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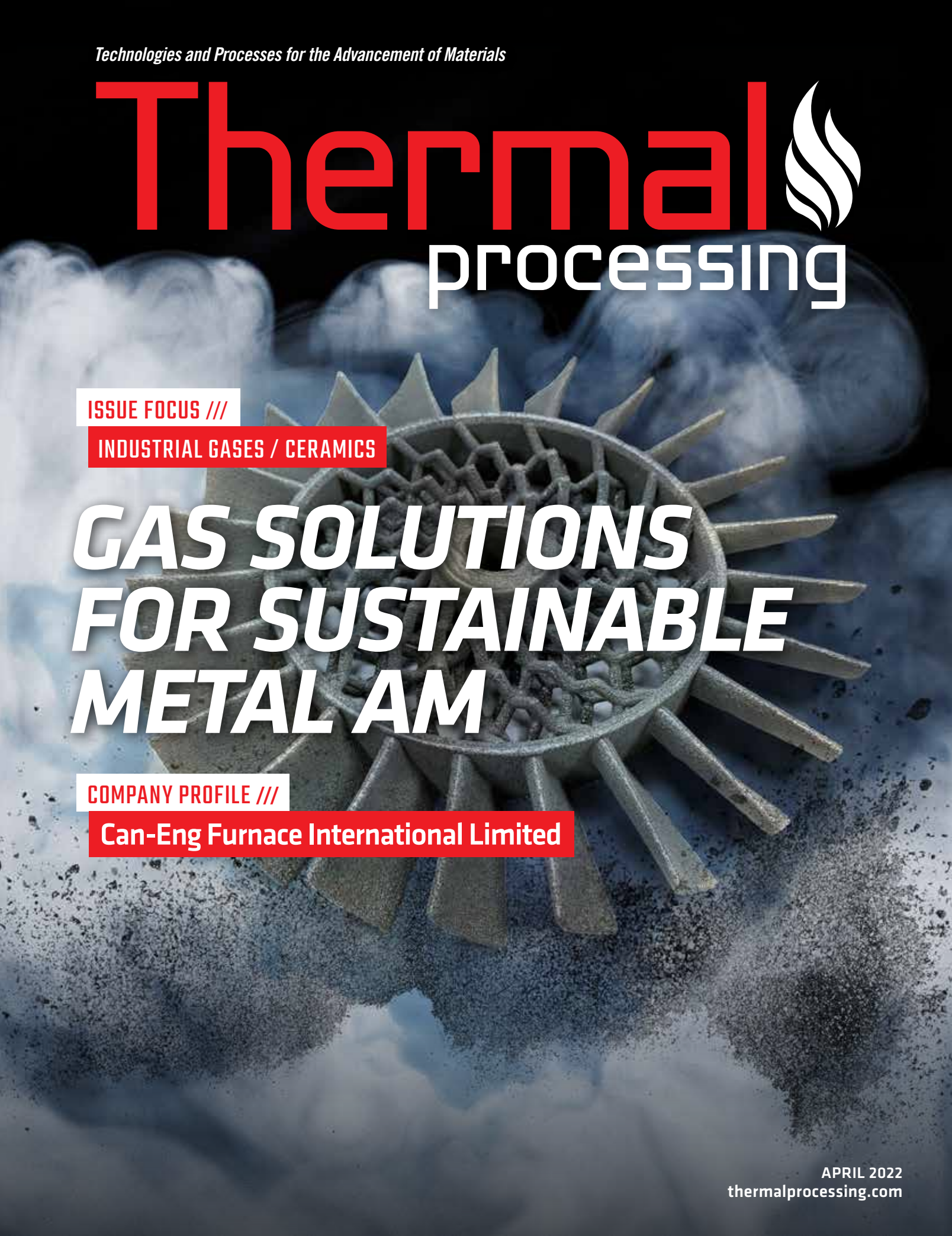

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CONTENTS ///

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DEPARTMENTS ///

APRIL 2022 VOLUME 11 / NUMBER 4

UPDATE ///

New Products, Trends, Services & Developments

»Chinese company orders Seco/Warwick Vector.

»Tenova launches interactive corporate website.

»Thermalogic offers internet-enabled, IoT capable controls.

Q&A ///

TOM SCHULZ

SALES MANAGER ///
L&L SPECIAL FURNACE CO., INC.

RESOURCES ///

International Federation for Heat Treatment (IFHTSE)

The international association whose primary interest is heat treatment and surface engineering shares news of its activities to promote collaboration on issues affecting the industry. **16**

Industrial Heating Equipment Association (IHEA)

The national trade association representing the major segments of the industrial heat processing equipment industry shares news of it's activities, training, and key developments in the industry. **18**

CERAMICS WORKS ///

Refractory ceramic fiber is versatile material that offers easy handling, high temperature tolerance, and cost-saving options. **20**

HOT SEAT ///

While not as efficient as agitators, sparging is useful for water and brine applications, and submerged jets work for small tank applications. **24**

QUALITY COUNTS ///

Nadcap accreditation is crucial to maintaining quality systems and heat-treat operations. Suppliers can make compliance a little easier by learning from others' mistakes. **26**

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FROM THE EDITOR ///

Industry continues to inch toward normal

As the world continues to move closer to normalcy, thanks for checking out the current issue of *Thermal Processing*, where we're always keeping that window open on the world of heat treating.

Judging from some of the news releases we've received from various companies, it would appear that, at least as far as heat-treating is concerned, business continues to grow at a steady pace.

That being said, April's Focus section takes a look at a variety of subjects important to heat treating that are as essential as they are innovative.

With part of this month's focus spotlighting industrial gases, our lead article from Taiyo Nippon Sanso Corp. looks at gas solutions for sustainable metal additive manufacturing.

We are also looking at ceramics this month as well. In an article from Mantec Technical Ceramics, Stewart Saunders discusses a new family of carbon-neutral ceramic products that can help customers reduce the thermal mass of their kiln cars by replacing older, denser refractories with lightweight insulation materials.

And be sure you check out the latest from some of our expert columnists:

In Quality Counts, frequent contributor Jason Schulze counts down the 2021 PRI Top 10 NRCs in heat treating.

In Hot Seat, Dr. Scott MacKenzie discusses quench tank agitation by submerged jets.

And in Ceramics Works, CeraMaterials' Jerry Weinstein gives an overview of refractory ceramic fibers.

You'll find all that and more in this month's issue.

Keep in mind that *Thermal Processing* is here to get your message out to your customers, whether that be with news releases that we happily share with our readers or advertising that can drive home what your company can offer. There are options available, and *Thermal Processing's* primary goal is to help you with your company's mission in any way we can.

As always, thanks for reading!

KENNETH CARTER, EDITOR
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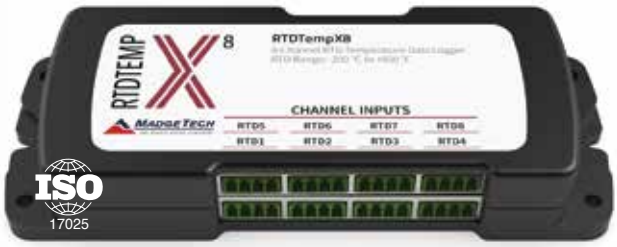

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Seco/Warwick's flagship machine, Vector, is a single-chamber horizontal vacuum furnace that offers a multitude of possibilities. (Courtesy: Seco/Warwick)

Chinese company orders Seco/Warwick Vector

A Chinese company (listed on the Shenzhen Stock Exchange) has ordered a horizontal vacuum furnace from Seco/Warwick. The furnace will help in producing highly specialized cast parts used in the aerospace industry.

The customer has ordered a Vector® horizontal vacuum furnace with a graphite chamber and a gas quenching system. The furnace heating zone is 1,500 x 1,500 x 1,800 mm and will handle loads of up to 3,000 kg of precision cast parts needed in aviation and astronautics.

This is Seco/Warwick's first contract with this client, but the Vector has been known on the Chinese market for years.

"Last year definitely belonged to the Group's Chinese company, for which it was a historic, record-breaking time full of new orders. The portfolio got bigger by eight new clients, including global companies from the Fortune Global 500 list," said Liu Yedong, managing director of Seco/Warwick China.

Seco/Warwick's flagship machine, Vector, is a single-chamber horizontal vacuum furnace that offers a multitude of possibilities. Hundreds of Seco/Warwick vacuum furnaces in operation around the world are proof of this machine's excellent performance and versatility. Vector single-chamber vacuum heat-treatment furnaces are the perfect solution for manufacturers of precision cast parts. They come with a graphite hot zone (among other options) and can be used for most standard hardening, tempering, annealing, solution heat treating, brazing, and sintering.

"Our Chinese partner expressed the need to improve the quality of its processed components. Vector is the ideal solution because it guarantees high production uniformity, quality, and repeatability. For the astronautics, aviation, and defense sectors, these attributes are crucial. Quality of the end product may decide the safety of many people, which is why precision is the foundation and the highest value for us," said Maciej Korecki, vice president of the vacuum furnaces segment at Seco/Warwick Group. "The contract means another reliable Vector has been sold and will work in that promising market. And I have no doubt that it will live up to the expectations, just like its predecessors. Because Vector is not only a proven product, but also the synonym for reliability, precision, and efficiency."

The furnace will be installed in a facility that specializes in the production of high-temperature alloys used in the aviation, shipbuilding, and power industries, offering a wide range of products, including but not limited to, bars, wires, bands, pipes, and specialized castings. Delivery of the furnace is scheduled for June this year.

MORE INFO www.secowarwick.com

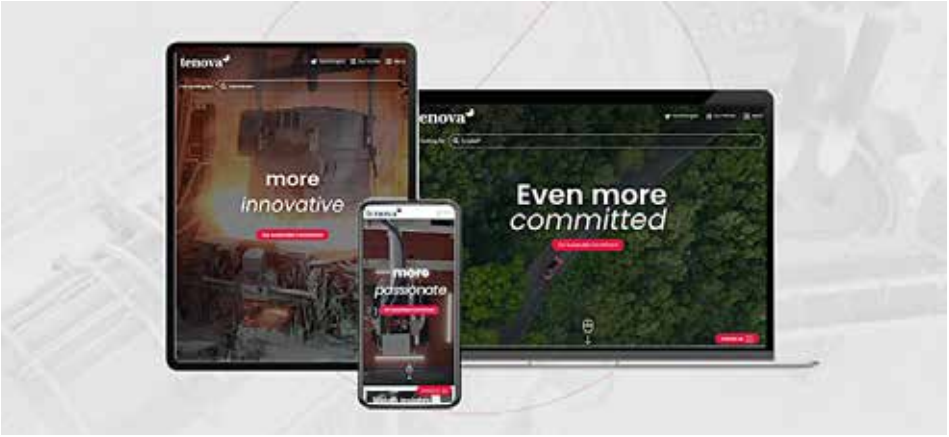
Tenova launches interactive corporate website

Tenova, a leading developer and provider of sustainable solutions for the green transition of the metals industry, has launched its new corporate website: a digital platform born to fulfill the need for a more engaging, interactive, and agile channel, reflecting the company's drive for continuous and sustainable innovation.

