Business Development Manager

Not only product supplier but also Solution provider

## **Corrosion Resistance Alloys**

**Tube Choice Matters** 

# **Alleima**

## Safety first

At Alleima our objective is zero harm to our people, the environment we work in, our customers and our suppliers.



Protective equipment



**Emergency number** 



Psychological safety



First aid kit



**Emergency** exit



Alarm







Health & well-being



Speak Up

### Our proud history

### 1862

Founded in Sandviken The Bessemer process makes it possible to produce steel on an industrial scale



## 1924

Stainless Tubes The first seamless tubes made of stainless steel are introduced in the market





SAF™ 2507 superduplex umbilical tubes for deep-water oil extraction were introduced.



### 1997

Acquisition of Kanthal Kanthal acquired to supplement the product offering with products for industrial heating and resistance materials

KANTHAL

2012

New tube mill A new state of the art tube mill for steam generator tubes for nuclear power was inaugurated and opened for operation in Sandviken, Sweden.

### 2019

2018

profitability

Acquisition of Thermaltek A manufacturer of high temperature furnace systems and metallic heating elements

### 2021 Acquisition of

Accuratech Group A niched medical wire forming and component manufacturer

### Listed Company Alleima is carved out of Sandvik and becomes a

2022

publicly listed company Acquisition of Gerling A precision tube engineering company

### 1880

Leading Supplier Becomes a leading supplier of cold rolled strip steel and flat wire

1921

1888

Seamless Tubes

Started supplying the

seamless steel tubes

new power industry with

**High-Strength Steel** High-strength steel developed for oil sources located at great depth in difficult conditions

### Stainless Steel Production start. Already then, scrap from our own production was remelted in the new induction furnace

# 1975

1985

### **Duplex Material** The first duplex

material. SAF™ 2205 made it possible to extract oil in the North Sea (~100m)

### 2010

**High-Temperature** Materials Introduces a full range of materials in iron-chromiumaluminum (FeCrAl) and nickel-chromium (NiCr) alloys that withstand high temperatures



## 2020

Acquisition of Summerill **Tube Corporation** A manufacturer of high precision tubes

**Divestment of Wire** Alleima completes the divestment of its Wire business, improving

Acquisition of Custom Electric Manufacturing A manufacturer of original equipment and replacement heating elements

### World-class capabilities

### Sandviken, Sweden One of Sweden's largest industrial sites in terms of ground area with c. 2,500 people working for Alleima

 Primary melting and hot rolling

(3 extrusion presses)

— Hot extrusion

- Tube mills (Seamless tube and pipe, steam generator tubing, Zirconium tubing)
- Rock Drill Steels
  Precision Strip
- Precision S
- R&D

Sales in

90 markets

R&D centers

27

40+ sales offices

production sites across the globe

 Global presence and proximity to customers;
 ~5,500 employees

- Creating flexibility and back-up
- Enabling specialization

## 7

## Sustainable steel



We aim to include sustainability in every aspect of our business.
For us that means integrating sustainability throughout the entire value chain – from research to final product. At the Alleima site in Sandviken, we use electricity made from

100%

fossil free sources

Over



of the material used in our products originate from recycled scrap

### Life Cycle Assessment (LCA)

- Supporting our customers on their journey to reduce their carbon emissions.
- LCA is quantification of carbon footprints from raw material to end product.



### Long term sustainability targets

- SBTi: Net Zero latest by 2050
- Reduce Scope 1 and 2
   CO<sub>2</sub> emissions with more than 50% by 2030
- 83% recycled steel in finished products by 2030
- 76% waste circularity, excluding slag by 2030
- Research, test and implement projects in order to move slag to circular waste streams

### A premium product offering

As a world-leading developer and manufacturer of advanced stainless steels and special alloys, as well as solutions for industrial heating, we make industrial processes more efficient, profitable and sustainable.



