

35
YEARS

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1989-2024

Cover story:

Alabama Heat Exchangers: Keeping customers up and running





Alabama Heat Exchangers, Inc.

Alabama Heat Exchangers, Inc. is an Engineered-to-Order fabrication and repair company in business to meet the highly specialized process equipment needs of our clients. We've been serving various industries as a small business with an unwavering passion for quality and excellence since 1986. We've earned a reputation from our customers as a "go-to" source for pressure vessels, heat exchangers, specialty welding, machining, and industry knowledge.

Core Capabilities

- Shell & Tube Heat Exchangers
- Plate & Frame Heat Exchangers
- Air-fin Heat Exchangers
- ASME Pressure Vessels
- Heat Exchanger and Tank Components
- Fabricated Piping Assemblies
- Heat Exchanger re-tubing & repair
- Process equipment repairs in house & onsite

Certifications & Specifications

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- NBIC – "R" certification (repairs)
- Small Business / C-Corp.
- Registered: SAM & FEDBIZOPPS

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Keeping out the cold

In this first issue of the year, I want to extend a warm welcome back to you all after the festive break. With the cold weather settling in here in the Northern Hemisphere, we are reminded of the importance of our industry in keeping power stations and district heating schemes running. Heat exchangers are essential equipment to keep the world warm and comfortable during the winter, and their importance cannot be overstated.



This month, we welcome back to the cover our friends at Alabama Heat Exchangers, an engineered-to-order fabrication and repair company that has been in business since 1986. This American company is justifiably proud of its heritage and company values. As the company grows from strength to strength, its culture remains firmly rooted in family values. You can read more about them from page 8.

With the Heat Exchanger World Europe Conference & Expo taking place in November in Rotterdam, the Netherlands, the Call for Papers is circulating, and the deadline to submit your abstract is rapidly approaching. With the motto of "Exchange What Matters", this event is tailored to meet the needs of European fabricators, suppliers and users of heat transfer technology, so get involved to have your say! Abstracts can be submitted online or sent directly to me; see the Call for Papers on page 17.

Our editorial team has prepared a range of articles for your reading pleasure this month. Notably, we have an interview with Stefan Spaas from Termanox, who is looking for partners around the world to participate in a pilot project for the company's remarkable antifouling product. Read the article on page 44, and who knows... your facility may be ideal to help provide a Proof of Concept for this economically and environmentally friendlier product!

If you are involved in the design of heat exchangers, you'll certainly be interested in reading the technical paper from Tubacex on page 40. It looks at the specification of the chrome-nickel-moly alloy UNS N06059 for stainless steel heat exchanger tubes, compared to other alloys.

As always, your feedback is welcome – if you'd like to be more involved in Heat Exchanger World magazine this year by writing an article, technical paper or case study, send me an email and let's talk!

Kind regards,
Joanne McIntyre
Editorial Manager
j.mcintyre@kci-world.com



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CALENDAR

11 – 12 September 2024

STAINLESS STEEL WORLD ASIA CONFERENCE & EXHIBITION

» Location: Singapore

Url: <https://stainless-steel-world-asia.com/>

6 – 7 November 2024

HEAT EXCHANGER WORLD CONFERENCE & EXHIBITION

» Location: Rotterdam, the Netherlands

Url: <https://heat-exchanger-world-europe.com/>

6 – 7 November 2024

DUPLEX WORLD CONFERENCE & EXHIBITION

» Location: Rotterdam, the Netherlands

Url: <https://stainless-steel-world-duplex.com/>

3 – 5 December 2024

VALVE WORLD EXPO & CONFERENCE

» Location: Dusseldorf, Germany

Url: <https://valve-world-conference.com/>

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Digital Subscriptions: **FREE!**



Community Update

Sharing good news from the heat exchanger community and wider industry...

Vahterus Wins EIC Scale Up Award 2023

On 22 December Vahterus was selected to be the winner of the 2023 "Scale up Award". Since 2017 the EIC (Energy Industries Council) annually interview member companies as part of their 'EIC Survive and Thrive programme', which generate the Survive and Thrive insight report, which assesses how the global supply chain is managing increasingly difficult market conditions.

This report demonstrates that a growing number of supply chain companies are developing exciting and innovative growth strategies. Combining this with effective leadership and development these companies are not just surviving, but growing, even in a tough market. Past success stories have covered topics including, collaboration, culture, digital, diversification,

energy transition, export, innovation, optimization, people & competency, resilience, scale up, service & solutions, technology, and transformation.

"This is an honour and an amazing result, representing all the hard work and effort our teams have invested into the business making it another record year for growth at Vahterus" the company state.



Solex Thermal Science Inc. acquires Econotherm Ltd.

Solex Thermal Science Inc., a Canadian-headquartered expert in thermal and bulk materials engineering, has acquired Econotherm Ltd., a UK-based leader in waste heat recovery technology.

The acquisition further expands Solex's capacity to help its customers reduce the primary energy consumed to produce

industrial goods. The company has deep expertise in solids, liquids and gas heat exchange, and Econotherm's solutions are welcome additions to the suite of products Solex offers.

For more than 30 years, Solex has supported its customers during their respective journeys to decarbonize operations while producing a better product at

less expense to them and the environment.

"We at Solex are passionate about working with customers to understand their operational needs," says Lowy Gunnewiek, Chief Executive Officer for Solex. Econotherm designs and manufactures heat pipes and exchangers for industrial waste heat recovery. The company focuses

on difficult-to-recover heat that includes hot and/or dirty exhausts in industries such as automotive, metals, construction, food, mining, oil and gas, power generation and pharmaceutical. Installed solutions include many "firsts of its kind" which have achieved successful energy savings in applications otherwise considered unsuitable for conventional equipment.



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Maus Italia is also able to provide custom solutions to solve extreme cases with ATEX / OFF-SHORE versions.

For tube bundles up to 125 T in weight



Maus Italia is at the pinnacle of the field in Europe and throughout the world since 1961.

One partner for all the phases of the production and maintenance of the heat exchanger bundle's.



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Trane recognized for sustainability

Trane Technologies has been named to Corporate Knights' 2024 Global 100, recognised as the leader in the Building Products industry and ranking 23rd overall.

Emphasising the impact of a company's core products and services, the Global 100 is one of the world's most valued and transparent sustainability ratings. To determine its rankings, over 6,000 companies were assessed across 25 key

performance indicators including sustainable investment, carbon productivity and racial and gender diversity.

"Corporate Knights' Global 100 only includes companies that make sustainable solutions a core part of their business, complimenting Trane Technologies' long-embedded and industry-differentiating strategy," said Paul Camuti, executive vice president and chief technology and sustainability

officer of Trane Technologies. "We are extremely proud of our 2024 Global 100 rankings and, guided by our purpose to boldly challenge what's possible for a sustainable world, look forward to driving continued investment in sustainable innovation – accelerating decarbonization of buildings and the cold chain."

In late 2023, Trane Technologies announced the fulfillment of its August 2021 commitment to deliver

fully electric, zero direct emission Thermo King® refrigeration solutions for every segment of the cold chain in the Europe, Middle East and Africa (EMEA) region by 2023. The company is also advancing its 2030 Sustainability Commitments, including the Gigaton Challenge – a pledge to reduce customer greenhouse gas emissions by 1 billion metric tons (or, one gigaton) – and its pledge to be net-zero by 2050.

Super Tube/Fine Tubes appoints Connie Wang

Connie Wang has been appointed as the Business Segment Controller for Superior Tube and Fine Tubes, part of the AMETEK Specialty Metal Products (SMP) business unit. This strategic decision marks a significant step forward for the precision tube manufacturers and sets the stage for continued growth and success. Based at the SMP headquarters in Collegeville, PA, USA, Connie now oversees the financial landscape of the Tube division. In this pivotal position, she will be working in close collaboration with the Superior Tube and Fine Tubes teams. Connie's primary focus will be on spearheading financial initiatives, ensuring the

attainment of accounting and financial operational goals, and reinforcing robust internal controls.

She brings a wealth of experience to this role, including progressively responsible positions across China and the United States.

Connie stated of her appointment:

"I am excited to take on the role of Business Segment Controller. I am committed to driving financial excellence and collaborating closely with the Superior Tube and Fine Tubes teams to achieve our operational objectives."

Ryan O'Connell, DVP Business Segment Manager Tube, adds: "We welcome Connie to AMETEK SMP. Her wealth of

knowledge, proven leadership and keen financial insight will play a pivotal role in our continued success."

Specialty metal tube businesses, Fine Tubes and Superior Tube, manufacture precision-engineered tubes for mission-critical applications in the aerospace, defense, medical, nuclear, renewable energy, and space sectors.

Educationally, Connie boasts a strong foundation with a Bachelor of Science in Finance from Shanghai University and a Master of Business Administration from Temple University. Her commitment to professional excellence is further underscored by her status as a Certified Management Accountant (CMA).



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Alabama Heat Exchangers: Keeping Customers Up

Alabama Heat Exchangers is an engineered-to-order fabrication and repair company that has been in business since 1986. *Heat Exchanger World* spoke to President and CEO Ricky Lightcap, Jr., to learn more about the family company culture, the different processes and capabilities, and how Alabama Heat Exchangers continues to provide unmatched quality and customization to its clients.



▲ The Alabama Heat Exchanger team prides itself on its history as a family-owned company that continues to cherish family values.

By Charlie Evans & Sara Mathov

A family company was founded

Alabama Heat Exchangers is a family business and always has been. “My mother and father started the company in 1986. After many years working in the industry and listening to the needs of his clients, my father decided to start his own heat exchanger company. His first job for this new company was re-tubing a heat exchanger in his own garage. Shortly after that, they opened a small office, and a few years later, moved into our current location in Theodore, Alabama,” said Lightcap.

Over the years, the company has grown to have the reputation it does today. “I started here in high school sweeping floors and doing deliveries, eventually getting to know welding and fitting and taking over the lead in Quality Control (QC) for six years, and then moving into the role of CEO,” stated Lightcap. “We have grown a lot and continue to do so, but we do not forget our company values and one of those values is family. We hire families. We have always had siblings working here and families working together. It is a different dynamic than most companies, but one we are proud of.”

Processes and specialties

Alabama Heat Exchangers offers a variety of services, including drafting and engineering, machining, welding, and fitting, as well as service, repair, and quality control. “For new custom equipment, we start the design process,” began Lightcap. They begin thermal engineering, wherein they size the heat exchanger and get approval from the client, ensuring that it is the desired product. From there, it moves onto the purchasing phase, where all the desired materials are acquired. “Once the materials arrive, QC performs a thorough inspection before issuing to production. Then we begin building, fitting, welding, machining, testing, and finishing until we have a completed custom piece that meets our customer’s production needs.”

This can also begin further along in the process, as there are many ‘in-kind’ replacement exchangers as well as vessels and reactors. The company also regularly performs repairs and alterations to the same type of equipment – in-house or on-site.

The company’s welding capabilities include a wide variety of alloys, including carbon, stainless steel, nickel, Hastelloy,

and Running



and more. “We complete a lot of dissimilar welding. This is monitored closely by our quality control process,” explained Lightcap.

Alabama Heat Exchangers uses a mix of in-house and third-party testing depending on the requirement. “We can also meet just about any non-destructive testing requirements provided by end users or any governing standard, usually ASME,” he continued. “Not only do we meet the code, but we also exceed it. We view code requirements as the level where the bar is set, and we always go above the bar. It is woven into the fabric of our culture as a top-quality mindset. Everyone from our experts to someone who sweeps the floor knows that quality matters and knows our code.”

Unmatched quality and speed

“One of our unique elements is that most new fabrication is made from scratch and customized to meet our end users’ requirements,” explained Lightcap. Alabama Heat Exchangers is also known for going out to take field measurements to ensure a piece of existing equipment can be replaced with exact dimensions. “We fabricate a replacement that fits perfectly back into place without the client needing to change any piping.”

Their main clientele is specialty chemical manufacturers; however, other applications include paper mills, power generation, marine, petrochemical, and clean/alternative fuels. “Our mantra is to keep the customer up and running,” Lightcap continued. “Customers come to the company because of our depth of technical knowledge. We are a go-to resource for ASME codes, as well as safety and more. Customers feel comfortable in our hands, and that helps us stand out.”

Not backing down from a challenge

Referring to their mantra to keep the customer up and running and keeping downtime to a minimum, Alabama Heat Exchangers has multiple examples of going above and beyond the expectations of their customers. Lightcap recalled when a paper mill sent a fairly large heat exchanger, about 30 feet long and 5 feet in diameter, all 304L stainless steel, for a re-tube. However, when it arrived, they found stress-corrosion cracking throughout the entire exchanger, making the equipment barely operational.

“After telling the customer they essentially needed a new heat exchanger, they came back saying they would need it in four weeks. So, I spoke with my team and we agreed to get it done, and we shipped on time. The end user was

“Our mantra is to keep the customer up and running.”

pleased as they did not lose any days on their shutdown window. We are very proud of that.” For reference, the normal turnaround on a similar job is estimated at about three months.



≈ Horizontal mixing vessel - carbon steel with PWHT and high-temp coating



➤ Obround-to-cylinder chiller.

“Another project we are proud of was when a plant wanted to add three feet of vertical length to a 15-foot diameter tank in place on site. First, we developed a plan of action. Then, we fabricated a new section of the tank. We cut the original tank and, using a portable water jet system, put the new assembly in place. The customer was so pleased because everything fit within a 32nd of an inch, over the entire 15-foot diameter,” shared Lightcap.

Clean energy and emissions

Lightcap said there has been a large increase in clean energy projects, including biodiesel plants, CO2 scrubbers,

and custom equipment to meet emission requirements. “We have done projects at several universities and new green start-ups, all related to clean energy emissions and research,” he said.

“Customers come to the company because of the depth of our technical knowledge.”

One of the first initiatives that was highlighted was wind energy. “Using compressed air for wind farms,



➤ Eductor for a chemical manufacturer, used in a carbon capture process at the plant. It is made of Hastelloy C276.



⌚ BEM style gas cooler.



⌚ 14' x 40' tall vertical pump

in times without wind, was something we played a part in. We built tanks, pumps, and ASME code equipment, to help with the pilot version of this. We then scaled it up and built the full-size version, that still exists in Texas as one of the largest single-piston pumps ever built, at 14 feet diameter and 40 feet tall."

"We are going to play a big role in building these custom pieces of equipment for companies that have great ideas of how to harness energy. We are excellent at following specifications, codes, and safety, along with a very high-level skill in welding, machining, and fabricating. Combined with our get it done and get it done right attitude, we will provide great support for companies in clean energy initiatives."

The future of Alabama Heat Exchangers

Going forward, Alabama Heat Exchangers will continue to grow and expand. "We have been around the same size facility for about 30 years, and we are ready to take the company to a higher level. Because of that, I plan to expand into different regions. We have always built equipment that has gone all

over the world, but I would like to start expanding our presence, starting in the Houston and Louisiana areas," said Lightcap.

"One of our unique elements is that most new fabrication is made from scratch and customized to meet our end users' requirements, combined with our get it done and get it done right attitude."

"Over the years, we have stayed in a smaller area radius, where most of our work is done. We are now at the point where I want to bring our skills and expertise to a larger area and maintain a greater reach. The company is growing, and I am excited to be leading that initiative," concluded Lightcap. ■



⌚ Vertical NEN style turpentine condenser with stress corrosion cracking (before repair).



⌚ Vertical NEN style turpentine condenser rebuilt in 4 weeks (all 304L SS).

Industry News

NIBCO announces promotions of Stanley and Smith



NIBCO Inc. has announced the promotion of Allen Stanley to Vice President, Fittings Manufacturing and Distribution, and Rudy Smith to Vice President, Valve Manufacturing. Both Stanley and Smith will report to Ashley Martin, President and COO, NIBCO. "Allen and Rudy have long careers with NIBCO, and the knowledge and expertise that they both bring to these roles will be valuable for the success of our organization," said Martin. "Join me in congratulating

them on their well-deserved promotions." In this new role, Stanley has responsibility for the Stuarts Draft, Virginia manufacturing operations, and the Demand Planning department, along with his current responsibilities for the U.S. distribution centers, world headquarters logistics, and all plastic manufacturing facilities. In his new role, Smith will have responsibility for NIBCO's Blytheville, Arkansas, facility, along with the company's Nacogdoches, Texas, McAllen, Texas, and Reynosa, Mexico facilities.

Vertiv unveils new manufacturing facility

Vertiv has officially inaugurated a cutting-edge manufacturing facility in Chakan, Pune. This strategic move comes in response to the escalating demand for data centers and associated infrastructure solutions in India. The newly opened facility, complementing Vertiv's existing manufacturing plants in Ambarnath and Pune, is specifically dedicated to the production of thermal management products and solutions catering to various sectors such as data centers, telecom, commercial, and industrial applications. With a focus on serving both domestic and international markets, the facility addresses the growing need for advanced infrastructure solutions.

Encompassing an impressive 210,000 square feet (19,510 square meters), the Chakan facility plays a pivotal role in manufacturing a diverse range of cooling solutions, spanning from 200W to 2MW and beyond. This includes innovative products such as adiabatic free cooling chillers, large custom air handling units (AHU), thermal wall units, a new series of large direct expansion (DX) units, packaged DX and free cooling with economiser units, a fresh line of in-row cooling units, wall mount units, and rack cooling systems. Notably, the facility is equipped with state-of-the-art psychrometric labs, ensuring rigorous performance testing of the manufactured solutions. In addition to the production



capabilities, the site features a dedicated customer experience center and design support facilities, reflecting Vertiv's commitment to delivering top-notch products and services.

GTS receives natural refrigerants label from ATMosphere



GTS, a hydrocarbon gas manufacturer based in Genova, Italy, has received the ATMO Approved

Natural Refrigerants Label from ATMosphere, a global market accelerator of clean cooling and heating solutions and publisher of Hydrocarbons21.com. ATMosphere (formerly shecco) launched the label in 2022 as a global gold standard highlighting best-in-class manufacturers of natural refrigerant systems and components around the world. Recipients in 2023 included Fenagy, SCM Frigo, Güntner, Secon, M&M Carnot, Zudek, TEKO, MIRAI Intex, Novum and Temprite. GTS produces more than 25,000 metric tons per year of natural refrigerant Polarpure-branded gases with a purity of up to 99.99%, including

propane (R290), isobutane (R600a), n-butane (R600), propylene (R1270) and propane and propylene mixtures (R433A, R433B, and R433C). Its distillation plant in Arquà Polesine, northeastern Italy, uses R290 heat pumps and is powered by a 1MW solar plant, thereby reducing Scope 3 CO₂e emissions. GTS serves different sectors such as refrigeration, food, construction, aerosol industries, and many other fields. The company has five branches in Italy, Belgium, Romania, Brazil, and Thailand and is able to supply its products all over the world in its own trucks, isotanks, and cylinders to avoid contamination and assure top quality.

WSP garnered 4 honours at CIBSE Hong Kong Awards 2023

Organised by the Chartered Institution of Building Services Engineers (CIBSE), the biennial award aims to recognise remarkable building projects that deliver efficiency, quality, safety, sustainability, and cost-effectiveness, focusing on actual and measured performance. WSP is involved in four award-winning projects, including one Winner Award and three Merit Awards. In particular, WSP was involved in all three awarded projects in the Public Use Building category of the Project of the Year Award, signifying the positive impact we deliver through our Future Ready design to the wider community. The project is an integrated complex consisting of 16-storey police facilities with car parks providing enhanced services to the new Kai Tak community. To achieve a green government building with an emphasis on building energy efficiency and sustainability, we incorporated a number of innovative building services systems and renewable energy technologies to achieve low carbon emissions. They included the adoption of the existing Kai Tak District Cooling System (DCS); photovoltaic system and solar hot water system as renewable energy sources; CO/NO₂-based demand control ventilation,



air-side heat recovery wheel, and free cooling to reduce energy consumption; and use of rainwater harvesting and condensate water recycling system for landscape irrigation. In addition, energy-efficient building envelope with a low-E glazed curtain wall was adopted to ensure visible light transmittance, reduce light pollution, and prevent heat losses. Modular Integrated Construction (MiC) and MultiTrade Integrated Mechanical, Electrical and Plumbing (MiMEP) and Building Information Model (BIM) application were implemented to facilitate the construction programme as well as smooth coordination for plant room layouts and installations.