"Due to the changing environment we operate in, we felt the necessity to better represent our distinctive positioning and vision of the future. Therefore, we started from the roots of our identity, conducting internal analysis and precious listening activities of our stakeholders. The result is very adherent to Tenova's nature: a dynamic platform where users can easily reach out to us, discover how innovation drives our company, and know more about our strategic vision," said Sara Secomandi, Tenova chief communications officer.

The new website is designed as a digital hub, focused around different stakeholders, targeting their specific needs with direct access to dedicated portals and customized paths to find the contents of interest, with

SEND US YOUR NEWS Companies wishing to submit materials for inclusion in Thermal Processing's Update section should contact the editor, Kenneth Carter, at editor@thermalprocessing.com. Releases accompanied by color images will be given first consideration.



Tenova's new digital platform aims to spotlight the company's forward-looking approach to enable a sustainable future for the metals sector, as well as to enhance proximity and interaction with stakeholders. (Courtesy: Tenova)

special attention to multi-device accessibility.

The company's premium technology portfolio can be navigated through multiple entry points, whereby technical information is complemented by more descriptive and narrative contributions to lay the focus not only on "what we do," but also on "how and why we do it," diving into the creative processes and values behind the products and projects.

To enhance proactive dialogue with stakeholders, contact forms are available all over the website, creating a direct link with company experts and increased touch-point opportunities.

The substantial presence of Tenova people — through their first-hand testimonies, articles, and contact cards — is the real value added to the website. They are the protagonist, representing the most important asset of the company.

The new communication tool aims to reflect the renewed and reinforced commitment to supporting and enabling a sustainable future for the metals sector and, ultimately, to bringing a significant contribution towards the safeguarding of our planet and its inhabitants.

MORE INFO www.tenova.com

Thermalogic offers internet-enabled, IoT capable controls

Thermalogic offers a multitude of IoT capable temperature, humidity, and other process controls, sensors and transmitters. Experts are on hand to help customers design a system to monitor and configure devices remotely, saving overall time and labor.

Communication options available with the company's controls, sensors, and transmitters include Ethernet, WiFi, Bluetooth, USB, RS232, RS422, RS485, ModBus, and more.

Thermalogic specializes in built-to-order temperature, humidity, and process controls and sensors for OEMs and volume users. A plethora of inputs, outputs, power supplies, and communication interfaces are available. Sales engineers work closely to design a device built to customers' applications

Thermalogic specializes in built-to-order temperature, humidity, and process controls and sensors for OEMs and volume users.

exact specifications.

"When companies want something that is top notch, they come to Thermalogic," said Joe Grein, president of Thermalogic.

Since 1971, Thermalogic has provided design, engineering, and manufacturing services of temperature controls and sensors for OEM and volume users.

MORE INFO www.thermalogic.com

ITS plans for growth with move to new, expanded facility

International Thermal Systems (ITS) has moved into a new, more expansive and modern facility.

The new facility will allow ITS to meet its goals for continued growth by providing additional, upgraded space for developing precise heat-processing and aqueous washing solutions for a broad array of industries including automotive, aerospace, power generation, battery manufacturing, building products, foundry, and metal packaging industries.

"This new, modern location is another milestone in the long, successful history of ITS. It is a key part of our plan to keep growing and improving our business. In this new location, we will continue to provide our customers exactly the solutions they expect and rely upon us to deliver," said Tom Stricker, president, ITS. "We are very excited to highlight all of our capabilities in this new space and to continue to bring fresh, new talent into our organization."

The new address is International Thermal Systems (ITS); 3000 North 114th; Wauwatosa, WI 53222.

Phone numbers remain the same.

MORE INFO www.internationalthermalsystems.com

AHT names Chris Molencupp new sales manager

Advanced Heat Treat Corp. (AHT), a recognized leader in heat treat services and metallurgical solutions, has added Chris Molencupp as its new regional sales manager. Molencupp will be responsible for driving sales from Michigan, Indiana, Ohio and Canada. He joins AHT with more than 30 years of experience in heat treatment and manufacturing.

"Chris comes to AHT with a background in both operations and quality, and in-depth experience with heat treatment, brazing, forging, and other metallurgical services. His well-rounded background will serve our customers and their diverse needs well," said AHT president Mikel Woods.

Chris Molencupp

Molencupp will be based in Monroe, Michigan. The AHT facility in Monroe offers ion (plasma) and gas nitriding, ferritic nitrocarburizing, UltraOx®, UltraOx® Hyper, black oxide, stress relieve, and more. While the location can accommodate parts of all sizes, it is uniquely positioned to handle long parts with its 31-foot tall nitriding unit and 40=plus years of heat-treat experience.

"With our knowledgeable sales staff and multiple locations, we're able to better serve our customers and give them the UltraGlowing® experience in every location, every time," Woods said.

MORE INFO www.ahtcorp.com

Nitrex facility in Mexico receives Nadcap accreditation

As a global provider of turnkey systems (nitriding, nitrocarburizing, vacuum), heat-treatment services, as well as instrumentation and automation solutions, Nitrex recently announced that its facility in Querétaro, Mexico, has been awarded its heat treating Nadcap accreditation.

"We are extremely proud of our team in Querétaro, Mexico, for their invaluable contributions in achieving this significant quality system accreditation for the aerospace sector," said Jason Orosz, president of Heat Treating Services (HTS) at Nitrex. "Nitrex has had a long history of developing processes and methods for exacting surface treatments. A Nadcap accreditation is the apex of this achievement in the aerospace sector. We are happy to push our knowledge and quality systems to our worldwide facilities."

"This is a major accomplishment for

our Querétaro team. A Nadcap accreditation requires a rigorous commitment to all aspects of the quality system. Our team's expertise is built on a foundation of continuous improvement, which will undoubtedly benefit our facility's customers from all sectors, not just aerospace," said Mark K. Hemsath, vice president of sales at Nitrex Heat Treating Services Americas.

Nitrex HTS has a global presence, with service centers in Mexico, China, Italy, Canada, and the United States. In Querétaro, Mexico, the facility focuses on gas nitriding and nitrocarburizing, with new equipment being added in vacuum heat treatment for its aerospace customers.

Currently, Nadcap has approved the operations of the Nitrex HTS facilities in Franklin, Indiana, and in Querétaro, Mexico.

Nitrex was founded in 1984 in Montreal, Canada, and operates three business units — Nitrex Turnkey Systems (NTS), with turnkey nitriding, nitrocarburizing, and vacuum systems; Heat Treating Services (HTS), a worldwide network of commercial heat-treating service centers; and UPC-Marathon, a leading provider of controls upgrade and automation solutions for heat treating and combustion.

With more than 450 employees and a market presence in more than 55 countries, Nitrex serves its customers globally from 14 locations across the United States, Canada, Mexico, Brazil, Germany, Poland, Italy, France, China, Japan, and through a global network of representatives and licensees.

MORE INFO www.nitrex.com

Salzgitter and Tenova reach agreement on SALCOS

Salzgitter AG and Tenova are stepping up their close technical cooperation and have concluded an important agreement for the realization of SALCOS® - SALzgitter Low CO2-Steelmaking.

The two partners have signed a Memorandum of Understanding, thereby substantiating their close cooperation in the next steps toward realizing SALCOS. Conditional on the respective funding approvals, Salzgitter AG intends to order a DRI plant from Tenova with an annual capacity of 2.1 million tons for the future industrial production of directly reduced sponge iron. The plant will be based on the ENERGIRON® technology, jointly developed by Tenova and Danieli.

Tenova affirms its interest in realizing this project together with Salzgitter AG and, beyond this, in cooperating closely in future facilities projects in the areas of development, production, installation, and construction of plants of this kind.

In signing the Memorandum of Understanding, the two companies reaffirm their cooperation based on a spirit of partnership and their joint determination to

Standing, from left, Martin Zappe, program director Salcos®, Salzgitter AG; Paolo Argenta, executive vice president Upstream Business Unit Tenova; Mario Marcozzi, marketing and sales director Upstream Business Unit Tenova; sitting, from left, Dr. Markus Dorndorf, vice president Iron- and Steelmaking Tenova Germany; Roberto Pancaldi, chief executive officer Tenova; Ulrich Grethe, CEO Salzgitter Flachstahl GmbH; Roland Bruckmann, head of procurement of investments, industrial services and mobility, Salzgitter Flachstahl GmbH. (Courtesy: Tenova)

start construction work on the first stage of SALCOS as early as the summer of this year.

SALCOS is a ground-breaking program designed to significantly reduce CO2 emissions in steel production. The program is aimed at achieving a gradual transformation process away from carbon-intensive conventional steel production and toward direct reduction with the flexible and increasing deployment of hydrogen. Ultimately, CO2 emissions in the process chain can be reduced by more than 95 percent and, upon full implementation, avoid one percent of Germany's entire CO2 emissions.

"The agreement with Tenova is a momentous milestone in the implementation of the SALCOS program. It enables us to be in a position to commence directly with the construction phase for realizing low CO2 steel production, once approval has been given to the public funding requested. SALCOS secures the future sustainability of Salzgitter as a steel location and the jobs there," said Gunnar Groebler, chief executive officer of Salzgitter AG.

"Tenova has invested hugely in recent years in developing technologies to substantially reduce energy consumption and improve steel production's environmental footprint. In this landmark development, hydrogen plays a central role and the SALCOS concept could become a decisive milestone for our industry," said Roberto Pancaldi, chief executive officer of Tenova.

MORE INFO www.tenova.com
www.salzgitter-ag.com/de

Seco/Warwick chosen for medical precision brazing

Seco/Warwick is scheduled to deliver a Vector® vacuum furnace to a manufacturer of precision medical devices including X-ray and radiotherapy equipment.

The Vector furnace on order will be used in the manufacture of components for devices used in demanding industrial applications such as the production of medical equipment. The flagship Seco/Warwick product will be intended for annealing and brazing processes.

The high-tech medical industry is one of the most demanding industries in terms of standards, procedures, and process parameters to be met by the equipment involved in the production process. Medical equipment components (e.g., RF components, X-ray tube components, ceramic components) are precision manufactured to the highest quality standards. This is because these components are used for processes that are decisive not only for the quality of treatment, but also for human life. Therefore, when selecting devices for their hardening plants, medical equipment manufacturers are guided first and foremost by quality and reliability.