Heating technology 17%





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### Advancing industries through materials technology



### Industrial

Alleima

- Solid round bar and hollow bar
- High pressure tubing
- Composite tubing
- Wear resistance strip



Chemical and petrochemical

- Fertilizer tubing
- Hydraulic and instrumental tubing
- Heat exchanger tubing



Oil and gas

- Umbilical tubing
- Control lines
- Oil Country Tubular



Industrial heating

- Metallic heating elements
- Ceramic heating elements
- Radiant Kanthal® APM / Kanthal APMT® tubes
- Diffusion cassettes



Consumer

- Compressor valve steel
- Stainless knife steel
- Razor blade steel
- Appliance wire



Power generation

- Steam generator tubes
- Cladding tubing
- Nuclear tubes and pipes
- Strip steel spacers



Mining and construction — Rock drill steel



- Transportation
- Titanium and stainless steel tubes
- Gasoline Direct Injection (GDI) tubes
- Compressor valve steel
- Shock absorber steel



- Medical
- Medical precision wire
- Medical tubing
- Medical strip



Hydrogen and renewable energy

- Coated strip steel for fuel cells
- High pressure tubing for hydrogen applications
- High nickel alloy tubing for concentrated solar power applications

# Materials innovator and technology leader

- R&D team focused on evolutionary refinements, expansion of existing portfolio as well as product innovation to capitalize on the on global mega trends
- Scope of R&D objectives extends beyond products unique ability to innovate along whole value chain, incl. process and manufacturing



## How we win, today and tomorrow

Customer partnerships Relationship with academia

Shared R&D platforms

Application specific R&D

Products focusing on growth industries Defend core

Widen materials portfolio

# Active recepies >900

pies # Patents ~850

# FTE:s Dec 2021 **230** 

1 R&D % sales '19-21 **1.5%** 









Megawatt process gas heater, which is developed to heat hydrogen up to 1,000 degrees Celsius

Next generation of compressor valve steel. Freeflex is a hardened and tempered martensitic stainless compressor valve steel alloyed with copper.



New super austenitic high strength steel with high structure stability to simplify welding and heat treatment.

### Examples of new products



## Fully integrated value chain

Control of the supply chain from R&D to final product.

- Ensure independence
- Industry-leading technology
- Secure product quality
- Prerequisite for new materials and product development

Customer need identification



Research & Development



**Primary Melting** 



Hot Working



Cold Working



Finishing



Sales & Marketing

## $\mathbf{\lambda}$

# 2 Tube Manufacturing

Alleima Document title

| 11

## Hot extrusion

- Latest Technology
- Impurities from core removed with 20% loss of material ensures defect free product
- Lubrication in ID & OD during extrusion, results in low friction.
- Induction heating of billet results in negligible scaling.
- Compression forces resulting in fine grain defect free micro structure.
- Uniform thickness through the length.

## Hot piercing

- Older method
- No Material removal hence more defect on ID
- Difficult to process high alloyed grades/high deformation resistance
- No Lubrication between mandril and billet results in high friction causing wear & tear on mandril.
- Gas fired rotary furnace heating resulting in heavy scaling, carburization and sulfer impregnation.
- Shearing forces results in cracks & lamination in ID
- Higher time in piercing might result in temperature drop of billet during process and defect creation.
- Thickness variation though out the length.





Figure 2: Mannesmann process





Figure 11: Accelerated plug wear



Defect from Production – Piercing method

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# Nine steps towards a clean conscience

### KEY BENEFITS

- No issue with dirty tubes
- Avoid costly shutdowns
- Interior free of scale and contamination
- Reduced risk of system failure or unplanned maintenance
- Protects against malfunctioning pumps, filters, valves and actuators



# 25 YEARS AS THE WORLD-LEADING MANUFACTURER OF UMBILICAL TUBING

We have supplied 122 million meters (400 million feet) of umbilical tubing with zero failures and 99% on-time delivery - enough tube to circle the world three times.

PU Mehsana has supplied mother hollows for half of this quantity since 2004.





 Once in operation can not be stopped for min 10 years
 Subjected severe conditions

WHAT IS AN UMBILICAL?

An umbilical is a crucial connection between the surface and the well head of a sub-sea oil or gas well. Through the bundled and encapsulated stainless steel tubes, different type of fluids control a variety of functions down on the well head.

## Entire nickel and special alloy portfolio produced in India Melt-to-Finish Tube + Delivery + Reliability



All austenitic stainless steel and duplex stainless steel are standard manufacturing products.

