fertilizer supply is often delayed due to inadequate warehousing and inefficient last-mile delivery mechanisms, particularly during peak agricultural seasons. This not only disrupts crop cycles but also leads to hoarding and price manipulation at the retail level.

Policy uncertainties and regulatory complexities further complicate the operating environment. Frequent changes in import duties, subsidy formulas, and compliance requirements create ambiguity for both domestic producers and importers. Moreover, delays in subsidy reimbursements and lack of clarity on long-term policy direction inhibit private sector investments and innovation in the industry.

BOTTLENECKS

High Import Dependence – Especially for phosphatic and potassic fertilizers

Rising Subsidy Burden – Significant strain on government finances.

Soil Imbalance – Overuse of urea leads to nutrient imbalance and soil degradation

Delayed Subsidy Payments – Impacts cash flow of manufacturers and retailers

Logistics Issues – Inefficiencies in last-mile delivery and storage

Environmental Concerns – Fertilizer runoff causes pollution and water contamination

Low Adoption of Alternatives – Limited use of bio-fertilizers and nano variants

Farmer Awareness Gaps – Lack of knowledge on balanced fertilizer use

Growth Projections Remain Optimistic

The Indian fertilizers industry is poised for substantial growth in the coming years, driven by factors such as increasing agricultural productivity, government initiatives, and a shift toward sustainable farming practices. Projections indicate that the market size, valued at approximately US$ 10.8 billion in 2024, is expected to reach US$ 14 billion by 2030, reflecting a compound annual growth rate (CAGR) of around 4.2 per cent. Other analyses suggest a more accelerated expansion, with the market potentially growing from US$ 43.54 billion in 2024 to US$ 74.06 billion by 2033, at a CAGR of 6.08 per cent.

Urea fertilizers are projected to maintain their dominance in the market due to their critical role in nitrogen supply and the government's subsidy support, which enhances affordability for farmers. Additionally, the specialty fertilizer segment, including products like bio-fertilizers and nano-fertilizers, is expected to experience significant growth. The specialty fertilizer market is anticipated to reach US$ 1.77 billion by 2030, growing at a CAGR of 6.80 per cent from US$ 1.27 billion in 2025.

The Indian fertilizers industry is on a growth trajectory, supported by favorable market dynamics and policy interventions. The focus on increasing domestic production, promoting sustainable practices, and enhancing efficiency is expected to drive the industry toward a more resilient and self-reliant future

BOOSTING CAPACITY THROUGH OPERATIONAL EXCELLENCE & EXPANSION

In 2025, we aim to optimize production, expand our reach, and advance initiatives to boost India's urea self-sufficiency



SIBA PRASAD MOHANTY
Managing Director
Hindustan Urvarak & Rasayan

Q How do you see the future of the fertilizer industry in India and globally?

The fertilizer industry is at a pivotal juncture, with increasing global demand for food and the necessity to grow sustainably. In India, the focus is on achieving self-reliance in urea production, promoting the balanced use of fertilizers through initiatives like PM-PRANAM, reducing dependency on imports, and enhancing agricultural productivity. Globally, the fertilizer sector will increasingly align with sustainable practices, integrating technology, renewable energy, and circular economies. A shift towards organic fertilizers, improved resource management, and eco-friendly production will shape the industry's future while addressing its environmental impact.

Q What challenges is the Indian fertilizer industry facing and what solutions would you suggest?

The industry faces several challenges: heavy reliance on imported raw materials (such as natural gas and phosphatic raw materials), aging plants, and environmental concerns about emissions. The solutions lie in increasing domestic production, reducing dependency on imports, and embracing technologies that boost efficiency. Incorporating organic fertilizers and promoting balanced use in line with PM-PRANAM can help reduce environmental pressures while enhancing productivity. Strengthening infrastructure, ensuring policy reforms, and integrating sustainable agricultural practices will be crucial to addressing these challenges.

Q How has the overall performance of HURL been in 2024, and what are your expectations for 2025?

In 2024, HURL demonstrated robust performance, with our plants in Sindri, Gorakhpur, and Barauni operating at near-optimal capacity. We've strengthened our commitment to sustainability, energy efficiency, and operational excellence. Looking ahead to 2025, we aim to further optimize production, expand our footprint, and roll out key initiatives to increase India's self-sufficiency in urea. We will continue working on enhancing capacity, reducing dependence on imports, and promoting the balanced use of fertilizers to support Indian agriculture.

Q What is the current production capacity and capacity utilization of HURL plants, and what are your goals?

HURL's plants have an installed capacity of 2,200 MTPD of ammonia and 3,850 MTPD of neem-coated urea, totaling 1.27 MMTPA of annual production. We are consistently working towards achieving 100 per cent capacity utilization to ensure consistent delivery that meets growing domestic demand. Our goal is to increase this capacity, particularly through operational excellence and expanding production facilities, while maintaining a focus on the balanced use of fertilizers and sustainability.



Q HURL is working on a mega Rs. 3,000 crore expansion plan. What is the latest development on this?

We are actively exploring the manufacturing of Nano fertilizers, Ammonium Sulphate, and NPK as part of this expansion.

Q HURL is also planning to set up a new urea unit in Assam. Could you please share more details about this?