"The Vector ordered by our partner is a standard and very popular solution. It has proven performance in many fields in precision industries such as aviation, automotive, and medical branches. We are selling many devices for brazing processes that are used for industrial production," said Maciej Korecki, vice president, vacuum furnace segment, Seco/Warwick Group. "This time, our partner is an expert when it comes to brazing complex components that require high precision. I am very glad that having such extensive experience in the industry, and having operated competitive equipment, after detailed analysis, our partner selected our product. This proves our partner's trust that we shall never fail. We should remember that every day Vector furnaces are being operated in 70 countries over five continents."

Among the many types of equipment in the Seco/Warwick Group portfolio, Vector is the most versatile vacuum furnace. Vector can be used in a multitude of processes, including quenching, tempering, annealing, brazing, and sintering. Its characteristic feature includes low energy and process gas consumption while maintaining high performance. This most-popular solution of the vacuum division has already been delivered to manufacturers of landing gears, tools, aluminum extrusion dies, and even dental implants. This time it will be added to the

Seco/Warwick equipment belonging to the Vector range has been proven in brazing processes used in the mass production of simple components. (Courtesy: Seco/Warwick)

French plant, where components for radiotherapy equipment are manufactured.

The vacuum furnace on order enables the efficient heat treatment of many components. A characteristic feature of this design is the high-vacuum system based on a diffusion pump that creates perfect brazing conditions.

"The furnace which was ordered solves the problem associated with production capacity. Large working dimensions combined with a graphite chamber will provide us with great performance. However, this is most important: The Vector is a very precise piece of equipment in which hundreds of companies around the world have placed their trust. The brazing process will include components for systems for targeted radiotherapy. We could say that the Seco/Warwick furnace will help to save human lives," Korecki said.

Seco/Warwick equipment belonging to the Vector range has been proven in brazing processes used in the mass production of simple components. It is also perfect for brazing and annealing in high-tech industries focused on small, precision components, where the production process itself involves many variations associated with the selection of materials.

MORE INFO www.secowarwick.com

L&L special furnace company ships large car-bottom furnace

L&L Special Furnace Co., Inc., has shipped a large gas-fired normalizing furnace to a worldwide manufacturer of pipe, tube, and fittings used for various military contracts.

The furnace was scheduled for delivery at the end of Q4 2021 and ran about four weeks behind schedule due to various supply chain issues.

It is rated to operate at temperatures from 1,300°F/704°C to 2,200°F/1,204°C and heated with six medium-velocity burners. The furnace will be able to maintain uniformity of ±25°F/12.5°C at temperatures above 1,300°F/704°C. The L&L model FCG4410 has working dimensions of 48" wide by 48" tall by 120" deep.

The car-bottom-style furnace features a load car that moves in and out of the unit on supplied railroad-type rails. The door is mounted to the car, which is motorized with all required stops and clearances. The side seals are pneumatic and seal to the car bottom once the car is inside the furnace. Castable piers provide good support for up to a 10,000-pound load. The furnace is completely insulated with ceramic fiber modules.

The control is a floor-standing NEMA12 panel with fused disconnect at the source. All fusing and interconnections are included. The furnace is controlled by a Eurotherm Nanodac program control. Three-zone burner control is provided to promote uniformity. Overtemperature protection is included along with a six-input paperless chart recorder and jack panel.

All L&L furnaces can be configured with various options and be specifically tailored to meet customers' thermal needs. The company also offers furnaces equipped with pyrometry packages to meet ASM2750F.

Options include a variety of control and recorder configurations. A three-day, all-inclusive startup service is provided with each system within the continental United States and Canada. International startup and training service is available by factory quote.

MORE INFO www.llfurnace.com

A hydrogen-based 1,000,000 ton/year ENERGIRON® direct reduction plant will reduce carbon dioxide emission. (Courtesy: Tenova)

Order sets up largest hydrogen-based DRI facility in China

Sinosteel Engineering & Technology Co., Ltd., located in Beijing, China, has recently contracted Tenova, a leading developer and provider of sustainable solutions for the green transition of the metals industry, for the design and supply of a hydrogen-based 1,000,000 metric ton/year ENERGIRON® direct reduction (DR) plant.

The plant will be installed at Baosteel Zhanjiang Iron & Steel Co., Ltd, located in the Zhanjiang Economic and Technological Zone, Guangdong Province, China. The plant capacity of 1,000,000 ton/year will make it the largest hydrogen-based DRI facility in China.

As the effort to lower carbon emissions worldwide continues, the replacement of traditional blast furnace steelmaking technologies — often characterized by the intensive use of coal — is currently the new trend for a sustainable steel industry, and the use of gas-based ironmaking technologies is a valuable alternative. The ENERGIRON® technology, jointly developed by Tenova and Danieli, is the most flexible DR technology for virgin metallic unit production in terms of makeup gases utilization and is already designed to maximize the reduction of CO2 emissions.

The new ENERGIRON® plant will use mainly hydrogen as reducing gas with the possibility to mix it with natural gas (NG) and coke oven gas (COG). The plant has the flexibility to use different reducing gases in any combination or proportion, using the same ENERGIRON® ZR scheme.

The plant will also be designed to have the capability to capture and sell CO2 on the commercial market; this will further reduce the overall plant CO2 emissions and provide an additional revenue stream for the plant operations.

The plant will produce cold DRI pellets through an external cooler for potential future hot DRI production and transport (using the proven HYTEMP system) to a new EAF mill to be located next to the ENERGIRON® plant.

"This is the first direct reduction iron production line integrating hydrogen, natural gas, and coke oven gas for industrial production. Thanks to our technology, Baowu group can proceed towards the path of reducing carbon emission and reaching carbon neutrality in 2050 and Tenova is very proud to be part of this journey," said Stefano Maggiolino, president and CEO at Tenova HYL, the company's competence center in direct reduction.

MORE INFO www.tenova.com

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Conference updates for IFHTSE members

The Tooling 2022 Conference will focus on a broad range of topics related to materials modeling, manufacturing and treating. (Courtesy: Shutterstock)

There are a few conferences members should make sure are on their calendars for the coming year.

They include:

TOOLING 2022 CONFERENCE AND EXHIBITION

April 25-27, 2022 | Örebro, Sweden

The Tooling conferences have been held since 1987 and attract speakers and participants from all continents. The conference topics will include cold- and hot-working tool steels, high-speed steels, plastic-mold steels, hard metals and cermets, steel/material design, tool-steel development, microstructure, properties and performance, production of tool steels, simulations and modeling, additive manufacturing, processing, machining, polishing, heat treatment, surface engineering and coating, wear resistance, fatigue under mechanical and thermal cyclic loads, corrosion resistance, tooling applications, tooling contributions to e-mobility, digitalization in the tool steel and toolmaking industry, sustainable toolmaking including health aspects, circular economy, and tooling supply chain.

For more information, go to www.tooling2022.org.

EUROPEAN CONFERENCE ON HEAT TREATMENT/ IFHTSE 27TH CONGRESS

September 5-8, 2022 | Wyndham Grand Salzburg Conference Center, Salzburg, Austria

The conference is sponsored by ASMET, the Austrian Society for Metallurgy and Materials.

Keynote speakers expected to attend include:

»Prof. John G. Speer, director of the Advanced Steel Processing and Products Research Center (ASPPRC), Colorado School of Mines, Golden, Colorado, on "Recent developments and perspectives of Heat Treatment in Steel Processing." Speer is the 2022 IFHTSE Medalist.

»Prof. Jianfeng Gu, director of the Institute of Materials Modification and Modeling, Shanghai Jiao Tong University. "Modeling and Simulation in Heat Treatment and Surface Engineering." Gu is an IFHTSE Executive Committee Member.

»Dr. Stefan Hock, IFHTSE Secretary General, "50 Years of IFHTSE — Past, Present and Future."

»Prof. Massimo Pellizzari, Department of Industrial Engineering University of Trento, Italy, "Heat Treatment and Surface Engineering in Additive Manufacturing." Pellizzari is vice president IFHTSE, 2022–2024.

»Dr. T.S. Sudarshan, president and CEO of Materials Modification Inc (MMI), Fairfax, Virginia, "Kaleidoscope of Surface Engineering."

For more information, go to www.ifhtse-echt2022.org.

SPOTLIGHT ON MEMBERS

IFHTSE is a federation of organizations, not individuals. There are three groups of members: scientific or technical societies and associations, universities and registered research institutes, and companies. In this segment, we will highlight our members. This month we highlight:

The Heat Treating Society of ASM International

The Heat Treating Society of ASM International, is the largest heat-treating society in the United States. It was originally founded in Detroit in 1913 as The Steel Treaters Club. This group eventually was expanded to form ASM International.

In 1994, the heat treating constituency of ASM – in many ways, the first members of ASM and still one of the largest affinity groups within the membership – created the ASM Heat Treating Society to provide focused leadership, communications, and service development to this vital member group.

Today, HTS continues to grow and prosper. HTS is the world's largest network of heat treaters, and HTS members work to provide events and services to serve their worldwide membership of captive and commercial heat treaters, equipment manufacturers, researchers, governments, and technicians.

IFHTSE 2022 EVENTS

APRIL 25–27, 2022
12th Tooling Conference & Exhibition (Tooling 2022)
Örebro, Sweden | www.tooling2022.org

MAY 11–13, 2022
International Bosphorus Heat Treatment Symposium
Milan, Italy | www.sct-2020.com

JUNE 19–23, 2022
6th International Conference on Steels in Cars and Trucks
Salzburg, Austria | www.sct-2020.com

SEPTEMBER 5–8, 2022
27th IFHTSE Congress / European Conference on Heat Treatment
Salzburg, Austria | www.ifhtseecht2022.org

OCTOBER 10–14, 2022
Advances in Materials and Processing Technologies
Portorož, Slovenia | www.ampt2022.org

NOVEMBER 2–4, 2022
HTS – 14th International Exhibition and Conference on Heat treatment
Mumbai, India | www.htsindiaexpo.com

APRIL 21–24, 2023
5th International Conference on Heat Treatment and Surface Engineering of Tools and Dies
Liangzhu Dream Town, Hangzhou, China