# 3 Corrosion

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### Corrosion Common challenges in heat exchanger

Heat exchangers are subject to numerous numbers of different corrosion mechanisms, but the most common are:

### **General or uniform corrosion**

- Nitric acid (HNO<sub>3</sub>)
- Hydrochloric acid (HCl)
- Sulfuric acid  $(H_2SO_4)$
- Caustic (NaOH or KOH)
- Formic acid (CHOOH)

### **Pitting corrosion**

- Shell side of tubes is more common than the tube side.
- Tube to tube sheet weld joint.

### **Crevice corrosion**

— Mainly a problem at gasket between header and tube sheet.

### **Under deposit corrosion**

Solid salts or fouling on tube surfaces.

### **Erosion-corrosion**

- Fluid flow causes erosion.

### Stress corrosion cracking (SCC)



## Solution to specific problem

### **APPLICATION SPECIFIC GRADES**

Grade	Application
Alleima 2RE10	Nitric Acid
Sanicro 35	Speciality Chemical /Sea Water Application /Soda Ash Plant / Versatile Grade
Alleima SX	Concentrated Sulfuric acid
Sanicro 28	Phosphoric Acid
Alleima 2RE69	Urea carbamate Condenser / MPDC
Alleima 253MA / 353MA	High temperature
Bimetallic tubes	Urea Striper
High Ni grades 200/201/C276/C-22	Critical application in chemical Industry

# 4 Sanicro 35

# Bridging the gap between stainless steels and nickel-based alloys.

- Sanicro<sup>®</sup> 35 is one of the latest grade additions to our growing portfolio of nickel alloys and austenitic stainless steels.
- This super-austenitic grade is unique because it bridges the performance gaps between stainless steels and higher cost nickel alloys.



## **Material Selection**

- Carbon steel
- Admiralty brass/Cupronickel
- Low alloyed Stainless Steels
- Duplex Stainless-steel family
- Sanicro<sup>®</sup> 35
- Nickel alloys





**TEMPERATURE** 

## Sanicro<sup>®</sup> 35 – UNS N08935

### Chemical composition (nominal)%

С	Mn	Ρ	S	Si	Cr	Ni	Мо	Cu	Ν	Fe	PREN:
0.030	1.2	0.030	0.020	0.5	27	35	6.5	0.4	0.3	Remainder	52



- Balanced chemistry
- High structural stability

### Standards/Approvals

- ASTM B163
- ASME code case 2982. Boiler and pressure vessel code, section VIII, division I and II.

■ 550°C

 Particular material appraisal (PMA), TÜV file 1326W043219



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# 5 Sanicro 35 Installation examples Across Industry

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## Sanicro<sup>®</sup> 35 – Applications – Chemical Industry

Application	Soda ash plant WLDS preheater	
Location	India	
Product	Ammoniacal liquor & gas	
Service conditions	Tube side: Ammoniacal gas NH3 +Co2+N2+02+H2o Shell side: Ammoniacal Liquor Sodium + Sulphide+Amonia Tube Side Temp- 88-95 C Shell Side Temp-35-45 c	
Previous experience	Earlier constructions using Ti Grade 2 have shown pitting corrosion over time. The customer tested a San35 coupon and found it to perform better than Ti Grade 2.	
Sanicro <sup>®</sup> 35	Installed and running successfully for 1 year (Installed in 2024) without any failure since installation	



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## Sanicro<sup>®</sup> 35 - Applications

Application	Oil refinery CDU overhead condenser	25
Location	USA, Gulf Coast area	
Dimension	19.05 x 1.24 mm, U-bent tubes	
Service conditions	$\label{eq:side} \begin{array}{l} \mbox{Tube Side} \\ \mbox{Crude oil} \\ \mbox{T}_{in}: 100^{\circ}\mbox{F} (38^{\circ}\mbox{C}) \mbox{T}_{out} \mbox{140}^{\circ}\mbox{F} (60^{\circ}\mbox{C}) \mbox{, Pressure: 350 psi} \end{array}$	
Previous experience	Previous use of superduplex and hyperduplex stainless steel. Due to the refinery's increasingly challenging process conditions, an upcoming retubing called for an even higher corrosion-resistant alloy	
Sanicro <sup>®</sup> 35	After an extensive evaluation Sanicro® 35 was selected by the refinery for its high performance and cost- effective offering 2 full scale u-tube bundles installed, with the tubes welded into the existing superduplex tubesheets	