ANDRITZ completes retrofit of waste gas treatment units



International technology group ANDRITZ has successfully retrofitted two selective catalytic reduction systems (SCR) at the Leverkusen Chemical Park, Germany, significantly contributing to the park's rapid revitalization after a devastating explosion in 2021. After the incident, which led to the shutdown of all four lines of the

hazardous waste treatment plant, Currenta GmbH & Co OHG, the operator of the chemical park, commissioned ANDRITZ to retrofit the severely damaged SCR II. However, unexpected corrosion damages at the SCR I unit made it necessary to put this unit out of service as well. ANDRITZ proposed an innovative concept that minimized downtime and allowed for the earliest possible restart of both units. The ANDRITZ retrofit team redesigned the plate heat exchanger originally intended for SCR II to meet the specifications of the SCR I unit. At the same time, they developed a strategy to repair the damaged SCR II heat exchanger for temporary use until a new one became available. The successful completion of this project underlines ANDRITZ's commitment to providing innovative, timely, and reliable solutions under challenging conditions.

Capstone promotes Victor Kong as VP of Technology



Capstone Green Energy Holdings, Inc., the public successor to Capstone Green Energy Corporation (Predecessor Capstone), has promoted Victor Kong to Vice President of Technology. With over 18 years of dedicated service to Capstone, Victor's journey has been marked by his exemplary

contributions beginning in R&D testing and spanning through Core Engineering and Certification & Compliance. In his new role, Victor will play a critical part in shaping the future of Capstone's engineering and technology activities. His wealth of experience and strategic vision will be instrumental in overseeing the expansion of the technology department, ensuring its alignment with the company's overarching goals. This appointment reflects Capstone's commitment to recognizing and nurturing talent from within the organization. Victor Kong's extensive experience and deep understanding of the company will undoubtedly contribute to the growth and innovation of the engineering and technology department.

Comfort Systems USA to acquire Summit



Comfort Systems USA, Inc. has entered into a definitive agreement to acquire Summit Industrial Construction, LLC (Summit)

headquartered in Houston, Texas. The transaction is currently expected to close in the first quarter of 2024.

Summit is a specialty industrial mechanical contractor offering engineering, design-assist, and turnkey, direct hire construction services of modular systems serving the advanced technology, power, and industrial sectors. Summit's capabilities encompass a wide range of modular and site-based construction, including process piping, equipment setting, large pipe rack trestles, and related steel erection and specialty concrete work. Summit is a trusted supplier to some of the advanced technology, power, and industrial companies and is currently deployed on several major chip fabrication projects.

Initially, Summit is expected to contribute annualized revenues of approximately USD 360M to USD 400M, and earnings before interest, taxes, depreciation, and amortization of USD 30M to USD 45M. In light of the amortization expense, Summit is expected to make a neutral to slightly accretive contribution to earnings per share in 2024 and 2025. Comfort Systems USA® is a provider of commercial, industrial, and institutional heating, ventilation, air conditioning, and electrical contracting services, with 169 locations in 129 cities across the nation.

Danfoss acquire ENFOR's district energy efficiency software

Danfoss has acquired ENFOR's district energy software and will bring the solutions to the global market under the Danfoss Leanheat® suite of sustainable heating and cooling solutions. The Danfoss Leanheat® solution combines cutting-edge technology, data analytics, and artificial intelligence to optimize energy consumption and improve the operational efficiency of district energy and buildings. Danfoss has been a minority shareholder in ENFOR since 2020. By fully acquiring ENFOR's district heating software business, Danfoss enhances the capabilities and accuracy of its Leanheat network suite for district energy

utilities to include data-driven temperature optimization, intelligent load forecasting, and micro weather forecasting, which support district energy utilities and energy companies with their green transitions. ENFOR is an innovative spin-off from the Danish Technical University and delivers solutions for forecasting and optimization of energy production and demand, incl. optimization of district energy systems. The potential of using data and machine learning in the energy sector is massive. The latest Danfoss Impact White Paper reveals that an ambitious but realistic roll out of demand-side flexibility technology in the EU and



UK can save 40 million tons of CO2 emissions each year by 2030, more

than Denmark's domestic climate footprint.

KJTS Group Berhad launches IPO



KJTS Group Berhad, a specialised building facilities provider, has officially launched its initial public offering (IPO) at RM 0.27 per share. The company, known for its involvement in cooling energy, cleaning, and facilities management, has established a strong presence in regional markets across Malaysia, Singapore, and Thailand. The IPO's target price is set at RM 0.33, indicating a potential upside of 22.2% from the initial offering price. This optimistic outlook is backed by KJTS's robust portfolio of unbilled EPCC projects in the cooling energy systems segment, amounting to RM 32.5M, and its consistent revenue from cleaning services contracts. Founded in 1984, KJTS initially focused on air-cooled split unit installation and servicing.

The company has since expanded, landing its first EPCC contract for a district cooling system in Kuala Lumpur in 1997. This project marked the beginning of a series of successes, including a significant contract in 2003 for a mixed-development project in Mid Valley City, Kuala Lumpur, and another in 2008 with a semiconductor manufacturer in Muar, Johor. KJTS's expansion continued with its foray into Singapore in 2019 through the acquisition of KJ FEM and into Thailand in 2021 with the incorporation of KJTN Engineering. Today, KJTS is a diversified specialist in building support services, offering a range of solutions from cooling energy to facility management.

Vance Street and Micronics acquires SOLAFT



Vance Street Capital's portfolio company, Micronics Engineered Filtration Group (Micronics), a provider of aftermarket filtration consumables, announced the acquisition of Solaft Filtration Solutions (Solaft), an innovative, vertically integrated, global industrial filtration solutions provider with in-house product design capabilities, research & development facilities and manufacturing operations in Australia, Brazil, China, and India. Founded in 1983, Micronics is a global provider of aftermarket and OEM filtration equipment and consumables. The Company serves a diversified base of approximately 3,000 customers across over 20 distinct end markets, including mining and

mineral processing, energy and power generation, battery recycling, chemical manufacturing, pigments and dyes, food and beverage, steel and iron processing, aggregates, cement and asphalt, pharmaceutical and biotech, and water/wastewater treatment end markets. The acquisition of Solaft expands Micronics' portfolio of engineered filtration solutions and its geographic footprint to better serve its global customers' filtration needs in industries such as aluminum, alumina, power generation, and steel, where demanding environmental/emissions control needs require deep technical filtration expertise, application knowledge, and a localized, consultative approach.

Laars® Heating Systems acquires Electro Industries

Laars® Heating Systems, a subsidiary of Bradford White Corporation and U.S. designer and manufacturer of boilers, water heaters, and pool heaters used in residential, commercial, and industrial applications, have acquired Electro Industries, Inc., based in Monticello, Minnesota. Electro Industries is a manufacturer of electric boilers, air-to-water heat pump technology, electric duct heaters, and controls. This acquisition will expand Laars' residential, commercial, and industrial space heating

portfolio, furthering Laars' commitment to meet the growing needs of customers as state and local electrification policies and regulations continue to evolve throughout North America. This acquisition of Electro Industries includes all company assets, including the Electro Industries facility in Monticello, increasing Laars Heating Systems U.S. manufacturing presence. Electro Industries will be organized as a division of Laars Heating Systems, a subsidiary of Bradford White Corporation.



Thermal Energy subsidiary BEI receives PO for 8 boiler economizers



Thermal Energy International Inc. has announced that its wholly owned subsidiary, Boilerroom Equipment, Inc. (BEI), has received a purchase order valued at approximately CAD 540,000 from a Fortune 500 food processing and commodities trading company for eight HeatSponge boiler economizers. This is the largest single order in BEI history. The project is

expected to be completed and revenue earned within the next six months. All figures are shown in CAD. "We are pleased to kick off the calendar year with the receipt of this custom equipment order, which is BEI's largest single purchase order ever," said William Crossland, Thermal Energy CEO. "The genesis of this order traces back to a customer inquiry for

a replacement of a single failed economizer made by another manufacturer. Upon reviewing the value-added design of BEI's HeatSponge COLOSSUS-model economizers, which translates to longer service life, shorter downtime, and lower maintenance costs, the customer chose to replace seven more economizers with BEI's HeatSponge economizers."

Alfa-Laval joins SCO2OP-TES program



Alfa Laval has joined the EU-funded development program SCO2OP-TES to revolutionize thermal energy storage and drive industrial decarbonization. The company is part of a new consortium consisting of 16 European companies and academic institutions, to develop a pioneering next-generation Power-to-heat energy storage technology. The initiative named SCO2OP-TES, is expected to revolutionize the TES (Thermal Energy Storage) industry with cost effectiveness, grid stability, and continuous industrial heat supply using renewable energy sources. It is a pivotal part of the European Union's strategy to accelerate the transition towards renewable energy sources and decarbonization in the European energy market. SCO2OP-TES is aligned with the REPowerEU Plan aiming for 1236 GW of renewable energy capacity

by 2030, which is a significant increase from the 1067 GW target in the "Fit for 55" package. To meet this, effective energy storage ensuring grid stability and continuous renewable energy use is crucial. Alfa Laval's contribution to SCO2OP-TES is to develop and deliver the innovative and efficient heat exchangers which will be key to the thermal energy storage process and play an important role in the success of the new technology. "We are excited that our pioneering and highly efficient heat exchanger technologies will contribute to this revolutionary TES project. Energy storage is pivotal in the transition towards renewable energy sources and an important pathway to decarbonization and a more sustainable future," says Alasdair Maciver, Head of Energy Storage Solutions at Alfa Laval.

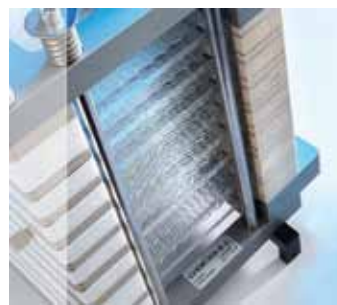
Turnbull & Scott



While the vast majority of its heat exchangers will successfully go into service from design to operation with no issues, the growing focus on energy efficiency and long-term system performance has led to an increased customer demand for detailed pressure drop data and testing. The testing (sometimes called Factory Acceptance Testing - FAT) is cost effective as it only requires a small section of exchanger – the entire unit does not need to be produced to use the wind tunnel as the behaviour of the exchanger in a section will reflect the whole unit.

Turnbull & Scott have announced that it now has a wind tunnel to offer in-house aerodynamic tests for heat exchangers. This investment is all about delivering the best services and Trusted.™ products to clients.

AGI Group acquires Chemtrix



AGI Group has acquired Chemtrix B.V., a Netherlands-based company specializing in the design and manufacturing of scalable flow reactors. The acquisition, effective from Dec. 29, 2023, marks a strategic move by

AGI Group to expand into the large-scale flow chemistry market. The Chemtrix flow reactor portfolio complements AGI's portfolio of precision-manufactured glass equipment for chemical processing industries, including the scientific and pharmaceuticals sectors, the Japan-based company said. AGI is looking to expand its global presence to support customers and enable sales growth in markets outside of Japan. Chemtrix collaborates with end users in academia, fine chemicals, specialty chemicals, and pharmaceutical industries to develop its products, said Charlotte Wiles, Chemtrix CEO.

Bespoke cooler meets supermarket's environmental goals



UK, came up with a bespoke unit fitted with an adiabatic system with pads. It is also the first system of its kind to have just one row of fans and a gas cooler. An adiabatic system uses the evaporation energy of water to cool down the air by increasing its humidity. The product is specially designed to ensure that air is cooled evenly, with a reduced water loss. Satisfied that the Kelvion solution would meet all specifications, the customer placed the order at the beginning of the year. Although the schedule of four months was tight, the Baierbrunn and Fareham teams rose to the challenge and the unit was delivered on time.

When a major Dutch supermarket chain wanted a gas cooler for one of its stores, it had several green requirements. The unit had to be an adiabatic system that was low on power consumption, didn't use a lot of water and was less noisy to operate. Kelvion provided the

solution that ticked all the boxes. Low noise levels were particularly important as the supermarket is based in a town center. After investigating all the possibilities, Kelvion's R&D teams in Baierbrunn in Germany and Fareham in the

Iraq to award waste-to-energy projects in Q1 2024



Iraq intends to award waste-to-energy projects in the capital Baghdad in the first quarter of 2024, an Iraqi official has said. The cabinet has approved the projects which will be awarded to global companies with relevant experience, said Mohammed Al-Rabei, a spokesman for Baghdad Municipality. "Serious discussions will begin in the first quarter of this year for the award of such projects to giant companies on an investment basis," he said. Rabei did not elaborate on these projects apart from saying a plant with a capacity of 3,000 tonnes of waste can generate nearly 80 megawatt-hours of electricity per day.

Malta Inc., Alfa Laval, Siemens Energy, and DLR secure extensive grant to drive Germany's clean energy transition



♣ Storing intermittent renewable energy for later use will be crucial to unlock the energy transition.

Malta Inc., a world leader in long duration energy storage (LDES), announced that its German subsidiary was awarded a grant to support a €9-million effort to accelerate the German energy transition.

By Alfa Laval

Malta Hochtemperatur Wärmepumpen Stromspeicher GmbH, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Alfa Laval, and Siemens Energy were awarded funding by the German Federal Ministry for Economic Affairs and Climate Protection (BMWK) to support Germany's efforts to achieve Paris Agreement climate targets and to be climate-neutral by 2045. Germany needs to electrify its heating sector and to ensure that expanded renewable power generation is available on-demand and around-the-clock. The grant will fund a technoeconomic analysis of the potential for Malta's LDES technology to help decarbonize both electricity and heat generation in Germany. It will also support the expansion of DLR's world-leading test facility for thermal energy storage in molten salts (TESIS) to validate an innovative, Alfa Laval-built heat exchanger.

On course for decarbonization

"We are honored to partner with the German government and its leading national laboratory, the DLR, to explore how Malta's technology can accelerate the transition off natural gas," said Ramya Swaminathan, CEO of Malta. "This important work will identify how best to meet Germany's decarbonization goals, create jobs in German turbomachinery manufacturing, and deliver a just transition by creating clean energy construction and operations jobs for the nation's current energy workforce." Sigmund Brielmaier, Head of LDES at Siemens Energy, states: "Besides being the turbomachinery supplier for Malta's technology, we are keen to contribute with our expertise to this project that enables the energy transition. LDES is a key to decarbonize the energy system and this project offers a great opportunity to explore new ways of decarbonized combined heat and power applications." Alasdair Maciver, Head of Energy Storage Solutions at Alfa Laval comments: "Energy storage is pivotal when

driving the shift towards renewable energy sources. We are very pleased that our pioneering and highly efficient heat exchanger technology, tailored for Malta's energy storage process, will be running in actual operational settings. It is a milestone in the pathway towards competitive, long-term energy storage and the transformation of the European energy market into a more sustainable future."

Clean power plant

Malta's innovative pumped-thermal energy storage (PTES) plant is a like-for-like replacement for fossil-fueled power plants. It generates 100-MW of clean power and 70-MW of clean heat, but it uses an industrial grade heat pump to replace the carbon emissions and volatile price of fossil fuels with zero-emissions, lowest-cost-available renewable energy. The heat pump converts the electricity to thermal energy, which can be stored for hours to days. When needed, a heat engine reconverts the thermal energy into clean power and heat, returning more than 90% of the original energy to the grid with little-to-no degradation over its 30+ year lifespan. As an LDES asset, Malta's technology allows utilities to reliably deploy vastly more wind and solar power without the risks of unavailability or wasting surplus generation. As a clean power plant, it delivers the same grid resilience and reliability services that fossil-fueled plants do but wind and solar do not. With among the best-available round-trip efficiencies, lowest system degradation, and longest plant life, Malta's clean power and heat plant allows customers to make up lost ground on decarbonization goals. In close collaboration with DLR's Institute of Engineering Thermodynamics, led by Prof. Dr. André Thess, the partners will collaborate on analyses of:

- Use cases for long-duration energy storage in the electricity grid, including grid services, and heat grids;
- Suitable market mechanisms for long duration storage systems;
- Identification of sites for potential deployment; and
- Validation of an innovative Alfa Laval heat exchanger at DLR's TESIS, the world-leading facility for high-temperature, molten-salt, thermal storage technology. ■

Heat Exchanger World Conference & Expo Europe

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The Heat Exchanger World team welcomes our community back to Rotterdam on 6th & 7th November for our Conference & Exhibition 2024. Having grown almost twice the size, the 2024 event will be hosted at the Rotterdam Ahoy where even more of the heat exchanger industry can come together.

Heat Exchanger World Conference Europe 2024

Our 2024 Conference will provide a stage for professionals across the heat exchanger industry to present on the challenges, successes, and key topics concerning heat exchangers. Aided by a panel of experts, we will select the most relevant and engaging presentations for the 2024 conference programme.

Conference: Call for papers!

The Heat Exchanger World Conference 2024 will provide a dedicated meeting ground for professionals working in the heat exchanger supply chain to address key issues in the industry from design and manufacture, through purchasing to usage and maintenance. It will enjoy an atmosphere of information sharing, connection, and learning in a relaxed and informative atmosphere.

Do you have an idea for a presentation which addresses a key topic in the heat exchanger industry? We invite you to submit a 150 word abstract by **Monday 5 February**. This will then be assessed by our Heat Exchanger World Steering Committee.



SUBMISSION DETAILS

Submit your 150 word presentation abstract to Heat Exchanger World in Word format to Conference Coordinator, Ms Joanne McIntyre at j.mcintyre@kci-world.com.

Explain the outline of your presentation as clearly as possible, include key topics and keywords.

DEADLINE: Monday 5 FEBRUARY

Conference contact:

Joanne McIntyre,
Conference Coordinator
Tel: +31 575 585 298
Email: j.mcintyre@kci-world.com



Suggested topics:

- Repair, cleaning, and maintenance
- Corrosion and fouling – Prevention and protection
- Design and innovations
- Workforce: Attracting the next generation
- Standards
- Industry challenges
- Welding of heat exchangers
- And more...



DEADLINE: Monday 5 FEBRUARY

Heat Exchanger World Conference & Expo Europe 2024

Heat Exchanger World Conference 2024 Steering Committee

Our 2024 Conference will be headed by a panel of experts, representing the heat exchanger industry from end users to manufacturers to service providers. With their combined knowledge and experience, the Heat Exchanger World Steering Committee will work to ensure that the conference programme is engaging, topical, and full of technical insights.

Meet our 2024 Steering Committee!

Abdollah Bayati – *Heat Transfer Subject Matter Expert, McDermott*

Aeishwarya Chaudhari – *Lead Mechanical Engineer, BASF (Mumbai)*

Barinder Ghai – *Director Technical Marketing, Alleima*

John Houben – *Principal Welding and Surface Modification Engineer, ExxonMobil*

Himanshu Joshi – *Heat Exchanger and Fouling Consultant, formerly of Shell*

Dr. Ing. Hans Zettler – *President HTRI*

Massimo Brignoli – *Senior Sales Manager Italian Market, Mannesmann Stainless Tubes*



Alleima is a leading manufacturer of high value-added products in advanced stainless steels, special alloys, and products for industrial heating. Based on long-term customer partnerships and leading materials technology, the company advances processes and applications in the most demanding industries. With more than 900 active alloy recipes, Alleima's product range offers seamless stainless tubes, electric heating technology & resistance materials.