NOVEMBER 13-16, 2023
28th IFHTSE Congress
Yokohama, Japan

For details on IFHTSE events, go to www.ifhtse.org/events

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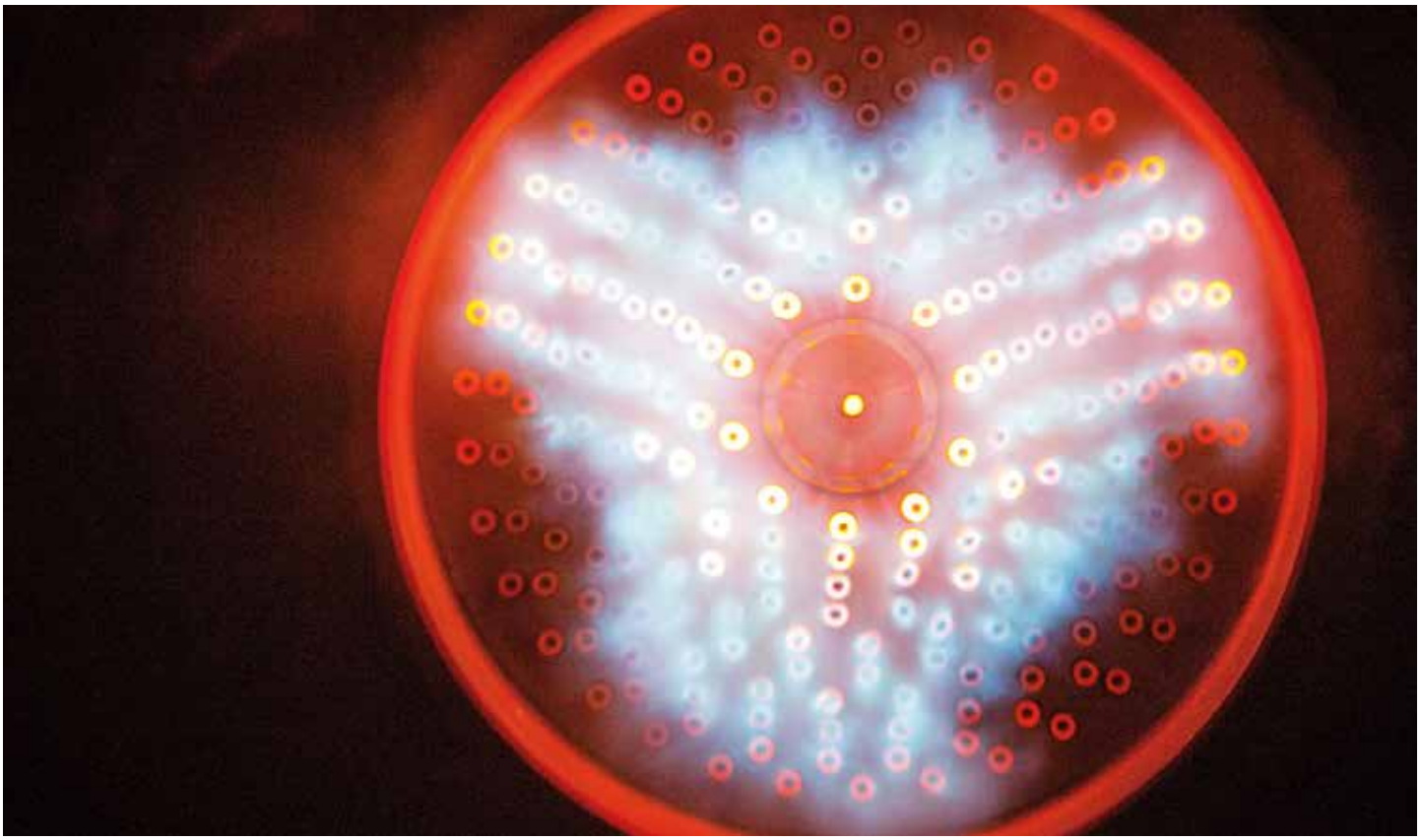
INDUSTRIAL HEATING EQUIPMENT ASSOCIATION

Spotlight on IHEA member WS Thermal Process Technology Inc.



WS is also known for inventing the game-changing flameless oxidation (FLOX®) technology, which enables high-combustion efficiency with low NOx emissions.

WS Thermal Process Technology is the U.S. subsidiary of WS Wärmeprozesstechnik GmbH, which was founded in 1982 in Renningen, Germany. The company manufactures self-recuperative and self-regenerative gas burners for the heat-treating and steel industries. WS Thermal Process Technology opened its doors in Lorain, Ohio, in 1997 and currently has 10 employees for sales, service, training, and repairs. The German headquarters employs about 150 people in Europe.

The IHEA member's signature product is the REKUMAT® self-recuperative burner, which is available in both direct-fired and indirect-fired (radiant tube) versions and is equipped with a recuperator of either metallic or ceramic (SiSiC) composition. High-efficiency options well above 80 percent efficiency have become a standard for WS.

WS is also known for inventing the game-changing flameless oxidation (FLOX®) technology, which enables high-combustion efficiency with low NOx emissions. The significance of FLOX® did not go unnoticed. Joachim G. Wuenning and his father were awarded the German Environmental Award for inventing and commercializing the technology. All WS burners can run with FLOX®, thus achieving the lowest NOx emissions with high-efficiency self-recuperative and self-regenerative gas burners.

Speaking of self-regenerative burners, the REGEMAT® integrates regenerators and switching valves into one compact unit so each burner can act individually. The highest air preheat temperatures are achieved by using ceramic honeycomb heat storage material. Both direct-fired and indirect-fired versions are available. REGEMAT can achieve efficiencies close to 90 percent, which can lead to tremen-

Over the years, WS has proven the global importance of energy-efficient and low-emission combustion systems by supplying in excess of 100,000 burners to the industry.

The REGEMAT® integrates regenerators and switching valves into one compact unit so each burner can act individually.

dous energy savings at high operating temperatures and in continuously operated furnaces.

WS pioneered the use of ceramic single-ended radiant tubes in industrial furnace applications, achieving operating temperatures up to 2,300°F, unmatched temperature uniformity and long lifetime with low maintenance. With thousands of tubes in operation around the globe, WS has helped hundreds of customers improve their processes and drastically reduce their energy costs.

Over the years, WS has proven the global importance of energy-efficient and low-emission combustion systems by supplying in excess of 100,000 burners to the industry. Today, WS is heading toward the future of thermal processing at full speed. The company declared its products to be "green-gas ready," meaning they are prepared to run on green hydrogen and various other promising fuels of the future while still achieving the low emissions one has come to expect from WS. Research and development efforts have been geared toward this goal for years, leading to a series of patents and putting WS in a unique position to provide its customers with solutions that last and, most importantly, are robust toward various different scenarios in the energy sector.

MORE INFO www.flox.com

JERRY WEINSTEIN, PH.D.
MATERIALS SCIENCE ENGINEER /// CERAMATERIALS

This lightweight and versatile material offers easy handling, high temperature tolerance, and cost-saving options.

An overview of refractory ceramic fibers

This article will review refractory ceramic fibers (RCFs), which are amorphous, inorganic, man-made aluminosilicate fibers. RCFs belong to a class of materials termed man-made vitreous fibers, which includes glass wool, rock (stone) wool, slag wool, mineral wool, and special-purpose glass fibers.

The products made from RCF wools are most important for thermal-processing installations and industrial furnace construction and insulation. The RCF products are lightweight and easy to handle, with high temperature capabilities, good thermal shock and chemical resistance, and low thermal conductivity and heat loss. They are generally used in commercial applications requiring lightweight insulation that is capable of withstanding high temperatures, such as furnace and kiln insulation, fire protection, and automotive exhaust systems.

RCF products are used in high-temperature applications in many industries including metals processing, heat treating, glass and ceramics, chemical and petrochemical, automotive, aerospace, power generation, and even domestic appliances.

The maximum service temperature of different RCFs varies in different atmospheres. Complete replacement of dense refractories with an RCF product form provides the most savings in this regard. Using RCF as backup insulation or as a hot-face veneer over an existing refractory lining, however, affords significant energy savings as well.

Ceramic fiber blanket from CeraMaterials available in varying dimensions, densities, grades, and temperature ratings. (Courtesy: ©CeraMaterials)

VARIOUS TYPES OF RCFS

Refractory ceramic fibers are synthetic fibers produced by the melting and blowing or spinning of calcined kaolin clay or a combination of alumina (Al_2O_3), silicon dioxide (SiO_2), or other oxides, usually in a 50:50 weight ratio. The most common grade RCF fiber provided by most USA-based fabricators and suppliers is the "high purity" grade having a temperature rating of around 1,260°C max or 1,180°C continuous use.

There is a higher temperature grade RCF containing about 15 percent ZrO_2 with improved temperature rating of about 1,427°C max or about 1,343°C continuous use for the most common zirconia grades. Pricing for this grade is a bit higher than the standard high purity grade.

A biosoluble RCF grade is called AES wool (alkaline earth silicate), consisting of amorphous fibers produced by melting a combination of CaO, MgO, and SiO_2. AES fiber products having a temperature rating of around 1,260°C max or 1,150°C continuous use, not quite as high as the standard high purity RCF. The calcium and magnesium oxide content are easier for the body and lungs to dissolve, so called biosoluble.

Products made of AES exhibit lower chemical resistance and are more prone to recrystallization, thereby limiting their potential application in thermal-process engineering. The main application for these AES materials is in the domestic appliance industry and in industrial processes for temperatures to a maximum of 1,100°C, although rated for 1,150°C continuous.

Polycrystalline wools (PCWs) are a higher temperature RCF,

HIGH TEMPERATURE INSULATION WOOL (HTIW)

HTIW Grades		Chemical Composition		Acid / Alkaline	Max Temp.	Continuous Use Temp.	Typical Service Temp.	Melting Point	Mean Fiber Length	Thermal Shock Sensitivity	Bulk Density
	AES Wool	CaO MgO SiO_2	27 - 32 % 2 - 6 % 61 - 68 %	- / +	1260°C 2300°F	1150°C 2102°F	< 1000°C < 1832°F	≈ 1300°C ≈ 2372°F	1 - 4.5 µm	+	64-128 kg/m³ 4 - 8 lb/ft³
RCF	Aluminum Silicate Wool	Al_2O_3 SiO_2	47 - 49% 50 - 52%	+ / -	1260°C 2300°F	1180°C 2156°F	< 1150°C < 2102°F	≈ 1760°C ≈ 3200°F	1 - 4.5 µm	++	64-160 kg/m³ 4 - 10 lb/ft³
		Al_2O_3 SiO_2 ZrO_2	35 - 40% 38 - 50% 15 - 17%	+ / -	1427°C 2600°F	1343°C 2450°F	< 1300°C < 2372°F	≈ 1760°C ≈ 3200°F	1 - 4.5 µm	++	96-160 kg/m³ 6 - 10 lb/ft³
PCW	Polycrystalline Wool	Al_2O_3 SiO_2	72 - 80% 20 - 28%	+/+	1649°C 3000°F	1600°C 2912°F	< 1600°C < 2912°F	≈ 1871°C ≈ 3400°F	1 - 4.5 µm	++	96-160 kg/m³ 6 - 10 lb/ft³
		Al_2O_3 SiO_2	95 - 97% 3 - 5%	+/+	1800°C 3272°F	1650°C 3002°F	< 1650°C < 3002°F	≈ 2000°C ≈ 3600°F	1 - 4.5 µm	++	96-160 kg/m³ 6 - 10 lb/ft³