## Formic acid orders

### C22

- Order booked: Dec2021
- New plant
- Size&quantity: 64 tons of U bended tubes, 19.05 x 2.11 M/W x 22 M

### San35

- Order booked: Jan2023
- Old plant maintenance
- Size & quantity: 20tons of U bended tubes, 25.4\*2.11mm

Equipment name: Waste Heat Recovery Boiler



### Background:

- Application: Formic Acid
- Customer in Asia
- Service condition:
  - Tube side: Formic acid + water
  - Shell side: water &steam
- Background:
  - Old plant experience guide the new plant material selection
  - Material selected by BASF
    - 2507→904→C22
  - Lifetime of 2507 in the old plant just 10 years, upgrade to sanicro35(aim to have 20-year design lifetime)
  - 904L in the old plant failed / 3yrs, upgrade to C 22 for new plant







## Sanicro<sup>®</sup> 35

### Project name: PTA phase3 MRO China

### Equipment name:

**Recuperative Heater CE-805** 

### Grade, size and quantity

19.05\*1.651\*9754mm,521pcs,3.7tons = 2.15 M SEK

### **Background:**

- Service condition:
  - Tube side: catalyst oxidation reactor effluent(CO,CO<sub>2</sub>,BR<sub>2</sub>,H<sub>2</sub>O) inlet 340C, outlet:171.5C
  - Shell side: feed of the catalyst oxidation reactor(Acetic acid, Br<sup>-</sup>) inlet 114C, outlet:283.7C
- 316L experienced sever corrosion in the bottom 2 rows need maintenance every year
- 904L has been tested but not suitable,
- NBA was 1 meter C276 butt welded with 316L in the lower rows
- Bottom 6 rows with Sanicro 35 = 3.7 Tons



Project name: iron and steel wet desulphurization MRO China

### **Equipment name:**

Vaporizer in ammonia sulfate unit

### Grade, size and quantity

φ38mm×3mm(AW)×6000mm, 5pieces

### **Background:**

- Service condition:
  - Tube side: 100,000ppm chloride+4,000ppm fluoride,76C
    - Shell side: steam, 110C.
- 2507 with lifetime around 1 year.
- Sanicro 35 vs 2507 after 30 days running .



30 days after service

## Formic acid orders

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## Sanicro<sup>®</sup> 35 - Applications

Application	Oil refinery Desulfurization Heat Exchanger		
Location	Europe	State of the second sec	
Product	Heat Exchanger Tubes		
Service conditions	$\begin{array}{l} \label{eq:side} Tube Side \\ \mbox{Hydrocarbons, } \mbox{H}_2 \mbox{S}, \mbox{H}_2 \mbox{ and } \mbox{NH}_3 \\ \mbox{T}_{in} \mbox{:} 437 \mbox{-} 509^{\circ} \mbox{F} (225 \mbox{-} 265^{\circ} \mbox{C}) \\ \mbox{T}_{out} \mbox{ 338 \mbox{-} 392^{\circ} \mbox{F} (170 \mbox{-} 200^{\circ} \mbox{C}) \mbox{,} \\ \mbox{Pressure: 580 psi (40bar)} \\ \hline \\ \begin{array}{l} Shell \mbox{Side} \\ \mbox{Hydrocarbons, } \mbox{H}_2 \mbox{O with } \mbox{H}_2 \mbox{S/NH}_3 \\ \mbox{T}_{in} \mbox{:} 212 \mbox{-} 248^{\circ} \mbox{F} (100 \mbox{-} 120^{\circ} \mbox{C}) \mbox{T}_{out} \mbox{ 356}^{\circ} \mbox{F} (180^{\circ} \mbox{C}) \mbox{,} \\ \mbox{Pressure: 580 psi (40bar)} \end{array}$		
Previous experience	Originally Carbon steel, in 2014 upgraded to super duplex SAF2507; until 2020 lifetime +/- 6 years; in 2020 retubing after only one year		
Sanicro <sup>®</sup> 35	After an extensive evaluation, Sanicro® 35 was selected by the refinery for its high-performance offering		

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## Sanicro<sup>®</sup> 35 - Applications