Heavy Metal & Tubes (India) Pvt. Ltd. specialises in seamless carbon and alloy steel tubes/pipes, as well as stainless steel seamless and welded variants. Their products are largely used in shell & tube heat exchangers, but also find use in air-fin coolers, boilers, condensers, and more. Proud to be an Indian company, Heavy Metals has a global customer base.



Mannesmann Stainless Tubes' (MST) serves diverse markets, including oil & gas, power, and aerospace. The company embraces innovation and is a key driver and contributor to the generation of new specifications that become tomorrow's standards. MST's products range from 1.6mm (0.063") to 280mm (11") outside diameter across the full range of seamless austenitic stainless and Nickel alloy grades, complemented by super-austenitics like 904L and 6Mo, duplex and super duplex alloys, and a complete family of Nickel alloys.

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Heat Exchanger World Conference & Expo Europe 2024

Event information

Heat Exchanger World Conference & Expo will be held at the Rotterdam Ahoy event space in Rotterdam, the Netherlands.

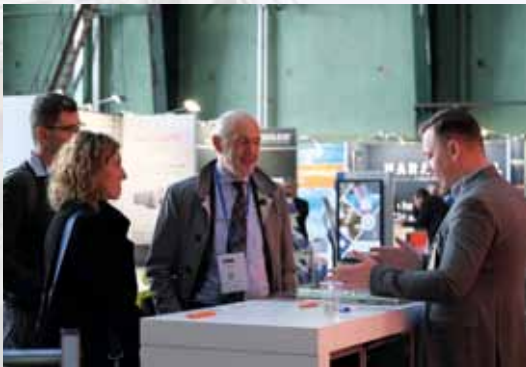


LOCATION:

Rotterdam Ahoy
Ahoyweg 10
3084 BA Rotterdam
The Netherlands
Phone: +31 10 293 3300
Website: www.ahoy.nl/en/

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The Heat Exchanger World Expo 2024 will be a meeting ground for those working in every field of the heat transfer industry. It will be tailored toward providing direct business-to-business and networking opportunities, and will welcome the diversity of global knowledge from exhibitors, visitors and conference delegates, further generating the understanding and knowledge necessary for future industry growth.



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■ Available	Corner stand: € 375 / m ²
■ Option	Co-exhibitor: € 900,-

Updated: 15 January 2024

Understanding fouling in heat exchangers – Part 2



⚡ Heat exchanger shell and tube at offshore oil and gas central facility.

In part one of this article (published in Heat Exchanger World October issue), we discussed the types, causes, effects, cost, and mitigation strategies for fouling in heat exchangers. Now we will explore the detection methods to assist in fouling intervention.

By Omari Hussein Sabuni, Mechanical Engineer - Kinyerezi Power Plant

Detecting fouling in its early stages is crucial for timely intervention and effective mitigation. There are various methods for detecting fouling in heat exchangers, enabling proactive maintenance and optimal performance.

Thermal analysis

Thermal analysis techniques provide valuable insights into the presence and severity of fouling in heat exchangers. The following methods are commonly employed:

Temperature difference monitoring: By measuring the temperature difference between the hot and cold fluid sides of the heat exchanger, any deviations from the expected values can indicate the presence of fouling. An increasing temperature difference suggests reduced heat transfer efficiency, signaling the need for further investigation.

Heat transfer coefficient calculations: Calculating the heat transfer coefficient using heat exchanger performance data can help identify changes in heat transfer efficiency caused by fouling. A decline in the heat transfer coefficient over time indicates the presence of fouling and the need for remedial action.

Infrared thermography: Infrared thermography involves using thermal imaging cameras to detect temperature variations across heat exchanger surfaces. Hotspots or uneven temperature distribution can indicate areas of fouling or blockage, enabling targeted maintenance interventions.

Pressure drop monitoring

Monitoring the pressure drop across the heat exchanger can serve as an effective indicator of fouling. Fouling deposits restrict fluid flow, resulting in increased pressure drop. The following methods aid in pressure drop analysis:

Differential pressure measurement: By measuring the pressure difference between the inlet and outlet of the heat exchanger, any substantial increase in pressure drop indicates the presence of fouling. Regular monitoring of pressure differentials allows for timely fouling detection and appropriate maintenance actions.

Flow metre analysis: Analyzing flow rates using flow meters installed in the heat exchanger system can help identify changes in fluid flow caused by fouling. Reduced flow rates or fluctuations may suggest fouling issues, prompting further investigation.

Visual inspection

Visual inspection remains a fundamental method for detecting fouling in heat exchangers. Direct observation of heat exchanger surfaces can reveal visible signs of fouling, such as deposits, scaling, or corrosion. Key visual inspection approaches include:

Borescopic examination: Borescopes, equipped with cameras or fiber optics, allow for visual inspection of

internal heat exchanger components. This non-destructive method enables inspection of hard-to-reach areas for fouling identification and assessment.

Tube and surface inspections: Disassembling heat exchanger components, such as tubes or plates, and visually examining them can provide direct evidence of fouling. Visual inspections should include checks for scaling, deposits, biofilms, or any other visible signs of fouling.

Analytical techniques

Analytical techniques can provide detailed information about fouling composition and characteristics. These techniques are useful for understanding fouling mechanisms and developing targeted mitigation strategies. Commonly employed methods include:

Fouling deposit analysis: Analyzing fouling deposits through techniques such as scanning electron microscopy (SEM), X-ray diffraction (XRD), or Fourier-transform infrared spectroscopy (FTIR) can identify the composition, morphology, and structure of fouling deposits. This information aids in determining appropriate cleaning methods and preventive measures.

Fluid analysis: Analyzing the fluid circulating in the heat exchanger can provide insights into fouling precursors, such as dissolved solids, particulate matter, or microbial activity. Regular fluid sampling and analysis help monitor fouling potential and identify trends that require attention. Early detection of fouling in heat exchangers is crucial for maintaining optimal performance and minimising associated costs.

Effective cleaning techniques to ensure optimal performance

Regular cleaning of heat exchangers is essential to maintain efficient heat transfer and prevent the negative impacts of fouling. Cleaning techniques tailored to the specific type of fouling and heat exchanger design can help remove deposits and restore optimal performance. There are various effective cleaning methods for heat exchangers, ensuring their longevity and optimal operation.

Mechanical cleaning: Mechanical cleaning methods involve physical removal of fouling deposits from heat exchanger surfaces. Common techniques include:

- a) **Brushing and scrubbing:** Manual brushing or scrubbing with appropriate tools, such as wire brushes or scrub pads, can effectively remove loose or lightly adhered deposits. This method is suitable for accessible surfaces and areas with less severe fouling.
- b) **High-pressure water jetting:** Water jetting at high pressures can dislodge and remove more tenacious deposits from heat exchanger surfaces. The forceful water stream breaks down fouling and flushes it away, restoring heat transfer efficiency. Care should be taken to avoid damaging sensitive components or thin-walled tubes.
- c) **Chemical cleaning:** Chemicals can aid in loosening and dissolving fouling deposits, facilitating their removal. Acid-based or alkaline cleaning solutions are commonly used, depending on the nature of the fouling. Chemical cleaning requires careful handling, proper dilution, and adherence to safety guidelines to protect personnel and prevent equipment damage.

Ultrasonic cleaning: Ultrasonic cleaning is a process that uses high frequency sound waves, typically above 20 kHz,

to clean objects. The process involves immersing the object to be cleaned in a tank filled with a cleaning solution and then applying ultrasonic waves to the solution. These waves create high-pressure bubbles in the cleaning solution, which implode when they are exposed to the surface of the object to be cleaned. This implosion creates tiny cavitation bubbles that remove dirt, grease, and other contaminants from the surface of the object.

Chemical cleaning: Chemical cleaning involves the use of specialized cleaning agents or solutions to dissolve and remove fouling deposits. Different types of fouling may require specific chemical treatments:

- a) **Acid cleaning:** Acid-based solutions, such as citric acid, hydrochloric acid, or phosphoric acid, are effective in removing scale deposits and mineral-based fouling. Acid cleaning dissolves the deposits, allowing them to be flushed away with water. Proper safety precautions and neutralization of residual acids are essential to prevent equipment damage and ensure worker safety.
- b) **Alkaline cleaning:** Alkaline cleaners, such as sodium hydroxide or potassium hydroxide, are effective for removing organic fouling, oils, greases, and biofilms. Alkaline cleaning solutions emulsify and dissolve organic matter, making it easier to flush out of the heat exchanger. Appropriate safety measures and proper rinsing are necessary to neutralize any remaining alkaline residues.

Steam cleaning: Steam cleaning utilizes high-temperature steam to remove fouling deposits. The heat and moisture in the steam soften and loosen the deposits, allowing them to be easily removed. Steam cleaning is suitable for removing greases, oils, and some types of organic fouling. Care should be taken to prevent damage to sensitive components or materials that may be affected by high temperatures.

Electrochemical cleaning: Electrochemical cleaning methods, such as electrolysis or electrochemical dissolution, use an electric current to remove fouling deposits. This technique is effective for removing mineral-based scale deposits and can be applied to heat exchanger components immersed in a suitable electrolyte solution. Electrochemical cleaning requires expertise and proper electrical safety precautions.



⚡ Mechanic is cleaning condenser tube of Chiller - HVAC System.



➤ New but not yet painted mounted heat exchanger is connected to piping in a plant for refining.

Strategies for long-term efficiency

Preventing fouling is key to maintaining optimal performance and prolonging the lifespan of heat exchangers. There are various effective strategies for preventing fouling, ensuring long-term efficiency and reducing maintenance requirements.

Proper fluid treatment: Proper treatment of fluids circulating through heat exchangers is crucial in preventing fouling. Implementing the following measures can help minimize fouling potential:

- a) **Filtration:** Installing appropriate filters to remove particulate matter and suspended solids from the fluid can significantly reduce fouling. Filters should be regularly inspected and cleaned or replaced as necessary to maintain their effectiveness.
- b) **Water treatment:** Treating water to control the levels of dissolved minerals, such as calcium and magnesium, can prevent scale formation. Techniques like water softening reverse osmosis, or ion exchange can effectively reduce mineral concentrations, minimizing scale deposition on heat exchanger surfaces.
- c) **Biocide treatment:** Incorporating biocides or antimicrobial additives in the fluid can help control microbial growth and prevent biofilm formation. This is particularly important in applications where biological fouling is a common issue.

Adequate flow velocity: Maintaining an appropriate flow velocity within the heat exchanger is essential for preventing fouling. Sufficient flow rates help deter the deposition of fouling deposits on heat transfer surfaces by keeping the fluid in a turbulent state. This turbulent flow disrupts the adhesion of particles and inhibits fouling formation.

Surface modification: Surface modifications can be employed to enhance the resistance of heat exchanger surfaces to fouling. Some effective strategies include:

- a) **Surface coatings:** Applying specialized coatings, such as anti-fouling paints or polymer coatings can create a protective barrier that resists fouling adhesion. These coatings reduce surface roughness and promote easy release of deposits, making cleaning more efficient.
- b) **Surface energy alteration:** Modifying the surface energy of heat exchanger materials can discourage fouling. For

example, hydrophilic coatings or surface treatments can prevent the formation of hydrophobic fouling deposits.

- c) Some common types of coatings that are used to prevent fouling in heat exchanger components are:
 - i. **Non-stick coatings:** Non-stick coatings are designed to make the surface of the component resistant to adhesion, making it difficult for fouling agents to stick to the surface. These coatings are typically made of polymers such as polytetrafluoroethylene (PTFE), commonly known as Teflon, and can be applied by techniques such as spraying or electroplating. Non-stick coatings have low surface energy, which means they are easy to clean and prevent fouling caused by sticky or viscous fluids.
 - ii. **Hydrophobic coatings:** Hydrophobic coatings repel water and other fluids, which reduces the surface tension and makes it difficult for foulants to stick to the surface. These coatings are typically made of silicone or fluoropolymer materials and can be applied by techniques such as spray coating or dip coating. Hydrophobic coatings are effective in preventing fouling caused by water-based fluids.
 - iii. **Anti-fouling coatings:** Anti-fouling coatings are specifically designed to prevent fouling in heat exchanger components. These coatings typically have low surface energy and are resistant to chemicals and high temperatures. Anti-fouling coatings can be made of different materials such as polymers, ceramics, or metals, and can be applied by techniques such as spray coating, electroplating, or chemical vapor deposition. These coatings prevent fouling by creating a barrier between the component and the fluid flowing through it.

Regular cleaning and maintenance: Implementing a proactive cleaning and maintenance schedule is vital for preventing fouling. Regular inspections, cleaning, and maintenance procedures should be conducted to remove any initial fouling deposits before they become more stubborn and difficult to remove. Monitoring performance indicators, such as pressure drop and temperature differentials, can help identify signs of fouling and trigger timely maintenance interventions.

Conclusion

Taking preventive measures not only improves heat transfer efficiency but also extends the lifespan of heat exchangers, resulting in cost savings and enhanced operational reliability. By prioritizing fouling prevention strategies, industries can optimize heat exchanger performance and maintain efficient operations for years to come. ■

About the author

Omari Hussein Sabuni is an experienced mechanical engineer at Kinyerezi Gas Power Plant, specializing in heat exchanger design, optimization, troubleshooting and providing practical solutions for various heat exchanger problems. He is skilled in analyzing thermal systems and developing innovative solutions to enhance heat transfer efficiency and adept at conducting feasibility studies, performing risk assessments, and ensuring compliance with industry standards.



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100th anniversary for Type-B nickel-base (Ni-Mo) alloys

Prior to the introduction of the workhorse C-family of nickel-base alloys (Ni-Cr-Mo) in the early 1930s, work had been conducted on nickel-molybdenum alloy compositions. This resulted in the award of a patent, in 1921, for a nickel-molybdenum alloy composition range, which ultimately led to the introduction of Alloy B (Ni-Mo) in 1923 with a nickel content of 60% and nearly 30% molybdenum.

By Geir Moe, Nickel Institute

B-type alloys possess exceptional resistance to reducing acids, such as hydrochloric, sulphuric, acetic, and phosphoric. Unfortunately, B-type alloys have poor corrosion resistance to oxidising environments. Hence, they are not recommended for use in oxidising media or in the presence of ferric or cupric salts which may cause rapid premature corrosion failure. These salts may develop when hydrochloric acid comes in contact with iron and copper.

Prior to the Second World War, Alloy B was used in supercharger turbine blades in aircraft engines to boost performance and increase horsepower. This application was eventually replaced by other superalloys.

Alloy B-2, introduced in the 1970s, was a modification of the original B composition. It featured reduced silicon and carbon content, to improve thermal stability and resist the formation of grain boundary carbides. This improvement in corrosion resistance was particularly beneficial in the heat-affected zone after welding.

The composition was additionally optimised in Type B-3 to further enhance thermal stability and fabrication characteristics and resistance to stress corrosion cracking. Molybdenum primarily provides the corrosion resistance to acidic reducing environments, but it is the nickel-base that provides the foundation for an engineering alloy that can be easily fabricated and welded into industrially useful equipment. ■

Alloy	(UNS)	Introduction	Ni	Mo	Cr	Si max	Fe	C max
B	(N10001)	1923	bal	28	1	1	5	0.05
B-2	(N10665)	1970s	bal	28	1	0.10	2	0.02
B-3	(N10675)	1990s	bal	28	2	0.10	2	0.01

⚠ Typical composition of the B-family alloys.



⚠ The B-type alloys have been used mainly in hydrochloric and sulfuric acid environments, as well as in acetic, phosphoric, and formic acids. Specific applications include reaction vessels, heat exchangers, valves, pumps, and piping.

About Nickel Institute

The Nickel Institute is the global association of leading primary nickel producers. Its mission is to advocate for the responsible supply and sustainable development of nickel and the nickel industry. For information, visit nickelinstitute.org



Modern petrochemical heat exchangers in AISI 310

Heat exchangers transfer thermal energy in both heating and cooling processes. Due to the wide variety of processes in the chemical and petrochemical industries, knowledge of the materials used in the design of heat exchangers is of paramount interest to fabricators.

By Srikumar Chakraborty - ex ASP/SAIL, freelance consultant

Heat exchangers transfer heat between media, which may be a gas, liquid, or a combination. Fouling undermines heat exchange efficiency. Corrosive fluids associated with intensified fouling may be due to the selection of improper or sub-standard materials, design flaws leading to variable heat transfer, flow resistance degradation, and drops in pressure.

When designing the thermal and mechanical properties of heat exchangers, reputable manufacturers consider process characteristics such as fouling rates and the acidic corrosivity of fluids, taking guidance from their R&D team.

Heat exchanger equipment

Heat exchangers are widely used in the petrochemical, chemical and refining industries where chemical technology

processes (evaporation, rectification, drying, etc.) are associated with the need for heat supply or removal.

Physical properties – High heat transfer coefficient (requiring high thermal conductivity for tube/ pipe material), as low thermal expansion coefficient as possible considering the materials used for tube/sheet plates, tube support and shell to provide resistance to thermal cycling.

Mechanical properties – Good tensile and creep strength properties (high creep rupture strength at the highest temperature of operation and adequate creep ductility to accommodate localised strain at notches). Good fatigue, corrosion fatigue and creep-fatigue behaviour.

Most austenitic stainless steels with a chromium (Cr) content of at least 18% can be used at temperatures up to 870°C, while grades 309 and 310 can tolerate temperatures up to 1150 -1200°C. The high fracture toughness and impact strength of grade 310 means it has good resistance to fractures. The low corrosion rate minimises the corrosion allowance required. Grades 309 and 310 also offer corrosion resistance to abnormal chemistry, which may result from upstream leaks or chemistry control failures resulting from a mix-up of shell and tube fluids.

☛ Table 1. Maximum service temperature (°C) in austenitic grade stainless steel

Grade	Intermittent	Continuous
304	870	925
309	980	1095
310	1035	1150
316	870	925
321	870	925

ASM Metals Hand Book

Material selection for heat exchangers

A general procedure for identifying the most appropriate material for a heat exchanger application would consider the following:

1. Requirements of the heat exchanger;
2. Strategy evaluation;
3. Raw material selection;
4. Cost calculation;

While an assessment of costs for any equipment breakdowns or tube replacement should be considered, the raw material selection factors affect the performance of the heat exchanger.

Heat exchangers account for over 30% of the total market share of petroleum and chemical products requiring heating, cooling, or condensation processes. They play an essential role in product quality and process economy by utilising heat. The trend is for heat exchangers to develop towards large-scale, high-efficiency, high-alloyed products with low-temperature difference and low-pressure loss. In many situations, particularly offshore and remote locations, heat exchangers can be configured to provide maximum heat transfer for a minimal footprint while maintaining safety. Although stainless steel grade 310 is subject to stress corrosion cracking, it is more resistant than grades 304 or 316. It has good resistance to oxidation in intermittent service in air at temperatures up to 1040°C and in continuous service at 1150°C. It also has good resistance to thermal fatigue and cyclic heating, exhibiting remarkable flexibility, durability, toughness, high tensile strength, corrosion resistance and stability at elevated temperatures.

Heat exchangers manufactured from stainless grade 310 are used for cooling and heating processes in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical units, petroleum refineries, natural gas, heat treatment furnace parts and sewage treatment. A classic example of a heat exchanger is an internal combustion engine in which a circulating fluid known as engine coolant flows through radiator coils. Air flows past the coils, which cools the coolant



☞ Stainless steel tubes

and heats the incoming air. Another example is a heat sink, a passive heat exchanger that transfers the heat generated by an electronic or mechanical device to a fluid medium, often air or a liquid coolant.

Properties

Stainless steel 310/S products are non-magnetic as annealed and become lightly magnetic if cold-worked. The difference between grades 310 & 310S (described as a low-carbon version of 310) is the carbon content. Both grades are used in high-temperature applications. The lower carbon content of 310S minimises carbide precipitation and improves weldability. The mechanical properties for both grades are the same. Both grades contain 25% Cr and 20% Ni, making them highly resistant to oxidation and corrosion. Grade 310S is less prone to embrittlement and sensitisation in service. The high Cr and Ni content make these steels suitable for applications that reduce sulphur atmospheres containing H₂S. Both are widely used in moderately carburising atmospheres, as encountered in petrochemical environments.