Table 1: The physical and chemical properties of various high temperature insulation wools. (Courtesy: CeraMaterials)

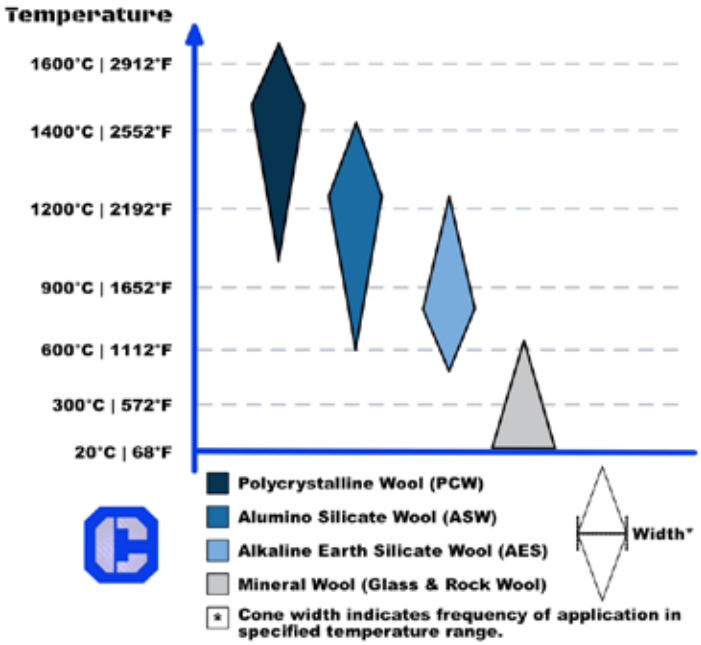


Figure 1: Frequency of use and common temperature ranges for the application of HTIW products. (Courtesy: www.htiwcoalition.org)

consisting of fibers with an Al_2O_3 content above 63 wt. percent and a SiO_2 content under 37 wt. percent. Most suppliers produce the PCWs fiber by aqueous spinning solutions in the sol-gel method. The sol-gel-derived green fibers formed initially as a precursor are then crystallized by means of heat treatment and then handled much like standard RCF and AES fibers. Polycrystalline fiber wools have a max temperature rating of around 1,800°C max and 1,650°C continuous use. (Table 1)

Note that the actual maximum continuous use temperatures for RCF fibers are generally at least 150-200°C (safety allowance) below the max use or classification temperature. This is because, in contrast to the determination of the classification temperature in ideal, neutral-firing conditions with a relatively short exposure (24 hours), the products used in the field are not only exposed to high temperatures but to additional chemical and physical stresses that often deviate far from ideal conditions and therefore limit the application temperature. (Figure 1)

The bulk RCF wool previously described can be used directly for some applications, but are more commonly converted into other physical forms, including blankets, modules, paper, board, vacuum-formed parts, textiles, foam and putties, or pastes, adhesives and coatings. Conversion to various physical forms takes place at locations where RCF fibers are produced, as well as at facilities operated by converters (producers of intermediate goods) or end users. (Figure 2)

CERAMIC BLANKETS

RCF blankets are manufactured by a felting process from a water-based slurry of the RCF fibers with needling from both sides to help interlock the fibers and felt layers, dried in continuous ovens, which results in high-porosity binder-free porous blankets with flexibility and good handling strength. Blankets are produced in varying dimensions, thicknesses, densities, and temperature ratings based on the RCF fiber used. For the standard RCF and AEW fibers, blankets are offered in four, six, and eight pound (per cubic foot) densities, widths of 12, 24, and 48 inches, and thicknesses from 1/8 to two inches. Alternate sizes and shapes are often special orders with capabilities up to 60 inches wide.

RCF blanket Wet Wool is a unique product that takes the standard RCF binder-free blanket and pre-wets it with water-based inorganic bonding agents and then packages it in a clear polyethylene bag to retain the wet binder during shipping and storage. The manufacturing process results in flexible insulation that can be formed to complex shapes in place and air dries to form a hard, rigid structure. Additionally, the material can be cured by immediate exposure to temperature in application. Material has a dry density of 12-18 lbs/ft^3.

Foil-backed or wrapped RCF blanket is also commercially popular, with the foil improving abrasion and moisture resistance, and reducing loose fiber loss. The foiled blanket is often used in appliances, automotive applications, chimney repair, and gasket seal applications.

MODULES

RCF modules are created from folded and compressed blanket, banded to standard block shapes and sizes, with metallic attachment mechanisms folded into the shape. These modules are then used as building blocks to line furnaces and kilns. The assemblies of the mod-

ules are designed to create a no-gap environment upon unbinding, where the modules spring apart laterally, sealing gaps and holding in place. Ceramic fiber module systems provide an energy-efficient solution that can aid in alleviating the need for controlled start-up after installation. Common uses include annealing and tempering furnaces, combustion chambers, oxidizers, burn-off ovens, hydrocarbon reformers, kilns, incinerators, ducts and flues, and more.

Figure 2: An overview of products made from high temperature insulation wools (HTIW). (Courtesy: CeraMaterials)

CERAMIC PAPER

Ceramic fiber paper is manufactured through a fiber washing process which produces a non-woven matrix blend of the fibers, water-based organic binders (~10 percent), and additives to form randomly oriented fiber continuous mat that is flexible and uniform. This process controls the content of unfiberized glass to a minimal level within the paper. Ceramic paper is typically available in RCF and PCW grades in rolls that are 24 and 48 inches wide, with customized sizes up to 60 inches wide. Note that the high binder content results in smoke during initial heat up, resulting in a very weak powdery product after firing.

Binderless paper is available at a premium price which provides a smoke-free option and is manufactured without the organic binder system.

VACUUM FORMED PRODUCTS

RCF porous rigid boards are manufactured through a vacuum casting process using a slurry made of RCF fibers with inorganic and organic binders, formed to near thickness, dried in an oven, and sanded to final thickness. Standard casting thickness can be up to six inches, but thicker than four inches is often made by stacking board assemblies. Boards are fabricated in low and higher densities to standard sizes, but also available up to 60 inches diameter. Low density boards are slightly better insulators, but they are not as durable and strong as high density.

Customized shapes can be fabricated with made-to-order vacuum molds or by assemblies of smaller parts and layers bonded with RCF cement. The rigid RCF molding mix is machinable and can be manufactured in a wide range of shapes and sizes to meet customer needs, including bolt-together pipes, manifolds, elbows, transitions, and custom fittings, as well as burner blocks, peep-sight windows, and sleeves for any unique furnace system design. It also is possible to embed heating elements in the hot face of the insulation and attachment mechanisms into the body and back of the boards.

MOLDABLE MIXES AND ADHESIVES

There are various RCF ceramic moldable mixes consisting of RCF fibers dispersed in a slightly sticky refractory binder system to permit vibratory or hand-packed casting. The putty-like consistency allows easy application by caulking, troweling, hand-forming, and pressure molding. Once cast in place, the moldable mix dries and hardens with minimal shrinkage yielding high porosity, rigidity, high strength, and machinability.

Fiberboard glue is a colloidal silica- and alumina-based RCF mix best used for joining two pieces of ceramic fiber board together or patching small areas. The glue is manufactured by dispersing ceramic fibers in a liquid-based refractory binder system. The resulting viscous consistency allows the glue to be easily applied to refractory ceramic fiber surfaces by troweling or hand forming. Once fully dried, the glue can be sanded or cut using traditional finishing methods due to the product's excellent mechanical strength. Additional coats can be applied or used as a coating on fiberboard shapes, available to match all RCF temperature ranges.

TEXTILES AND ROPE

Textile products are manufactured from RCF and PCW fiber with the same temperature ratings. For improved manufacturing and handling, most textile products do contain approximately 15 percent organic carriers, which will smoke during burn out. Textile products can also

Ceramic fiber blanket with and without foil backing. (Courtesy: ©CeraMaterials)

contain reinforcement insert materials of Inconel wire or continuous fiberglass filament to increase handling strength during installation and to enhance fiber durability. Inconel reinforcement has a temperature rating of 2,000°F (1,093°C) and fiberglass reinforcement has a temperature rating of 1,200°F (649°C), so while the fiber can handle higher temperatures, the reinforcement may give out sooner.

RCF cloth, tape, and sleeving are very strong and flexible fabrics as formed. Insert materials of Inconel wire and fiberglass filaments are incorporated into the yarn to increase the tensile strength of the fabrics both before and after exposure to heat. Typical applications include gaskets, seals, pipe wrapping, furnace, and welding curtains. A variety of sizes, diameters, and rolls are available off the shelf.

Round and square RCF braid are manufactured by over-braiding around a core of ceramic fiber to achieve maximum resistance to mechanical abuse. In addition to its superior strength, round and square braids also exhibit minimal unraveling when cut.

Three-ply twisted ceramic fiber rope is manufactured by forming strands of thick RCF yarn, which are then twisted into a three-ply rope.

Both the braid and ropes are readily available in diameters from 1/8 to 2 inches and are used as gaskets and seals in furnaces and reinforcements for larger RFC forms.

Tadpole gaskets are custom manufactured to customer specifications from sewn blends of RCF fabric, blanket, rope and tape. Available in many designs such as single or double bulbs or single or double tails, these gaskets provide an excellent solution for high-temperature sealing applications such as door, flange, and air-handling valve gaskets.

Ceramic fiber products have lightweight, good heat insulation performance and thermal stability, good chemical stability, easy processing, and convenient construction. Its defect is that it is not abrasion and impact resistance, which cannot resist high speed air flow scouring, and the erosion of slag. There are various ceramic coating materials and rigidizer (colloidal silica and alumina) available to reduce the thermal shrinkage and increase the mechanical strength of the RCF parts.

CONCLUSION

Refractory ceramic fibers are used in commercial applications requiring lightweight insulation that is capable of withstanding high temperatures, such as furnace and kiln insulation, fire protection, and automotive exhaust systems. The RCF fibers are formed into lightweight and easy-to-handle high-temperature insulation products with excellent thermal shock, chemical resistance, low thermal conductivity, and heat loss and low weight.

These products include bulk fiber, blankets, modules, paper, board, vacuum formed parts, textiles, foam, putties, adhesives, and coatings. The RCF products are used in high-temperature applications in many industries including metals processing, heat treating, glass and ceramics, chemical and petrochemical, automotive, aerospace, power generation, and even domestic appliances.

Complete replacement of dense refractories with an RCF product provides cost savings in fuel needs and efficiency. Even using RCF as backup insulation or as a hot-face veneer over an existing refractory lining results in significant energy savings as well.