Application	Oil refinery Fluid Catalytic Cracking (FCC) Unit	to and the
Location	India	
Product	Heat Exchanger Tubes	
Service conditions	Tube Side Seawater $T_{in}$ : 91°F (33°C) $T_{out}$ 109°F (43°C) , Pressure: 75 psi (5bar) Shell Side Debutanizer Overhead Vapor $T_{in}$ : 143°F (61,5°C) $T_{out}$ 117°F (47°C) , Pressure: 154 psi (11bar)	
Previous experience	Super duplex tubes failed in 8 -9 years of span because of Stress corrosion cracking.	
Sanicro <sup>®</sup> 35	Running since summer 2022	

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## Sanicro 35 - Applications

Application	Oil refinery Hydrogen Generation Unit (HGU)
Location	India
Product	Heat Exchanger Tubes
Service conditions	Tube SideSeawater $T_{in}$ : 93.2°F (34°C) $T_{out}$ 107.6°F (42°C) ,Pressure: 58 psi (4 bar)Shell SideProcess Gas $T_{in}$ : 149°F (65°C) $T_{out}$ 104°F (40°C) ,Pressure: 338 psi (23.3 bar)
Previous experience	Monel 400/SDSS Tubes failed because of Pitting and Stress corrosion cracking.
Sanicro <sup>®</sup> 35	Installed in May 2023



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## Sanicro<sup>®</sup> 35 - Applications

Application	Pneumatic Lines for Valves
Location	India
Product	Instrumentation Tube used to operate Pneumatic Valve
Service conditions	Media : HCL + NaClo2 + NaOH (Hydrochloric acid + Sodium Chlorate + Sodium Hydroxide)
	pH Value : <1.5 / 12 to 13 / 12 to 13
	Concentration: 33% / 25% / 44%
	Operating Temperature : 60 Deg.C
	Operating Pressure : 2 Kg/cm2
Previous experience	Severe Corrosion of pneumatic instrumentation line due to which the Instrumentation tubes of SS 316L was replaced in the frequency of every month
Sanicro <sup>®</sup> 35	Installed and running successfully for 1 year (Installed in 2022) without any failure since instllation



## $\mathbf{X}$

# HOW TO AVOID RECEIVING POOR QUALITY MATERIAL? BY SPECIFYING WHAT YOU WANT TO BUY

### MANUFACTURING, QUALITY CONTROL AND DELIVERY TESTING GUIDELINES

### **Chemistry:**

- ASTM A789 ranges for Cr and Mo are 24-26 and 3-5% respectively, but Cr and Mo contents above 25 and 3.8%, respectively, ensure good properties
- low levels of impurities (C<0.025 and S< 0.015) are ensured by adopting the Electric Arc Furnace route (EAF) followed by Argon Oxygen Decarburization (AOD) and Ladle refining process.

### Manufacturing Process:

Hot working process flow of hot extrusion followed by cold pilgering or drawing ensures a defect-free and better-quality product compared to hot piercing.

### **Corrosion Resistence:**

- A minimum PREN value of 42.5 would ensure the highest resistance against pitting corrosion
- ASTM G48 Method A test at 50°C (maximum weight loss < 0.5 gm/m<sup>2</sup>) (Pitting corrosion check)
- ASTM A 923 Practice C, at 40°C for 24 hours and maximum weight loss should be < 5 mdd (Pitting corrosion check)
- ASTM G48 B or G78 (Crevice corrosion check)
- ASTM G36 (Stress corrosion check)

### **Other Quality Control:**

- ASTM A1016 (Eddy current check)
- 100% PMI should be conducted on finished tubes on each lot
- Hardness Level should be max 30 HRC
- Roughness Value (Ra) at OD  $\leq$ 1.5 µm, and at ID  $\leq$ 1.0 µm in as-pickled condition

## VALUE ADDED SERVICE

### **ALLEIMA SOLUTION**

- Failure analysis
- Coupon test or tube sample
- Support decision making in material selection

## Points to be noted while buying tubes

- Raw material source
- Tube production process Hot extrusion followed by cold pilgering
- Chemical composition Higher side of the range specified in ASTM standard is better
- Delivery corrosion test IGC test, ASTM 923C for duplex, ASTM G48 tests etc
- PREN number

# Thank you alleima.com

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