For more severe carburising atmospheres, grade 310 is not recommended for frequent liquid quenching as it suffers from thermal shock. The grade is often used in cryogenic applications due to its toughness and low magnetic permeability. Similar to other austenitic stainless steels, heat treatment cannot harden these grades. They can be hardened by cold work, although this is rarely done in practice.

Grade 310/S for heat exchangers

While designing and constructing heat exchangers, it is necessary to satisfy the multilateral and often contradictory requirements as far as possible. The main issues are compliance with the conditions of the technological process, a possibly higher heat transfer coefficient, low hydraulic resistance, resistance of heat

☛ Table 2. Chemical composition & mechanical properties (primary alloying elements being Cr & Ni)

Composition %	C	Mn	Si	P	S	Cr	Ni
Stn310	0.25 max	2.0 max	1.5 max	0.045 max	0.030 max	24-26	19-22
Stn310S	0.08 max	2.0 max	1.5 max	0.045 max	0.030 max	24-26	19-22

Tensile strength - 520MPa min, Yield strength - 205 MPa min	% Elongation – 40 Hardness -205 BHN	PREN 25, & in Sea water 22 similar to 316 grade
-------------------------------------------------------------	-------------------------------------	-------------------------------------------------

exchange surfaces against corrosion, accessibility of the heat transfer surface for cleaning, manufacturability of structure from the point of view of fabrication, and the economical use of costly materials. This final point requires the consideration of factors including:

1. Fabrication characteristics – Stainless grades 310 and 310S rolled pipe, tube, plate/sheet in bent condition, and any forged component can be fabricated by cutting the products as designed, as these grades can withstand working temperatures in the range of 975-1175°C. Heavy work is carried out down to 1050°C by standard methods and equipment.
2. Machining – the machinability of grades 310 and 310S is similar to that of grades 304 and 316. Work hardening can be a problem, and it is customary to remove the work-hardened layer using slow speeds and heavy cuts with sharp tools and good lubrication. Powerful machines and heavy, rigid tools are used.
3. Weldability – Grade 310/310S products in any shape are a great way to connect two pieces of metal and have many advantages over other welding methods. Grade 310 is corrosion and heat-resistant, does not require a heat treatment step, and can be welded using various welding equipment. It is also ideal for projects that involve environmental protection and safety aspects.

Stainless 310/310S grade is welded with matching electrodes and filler metals. Products are readily welded by standard welding manuals using techniques such as GMAW (MIG), GTAW (TIG) and SAW. Preheat and post-heat are not required, but post-weld solution

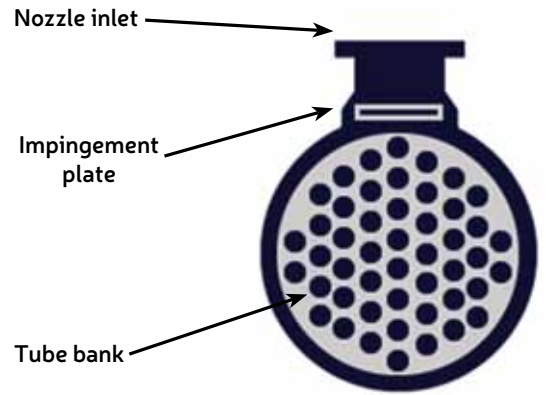


Figure 1. Sectional view of a heat exchanger

annealing is essential for corrosion service in liquids. Pickling and passivation of the surface to remove high-temperature oxides are necessary to restore complete aqueous corrosion resistance after welding. This treatment is not required for high-temperature service, but welding slag should be thoroughly removed. Grades 310/310S are solution annealed by heating to 1040-1065°C, holding at temperature until thoroughly soaked, then water quenching.

Design and fabrication

The primary function of heat exchangers in the petrochemical industry is solvent condensation undergoing chemical cooling and heating reactors. The design of the equipment is based on temperature ranges,



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▲ Steel welding fittings

product mix, pressure drops across the exchanger, fluid flow capacity, cleanability, repair and maintenance. Seamless or welded tubes of suitable materials are used without compromising quality during manufacture.

Fouling problems – cause & remedy

Fouling is a membrane separation phenomenon resulting from several mechanisms: precipitation of sparingly soluble salts, adsorption, cake or gel formation, and pore blockage because of the composition of the water in the system, causing a decrease in the heat transfer coefficient with time. Klarex’s (Netherlands) self-cleaning heat exchanger consists of a design that reduces the surface area by approximately 20%.

Scaling occurs because the water flowing through the heat exchanger contains impurities such as calcium carbonate, magnesium, chloride or iron. Fouling represents the theoretical resistance to heat flow due to a build-up of

a layer of dirt or other fouling substance on the tube surfaces of the heat exchanger.

A method for reducing the formation of deposits on the inner walls of a tubular heat exchanger through which a petroleum-based liquid is flowing comprises applying fluid pressure pulsations to the liquid flowing through the tubes of the exchanger and vibration to the heat exchanger to effect a reduction of the viscous boundary layer adjacent to the inner walls of the tubular heat exchange surfaces. Reduction of the viscous boundary layer at the tube walls not only reduces the incidence of fouling with a resulting beneficial effect on equipment life, but it also has the desirable effect of promoting heat transfer from the tube wall to the liquid in the tubes. Using a coating on the inner wall surfaces of the exchanger tubes may further reduce fouling and corrosion.

Conclusion

The high nickel content of austenite 310 grade is superior to grades 304, 316, 321 and 309. It combines high corrosion resistance and high-temperature properties with good ductility and fabrication characteristics. Due to the chemical composition of this grade, with chromium up to 25% and nickel up to 20%, products manufactured in grade 310 provide solid corrosion resistance, excellent resistance to oxidation, and superior strength at high temperatures up to 1150°C. High nickel (25+%) alloys are most commonly used to construct process equipment, including heat exchangers, when superior corrosion resistance and high-temperature mechanical properties are required. ■





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Super efficient custom tube heat exchangers

The Ekin Endustriyel team rolled up their sleeves for a heat recovery project in a textile plant in Bursa, Turkiye, applying their expert engineering knowledge in the field of energy efficiency.

By Enes Kuzey Er, Ekin Endustriyel

Due to the compactness of the design, this kind of heat recovery system is ideally suited to facilities which value the environment and are keen to preserve resources. An additional bonus is that in many countries, local governments support investments in this type of technology, which assists companies in fulfilling their aims of lowering carbon and other greenhouse gas emissions.

The heat recovery systems, which in this case were specifically designed for the textile industry customer, can be manufactured in various configurations depending on the process details and facility layout.

The heated oil and air resulting from the operation of the compressors contain a large amount of energy, which is recovered using a 3-stage heat exchanger system. This has resulted in significant savings in energy costs as the recovered waste heat provides hot water for the facility rather than using natural gas.

Three stage process

In the first stage, air at approximately 80 °C from each compressor flows through MIT shell and tube heat exchangers, heating the water. Two heat exchangers were designed for each of the two separate compressors. The exchangers measure DN150*1250 mm, are type BEM (TEMA) and are constructed from SF-Cu grooved

tubes (EN-12449) with an S235JR shell (EN-10217). Approximately 35 kW of heat is recovered with each exchanger at this stage.

In the second stage, the compressor recovers the hot oil in a closed cycle. At approximately 80°C, the oil passes through the primary circuit, and the water heated in the first stage passes through the secondary circuit. For this stage, two highly efficient MIT Plate Gasketed heat exchangers were deployed, and 150kW heat recovery per exchanger was achieved.

In the third and final stage, the water heated by the first two stages passes through a single heat exchanger constructed entirely in stainless steel. A custom-designed MIT Tubular Series heat exchanger heats both hard water and soft water while keeping them separated. The exchanger measures DN200*2950 mm and is type BEM (TEMA). The construction material was AISI 316 (EN-10216) for the tubes and AISI 304 (EN-10217) for the shell.

Clean water entering the system at 20 °C was heated to 50 °C, and a total heat transfer of approximately 350 kW was achieved.

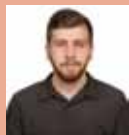
Energy savings

After passing through a stainless heat exchanger, the recovered clean hot water is used as domestic water by the facility. In this way, the business achieves significant reductions in fuel costs. The payback time of the system is calculated at approximately 14 months.

Another advantage of the system may yet emerge, as the hot water obtained in the second stage may eventually be used for other applications in future. ■

About the author

Enes Kuzey Er is a Heat Transfer Product Sales - R&D



Specialist at Ekin Endustriyel, responsible for the sale of heat transfer products such as plate heat exchangers (gasketed or brazed) and shell and tube heat exchangers. He also finds solutions for industry needs based on customer feedback and provides support for R&D processes.



✦ The 3-stage heat exchanger system has resulted in significant savings in energy costs.



Dynamic heat exchanger market drives the trend towards welded stainless steel tubing

The dynamic growth of the heat exchanger market poses new challenges for manufacturers as well as opens new doors and opportunities. Schoeller has anticipated the rising market needs and outlined the increasingly important role of stainless steel in heat exchangers.

By Timo Klein, Strategy & Marketing Manager - Schoeller

The market for heat exchangers is growing dynamically both globally and in Europe, especially in Germany. Forecasts predict an annual growth rate of 7 to 8 %. But where is this sharp rise in demand coming from? After all, heat exchangers have always been an important element of all major process industries around the world and are used in the oil and gas industry and in the energy, chemical, food, heating, ventilation and air conditioning (HVAC) and shipping sectors, among others.

The resurgence in demand for energy, which is still predominantly generated using fossil fuels, is making a major contribution to the current trend at a global level. On the German and European heat exchanger market, however, the drivers are different. Here, demand is being driven primarily by rising environmental standards in the supply of heat to buildings and the trend towards reducing CO₂ emissions in the industrial sector. The laws passed by the German government, such as the Energy Efficiency Act (EnEFG), the Building Energy Act (GEG), are providing significant impetus. In addition, due to geopolitical changes, Europe must rely on new energy sources such as LNG, which requires additional infrastructure and represents a further sales market for heat exchangers.

Stainless steel as a key material

The heat exchanger market can be segmented into steel, copper, aluminium and other materials depending on application. The steel segment accounts for the largest share, as steel-based heat exchangers have high mechanical strength and excellent corrosion resistance. Stainless steel, in particular, has very good thermal conductivity and is therefore the optimal choice for heat exchangers that must withstand very high temperatures, extreme burst pressure and harsh environments. Unlike aluminium and copper, it retains its mechanical strength even at high temperatures, improving the performance of heat exchangers and helping to reduce the risk of deformation.

But that's not all. There are other trends that are currently influencing the heat exchanger market: The requirements of industrial processes and the environment in which heat exchangers are used are constantly changing. For example, increasingly compact designs with significantly tighter material tolerances can be observed, particularly in applications in the chemical and energy industries.

All of these requirements contribute to the specific properties of stainless steel and promote market growth in this segment. Welded stainless steel tubes are increasingly being used here, replacing the higher-priced seamless stainless steel tubes more and more often. This is because premium manufacturers such as Schoeller, with their expertise and production technology such as TIG or laser welding technology, can produce welded stainless steel tubes with outstanding mechanical properties that are comparable with the properties of seamless tubes in terms of further processing as well as reliability, durability and efficiency in the construction of heat exchangers.

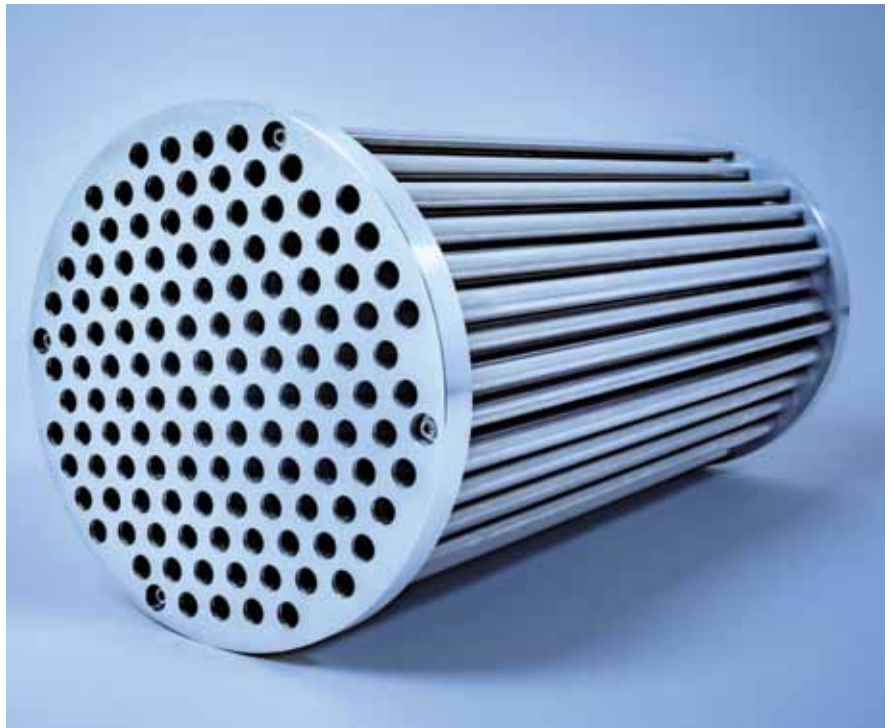
Rising demand drives quality and reliability

Successfully serving this market segment requires more than just the appropriate manufacturing expertise and the necessary production machinery. We are observing three other areas that are becoming increasingly important for the consumers of stainless steel tubes for heat exchangers:

- Expert material and product advice in combination with expertise in special materials and the supply of individual, customised tube lengths.
- Quality, strength, the tightest tolerances and therefore 100% guaranteed compatibility in the customer’s manufacturing process. This also includes perfect seam smoothing.
- Customer-centred, flexible logistics solutions that respond individually to the customer’s production and order situation and guarantee maximum delivery reliability despite short delivery deadlines.

This combination of material and manufacturing expertise, as well as optimised processes from order acceptance to logistics, are the necessary prerequisites for being able to benefit from the current dynamic development in the market for heat exchangers. This requires dedication to meet the highest demands, which include products with maximum corrosion resistance, functionality and process reliability as well as tight geometric tolerances and flawless surfaces in consistently high, reproducible quality. Such a performance promise also requires regular investment in machinery and reliable delivery performance thanks to sophisticated logistics concepts.

Only with such a setup are companies able to position themselves for the upcoming trends and to be accepted as premium suppliers by the customers. Think of



⚡ *Welded stainless steel tubes reliability and efficiency in the construction of heat exchangers. Image courtesy of Schoeller.*

LNG, the ramp-up of the hydrogen economy or heat pump technology - heat exchangers play an important, if not central, role in each of these segments. And in all of these applications, customers have high requirements not only for materiality, manufacturing tolerances and corrosion resistance, but also for processes and reliability combined with a high degree of flexibility. ■



⚡ *Laser welding technology promotes outstanding mechanical properties in stainless steel tubes. Image courtesy of Schoeller.*

About the author



Timo Klein has been working at Schoeller Werk for about 4 years. He studied Business Administration at the Bonn-Rhein-Sieg University of Applied Sciences. As Strategy & Marketing Manager at Schoeller, Timo is responsible for the company’s marketing and PR/public relations as well as for the “Strategy” division and thus for Schoeller’s strategic positioning.

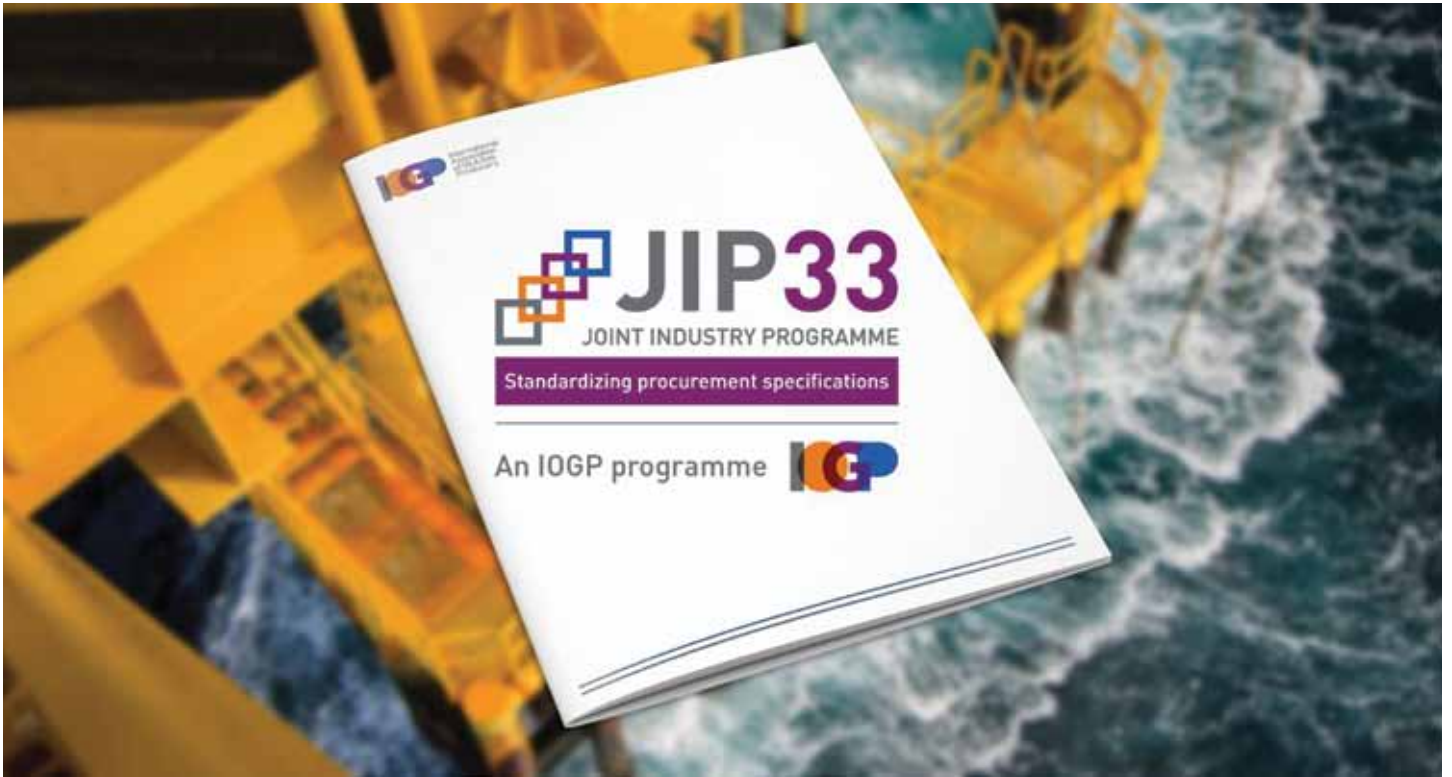


Image ©IOGP

JIP33 Specification published: S-749 Plate-and-frame Heat Exchangers (API)

Joint Industry Programme 33: Standardizing Procurement Specifications was initiated to make step-change improvements in the specification, procurement and delivery of equipment for the oil and gas industry through the use of standardized industry procurement specifications.

Together with a purchase order, they define the overall technical specification for procurement. They are developed in consultation with a broad user and supplier base to realize benefits from standardization and achieve significant project and schedule cost reductions.

Text by IOGP

JIP33 has published the S-749 Plate-and-frame Heat Exchangers (API) specification.