ABOUT THE AUTHOR

CeraMaterials' Materials Science Engineer Jerry Weinstein has a Ph.D. in ceramic engineering from Rutgers University with more than 30 years' experience, 46 U.S. patents, and numerous publications and presentations. He has extensive experience working and consulting in fields such as advanced ceramics, graphite composites, heat treating, armor, aerospace, turbine engines, electronics, nano-composites, erosion/corrosion and whitewares. Jerry also consults outside projects through CeraGraphiSolutions.

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SENIOR RESEARCH SCIENTIST–METALLURGY /// QUAKER HOUGHTON INC.

While not as efficient as agitators in terms of flow versus power consumption, sparging is useful for water and brine applications, and submerged jets work for small tank applications.

Quench tank agitation by submerged jets

In this column, I will discuss agitation by submerged jets.

Common methods of agitating quench tanks, and other types of tanks, are by sparging or air or by submerged jets.

AIR SPARGING AND SUBMERGED JET AGITATION

Agitation of simple configuration quench tanks is often cost constrained. A simple agitation scheme is needed to achieve the necessary amount of agitation, while keeping costs low. Proper agitation is critical to achieving part properties and low residual stresses [1].

AIR SPARGING

In this method, compressed gasses such as compressed air are introduced into a quench tank. The expansion and rise of the air bubbles cause rapid motion and displacement of the quenchant. While this method may be acceptable for water or brine quenchants, it is not suitable for oil quenchants.

In this type of agitation, when a gas is injected into a liquid, there is a gas core (either bubbles or jet) surrounded by liquid circulating around the gas core. As the velocity is increased, a two-phase zone of turbulent mixture of gas and liquid is formed around the gas core. Formation of jet flow is influenced by the gas velocity, nozzle geometry, liquid properties, and the submersion depth.

For air nozzles, there are two regimes: bubble and jet [2]. For most applications, bubble formation occurs at low velocities, and transition to a jet flow occurs as the velocity of the submerged jet increases. For small nozzles, the gas jet requires a higher velocity to form. As the viscosity of the fluid increases, the formation of a gas jet is slowed. Generally, the jet length is linearly proportional to the jet exit velocity.

Use of air agitation is easy to implement, as it is a matter of piping, regulators, and valves. However, use of compressed gas is not cheap. As an estimate, many companies estimate that compressed gas costs between $0.30 - $0.50 per 1,000 cubic feet of air [3]. While it is difficult to estimate usage due to the many different types of possible configurations, estimates can be drawn from product literature (Figure 1) [4].

The use of air agitation is acceptable for water and brine solutions. However, foaming may become a serious problem, requiring the use of defoamers. Use of air agitation is not recommended for oil quenchants, as the presence of air would result in thermal oxidation of the oil. There is increased potential for severe fires when air agitation is used with oil quenchants. Use of air agitation with polymer quenchants is also not recommended. First there will likely be problems with foaming. This can cause problems with quenching and the formation of soft spots on the parts. There is also the problem of thermal oxidation degradation of the polymer quenchant. The use of an inert gas, such as nitrogen, is cost prohibitive.

SUBMERGED JET AGITATION

In submerged jet agitation, a series of small nozzles is submerged

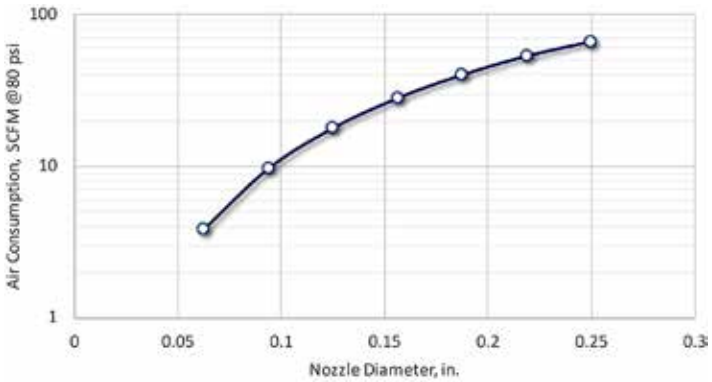

Figure 1: Air consumption of simple nozzles, based on hole diameter in pipe [4] at 80 psi.

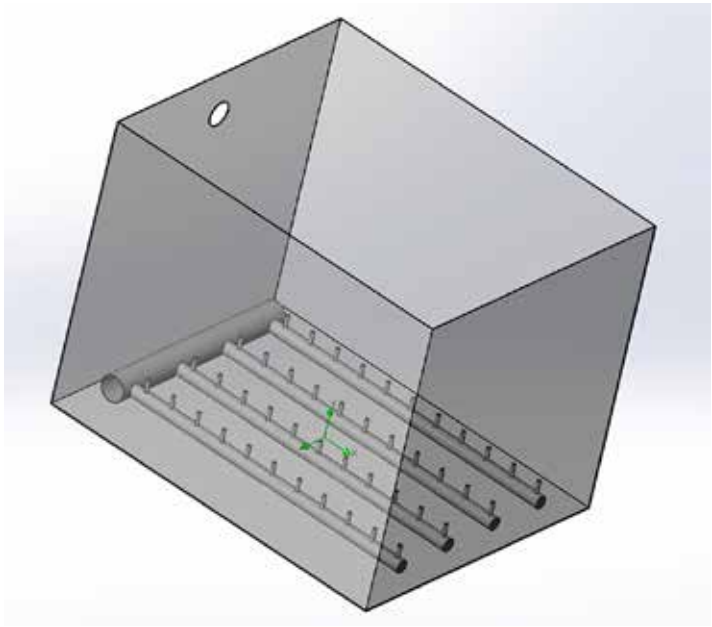

Figure 2: Schematic of a typical submerged jet agitation in a small quench tank. Intel pipes to the nozzle header are not shown for clarity. Quenchant is pumped through the nozzles and returned to the pump.

in the tank, and the quenchant is pumped through these nozzles (Figure 2) using a centrifugal pump. The motion of the quenchant through the nozzles provides the agitation.

This type of mixer can be in many different types of arrangements. Typically, these nozzles are arranged in a header, and fed from a central manifold. Because of the complexity of examining multiple jets, our discussion will focus on a single jet.

Figure 3 illustrates a typical pattern of a jet [5]. The radius for the jet (Rj) at the centerline distance (x) from the nozzle can be cal-

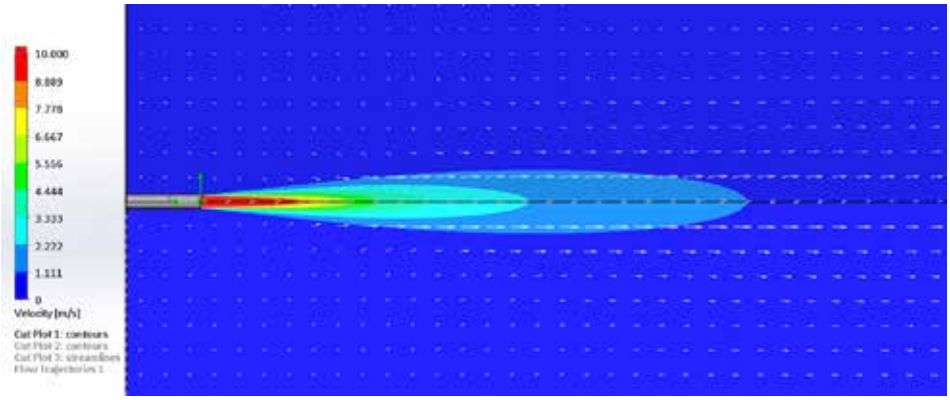

Figure 3: Flow pattern of a submerged jet based on CFD analysis. Nozzle is 25-mm in diameter, with a flow of 1.25L/s. The fluid is water at 20°C.

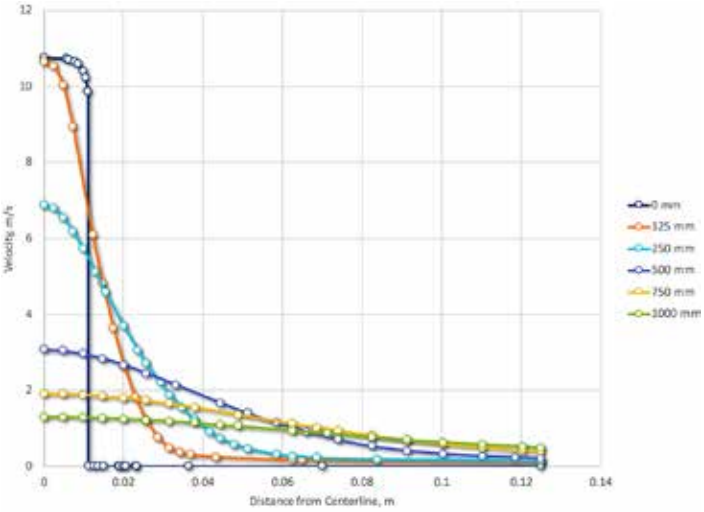

Figure 4: Pattern spread and velocity profile of a 25-mm submerged jet nozzle, using water at 20C, as a function of distance from the exit of the nozzle.

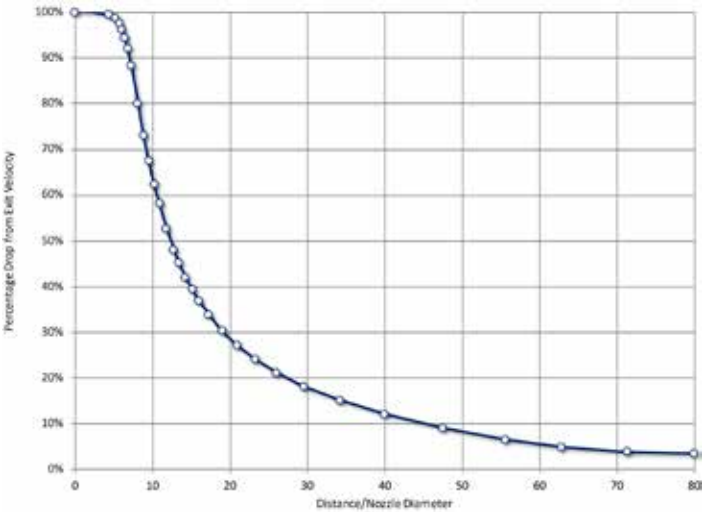

Figure 5: Centerline velocity of a submerged jet based on CFD analysis. Nozzle is 25-mm in diameter, with a flow of 1.25L/s. The fluid is water at 20°C.

culated from [6]:

$$R_j = 0.232x$$

The velocity profile and spread of the nozzle pattern is shown in Figure 4.