HURL is set to participate in a proposed joint venture to establish the Namrup IV fertilizer plant, an ammonia-urea complex in Namrup, Assam. The project aligns with the government's budget announcement and aims for an annual production capacity of 12.7 lakh tonnes of urea. HURL's board has approved a 13 per cent equity stake in this venture. This new plant will leverage the abundant natural gas resources in the region, improving fertilizer availability in Northeast India, reducing transportation costs, and contributing to meeting domestic fertilizer demand. It will also support India's goal of reducing dependency on imported fertilizers, further enhancing the country's self-reliance in urea production.

Q How can HURL contribute to India's self-sufficiency in urea production while maintaining profitability?

HURL is committed to increasing domestic urea production to reduce reliance on imports, thus contributing to self-sufficiency. By focusing on improving plant efficiency, utilizing energy-efficient technologies, and promoting the balanced use of fertilizers (as outlined in PM-PRANAM), we can offer cost-effective, environmentally friendly fertilizers. Our future expansion projects and ongoing technological advancements will allow us to meet domestic demand while remaining profitable and fulfilling national agricultural needs. Currently, HURL contributes around 4 million MT annually, a significant contribution toward India's self-sufficiency.

Q How do you plan to manage costs and optimize supply chain efficiency?

Cost management will be driven by leveraging cutting-edge technologies such as automation and AI-basedW predictive maintenance. Optimizing supply chain will involve strengthening relationships with local suppliers, ensuring efficient logistics, and reducing transportation costs.

Q What strategies would you implement to ensure HURL remains competitive in a changing regulatory and environmental landscape?

HURL's competitiveness will be driven by continuous innovation, strict adherence to regulatory compliance, and active investment in the latest technologies. By emphasizing sustainable agricultural practices, we will ensure our production aligns with environmental goals. We will also work with the government and stakeholders to shape favorable policies and adopt renewable energy sources, keeping us ahead of regulatory changes while promoting a circular economy. Additionally, HURL is diversifying its product portfolio.

Q How should HURL approach sustainability and environmental responsibility in fertilizer production?

Sustainability is foundational to HURL's operations. We're committed

> **We will continue working on enhancing capacity, reducing dependence on imports, and promoting the balanced use of fertilizers to support Indian agriculture**

HURL is set to participate in a proposed joint venture to establish Namrup IV Fertilizer Plant, an ammonia-urea complex in Namrup, Assam

to reducing emissions, improving energy efficiency, and integrating renewable energy sources. Our plants are designed with cutting-edge waste management and carbon reduction strategies, ensuring we meet the highest environmental standards while contributing to India's green growth through the lowest energy consumption, CO2 emissions, and tree plantation initiatives.

Q What initiatives would you introduce to reduce the carbon footprint and improve green manufacturing?

To reduce our carbon footprint, we are focused on improving plant energy efficiency. We are also closely monitoring government policies on green energy and examining ways to integrate them into our operations.

Q How can HURL leverage AI, automation, and IoT to improve efficiency?

AI, automation, and IoT offer immense potential to streamline our operations. By implementing AI for predictive maintenance and utilizing IoT for real-time monitoring, we can significantly improve operational efficiency, reduce downtime, and optimize resource management. These technologies will also help reduce waste, improve fertilizer efficiency, and contribute to more sustainable production processes.

Q What strategies would you use to strengthen partnerships with farmers and distributors?

HURL's focus on building strong, lasting relationships with farmers and distributors will involve training programs, field days, and digital platforms to provide farmers with better insights into fertilizer use and sustainable practices. By integrating organic options and balanced fertilizer use under PM-PRANAM will help farmers enhance soil health while improving crop productivity. Strengthening the distribution network and ensuring timely deliveries will also be a focus to ensure seamless access to fertilizers.

Q HURL and CIPET have signed a MoU for skill development. How is this program progressing?

The skill development initiative under the SAKSHAM program is progressing very well. HURL is working closely with CIPET to train the next generation of skilled workers in the fertilizer sector, focusing on technical expertise and safety standards. Through this collaboration, HURL aims to train a total of 320 youth across its operational areas, including Gorakhpur, Barauni, and Dhanbad. The program is designed to bridge the skill gap and provide vocational training that will enhance employability and support the growth of HURL and the wider fertilizer industry. This partnership is crucial to ensuring that our workforce remains competitive



and adaptable to future technological advancements.

What is your vision for HURL in the next five years?

Over the next five years, HURL aims to be a leader in India's fertilizer industry, known for its commitment to sustainability, innovation, and reducing import dependency. Our focus will be on increasing capacity, integrating green practices, and supporting balanced fertilizer use in line with PM-PRANAM. HURL will work to become a key player in sustainable agricultural growth while continuing to innovate in both production and distribution, ultimately benefiting farmers, communities, and the environment.

Would you like to add anything from your side?

At HURL, we see our growth not just as a company but as a vital part of India's journey toward agricultural sustainability and self-reliance. As we embrace the future, we remain committed to driving positive change through technology, sustainability, and partnerships that empower farmers and local communities. By focusing on balanced fertilizer use, environmental responsibility, and continuous innovation, we will contribute to the nation's agricultural resilience and help build a greener, more prosperous India

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