The purpose of the IOGP S-749 specification documents is to define a minimum common set of requirements for the procurement of plate-and-frame heat exchangers in accordance with API Standard 667, First Edition, March 2022, Plate-and-Frame Heat Exchangers, for application in the petroleum and natural gas industries

About JIP33 specifications

JIP33 standardized specifications follow a common structure, normally comprising four documents:

- Supplementary specification
- Quality requirements
- Information requirements and;
- Procurement Data sheet

This specification comprises of one additional version with justifications pertaining to the Supplementary Specification.

IOGP Library

Any previous versions of any of the JIP33 specifications can be found in the JIP33 Archives within the IOGP Library.

More than 55 specifications have now been published to date and are already delivering benefits for users worldwide, with another 9 in development (including scope expansion) and 10 in maintenance.

All published JIP33 specifications are available to download for free, either by using the newly created QR code, or via the JIP33 Specification Library. ■



JIP33 Specification Library

Zero-fouling with hard water cooling

In this case study, TAPROGGE* explains how it was able to achieve up to zero-fouling operations at a dairy plant by using its KLAREN self-cleaning heat exchanger technology.

All text and images provided by TAPROGGE GmbH

A dairy plant in the USA suffered from severe fouling of three condensers used for condensing the vapor of a multi-effect falling film evaporator due to hard well water used for the cooling process. Hard well water is water that originates from a well and contains a high mineral content, especially calcium and magnesium ions. When hard water is employed as a coolant in a condenser, these minerals can scale on the surfaces, diminishing the efficiency of heat transfer and potentially causing operational issues.

Problem

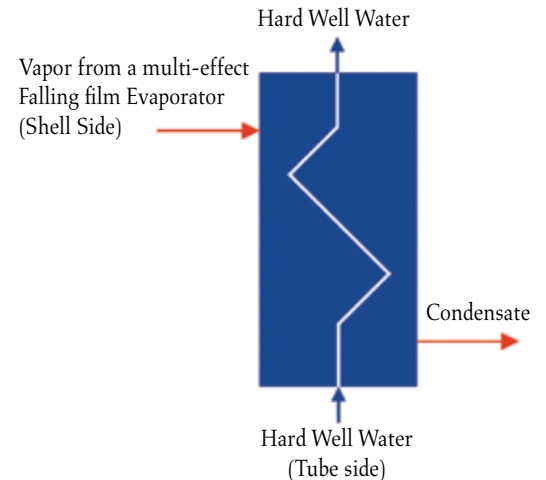
The hard well water that is applied in the condensers has a hardness of 7-8 grain per gallon (gpg) and led to rapid scaling, reducing the cooling capacity significantly in a matter of days. One grain per gallon (gpg) is equivalent to 17.14 parts per million (ppm). Water hardness can be measured in gpg or ppm, but gpg is the most used measurement. Various conventional solutions (for example regular cleaning, optimizing process conditions, etc.) had been tried by the customer to prevent this fouling problem, however without success. Plant management decided to replace their fouling conventional condensers by self-cleaning fluidized bed heat exchangers.

Results

All three exchangers went into operation without any problems and were only opened once to twice a year for

⚡ Table 1. KLAREN Technology dairy plant self-cleaning condenser operation.

Industry	Dairy (food)
Application	Hard well water condenser
Product	Self-cleaning Condenser
Location	USA
Year of Installation	1988
Additional Purchase	2023



⚡ Condenser system.

inspection. The units operate 85% of the time and are still running (as of 2023 from 1988) to the satisfaction of the customer.

The plant expresses that they are satisfied with the performance and operation of the heat exchanger. Fouling has never been observed, contrary to earlier experiences with conventional exchangers that required a lot of maintenance on a regular basis.

The self-cleaning heat exchanger technology helped the customer to achieve up to zero-fouling operations. ■

⚡ Table 2. Condenser system details.

Parameters	Condenser		
	I	II	III
Tube Side	Hard Well Water		
Shell Side	Vapor		
Number of Tubes	7	19	19
OD/ID Tubes (mm)	51 x 1.5		60.3 x 1.5
Length Tubes (m)	6		
Heat Transfer Area (m ²)	6	18	21
Particle Size (mm)	3		



⚡ Self-cleaning condenser.



⚡ Conventional



⚡ Self-cleaning

* KLAREN Technology is one of the competence brands of Taprogge GmbH and can be applied to heaters, coolers, evaporators, crystallizers, reboilers and condensers.



Supporting Simpsons Malt with renewable energy solutions

An ambitious target to achieve carbon neutrality by 2030 led a British whiskey distillery to implement an innovative heat-recovery system.

By Sam Rippin, Turnbull & Scott

The team at Turnbull & Scott received an enquiry from Simpsons Malt, a renowned supplier of high-quality malts who they have long supported, and for whom they have become a Trusted™ supplier. Simpsons Malt shared their ambitious plans to meet their sustainability goals, ultimately achieving carbon neutrality by 2030 across their malting sites.

Their plans involved commissioning a low-carbon Energy Centre at the Tweed Valley Maltings site in Berwick. This setup aims to save 25,000 tonnes of carbon annually, translating to an approximate 80% reduction in carbon emissions at the UK's largest malting site.

Traditionally in the UK, malt is dried in kilns fed with a hot air stream. The air is heated to the required temperatures using a series of gas-fired burners. This

plan includes the implementation of a pioneering 12MW electric boiler powered by 'curtailed' wind energy alongside three 6MW biomass boilers, utilising locally sourced, low-grade woodchip to replace the gas consumption of the burners.

Groundbreaking initiative

In this groundbreaking initiative, the high-voltage electric boilers would be powered by wind energy, which traditionally would have been switched off during excess wind generation, addressing the issue of renewable energy wastage in the UK's energy grid. The challenge for Turnbull & Scott is to help Simpsons Malt redesign the air intake stream to allow 80% of the heat required to be delivered in the form of low-pressure hot water from the Energy Centre, rather than the traditional gas burners.

The solution

The team quickly mobilised to assist Simpsons in developing an innovative malt drying solution that fitted with their plan to electrify the industrial air

heating process and harness renewable wind energy efficiently. A specialist design team at the company's Edinburgh Design Hub undertook thermal modelling to determine the size and geometry of the heat exchangers which would be required for the upgraded malting kilns.

A plan was developed to use custom-designed LPHW heating coils for the malting kilns, which would be crucial in enhancing the traditional kilning stage of the malting process. A concern expressed by the client was that any alteration to the airflow could impact on the drying process of the product. It was therefore vital that the Turnbull & Scott team understood the impact of the heat exchangers on the air-side pressure drop.

Working collaboratively with the client, project funders, and EPC's design teams, the team reviewed CFD analysis on airflow and pressure drops to hone the heat exchanger geometry to optimise airflow and thermal performance.

To guarantee the performance of the heat exchangers, a wind tunnel was constructed, and prototype heat exchangers were produced to test and validate the pressure drop performances.

Unique plate-fin coils

Renowned for designing and manufacturing highly durable industrial coils, the Turnbull & Scott solution is to supply unique plate-fin coils with steel-encased tube header design, incorporating the taper ferrule joint.

The company will deliver 30 custom-designed LPHW plate-fin air heating coils for the malting kilns. These coils aim to ensure integrity at high temperatures and pressures, overcoming the challenge of traditional return bends which are known for their fragility.

The products will be delivered to the site for the customers by May 2024, contributing significantly to the project's goal of blending traditional and modern technology to reduce carbon emissions substantially.

Achieving carbon-neutral goals

"This collaboration with Turnbull & Scott marks a significant stride towards our carbon-neutral goal, blending cutting-edge technology with time-honoured traditions," stated Steven Rowley, Operations Director, Simpsons Malt Limited.

"Our partnership is a testament to the power of innovation, and we're optimistic about embarking on more sustainable journeys together." ■

"This collaboration blends cutting-edge technology with time-honoured traditions"
– Steven Rowley, Simpsons Malt.



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Introducing Cr-Ni-Mo alloy UNSN06059 for seamless heat exchanger tubes

Stainless steels alloyed with a high percentage of Chromium, Nickel, and Molybdenum have been widely popular as a material in the construction of heat exchanger tubing (as well as pipes, fittings, plates, and more) for demanding and highly corrosive process conditions such as acids and salts, as well as operating in high temperatures. The two most used alloys in this segment are UNS N10276 and UNS N06022. Another alloy, UNS N06059, is gaining popularity as a material used in severe corrosive environments.

Venkat Ramesh – Global Product Manager (Heat Exchanger tubing) and Shabareesh Nair – Director (Technical Marketing Asia), Tubacex Group, Spain

UNS N06059, also referred to as Alloy 59, is a suitable alternative within Chromium, Nickel, and Molybdenum alloys depending on process conditions. This gives flexibility to material selection engineers on the choice of material depending on technical and commercial aspects. This material has been used for many years, mostly in the form of plates or welded tubes. This article will discuss its suitability for seamless tubular applications.

UNS N06059 has good resistance against a multitude of corrosive media under oxidizing and reducing conditions, against chlorine-induced pitting and crevice corrosion, as well as resistance against stress cracking. This alloy was already used in the fertilizer industry for melamine processes and in the power generation industry for Flue Gas Desulphurization applications (plates and welded tubes).

It was then explored for other applications within the mid- and downstream hydrocarbon industry, working with formic, acetic, hydrochloric, and sulfuric acid, and more. This article highlights the corrosion properties and applications of Alloy 59 in the stainless steel seamless tube category in more detail.

Critical alloying elements

Extremely low carbon and silicon mean there is no tendency for grain boundary corrosion. A high percentage of Chromium, Molybdenum, and Nickel lead to a high resistance to chlorides. Higher Molybdenum in Alloy 59 compensates for the absence

≈ Table 1 - Chemical composition (key elements)

	C Max	Cr	Ni	Mo	Co	Al	Others
N 06059	0.01	22-24	56-63	15-16.5	<0.3	0.1-0.4	Si < 0.1
N 10276	0.01	15-16.5	51-59	15-17	<2.5		W < 4.5
N 06022	0.015	20-22	51-60	12.5-14.5	<2.5		W 2.5-3.5

≈ Alloy 59 approved with both European and ASTM, Designations 2.4605/NiCr23Mo16Al, N 06059, Standard ASTM B 622.



≈ Heat exchanger assembly.



≈ Sample tubes for testing.

of Tungsten, or N10276/N06022, leading to better thermal stability.

Corrosion properties

The high chromium content gives them good anti-corrosion properties in oxidizing media, while the molybdenum content also protects them from corrosive attack in reducing media. The high nickel content makes them insensitive to stress corrosion cracking. Purest form of Cr-Ni-Mo with minimal Fe and absence of other alloys such as Cu and W (which are present in other C-Alloys). Excellent resistance

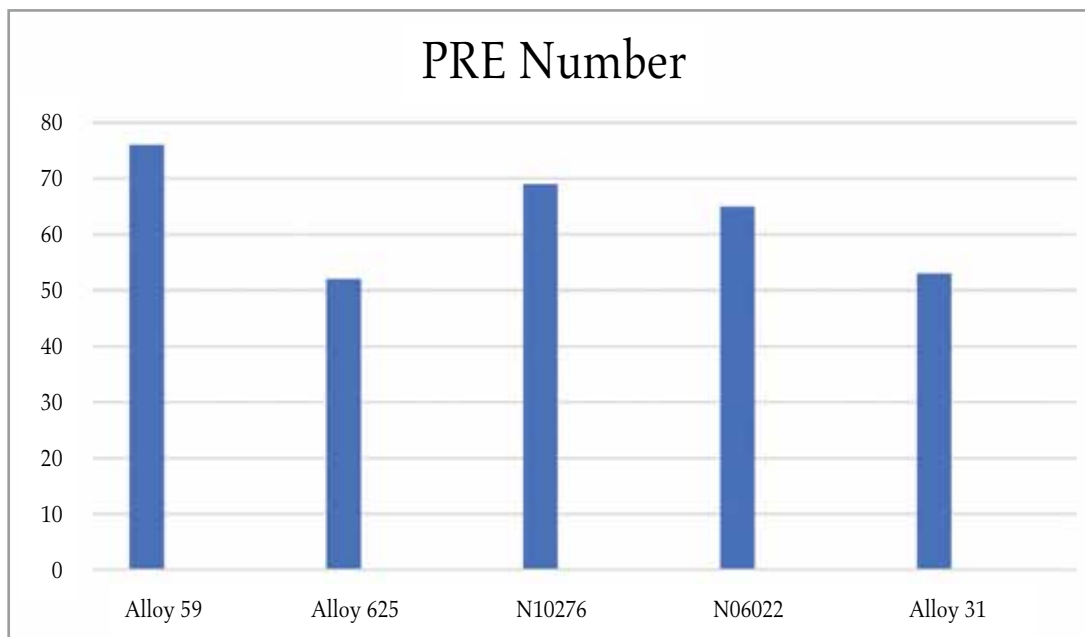


Table 2 - PRE Number (Pitting resistance equivalent) using Cr + 3.3 Mo + 30 N

Grade	PREN Range
N06059	75-77
N10276	68-70
N06022	64-66
Alloy 31	52-54
Alloy 625	51-52

Graph 1: PREN Chart

Table 3 - Mechanical Properties

	Rp0.2 Min	Rp1.0 Min	Rm	A 2" %	Impact J / Cm2
Min. req VdTÜV WB505	340	380	690-900	40	225
Min. req B 622	310	na	690	45	na
K33 (N06059)	444 (Avg)	478 (Avg)	836 Avg	62	229

Higher yield strength of Alloy 59 vs N10276/N06022 allows for use a smaller wall thickness in seamless tubular applications allowing for reduction in cost and weight.

against a multitude of corrosive media under oxidizing and reducing conditions. Outstanding resistance against chloride-induced pitting and crevice corrosion, as well as resistance against stress corrosion cracking. Excellent resistance in mineral acids such as nitric, phosphoric, sulfuric, and salt acids, but especially against sulfur/salt acid mixtures. excellent resistance in contaminated mineral acids. Good resistance to Hydrochloric acid over entire concentration range up to 40-degree C.

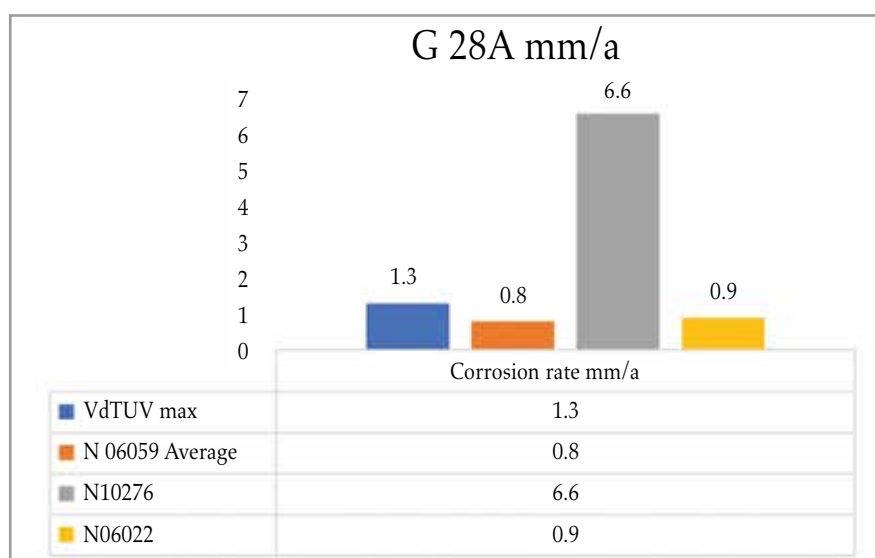
Petrochemicals—Acetic Acid/Formic Acid/Sulfonic Acid

Condensers and other components are prone to heavy corrosion when acids are contaminated by oxidizing chlorides. Formic acid reduces but can shift to oxidizing in the presence of contaminants. The use of nickel-containing stainless steels like Alloy 59 can help to mitigate corrosion in such process conditions, while corrosion severity depends on the method of acetic acid production.

Applications

Refinery

Crude Distillation Units overhead condensers are prone to hydrochloric acid condensation (dew point corrosion) leading to accelerated corrosion on tube OD side. Alloy 59 is an option in such environments and as it has good resistance to chloride induced pitting or stress corrosion which is helpful on tube ID if it has cooling water with high % of chlorides. Gas units Sulfur Condensers- Often subjected to severe corrosion due to sulfuric acid dew point corrosion. In some cases, carbon steel has life of less than one year. Alloy 59 is suitable alternative in such harsh environments. Alloy 59 can also be used in narrow temperature and concentration range for handling HF acid in Alkyl units HF catalyst. For Bio / Green diesel plants, Hydrotreating units Alloy 59 can be used for resistance to corrosion against fatty & Carbonic acids.



Graph 2: G28 Method A (resistance to intergranular corrosion). Ferric sulphate and sulphuric acid boiling test 50% H₂SO₄ + 42g/litre Fe₂(SO₄)₃

About the authors

M Venkat Ramesh, Global Product Manager, Heat Exchanger

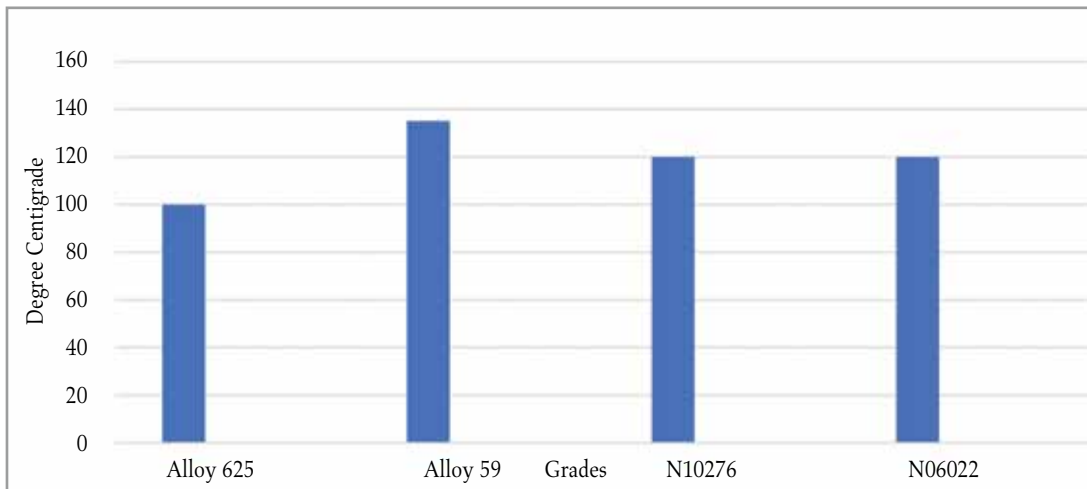


tubes, Tubacex, has worked more than 17 years in stainless seamless tube and pipe industry in different roles including Sales, Business development, Key Account, Technical marketing and as Product Manager. He has worked closely with some of the refineries and chemical companies involving suggestions and resolving corrosion issues, material testing, material upgrade suggestions etc. He has published technical articles in Leading Industrial Magazines and presented a paper at NACE in the past.

Shabareesh Nair, Technical Marketing Director-Asia, Tubacex, has a Bachelor's



in Mechanical Engineering, and a Post Graduate Diploma in Marketing Management. Having a total industry exposure of 15 years, the last 12 years have been exclusively with the Stainless Steel industry and has been associated with a similar industry before joining Tubacex. At Tubacex, responsibilities include developing hydrogen value proposition in Asia, Technical Marketing support to the regional offices in Asia and identifying and developing new business applications/opportunities.



Graph 3: CPT in green death solution- (8vol.% H₂SO₄ + 3vol.% HCl + 1% CuCl₂ + 1% FeCl₃ × 6 H₂O after repeatedly heating for 24 hours using 5 °C (9 °F) temperature increments).

Anhydrous acetic acid can increase the corrosion rate. Hot acetic acid and the presence of chlorides can also increase corrosion rates.