The velocity at the centerline distance (Ucj) for x/Dj >8 can be calculated [6]:

$$U_{cj} = 5.13\left(\frac{D_j}{x}\right)U_0$$

Where Dj is the diameter of the jet at position j, and U0 is the velocity of the jet at the orifice (R0). This is shown in Figure 5.

To optimize mixing, the entrainment of the quenchant into the jet should be maximized. Rushton [7] showed that the maximum entrainment occurred approximately 17 jet diameters from the nozzle. Tatterson [8] reported that the fluid entrainment decayed to zero when the centerline distance exceeded 100 diameters. Therefore, large jets should be used for large tanks, and the nozzles should be placed within 17 diameters (maximum) of the surface being quenched.

To achieve uniform quenching, the jet plumes should overlap. Using the equation for the radius of the plume [6]:

$$R_j = 0.232x$$

Substituting 17d for x (d is nozzle diameter) we obtain:

$$R_j = 3.944d$$

as the maximum spacing for nozzles to achieve the desired overlap. Using a 25 mm nozzle diameter example, then the maximum nozzle spacing is 98.6 mm.

CONCLUSIONS

In this short article, I have discussed the use of air sparging and submerged jet nozzles for the use of agitation. While not as efficient as agitators in terms of flow versus power consumption, sparging is useful for water and brine applications, and submerged jets are useful for small tank applications to achieve necessary flow rates.

If you have any questions or comments regarding this column, or have any suggestions for further columns, please contact the editor or me.

REFERENCES

[1] G. Totten, C. Bates and N. Clinton, Eds., Handbook of Quenching and Quenchants, Metals Park, OH: ASM International, 1993.

[2] S. R. Syeda and A. M. Ansery, "Formation and Development of Submerged Air Jets," J. Mech. Eng., vol. ME 44, no. 2, pp. 137-141, December 2014.

[3] U.S. Department of Energy, "Energy Tips - Coompressed Air," Department of Energy, Washington, D.C., 2004.

[4] Nex Flow Air Products Corp., "Air Nozzles and Jets," Richmond Hill, ON, Canada, 2022.

[5] H. Fossett and L. E. Prosser, Proc. Inst. Mech. Eng., vol. 160, pp. 224-251, 1949.

[6] R. G. Folsom and C. K. Ferguson, Trans. ASME, vol. 71, pp. 73-77, 1949.

[7] J. H. Rushton, Petrol. Refin., no. August, pp. 101-107, 1954.

[8] G. B. Tatterson, Fluid Mixing and Gas Dispersion in Agitated Fluids, New York, New York: McGraw-Hill, 1991.

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JASON SCHULZE
METALLURGICAL ENGINEER /// CONRAD KACSIK

Nadcap accreditation is crucial to maintaining quality systems and heat-treat operations. Suppliers can make compliance a little easier by learning from others' mistakes.

The 2021 PRI Top 10 NRCs in heat treating

As the pandemic adjusted our lives and systems, we have still had to maintain Nadcap accreditation in heat treat and other commodities. While the pandemic may have changed our day-to-day operations, it has not changed the fact that Nadcap accreditation is crucial to our quality system and operations. As the aerospace industry ebbs and flows, as does the U.S. economy, the commitment to Nadcap accreditation does not, by any means. Suppliers are committed to maintaining the most robust quality system to ensure AS9100 and Nadcap requirements are accounted for and maintained throughout the process. It is beneficial to make connections all through the aerospace industry and understand what others may miss or, mistakenly, do not account for. This amounts to, "what do my colleagues receive findings for?". While our colleagues may be competitors at times, they are our peers nonetheless, and we need to learn from each other, so we do not make the same mistakes.

With this in mind, I will use this article to examine the Top 10 findings from the Nadcap/PRI Heat Treat commodity from 2021. I will discuss each section in detail and talk about how to avoid becoming a part of the 2022 statistic.

AC7102 CHECKLIST

PRI publishes the Top 10 findings on the eaudit.net site each year. This information is public and available to all who have log-in credentials. The list is separated into three categories: 1) AC7102 less the job audit portion, 2) AC7102 with job audits included, and 3) AC7102/8. They share the same findings within the lists, as we will see. Keep in mind, the revision of the Nadcap checklists in question is AC7102(J) and AC7102/8(NA). The numeric value identified below may not actually correspond with what is listed by PRI as I will be attempting to combine both the AC7102 with job audits and AC7102 without job audits. In other words, there will not be exactly 10 references on the list below as I have combined several.

#1

The top finding from 2021, from the list which does not include job audits, is from AC7102 para 1.1.4 which states, "Did the auditee provide a copy of their completed self-audit, including all 10 (ten) applicable job audits (exemption for ITAR and Export Control documents applies), to the Auditor at least 30 days prior to the audit utilizing the version of the checklist(s) applicable to this audit?". This finding issued because the supplier either did not have a completed checklist or because the 10 required job audits were not completed. Suppliers are required to complete the entire checklist (as it applies) and this must include the 10 required job audits. The challenge for some suppliers may be when preparing for an initial Nadcap HT audit. Suppliers going through an initial audit typically need to use scrap material to simulate jobs. This would, of course, include simulated flow down documentation including POs, routers, and even work instructions. Regardless whether the audit is an initial audit or a reaccreditation audit, all 10 job audits must be completed. It would be beneficial to ensure supplier's internal audit procedure specifically requires that 10 job audits are included. Unfortunately, this and para 1.1.3 seem to make up 1-4 of the top ten findings.

#2

The next top finding is from AC7102, para 1.1.3. This somewhat relates to #1 above. Para 1.1.3 states, "Did the auditee provide the following documents to the Auditor 30 days prior to the audit?". The list of documents needed is a list of equipment; list of purchased services (including name(s) of outside provider for calibration), processing, testing, etc.; list of prime customers and specifications for which heat treater is approved; list of heat treat specifications [military, government, industry (AMS, etc.), and customer] that auditee is working to; copy of internal general procedures for heat treat processing, pyrometry and testing/inspection of heat-treated product(exemption for ITAR and Export Control documents applies); and, finally, an organization chart. If a supplier receives a finding for this it could have been because they would have missed any one of the items listed. I recommend suppliers design a template document (controlled) which contains all of this information which can then be uploaded prior to every Nadcap HT audit. If the document is kept controlled, it will should always be accurate.

#3

Number three comes from para 3.2.1.1, which states, "The quality and technical requirements, including any unique customer requirements, are adequately defined and documented". This statement tends to be very general and can have many different situations associated with it. For example, if a supplier forgets to flow down a require of "cool to below 250°F prior to exposing to air," this will fall into this question. To ensure conformance, suppliers need to start with contract review. Capturing the requirements is the first step. After this, quality should be performing a review of all work instructions to ensure requirements are documented and flowed down the operators.

#4

This one is what we call a two-for-one deal — repeat findings. Para 3.4.1 states, "Are all corrective actions from the previous Nadcap audit still implemented (check the last full audit)?". This is most likely one of the most difficult findings to respond to as suppliers, not only to receive a major finding for the specific issue, but also a major finding against their quality system for not properly implementing and/or maintaining the previous finding. Often, this finding is issued because suppliers are simply not giving the process the

attention that is required. Quality should be involved in the internal audit process to ensure previous findings have been properly closed and corrective actions maintained. It is worth mentioning that when suppliers receive this finding, it will affect any merit status, if the supplier has it at the time.

#5

Number five is against para 1.1.1.2 which states, "For each question in the checklist, has the auditee identified where the means of compliance or evidence* of compliance may be found. (*procedure, form, log, physical location of evidence, etc.)?". When I perform internal audits for suppliers, I ensure each question, even if it is not applicable, has some type of verbiage beneath the question. Questions that use the phrase "do procedures ..." or "does documentation," are a signal that that question must have the supplier's internal procedure and applicable paragraph number where the requirement is accounted for. Other questions, such as 3.3.1, "Is the nonconforming material controlled, and the customer notified of each instance of nonconforming product in accordance with the contractual requirements?", which does not specifically request a procedure or document, can still have a procedure referenced. With this example, the supplier can list the procedure and paragraph of their own procedure for nonconforming material which states this or is similar to this. The point is, each question should have a statement beneath it to show conformance. Below are examples of this from internal audits I have performed.

#6

Number six replates to periodic testing. Para 7.2.2 states, "All qualification, periodic, and lot/batch acceptance testing as required by specifications?". This can be a wide array of testing, depending on the material, customer requirements, and internal supplier requirements. It is important for suppliers to list all periodic testing, and the frequency and the specification it is derived from (see AC7102 para 7.0 and the Nadcap HT auditor handbook). Depending on the periodic testing required, some suppliers put the testing within a system similar to Gauge-Track which automatically reminds suppliers that a test (or calibration) is due.

#7

This finding comes from para 9.1.2.1 of AC7102 and states, "Does the internal procedure specify the method for determining heat-up rate, start of soaking time, end of soaking time, and cooling rate?". In reading this question carefully, you will see there are a total of four requirements. First, how is heat-up rate determined; second, how is the start of soak determined; third, how is the end of soak determined; and fourth, what are the cooling requirements. I typically see suppliers account for these four requirements by writing default definitions within their internal general heat-treat procedure and, when more specific or modified requirements are needed, they are flowed down to the operator via work instruction/router. When answering this question, the internal procedure and applicable paragraph should be referenced.

AC7102/8 CHECKLIST

Below I will examine the Top 10 findings in pyrometry, although it will relate to AMS2750E. Regardless of the revision, it is still worth recognizing and discussing the findings as it is still relevant.

#1

The number one finding relates to the sticker for calibrations. It is against paragraph 4.2.4, which states "Do the instrument calibration records and stickers show conformance to the requirements of AMS 2750E, or more stringent customer requirements?". AMS2750F is one additional requirement which is to identify the instrument or furnace number. The challenge I see, at times, is some suppliers have a metrology department with a template sticker for anything from calipers to gauge blocks to furnace instruments. The problem with this through process is simply that AMS2750F has different requirements than 17025:2017.

#2

Number two will, most likely, pertain to field test instruments more than primary or secondary standard instruments. This one is related to paragraph 4.1.2 which reads, "Does the calibration of primary, secondary standard and field test instruments meet the requirements of AMS 2750E or more stringent customer requirements?". The majority of suppliers do not have primary standards although some may have secondary standards. For practical purposes, let's focus on field test instrument requirements. Field test instruments must be calibrated at six points encompassing the range used in the field. Readability must be to the tenth of a degree (0.1°F) and the permitted error is ±1.0°F or 0.1% of the reading, whichever is greater. It is permitted to use a field test instrument to calibrate another field test instrument in the field if that particular instrument meets secondary standard requirements. This is something quality should be reviewing on the field test instrument certification prior to signing off on it.