Alloy 59 works well in both oxidizing and reducing conditions, making it an ideal candidate for tubes, pipes, and more. The performance of the various alloys largely depends on the characteristics of the contaminants contained in the organic acids, and on operating temperatures. From tests, it was concluded that Alloy 59 is the best material for use in acetic and formic acid up to 300 degrees centigrade.

Flue Gas Desulfurization

There are different absorbents used to remove sulfur from exhaust emissions. In most cases, there is a possibility of the formation of sulfuric acid as a byproduct under high temperatures which causes severe corrosion. Alloy 59 works best in these conditions when compared to C alloys. It is the purest form of Cr-Ni-Mo with minimal Fe and therefore gives the best results.

Ammonium Sulphate

Ammonium sulphate can be one of the absorbents to remove sulfur in FGD. Saturated ammonium sulphate solution with 10,000 ppm of chloride and pH of 1 at 93° C was stimulated by syncrude. Alloy 59 gave the best results. This construction often gives a life of 20 plus years.

Fluoro Chloro Compounds

Manufacturing of Fluoro Chloro compounds involves Hydrochloric acid (HCl)/Hydrofluoro acid (HF)/ dichloro methane as by-products. Fluorides and chlorides, which are part of the Halide group, cause severe pitting corrosion, which accelerates further with concentration and temperature. The materials used in operating such conditions need high PREN and Alloy 59 can be used. This material has one of the highest PREN which works well in oxidizing and reducing conditions.

Geothermal Power Plants

Geothermal fluids containing dissolved CO₂, H₂S, NH₃ and chloride ions, can cause corrosion of metallic materials. Therefore, the safe utilization of geothermal systems depends on material selection. Corrosion types encountered in geothermal systems include: uniform corrosion, pitting

Table 4: Thermal Stability properties can be measured by completing the ASTM G28A & G28B tests after sensitizing the material at 871°C. Alloy C276, 22 Heavy pitting attack due to intergranular attack. Alloy 59 has no attacks.

Media	N10276	N06022	59
ASTM G28A	>500	>500	40
ASTM G28B	>500	339	4
Pitting attack	severe	severe	none
Intergranular attack	severe	severe	none

corrosion, sulfide stress corrosion cracking (SSC), hydrogen embrittlement, and erosion corrosion.

For high temperature geothermal fluids, it is suitable to use Ni-Cr-Mo alloys as a material. Alloy 59, having very similar Mo content to UNS N06022, has also shown outstanding pitting corrosion resistance in highly saline geothermal environments of near-neutral pH at 150° C. By having high amounts of Molybdenum in the alloy, the influence of temperature on pit nucleation and repassivation can be significantly reduced.

Welding

Low carbon and silicon content mean good weldability without susceptibility to hot cracking. Weld consumables in Alloy 59 have extra low carbon. High nickel filler metal with Chromium and Molybdenum can be used for MIG, TIG, or plasma arc welding to itself or other nickel-based alloys. Alloy 59 weld overlay has proven to be effective in other Cr-Ni-Mo alloys, Alloy 625, and even super austenitic alloys such as 6 Moly. This holds a low sensitivity to hot cracking. Alloy 59 has the lowest corrosion rates in weld zones tested with high chlorides and low pH, compared to N10276/N06022.

In Conclusion

Alloy 59 is quite versatile material as it can be used in oxidizing and reducing conditions. One of the purest Cr-Ni-Mo alloys has a minimum of unwanted alloying elements which makes it have excellent corrosion resistance. Alloy 59 also has good weldability features and can be used as an option to other Cr-Ni/Mo, C-Grades. It is also available in other forms such as plates/scheduled pipes, large OD pipes, fittings, flanges, and more. ■



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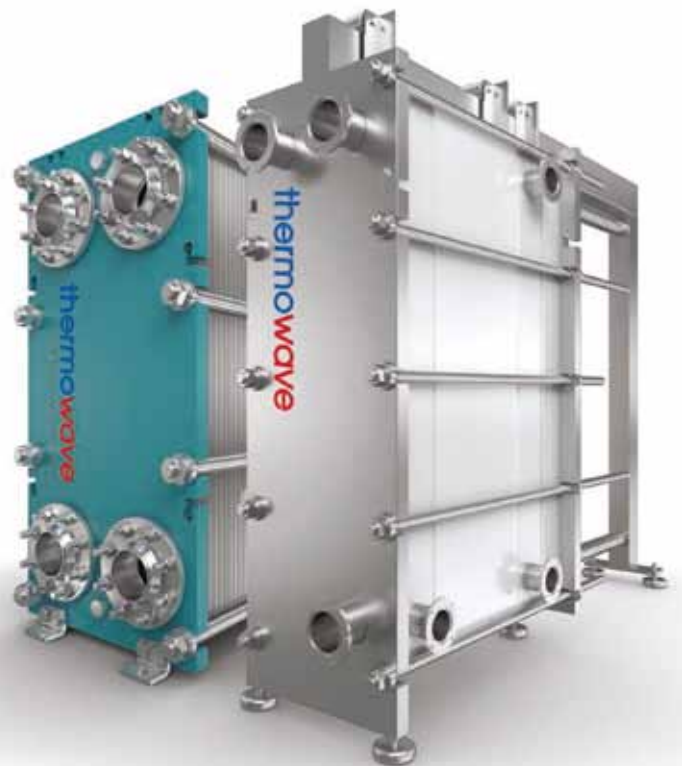
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⚡ Inspection of heavily fouled water inlets and condenser tubes at a power plant.

Unique antifouling compound better for people, planet & profit

Termanox is a Dutch start-up founded on years of experience in water treatment. With funding from the NOM and FOM Regional Investment Funds from the North of the Netherlands, its team is looking for partners to run a pilot project to prove the effectiveness of a unique compound that prevents biological fouling in (open) cooling water systems. As a new player in an industry dominated by giant chemical companies, the Termanox team are rising to this 'David vs Goliath' challenge to bring their environmentally and economically friendlier product to the global market.

By Joanne McIntyre, Heat Exchanger World



⚡ Stefan Spaas: "We are looking for a partner to embark on this exciting journey with us."

Stefan Spaas was a co-researcher with the Dutch KEMA Research Institute when he first encountered an amine-based antifouling product that would eventually change his career. At the time, he was part of a research team carrying out projects for the power generation industry, focusing on environmental issues such as emissions and CO₂ reduction. A French chemical manufacturer had developed a product to treat cooling water in heat transfer systems based on amines to mitigate biological organisms.

"This was a radically new approach to prevent biofouling, and we were asked to research its

effectiveness," explains Stefan. "Traditionally, biological load in water is treated by adding toxic chemicals at a high enough concentration to kill organisms, thereby preventing fouling of heat exchangers, pumps, piping systems, etc. This new product had a totally different approach, based on the premise of: why treat all the water when fouling only occurs where the water touches a surface, such as the inside of a pipe or heat exchanger? The product migrated to the pipe wall, creating a film that prevented fouling. The idea intrigued me because while a power plant operates with huge volumes of water flow, very few organisms actually come into contact with these surfaces...so why fill it with chemicals?"

Eventually, the French company pursued other areas of interest and agreed to sell the newest developed patent. Stefan and a group of colleagues formed Termanox and started their journey to perfect the product, defend the patent and then launch the product onto the market under the name Blueterm®. The Termanox team's research and intensive testing resulted in an updated recipe that was equally effective, cheaper, and easier to produce and handle. In the new-and-improved version, some of the film-forming compounds were replaced with an exopolysaccharide. Termanox is now seeking industry partners to undertake pilot projects to prove the unique product concept.



➤ An example of results with a previous film-forming technique; Blueterm® is expected to achieve the same result.

Research pilot project

“Research has proven the effectiveness of Blueterm®, but as a small player in a global chemical industry dominated by a handful of very large manufacturers, it’s challenging to break into the market,” explains Stefan.

Eventually, the team decided to go it alone, marketing Blueterm® themselves.

“While there has been a great deal of interest from power companies, it’s critical that we carry out more research to prove the effectiveness and raise awareness. In the summer of 2021, we carried out a Proof of Concept with seawater at a power plant on the Maasvlakte in the Netherlands. A test rig was built inside a container with a cooling water bypass, and an independent company carried out the study and compiled the results. We had our Proof of Concept within a few months and began promoting the product.”

How does it work?

Blueterm® is a unique patented formulation intended to treat open or semi-closed industrial cooling water circuits supplied with sea, fresh or brackish water. It effectively prevents the development of micro and macro biofouling



➤ An example of a typical injection system suitable for Blueterm® used at a power plant in the Netherlands.

(oysters, mussels, barnacles, hydras, etc.). The reduction of biofilm and sludge generated by macro biofouling reduces the phenomenon of bio-corrosion and therefore industrial maintenance.

Blueterm® is an organic formulation dissolved in water. It is a combination of a long-chain aliphatic amine with a highly specific exopolysaccharide (EPS). The synergistic effect makes the treatment extremely efficient compared to traditional methods. Moreover, Blueterm® contains no oxidizing components, quaternary amines, aromatic compounds or heavy metals.

The amine penetrates the biological membranes and the biofilm. This integration disrupts the coherence of the biological structure and leads to the destruction of the membranes. This is fatal for micro-organisms and for macro-organisms; the treatment causes a stress condition that is sufficient to prevent their permanent settlement. At the proper concentrations and duration, it is ultimately also fatal for macro-organisms (barnacles, hydras, etc). However, the aim of the treatment is to prevent fouling while reducing chemical use to a minimum.

The EPS acts as a surfactant that ensures that the active substance reaches the places where the problems arise. This means that you do not have to treat the entire water flow but only the surfaces of the system.

“We’re looking for industry leaders to work with us to validate and optimize this innovation in the field.”

Environmental & economic advantages

Stefan highlights how Blueterm® can help companies and operators reach their Sustainability Development Goals (SDG) while saving money. “This is a simple drop-in product, which enters the system and creates a film layer on every surface, preventing the attachment of biofilm and biological organisms such as mussels, larvae, barnacles, etc. The film is maintained by dosing a very small amount of the product daily. We are confident that it can also reduce anti-scaling chemicals and reduces microbiological induced corrosion, but for the power generation market and Termanox’s target, biofouling is the primary concern,” explains Stefan.

The advantages include:

- Biodegradable,
- Creates no by-products,
- 95% less chemical required than chlorine,
- Reduces operator's CO2 footprint, storage footprint, and transportation footprint, when compared with chlorine by 95%,
- Made from natural renewable resources,
- Active compounds can be produced CO2 neutral,
- Non-reactive compound,
- Dosage time just 30 to 60 min/day,
- Simple drop-in product.

"Power stations use vast quantities of chlorine and other highly reactive, toxic chemical compounds to fight biofouling. These chemicals are ultimately discharged into the surface water, where they continue to react and create toxic by-products, some even more harmful than chlorine. Desk research indicates that Blueterm® has a PNEC (Possible No Effect Concentration) value similar to chlorine, which means it is as toxic to biological organisms in water treatment systems as chlorine. However, it produces no by-products, is readily biodegradable, and all components in the biodegradable chain are less toxic than the original product."

But most significantly, comparing Blueterm® to chlorine, 95% less chemical is required to achieve the same antifouling effect, dramatically reducing risk, transportation costs, and storage. "That means 95% less handling of a chemical product," explains Stefan. "For a typical power station, that means 95% fewer trucks delivering to your plant. Furthermore, power plants routinely store many tons of chlorine on site, which is hazardous, requires permits, and is a risk for accidents and human health."

"There is also a significant environmental saving in the production of Blueterm® vs chemicals such as chlorine because it is based on naturally occurring compounds with a far lower environmental impact than chlorine, and it is produced using far less energy while generating much less CO2."



➤ Compared to chlorine, Blueterm® reduces an operator's CO2, storage, and transportation footprint by 95%.



➤ The amine-based product penetrates biological membranes and the biofilm, disrupting the coherence of the biological structure and ultimately proving fatal for micro- and macro-organisms such as those shown in this heavily fouled water inlet.

Monitoring biological & environmental impact

Stefan is keen to emphasize the environmental benefits of Blueterm®, and Termanox is willing to invest in extensive monitoring to gather data on its effects.

"Ideally, you would only start adding an antifouling product to a water system when fouling starts," explains Stefan. "We can do this by monitoring the system, adding the product at the perfect moment, and then monitoring its effect to minimize eventual discharge into surface waters. In our next pilot project, we will conduct extensive monitoring to measure the environmental effects in the receiving water where the cooling water is discharged, the concentration of chemicals, etc, to study its behavior effects based on actual measurements. We aim to achieve as close to zero discharge into the surface water as possible while maintaining effectiveness. This is a completely new approach; power plants currently discharge the maximum allowed levels of chlorine and other chemicals into the surface water."

"We want this technique to become known and accepted around the globe and to prove that it's greener than the current treatments. Hopefully, we will soon find a partner to embark on this exciting journey with us," concludes Stefan. "There are so many possibilities worldwide." ■

Looking for a pilot project

Today, the Termanox team is looking for a site to prove their product on a larger scale, and they have funding to pay for it. "The potential applications are vast; wherever there is water cooling, there is biofouling. At this stage, we want to focus on the power industry to run a pilot project to prove the technology," explains Stefan.

Termanox has received funding from the Dutch government to pay an operator to hold trials on a larger scale than those carried out so far. "Our aim is to run trials on a large site, possibly a seawater system, on a non-critical part of the cooling system. We're looking for a site anywhere worldwide," explains Stefan.

Interested parties are invited to contact Stefan Spaas at tel: +31 6 51 12 17 69, email: s.spaas@termanox.com or via the Termanox website www.termanox.com

State-of-the-art heat exchanger tube facility

India is experiencing strong growth in various industries. A new heat exchanger tube facility will help service demanding sectors such as (petro)chemical and renewable energy.

Alleima started the expansion of its Mehsana manufacturing facility in India in 2019. Now, the final phase of the project is fully completed and operational, with the formal launch of a new heat exchanger tube factory. This new facility will enhance the capacity and capabilities of the production unit to produce advanced alloys in application tubing like heat exchanger tubes for critical applications in the chemical, petrochemical, and renewable energy segments.

Economic bright spot

India currently stands as a global economic bright spot, emerging as a key player across various sectors. This growth is driving a significantly increased domestic demand for chemical and petrochemical products, the rapid transition towards renewables, and an increased shift towards localisation of manufacturing. Alleima launched its state-of-the-art heat exchanger facility in its mill located in Mehsana, Gujarat in November. It will enable Alleima to produce advanced alloys in heat exchanger tubing locally to meet the increasing demand for the high valued added tubes to India's chemical and petrochemical, renewable,



and other industrial segments, and serve as a production base for exports to Asia. With the completion of its Hydraulic and Instrumentation (H&I) facility earlier this year, the Mehsana mill has now completed Alleima's three-phase expansion in production capacity and infrastructure.

Göran Björkman, President and CEO of Alleima, said: "In 2019, we embarked on a strategic initiative to enhance our capacity and capabilities in growth markets, culminating in a three-phase expansion for India, which included a cold finishing heat exchanger tube manufacturing line that opened in 2020, a H&I tubing factory in March 2023, and now this brand-new heat exchanger tube facility. This expansion will increase heat exchanger tube capacity and capabilities to produce advanced alloys positioning us to capitalise on the growth opportunities arising from India's chemical and petrochemical industries over the next decade." says Carl von Schantz, President of Tube division at Alleima. ■



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Heat exchanger fouling in practice – understand & mitigate

Part 5 – fouling mitigation using design and process-related changes

In this series of articles we will look at how heat exchangers foul, how to understand the root causes of fouling, and how to mitigate the impact of fouling. The material presented is based entirely on the author's experience and analysis of operating situations in the Oil & Gas industry. However, many theories and varied experiences exist across the industry and amongst researchers.

By Himanshu Joshi, Heat Exchanger Specialist

In Part 4 we saw techniques which use external hardware to mitigate fouling. This month we will continue to look at fouling mitigation, but with changes to the heat exchanger geometry or to the fluid conditions like flow and temperature. Recall from Part 1 these most likely causes of fouling - single phase fluids foul due to deposition of particles, boiling services foul due to high wall temperatures leading to a wet-dry wall condition, and condensing services foul due to precipitation of salts at the tube wall and flow patterns which enable deposition or prevent the redissolution of the salts.

Shear stress (velocity) in single phase

Deposition of particles is controlled by two competing effects, fluid shear at the wall (τ) and the attraction between the solids and the tube surface. For a specific situation where the type of particles and the tube metallurgy (surface characteristics) are fixed, shear stress controls the rate of deposition. This behavior is seen both in liquids and gases. Increasing the shear stress is a very effective method to minimize fouling driven by deposition.

Although shear stress correlates with velocity (V), it is fundamentally a better parameter to use because it accounts for fluid properties, mainly the viscosity. Field and pilot-plant data has shown that the rate of fouling (increase in fouling resistance per day) varies as $(\tau)^{-a}$ on the tube side, and $(\tau)^{-b}$ on the shell side, where a is in the range of 1.0-1.2 and b is about 0.6. A substantial amount of data is available for the tube side, but relatively little for the shell side, so the latter relationship has more uncertainty. Another uncertainty on the shell side is that there are many flow paths and there is no exact calculation of velocities and shear stresses. Most commonly we use the crossflow shear stress.

The exponential relationship between fouling rate and shear stress means that as shear increases the fouling rate will eventually flatten out, see Fig. 1.

Data for the tube side shows this happens at about 10-12 Pa, beyond which little can be gained by increasing shear stress. The recommended value of tube side shear stress for minimum fouling is 10 Pa, which for most liquids will correspond to velocities between 2.0-2.5 m/s. Fig. 1 shows the fouling rates for three different fluids, varying by an order of magnitude, but they reach exponential lows at similar values of shear stress.

The best method to increase tubeside velocity is by changing the number of tube passes. Changing two passes to four doubles the velocity and reduces the fouling rate by about 60%, or four passes to six increases velocity by a factor of 1.5 and reduces fouling by about 40%. The price paid for an increase in velocity is increased pressure drop which varies as $V^2 \cdot L$, where L is the length of the flow path. Thus, when two passes are changed to four, the velocity and flow length both double, and the new clean pressure drop is approximately eight times. That much higher pressure drop may not be available but note that fouling also increases pressure drop and it may be that a factor of eight is already encountered in actual operation for severe fouling situations.

For the shell side, from a practical standpoint it is not possible to increase velocity beyond about 0.75 m/s for liquids. This is because as the baffle spacing is narrowed to increase velocity, the flow gets diverted away from the crossflow component to the various "leakage" paths and the crossflow shear does not increase significantly. There is also

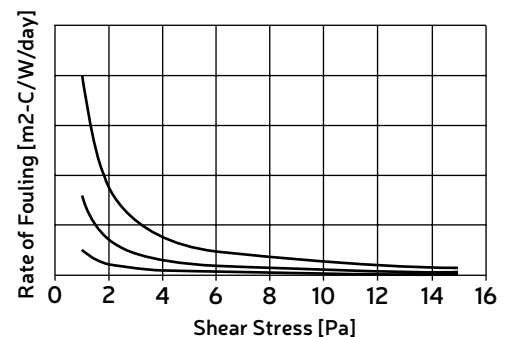


Fig.1 Dependence of fouling rate on tubeside wall shear stress.

About the author

Himanshu Joshi retired from Shell in 2021 after 34 combined years with ExxonMobil and Shell, during which he specialized in heat exchangers and fouling. He was part of a team that was granted a patent related to fouling deposit analysis at ExxonMobil, and led applied fouling R&D projects at both companies. He has made several



presentations about the field aspects of fouling and fouling mitigation, and deployed many mitigation technologies in the field. He can be reached by email at alph.hmj@gmail.com.

a fabrication limit on baffle spacing with the minimum standard being 20% of the shell diameter. Additionally, very little field data has been analyzed for the shell side and there is no reported pilot plant data to assign shear stress recommendations. Therefore, the general recommendation is to have shell side crossflow velocities at 0.75 m/s or higher to minimize fouling. Another factor which affects shell side deposition is the presence of low velocity circulation zones (aka "dead zones"), where particles can get trapped and cannot be swept away by the force of the fluid. These zones are the physical effect of the change of flow direction around baffle edges, see Fig. 2. Deposition in these corners can be minimized by making the crossflow and window velocities approximately equal, which minimizes the size of the dead zone. Also, a large spacing in the outlet and inlet areas leads to low flow near the tubesheets and promotes deposition.

Reboilers

As explained in Part 1, a wet-dry wall and the phenomenon of film boiling lead to deposition of insoluble material such as polymers or salts, which stay on the surface and may undergo thermal conversion to coke-like material over time. One or more of the following three conditions contribute to this mechanism - the presence of insoluble material, a surface temperature high enough so that a liquid film cannot be sustained on the tube wall, and excessive vaporization or vapor flow (especially locally) such that there isn't sufficient liquid to keep the surface wetted (vapor blanketed surfaces).

It may not be possible to avoid the presence of insoluble precursors as they are part of the process. However, some mitigation can be achieved by minimizing their formation or their quantity. An example is that of dienes which cause fouling in oil-refining reboilers. The composition of the feed to the process unit can be changed to minimize the component carrying the dienes, or the conversion of dienes to insoluble polymers can be limited by controlling reboiler temperatures.

The phenomenon of wet-dry surfaces can be controlled by limiting the heating medium temperature and by ensuring as much as possible that liquid can reach all of the boiling surface. A liquid covered surface is less likely to allow deposition to occur and therefore keep fouling from occurring. Lowering the heating medium temperature reduces the temperature driving force for heat transfer and may cause a loss in heat duty, but it may be a smaller loss than created by fouling, or it may allow a longer run length before cleaning is required.

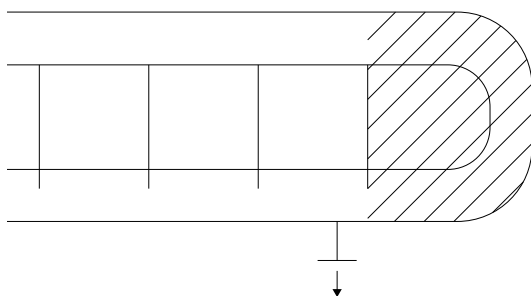


Fig.3 Shell side area with minimal to no flow.

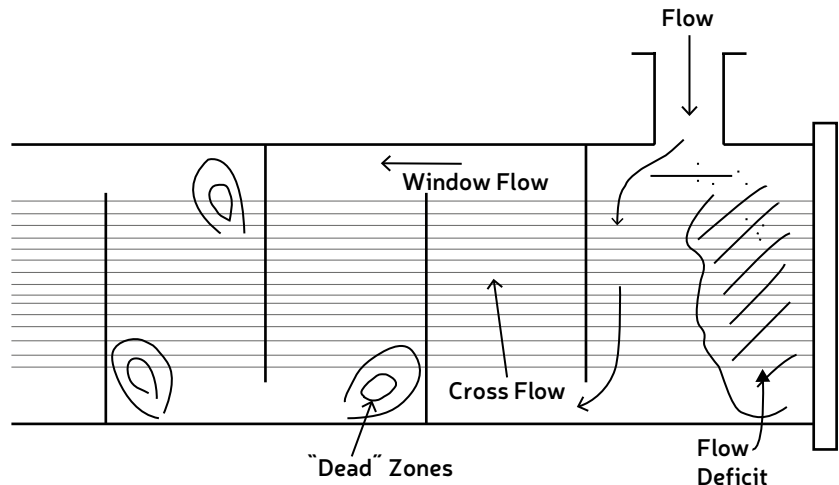


Fig.2 Shell side low velocity areas at baffle corners.

The phenomenon of excessive vapor flow can be due to two reasons. First, the operation may be such that sufficient liquid is not fed to the reboiler, and if the heat duty is fixed it necessarily means more vapor is generated. Second, the flow patterns in the heat exchanger might be such that parts of the heat transfer surface are starved of liquid and therefore are vapor blanketed. The latter also occurs in steam generators if proper liquid circulation is not maintained.

Condensers

Overhead condensers typically foul due to precipitation of salts as the condensing fluid cools. Two design strategies can be effective against this mechanism. First, the design should allow for uniform condensation in the heat exchanger by ensuring that vapor reaches all the surface and condensed liquid can be available to sweep away some of the precipitated salts. Second, a wash stream can be injected in the incoming vapor to dissolve precipitated salts - for example, water for water soluble salts, assuming it is acceptable for the process. In the case of wash streams, it is necessary to ensure that the wash stream can reach all the fouling locations on the shell side, or uniformly to all tubes for tubeside condensation. Fig. 3 shows the shell side exit where the location of the nozzle is such that only very little of the vapor, condensed liquid, or the wash stream can get to the shaded area and rapid fouling occurs there. One possible solution is to place the nozzle as far to the right as possible, or to truncate the length of the tubes so that all the surface is located to the left of the nozzle.

Mitigation Economics

All techniques described above and those in Part 4, require expense in terms of capital, engineering, replacement of tube bundles, increased pressure drop, and most importantly if process changes are considered. Although a mitigation action may look expensive when only its cost is considered, it often pays off to look at the savings provided by the mitigation and evaluating a longer-term return on the expense. In a future article we will take a detailed look at the economics of fouling and fouling mitigation. ■

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All articles are available in our online archive:

<https://heat-exchanger-world.com/category/technical-articles/>

Upcoming in Part 6

In the next article we will look at cleaning of fouled heat exchangers. Although it is not a direct mitigation action, it is an important aspect of minimizing the cost of fouling. The article will cover different cleaning methods, their relative costs and effectiveness, and the cost of not cleaning a heat exchanger to a fully clean condition.

Increasing interest in ZLD driven by costs and environment

In 2021 the global market for zero liquid discharge (ZLD) technology was estimated at \$1 billion and is forecast to grow at almost 12% over the next ten years^[1]. The rise is being driven in particular by an increase in adoption of the technology by the food and drink and textile industries as a growing world population puts greater pressure on fresh water supplies.

By Matt Hale, International Sales & Marketing Director, HRS Heat Exchangers

Zero liquid discharge (ZLD) is a liquid waste stream treatment which involves transforming liquid waste streams into clean water (which can be reused) and a minimum volume of solid residues. One of the advantages of ZLD over other treatment techniques is its theoretical ability to separate unwanted materials from water, whether they are benign, hazardous or toxic. The resulting solid residue is often more stable, making it suitable for recycling or landfill. However, poor management or handling of the remaining residue can result in unintended environmental consequences. For example, storage ponds may leak or affect local wildlife while there is the potential for toxic chemicals to leach into groundwater from landfill. It is therefore important that when implementing a ZLD system, full consideration is given to the entire process, including the ultimate fate of liquid and (semi-)solid waste streams. A well-designed ZLD system should minimise or even eliminate liquid waste streams, resulting in clean water for reuse or environmentally-friendly discharge, and a solid residue suitable for further processing (often to recover valuable components for use elsewhere) or for safe disposal.

The factors driving ZLD uptake

According to Transparency Market Research¹, ZLD is being implemented across a wide range of industries, including chemical and petrochemical production, food and drink production, textiles, energy and power, and pharmaceutical manufacturing. These industries are being driven to adopt the technology due to growing environmental awareness of the hazards of toxic wastewater and increasing environmental regulation. In turn this has increased the costs of handling and disposing of such waste streams, and in some cases has made such disposal impossible. As a result, companies are looking for more sustainable alternatives, and ZLD is one of the leading technologies in this area. The specific factors driving uptake are different for each industry. For example, in the energy and power sector (historically the largest user of ZLD technologies), access to clean water suppliers is an increasing concern. Pollution control is also a major driver, and the US EPA considers zero discharge as the preferred treatment option for fly ash and bottom ash transport water, and wastewater from flue gas mercury control systems^[2]. Elsewhere, growing awareness of the toxic effects of petrochemicals and petrochemical waste products is



➤ HRS has installed ZLD systems for clients in Europe. Image courtesy of HRS Heat Exchangers.

driving efforts by the industry to clean up its waste processing systems. ZLD methods are already widely used in industrial wastewater treatment to recover useable and profitable minerals and by-products from waste streams, and the success of such systems is encouraging their take up by other businesses. In 2015 the Indian government issued a draft policy requiring all textile plants generating more than 25 cu. m. of wastewater effluent a day to install ZLD facilities^[2].

ZLD technology has been utilised in various markets around the world, including Europe, Australia, Canada, the Middle East and Mexico, but the biggest markets, and the biggest potential for expansion, can be found in the United States, China and India^[2].

The benefits and challenges of ZLD

In general terms, the use of ZLD reduces water pollution and augments water supply, but this is sometimes offset by high costs and energy consumption and in the past these factors have limited the uptake of the technology. Wastewater reuse minimises the volume and environmental risk of discharged wastewater, but also alleviates the pressures associated with the abstraction of freshwater, but these benefits have to be balanced against the economic and energy costs of implementing ZLD systems.

As water scarcity and environmental pollution around the world intensifies, ZLD becomes more feasible and widespread, and the relative costs of ZLD technology versus the alternatives (assuming alternatives even exist) are lowered.

About the author



Matt Hale joined HRS Heat Exchangers as International Sales Manager in 2013 and in 2015 he took on responsibilities for group marketing. Today, he is responsible for overseeing and developing the HRS Group's strategies for business development and marketing. Matt has a proven background of over 20 years within process and mechanical engineering and holds a Sales & Marketing Management Diploma from the Ashridge Business School.

Increasing the efficiency of ZLD

Separating all of the water out of the product requires large amounts of energy. It takes roughly six times more energy to evaporate water (latent heat) at its boiling point than the energy needed to actually bring it to that boiling point (sensible heat).

For that reason, ZLD processes often start with a separation process based on (reverse osmosis) membranes. Membrane separation does not require phase change / boiling. Electrical energy (pumping) is used to push water through the pores of the membrane and separate it from the dissolved solids. Membrane can only work to bring the product up to a certain concentration. To achieve complete separation, evaporation / crystallization processes are needed for completing the process. As explained before, evaporation (due to the latent heat) is highly energy consuming. Therefore, it is wise to choose an evaporation process that involves ways of energy optimization, the most popular being:

- **Multistage evaporation:** using the latent heat of the evaporated water as energy source in a next evaporation stage reduces the overall consumption of the boiler to the evaporation plant.
- **Thermal Vapour Recompression (TVR):** evaporated steam is mixed with boiler steam. The reuse of the evaporate steam reduces the energy demand.
- **Mechanical Vapour Recompression (MVR):** An MVR compressor (driven by an electrical motor) can be used to compress the evaporated steam, thus increasing its pressure, and use this steam as the energy input for the process. MVR compression is very efficient in terms of energy consumption.

Due to the factors outlined above, (multistage) vapour compression plants remain the main method employed for ZLD processing globally, with evaporation typically recovering around 95 per cent of wastewater as distillate. Any remaining concentrate is then further treated physically or chemically to produce solid residues (such as crystals) and water. Evaporators used in ZLD systems are often run at lower pressures in order to reduce the boiling point of the liquid being treated.

The HRS ZLD solution

Depending on the product to be concentrated, HRS can select from a series of technologies for designing the most optimal ZLD process. Energy optimization methods (multistage, TVR, MVR) can be combined with several types of heat transfer technologies (plate evaporators, corrugated tube evaporators, scraped surface evaporators). Whatever the technology applied, the overall process can be separated into three steps:

1. **Evaporation / concentration:** The product is concentrated to just below its maximum concentration (saturation). The evaporation plant is usually a multistage evaporator setup.
2. **Cooling:** if the maximum solubility curve is steep (large concentration at high temperature, low concentration at low temperature), the product obtained in step 1 is cooled, provoking immediate precipitation of dissolved solids.
3. **Crystallisation:** Crystallisation / sedimentation of the solids produced in step 2 occurs in specially designed crystallisation tanks. A supernatant layer of



➤ HRS Unicis Series scraped-surface evaporators are used to maintain thermal efficiency and remove fouling during evaporation in ZLD installations. Image courtesy of HRS Heat Exchangers.

concentrated solution remains after this stage and is returned to step 1 for reprocessing.

For products without a steep solubility curve, it is necessary to concentrate inside the evaporator to above the maximum solubility. This means that the step 1 process is equipped with a final evaporator stage (finisher) that is specially designed to work with suspended solids. The fluid with suspended solids is then transferred directly to the crystallization tanks in step 3. The brine cooler and evaporator finisher work with solids in suspension and often this means dealing with fouling products. A typical HRS evaporator / finisher will use Unicis scraped surface evaporators that are self-cleaning and maintain optimal evaporation rates. Typically, our R series scraped surface coolers are used for cooling the saturated brines that are sent to the crystallization tanks. The result is an efficient process which can work continuously without requiring scheduled downtime. Whatever kind of evaporator is employed, heat exchangers have a crucial role to play in ZLD systems in reducing running costs by utilising heat from process water and other existing sources, and also recapturing heat at the end of the process and reusing it to boost the energy efficiency of the overall ZLD system. ■

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Product News

EcoDataCenter to utilize Alfa Laval heat exchangers



EcoDataCenter to be an industry first in deploying Alfa Laval heat exchangers made using recycled steel produced without new CO₂ emissions from SSAB. This deployment signifies a pivotal moment in the ongoing effort to reduce carbon emissions within the supply chain, exemplifying the significance of collaboration. It is crucial to leverage innovations together with partners. This underlines the importance of collaborative efforts in mitigating

emissions. Peter Michelson CEO at EcoDataCenter. The result of a Life Cycle Analysis made of the latest datacenter at EcoDataCenter shows that 60% of the embodied carbon comes from the equipment. The introduction of Alfa Laval heat exchangers made using SSAB Zero™, recycled steel produced without new CO₂ emissions, is a step forward in EcoDataCenter's mission to reduce emissions within the supply chain.

Bradford White launches Brute® XTR



Bradford White Water Heaters, the manufacturer of water heaters, boilers, and storage tanks, announces the release of its new Brute® XTR commercial boilers and volume water heaters. Brute XTR boilers and volume water heaters are available in six sizes, ranging from 399 MBH to 1500 MBH, and deliver AHRI-certified thermal efficiency of 96-percent.

Cooler Master introduces two cooling systems



Cooler Master has introduced two new generation processor cooling systems – the flagship air cooler Cooler Master V8 3DVC and the maintenance-free liquid cooling system Cooler Master G11 AIO. For both new products, the manufacturer claims that it can dissipate up to 300 W of heat energy from the CPU. Cooler Master V8 3DVC is the spiritual successor to the iconic Cooler Master V8 cooler series, the first representative of which was released by the manufacturer back in 2008. Externally, the Cooler Master V8 3DVC is similar to other tower coolers, but differs from its competitors by the presence of a

large evaporation chamber at the base and advanced composite heat pipes combined into a single unit, ensuring the most efficient heat transfer. The radiator of the cooler is surrounded by a black and silver housing, and two branded fans from Mobius with a diameter of 120 mm are responsible for the airflow in the new product. The manufacturer claims that the new V8 3DVC cooler is capable of dissipating up to 300W of thermal energy from the CPU. In addition to the V8 3DVC, Cooler Master has also introduced the maintenance-free G11 AIO liquid cooling system, which includes a 360mm radiator.

YORK launches air-cooled variable speed drive screw chiller



Johnson Controls has announced the launch of the first air-cooled variable speed drive (VSD) screw chiller in the United States to use ultra-low-global warming potential (GWP) refrigerant R-1234ze.

The YORK® YVAA Style B Air-Cooled Screw Chiller, an evolution of the first-generation YVAA, is engineered to drive efficiency now and meet or exceed future regulatory requirements. The R-1234ze refrigerant has a zero ozone depletion potential (ODP) and a GWP of 7, which is well below the Environmental Protection Agency's (EPA) SNAP requirement, making the YVAA Style B a future-forward solution for hydrofluorocarbon (HFC) phase-down requirements. In addition to the use of ultra-low-GWP R-1234ze, the YORK® YVAA Style B features next-generation condenser coils to minimize the refrigerant quantity and further reduce its carbon footprint. A newly

designed compressor optimizes part-load efficiency to deliver a significant reduction in annual energy consumption. Series flow evaporators coupled with falling film technology help achieve market-leading performance. YVAA Style B chillers are equipped with state-of-the-art technologies, allowing reliable operation for a wide range of -10 F to 130 F ambient temperatures. YVAA Style B can reach capacity ranges spanning from 100 TR to 400 TR for comfort cooling applications, and 200 TR to 500 TR compatible with data center mission critical requirements. A configurable design meets stringent data center requirements of higher leaving water temperatures up to 75 F.

HYTE releases all-in-one liquid cooler THICC Q60



HYTE, a manufacturer of cutting-edge PC components and peripherals has released its first all-in-one (AIO) liquid cooler, THICC Q60. Prominently displayed above the THICC Q60 CPU block on a double-hinged floating spout is a 5" ultra-slim IPS display that sports a 720 x 1280 resolution and an incredibly crisp 293 pixels per inch. A 60 Hz refresh rate provides a smooth visual experience while 300 nits of brightness deliver real-life depth to the digital experience. Included behind the display panel of THICC Q60 is a 42-pixel qRGB array designed to illuminate system components, all controlled through HYTE Nexus software. Dual harmonic pumps with aerospace grade ceramic bearings located in the 240 mm by 52 mm

thick heat exchanger of THICC Q60 efficiently circulate liquid with near silenced acoustics. The ginormous heat exchanger utilizes a parallel dual-pass design, maximizing both cooling capacity and efficiency. In tandem, a micro-skived copper cold plate enables a tremendous amount of heat transfer and thermal performance to effortlessly tame the modern-day CPU. Coupled with the THICC Q60 are two 32 mm THICC FP12 fans with fiberglass reinforced Liquid Crystal Polymer blades providing exceptional rigidity, durability, and aerodynamics. The dynamically adjustable 0 - 3,000 RPM fan speed delivers a monstrous 105.8 CFM airflow and 8.14 mm-H₂O static pressure.

XOi and Daikin form a strategic relationship



Daikin Comfort Technologies North America, Inc. (Daikin), a subsidiary of Daikin Industries, Ltd., a manufacturer of heating, cooling, and refrigerant products, and XOi, the provider of technician-first smart technology for commercial and residential field service companies, are transforming the possibilities

of field service technology through a new strategic relationship. Together, Daikin and XOi are working to revolutionize the way technicians interact with technology in the field. The collaboration connects Daikin HVAC technicians throughout North America with XOi's advanced AI- and data-driven solution, generating an unprecedented information and data ecosystem and delivering powerful insights that empower intelligent business decisions. Daikin and XOi provide HVAC technicians with a suite of premium tools for managing and

leveraging data from current jobs as well as historical projects, including powerful data collection, virtual support and mentoring, and data-based insights. With XOi, technicians have access to Daikin-specific workflows and a proprietary knowledge base, equipping them to perform full service diagnostics at any job site by applying data science across live video, workflow automation, and artificial intelligence - all of which not only support the technician but help deliver an incomparable end customer experience.

Pro Refrigeration introduces new product with hybrid solutions



PRO Refrigeration Inc., has recently launched their groundbreaking PROGreen Hybrid Packaged Chiller System. This new solution merges two independent refrigeration systems combined into a single packaged chiller system. What makes this pairing unique is one system utilizes all-natural CO₂/R744 as a refrigerant while the other system utilizes R448, a synthetic refrigerant with a Global Warming Potential (GWP) under 1300. Like industries and businesses worldwide, PRO strives to achieve environmental sustainability and reduce its carbon footprint, the need for eco-friendly refrigeration systems has become more crucial than ever. PRO recognizes the challenges faced by customers

when transitioning to natural (or any new) refrigerants and the need for efficient, user-friendly solutions. With the PROGreen Hybrid Solution, the company aims to make the transition easier by offering a reliable solution that combines the best natural refrigerant option with one of the "best" synthetic based refrigerants currently in the market. PRO chose to develop the "Hybrid Machine" 3 years after they launched their PROGreen Packaged CO₂-Charged Chiller System. The team and their partners have gone through rigorous field testing at breweries and dairy farms from Bakersfield, CA, to the foothills of the Denali National Park in AK.

Gigabyte extends its advanced cooling portfolio

Giga Computing, a subsidiary of GIGABYTE has recently introduced DLC ready servers, H263-S63-LAN1 & H273-Z80-LAN1, expanding its previously launched high-density server product line supporting NVIDIA Grace CPU & Grace Hopper Superchip. These servers, along with the R183-S90-LAD1 & R183-Z90-LAD1 1U dual-socket servers, are fitted with GIGABYTE cold plates and cater to diverse computing needs. Engineered for both 4th Gen Intel Xeon Scalable CPUs and AMD EPYC 9004 CPUs, they offer unparalleled computing power. In addition, the company is expanding its NVIDIA HGX server product line, a DLC SKU derived from the G593-SD0 launched in June. Specifically crafted for Large Language Models (LLMs), the newly launched DLC ready G593-SD0-LAX1 delivers unparalleled performance while maintaining peak computing power. GIGABYTE has continued its commitment to improving sustainability and energy efficiency in data centers by bringing immersion cooling and liquid cooling technology to the forefront. These DLC servers exemplify how GIGABYTE



stays ahead of the curve. The increased performance of current gen chips has led to pioneering cooling solutions, improving Power Usage Efficiency (PUE), and enabling sustainable peak system performance through DLC technology. For single-phase immersion cooling, GIGABYTE has introduced a new 12U EIA immersion tank, A1P0-EA0, adding to its immersion tank portfolio that already includes one that has a capacity of 18 OU OCP servers, A1O3-CC0, and another EIA tank, A1P0-EB0, that has a 25U server capacity.

Tranter to supply heat exchangers in Texas

Tranter recently won a large order for post combustion carbon capture application. The order is for six large plate and frame heat exchangers in stainless steel and 254 SMO with EPDM gaskets that will be used for heat recovery and vent condensers in the removal process of CO2 from a gas stream, carried out by absorption in a continuous process with regenerable solvents. The heat exchangers were ordered by a major EPC contractor in gas processing, separation, and liquefaction technologies. While the engineering and procurement activities were done by their entity

in India, decision making, and a purchase order were managed by their headquarters in Germany. The blue hydrogen plant will be built in Texas, United States, and will supply hydrogen and nitrogen for the production of blue ammonia in the region and will provide clean hydrogen to companies in the US Gulf Coast, decarbonizing their operations. The heat exchangers will be used as vent condensers and for heat recovery between the lean and rich solvent, where the rich solvent has absorbed the CO2 from a gas stream and needs to be heated prior to entering the desorption column where the CO2 is



separated from the solvent making it lean. The lean solvent in turn needs to be cooled down before being reintroduced to the absorber. Tranter's

plate and frame heat exchangers used for the vent condenser will condense any evaporated solvent in the desorption step back into the column.

Laars® Heating Systems introduces NeoTherm® XTR

Laars® Heating Systems, a U.S. designer and manufacturer of boilers, water heaters, and pool heaters used in residential, commercial, and industrial applications, announces the release of the new NeoTherm® XTR commercial boilers and volume water heaters.

The NeoTherm XTR is available as a condensing boiler or volume water heater, with venting up to 150 equivalent feet, has top water and gas piping connections, and can be common-vented, offering increased installation flexibility. NeoTherm XTR units have AHRI certified 96%-plus thermal efficiencies, a reliable low pressure-drop stainless steel heat exchanger, and a 10:1 combustion turndown.

Each NeoTherm XTR uses the powerful LaarsLinc® icon-driven control system that includes Laars Vari-Prime® pump control. Laars Vari-Prime controls a variable speed boiler pump to maintain a fixed, user-selectable, boiler temperature rise, maximizing total installed efficiency. The Laars Linc intuitive control system with color touchscreen has



an easy to navigate control structure that displays key performance measures, a quick start option, and a USB input for parameter upload. It easily connects to building automation systems via onboard BACnet or Modbus protocols and has many other features, including the ability to cascade up to eight units. NeoTherm XTR boilers and volume water heaters are available in six sizes, from 399 to 1500 MBH for natural gas applications.

SÄKAPHEN HR 60 Extra TG

The application of re-lining products for tube sheets guarantees a durable, cost-effective method to protect newly fabricated and already existing heat exchangers, condensers and coolers against corrosion and erosion as well as abrasion caused by challenging process conditions and also galvanic corrosion due to dissimilar metals.

For this complex field of application, SÄKAPHEN has developed several different coating and lining solutions to meet any requirement, regardless of the service conditions, substrate materials and types of job – tube-side lining, shell-side coating or coating of tube sheets only.

Tube sheets, in particular, are the most exposed part of a heat exchanger. SÄKAPHEN has fine-tuned various procedures and solutions to repair wear and tear on coated tube sheets' surfaces after years of operation, as shown by these three interesting success cases.



Pictured is a small heat exchanger operating at temperatures around 120 °C which was subjected to retubing. The customer specified the application of a tube sheet coating to prevent galvanic corrosion between the carbon steel tube sheet and the alloy tubes. SÄKAPHEN's Si 57 E baked epoxy-phenolic product was selected because it can perfectly withstand both the slightly elevated pH, as the medium was conditioned cooling water, and temperature (120 °C). SÄKAPHEN applied it in-house due to the operation's requirements in terms of baking technical equipment.

YORK® launches CYK heat pump fills



Now available in a smaller 400-ton capacity, the newly launched

YORK® CYK heat pump fills a North American market gap by providing a

practical, right-sized decarbonization solution for use in existing commercial building applications. The smaller 400-ton CYK heat pump model joins the existing 600 – 2,000-ton product line to extend the application to more commercial facilities.

Can reduce water and operational costs by as much as 50% when compared to traditional boiler and chiller applications. Johnson Controls has re-engineered the industry- YORK® CYK Water-to-Water Compound Centrifugal Heat Pump to deliver superior operational savings and stringent sustainability

standards. The YORK® CYK heat pump is available with optional ultra-low global warming potential (GWP) refrigerants, R-1234ze and R-515b, to further support decarbonization and net zero goals. Additionally, the heat pump delivers high-temperature hot water up to 170 degrees Fahrenheit by utilizing two electric motor-driven centrifugal compressors arranged in series. The design achieves simultaneous hot and chilled water cooling within the same equipment making it three to five times more efficient than a traditional boiler and chiller combination.

Project News

Wood secures major topside modifications contract with bp



Wood has been awarded a major contract to deliver topside modifications supporting bp's latest subsea tieback in the UK North Sea. Wood's Operations business will deliver engineering, procurement, construction, and commissioning (EPCC) services to enhance the central processing facility of bp's Eastern Trough Area Project (ETAP) production hub in the central North Sea. Repurposing of existing equipment on ETAP will be a key focus under the two-year contract to enable the platform's

connection to Murlach, bp's two production well subsea tieback development. The cost reimbursable contract follows Wood's delivery of pre-FEED and FEED work on the Murlach field, and the recent successful completion of brownfield scopes on bp's Seagull field, another subsea tieback to ETAP that commenced production in 2023. The Murlach project will be delivered by Wood's teams in Aberdeen, where over 300 employees support bp contracts.

thyssenkrupp Uhde signs master agreement with Ma'aden & Metso



thyssenkrupp Uhde has signed a master agreement with Ma'aden (Saudi Arabian Mining Company) for the development, engineering, and licensing of a calcination plant for phosphogypsum processing. The purpose of the proposed plant, to be located at Ma'aden's Ras al Khair site in Saudi Arabia, will be to recycle phosphogypsum and enable the capture of CO₂ emissions. The joint research and development will be carried out together with thyssenkrupp Polysius and Metso Outotec. Currently, significant amounts of phosphogypsum are produced as a by-product of phosphoric acid production, which is essential for producing phosphate fertilizers. The options for using phosphogypsum directly are very limited due to impurities and the general

properties of this material. The innovative phosphogypsum treatment process will have three major benefits: First, it converts phosphogypsum into quicklime (calcium oxide, CaO). By using alternative fuels such as hydrogen or sulfur, this calcination step is low in CO₂ emissions. Additional know-how for this process is provided by thyssenkrupp Polysius, a full range-supplier of the cement and lime industry. Secondly, it enables the recovery of sulphuric acid, which can be recycled and reused as feedstock for phosphoric acid production. And thirdly, the quicklime binds CO₂ through a carbonization process to form limestone. The limestone can then be used, for example, in the construction industry or for cement production.

Carrier signs agreement with Montana Technologies



Carrier Global Corporation (CARR) has announced entry into a binding term sheet with Montana Technologies LLC (Montana) to develop and commercialize Montana's transformational AirJoule dehumidification and cooling technology. In addition, Carrier has conditionally committed USD 10M in growth equity into Montana to foster commercialization of AirJoule. AirJoule's dehumidification technology substantially improves air conditioning efficiency by harvesting water and thermal energy from the air. The proprietary method and design can reduce electricity consumption as compared to

conventional air conditioning cooling systems, resulting in a corresponding reduction in carbon emissions as well as a reduction, or in some cases elimination, of refrigerants. Carrier will also receive the right to nominate a member to the board of directors of the post-combination entity following the merger between Montana and Power & Digital Infrastructure Acquisition II Corp. Montana announced on June 5, 2023, that it will combine with XPDB and listed on the NASDAQ under the ticker AIRJ following the merger. The transaction is expected to close in the first quarter of 2024.

AGSM AIM invests in geothermal project in Verona

The AGSM AIM Group has announced an investment in a geothermal project that aims to supply clean, renewable heat to the district heating network of the city of Verona in Italy. Further expansion of the project is also planned for the district heating plants in Vicenza. AGSM AIM is a public utilities company, with 61.2% ownership by the Municipality of Verona and 38.8% by the Municipality of Vicenza. The company is active in the fields of electricity, gas, district heating, energy efficiency, public lighting, telecommunications services, electric mobility, and environmental hygiene. Geothermal energy has been included among

the objectives and actions in the company's strategic plan which places sustainability as one of their pillars for growth. The geothermal project was initiated back in December 2023 when the Board of Directors of AGSM AIM approved the industrial and economic plan for the project. In the coming weeks, a company will be established for this venture. Geothermal development is expected to have an effect on five of the company's cogeneration plants in Verona located in Borgo Trento, Forte Procolo, Golosine, Centro Città e Banchette, and eventually in the district heating plants of Vicenza.



The project is expected to reduce the methane gas that is injected into the district heating plants, thus saving 40% of gas consumption and reducing CO₂ emissions by approximately 30,000 tonnes.

Bloom Energy and SK ecoplant collaborate on hydrogen project



Bloom Energy (BE) and SK ecoplant, an engineering and energy solutions provider and

a subsidiary of South Korean conglomerate SK Group, have announced a sale of Bloom's electrolyzer technology to deploy hydrogen as an energy source in a large-scale green hydrogen demonstration with Korea Southern Power Co., Ltd (KOSPO) and local government. The first-of-its-kind demonstration for South Korea, which will commence in late 2025, includes 1.8 megawatts (MW) of Bloom's industry leading Solid Oxide Electrolyzer (SOEC) technology to develop green hydrogen at scale for use as transport fuel on Jeju Island, South Korea. Jeju Island is known as a leading market for renewable energy projects. SK and Bloom have a strategic relationship on a number of projects in South Korea. For this project, SK and Bloom will combine the Bloom

Electrolyzer™ with SK's engineered infrastructure to produce hydrogen ready to be used as transport fuel.

The demonstration includes a consortium of companies and technologies. The Bloom Electrolyzer was chosen for its industry-leading high electrical efficiency, enabling KOSPO and its collaborators to achieve the highest efficiency results.

Jeju Island's "Carbon Free Island 2030" project aims to fully convert all vehicles and electricity generation to renewables by 2030. Hydrogen generated from this project will be used to advance that goal, demonstrating an alternative way to provide renewable and sustainable energy by helping supply green hydrogen to hydrogen refueling stations to power public vehicles.

Tecnimont to start engineering works for KIMA project



Further to the award of the project for a nitric acid and ammonium nitrate plant by KIMA, Egyptian Chemical Industries Company has announced that MAIRE (MAIRE. MI) informs that Tecnimont (Integrated E&C Solutions BU) has received the advance payment and the authorization to start the engineering works, while the notice to proceed with the full Engineering Procurement and Construction (EPC) activities is expected by the end of June 2024.

The EPC contract was awarded to a Tecnimont-led consortium for an overall value of USD 300M, of which approximately USD 220M pertaining to Tecnimont.

The plant will replace the older units for the ammonium nitrate at the site, significantly reducing the present greenhouse emissions thanks to state-of-the-art abatement systems improving the overall energy efficiency and environmental standards.

Once in operation in 2026, this plant will also allow to fully exploit the upstream ammonia production facility, recently built by Tecnimont and successfully started up in 2020 in the same industrial site, located in the Aswan Governorship, in Upper Egypt, thus improving the economic return of the complex. The ammonium nitrate will be used as a fertilizer both employed by local farmers to boost the productivity of their fields and exported on the international markets.

Proven MAN EGR incentivises continuous ME-GA engine orders



Nippon Yusen Kaisha (NYK), the Japanese shipping company has ordered 4 x 2 x 5G70ME-GA Mk. 10.5 engines in connection with the construction of 4 x 174,000 cbm. LNG carriers. All eight engines will feature MAN Energy Solutions' proprietary EGRBP (Exhaust Gas Recirculation ByPass) emissions-reduction technology. Bjarne Foldager, Head of Two-Stroke Business, MAN Energy Solutions, said: "We developed this engine for easy application to most

contemporary LNG carrier designs and, indeed, all ME-GA orders to date have been exclusively for this segment. Demand for the engine has been continuously strong since its introduction, especially due to its accompaniment by our self-developed EGR system that comes proven by more than a decade of in-service, operational experience, and optimisation."

Thomas S. Hansen, Head of Promotion and Customer Support, MAN Energy Solutions, said: "We have now logged more than 278 ME-GA engine orders since May 2021. Of these, seven vessels have already entered service with a total of 14 ME-GA engines on board. We have obtained ME-GA engine orders from both Korean and Chinese shipyards, but this is the first order from this prominent owner and we are thankful for NYK's trust in our product. We have a strong and long-lasting relationship with NYK and are happy to now count it among our ME-GA customers."

SLB announces collaboration with Geminus AI

SLB has announced an investment and technology partnership agreement with Geminus AI that will give SLB exclusive access to deploy the first physics-informed artificial intelligence (AI) model builder for oil and gas operations. The Geminus model builder fuses physics-based approaches with process data to produce highly accurate AI models that can be deployed at scale, far faster, and at much less cost than traditional AI approaches. The Geminus platform uses novel, physics-informed AI computing to translate constraints of the physical

world inside digital models. It requires only sparse data, and models are easily updated with the infusion of new data points. Data scientists and modeling engineers can use the platform to predict the behavior of complex systems and make informed real-time decisions.

In a customer use case, SLB delivered a Geminus hybrid AI-driven application to optimize economic performance while reducing carbon emissions at a natural gas plant. The application, created by Geminus' physics-informed AI solution, was trained by data from SLB's Symmetry™ process simulation



software. It took just days to create, including the underlying hybrid AI model and has the capability to evaluate 20,000 complex scenarios in under a

tenth of a second. The application enables operators to interactively explore the impact of changing process settings on the plant's carbon footprint and yield.

Wonder Cement to set up a new production unit in Gujarat



Wonder Cement to set up its new production facility at Tulsigam in

Gujarat. The company has also reached a milestone with 18 MTPA

cement production capacity in 2023.

The Tulsigam unit will augment the manufacturing capabilities of the company by integrating with its existing production lines to meet the growing market demand and ensure improved serviceability to the consumers.

Wonder Cement started its first unit in Nimbahera, Rajasthan, with a cement capacity of three MTPA, and later added production units in Maharashtra, Madhya Pradesh, and Haryana. In 2023, the company achieved 18

MTPA total cement capacity with its fourth production line and grinding units in Uttar Pradesh and Gujarat.

Driving its strategic goals by incorporating renewable energy sources such as wind and solar power, and employing waste heat recovery systems (WHRS) to optimise energy efficiency, the company has reinforced its focus on sustainability in its operations, and commitment to quality and innovation. The power generated through green energy initiatives is 60 MW.

Greece awards permits for 240MW of renewable projects



The Greek Regulatory Authority for Waste, Energy and Water (RAAEW) has awarded permits for 240MW of new renewable projects across Greece. In a big win for renewable capacity for the nation, installation has been approved for plants providing a total of 132.6MW of solar photovoltaic capacity and 108MW of wind power generation. Power producer Terna Energy has been given approval for two solar parks with a combined capacity of 37.6MW, while North Solar 1 will develop a 96MW solar complex in the north of Greece. Meanwhile, RAAEW has granted Energy Vorsana UAE permission

to build an 81MW wind energy complex in Alexandroupoli, in the Greek region of Eastern Macedonia. In central Greece, Enerkoplan Energy and Investments has plans for 21MW of wind turbine capacity, while Axia Monoprosopi IKE has been granted permission for a 6MW wind plant in Greece's Epirus region. Greece has made bold strides in reducing its dependence on fossil fuels in recent years, with a 2023 report by the International Energy Agency (IEA) praising the nation for enacting an "impressive array of measures to support its ambitious climate goals while maintaining energy security".

Vitherm awarded another order for bio-based polyamide plant



Vitherm recently clinched an order for the supply of a 254SMO unit for a chemical plant in Singapore. The primary focus of this plant lies in manufacturing 100% bio-sourced polyamide, catering to a wide range of critical applications, including electronics, 3D printing, and oil and gas extraction, among others.

Plate heat exchangers are typically constructed from corrosion-resistant materials, ensuring longevity and minimizing maintenance requirements in the harsh chemical environment of the polymerization process. The success of a bio-based polyamide plant lies in optimizing

the production process to ensure resource efficiency, reduced waste generation, and minimal environmental impact, and the customer has purchased Vitherm exchangers to facilitate efficient cooling within their extensive plant processes.

Vitherm welded heat exchanger will be used for this heat recovery process. With proven track records of its unique mechanical strength gave us the cutting edge over other competitors. It also allows easy accessibility, hence making it possible for 100% cleaning due to the pattern on Vitherm plates giving extensive and trouble-free operation.

Ambitions to heat homes in Walsall with rubbish

Homes in Walsall could be powered by rubbish treated at a new waste energy plant set to be built following an offer of support from the West Midlands Combined Authority (WMCA). The Walsall Energy from Waste facility, located at Fryers Road, has ambitions to partner up with the WMCA and local councils to help export heat to homes in the form of steam or hot water.

Rubbish collected to power the plant will come from a range of local and regional waste management companies. The facility itself will replace the region's ageing fleet of incinerators,

which are due to be retired over the coming years.

The plant will be built by energy recovery specialists Encyclis on eight acres of derelict land. The WMCA had originally stepped in with the offer of a GBP 7.5M investment to help get the project off the ground but the financial support was not needed in the end.

The offer had been made by the WMCA as part of its nationally acclaimed 'brownfield first' programme which is regenerating the region's derelict industrial sites for thousands



of new homes and modern, commercial workspaces.

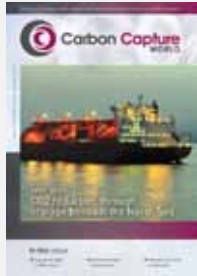
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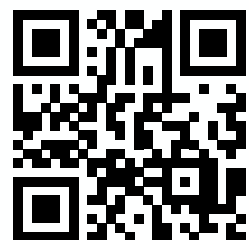
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