#3

Normally, I would skip a finding like this one. Paragraph 2.1.1 states, "Does the supplier have an internal procedure, or procedures for pyrometry addressing all the aspects of AMS 2750E and other customer specifications applicable to their operations?". I thought it would be a good idea to point something out about this question. If you are familiar with the AC7102/8 checklist, you'll recognize this as the first question on the checklist. What this means is, if any question beneath this one on the checklist is marked "NO," this one gets to be marked "NO" as well. In the end, you would need absolutely no findings in pyrometry to have this question marked as "YES."

#4

Finding number four is very common. It relates to para 5.4.1 which states, "Are the displayed temperature indication and recording of the sensor being tested, with appropriate offsets or correction fac-

tors, at any operating temperature, compared with the corrected temperature indication of the test sensor on a test instrument?". This can encompass quite a few errors based on different scenarios. One of the most common scenarios I see is when a supplier incorporates control thermocouple and control instrument correction factors algebraically yet they do not use them in production. If the control system was corrected in production, then this can be done, although very few suppliers actually do this. The majority of the time, the only system that gets algebraic correction is the test instrument system.

#5

This finding is a bit like number 3 above. It relates to para 6.1.1 which states, "Does the internal TUS procedure conform to the requirements of AMS 2750E, or more stringent customer requirements for the specific method used by the supplier?". This means if you get one finding associated with TUSs, this question gets marked as "NO."

#6 and #7

These two are together because of how closely related they are. They are derived from paragraphs 6.7.1.d, "Does the documentation of the performed TUS include as a minimum: Time and temperature data from all recorded sensors required for furnace instrumentation type for all zones tested (Reference AMS 2750 Rev. E section 3.5.13.3.2)?" and paragraph 6.5.4 which states, "Are temperatures indicated by all furnace thermocouples recorded and included as part of the TUS record?". This requirement is simple to conform to: Include the furnace chart from the TUS within the TUS package. The reason for this is the furnace chart needs to be reviewed for compliance along with the entire TUS report. Keeping them as one package is the only way to ensure this and Nadcap auditors expect it to be presented to them in this way.

#8

This finding has to do with system accuracy testing. It is from AC7102/8, para 5.3.2 and states, "Are the SATs performed upon installation and periodically thereafter in accordance with the requirements of AMS 2750E, Tables 6 or 7, or more stringent customer requirements, including any applicable frequency reductions? (The SATs frequencies are based upon equipment class and instrumentation type).". The most common issue I see when consulting is with regards to the SAT extension requirements. It is important to understand what tasks need to be completed to enable suppliers to go to the extended frequency for SAT testing. There are two options, and they need to be well understood.

SUMMARY

This was a summary of the Top 10 findings in the Nadcap heat treat commodity. As I stated, the full list can be downloaded on eAudit.net by anyone who has access. Please feel free to contact me for any clarification of questions.

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GAS SOLUTIONS FOR SUSTAINABLE METAL AM

Employing sustainable gas strategies in the production cycle of powder bed fusion is an important process and should be considered in the production of metal powder, storage of metal powder, and printing of final components, further reducing the environmental footprint of the additive manufacturing process.

By YUSHI ONO, TOMOHIRO OYAMA, ASHOK MATHUR, HIROTAKA MANGYO, and TADAHARU WATANABE

Sustainability is a key value driver and focus for industrial manufacturing, and additive manufacturing fulfills that need in more ways than one.

Additive manufacturing, a rapidly maturing industrial technology, has great potential to reduce the energy and resource requirements of current labor-intensive manufacturing processes through efficient and compact design, precision-fit materials, fewer manufacturing steps, reduced waste, and on-demand manufacturing. Metal additive manufacturing relies on high purity industrial gases and precision gas mixtures to fabricate products that meet the stringent technical specifications and the required mechanical and physical properties. Gases such as argon are an integral part of every manufacturing step in the metal powder production process — from inert powder storage to inert build chamber atmosphere — and to the final fabricated part post-processing.

Within the world of metal additive manufacturing, powder bed fusion (PBF) is currently among the most widely accepted industrial processes. End markets for PBF parts include automotive, medical devices and implants, defense, and aerospace components. Parts produced with PBF have even landed on Mars. As can be expected with any maturing manufacturing process, increased adoption of additive manufacturing, including PBF, demands consistent part quality, high reliability, and long-term repeatability. Equally important is the cost of production that needs to be comparable or better than current manufacturing techniques. While quality requirements have dramatically increased, total costs such as cost of production, equipment, and consumables have come under intense pressure. Many PBF machine operators, OEMs, and metal powder manufacturers have had to lower their prices to remain competitive, with the understanding that any loss in unit pricing would be gained through higher volume long-term.

Continuous removal of gas and metal contaminants from the build chamber, an essential step in the PBF process, affects both product build quality as well as cost. Up until now, less attention has been paid to industrial gas supply (arguably the second largest raw material cost of the PBF process after metal powder). However, this too is changing, as PBF manufacturers are demanding higher quality gas at a lower cost. As a result, industrial gas providers are innovating ways to meet stringent quality requirements through improved gas handling, while concurrently reducing unit pricing.

Industrial gas manufacturers who can demonstrate value to their customers in the form of higher process productivity, higher material utilization, higher gas use efficiency, competitive gas pricing, and more efficient and safer gas handling will be the ones most successful in helping the industry reach full commercialization.

There are numerous ways that industrial gas providers can add value to their PBF customers to ensure a robust and repeatable industrial manufacturing process. These include efficient build-chamber gas recirculation, improved powder handling using inert gases, specialty powder storage units, improved reliability of supply, gas recycling, and on-site gas generation.

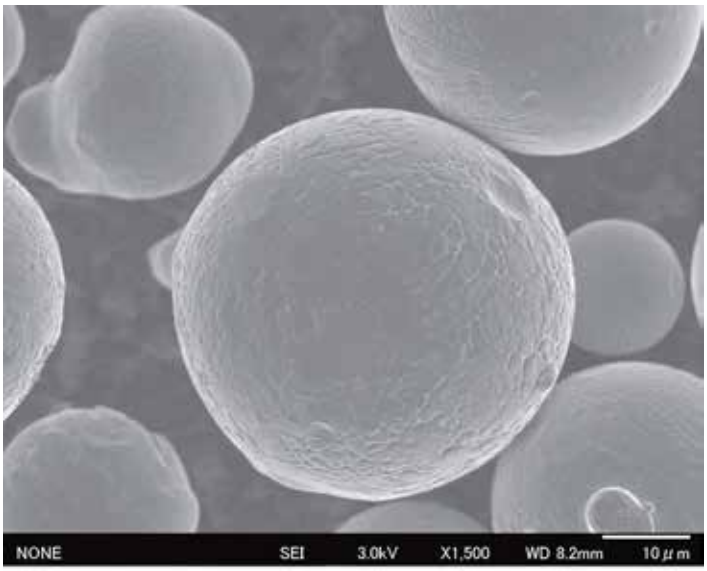


Figure 1: Metal powder under 1,500X magnification.

These process improvements will not only reduce failed builds but also result in lower gas cost and less powder waste — major goals for PBF manufacturers. It is important to understand that proper gas handling and recycling will reduce the costs and environmental impact of the PBF process. Over the past several years, leaders in the supply of argon to PBF manufacturers, such as TNSC, have worked to develop successful strategies for sustainable gas usage in (a) new powder production, (b) powder storage, and (c) the PBF process itself. This article provides greater detail on efforts underway in these three areas.

Additive manufacturing uses metal powders as the base material for manufacturing parts in several AM build processes. Metal powders have evolved in the last century to support a broad range of applications in multiple industrial manufacturing sectors. From simple earlier applications in ceramics, paints, and cosmetics they are now sourced for the most advanced applications such as superalloys, sophisticated electronics, and complex medical instruments.

Numerous methods are used to produce metal powders from valuable metals and alloys such as titanium, aluminum, stainless steel, iron, copper, nickel-base alloys, and cobalt-base alloys. Atomization

is generally viewed as the method of choice due to the geometrical properties of the powder particles that makes it an ideal choice for additive manufacturing (AM).

GASES IN POWDER PRODUCTION

In several metal powder manufacturing processes, gases are used to shear the molten metal into small droplets and to prevent oxidation through an inert atmosphere. In the gas atomization process, a molten metal stream is broken up into small droplets by a high-pressure gas stream in a tower. As the droplets free fall, their surface tension coalesces droplets into solid spheres collected below as metal powder. While any gas can provide the required shear force, the use of nitrogen or argon prevents oxidation. Powder size, shape, and surface roughness can be controlled by adjusting the metal feed rate, atomizing gas pressure and flow, and nozzle design. (See Figure 1)

GAS QUALITY

Building parts in a controlled atmosphere while removing build-process impurities is a major challenge in metal additive manufacturing. Thus, the selection of gas and its supply system are critical factors in the production of powders sensitive to oxidation since the choice of gas atmosphere and the gas purity play a major role in process productivity and powder quality. Contaminated atomizing gas will inevitably result in contaminated powder material.

GAS RECYCLING

The large volume of gas used in the powders production process creates an opportunity to reduce costs and lower environmental footprint. This is accomplished by capturing and recycling the gas back to the powder atomization tower. Reduced virgin gas requirements lower the energy needed to produce, package, and distribute the gas. However, the gas recycling system needs to be carefully designed. The intent is not only to reduce the net volume of gas consumed in the powder production process, but also to purify the recycled gas to near virgin gas quality. This is critical as even a very small atmospheric contaminant increase can alter the specifications of the powders used in the additive manufacturing machines.

If not caught during quality inspection, these powders can greatly affect the mechanical and/or chemical properties of oxygen-sensitive alloys such as titanium or aluminum. This results in reduced physical properties such as poor fatigue resistance, which is critical for AM growth in numerous industries (aerospace, automotive, medical, etc.).

GAS RECYCLING SYSTEM

A well-designed gas recycling system can recycle 80 percent or more (alloy-dependent) of the gas used in the atomizer, while achieving less than 50 ppm total impurity and less than 5 ppm oxygen impurity at parity with "industrial grade" (99.995 percent purity) virgin gas.

SYSTEM DESCRIPTION

The recycling system captures vent gas from atomizing towers downstream of the atomizer's cyclone separator and dust collector. A recovery blower facilitates gas transfer from the dust collector to a recovery compressor. The purifiers then remove fine dust and air contaminants in the recovered gas. Later, the high-pressure recycle compressor compresses the purified gas and stores it in the high-pressure tanks for reuse during the next atomizing cycle. The compressors have a fine particulate filter, coalescing filter, and a carbon bed filter for oil removal to 0.01 ppm. (See Figure 2)

Gas pressure is regulated down to 300 to 500 psi depending on the atomizing process requirement for on-demand gas supply to the atomizing towers. Virgin gas is automatically supplied as needed

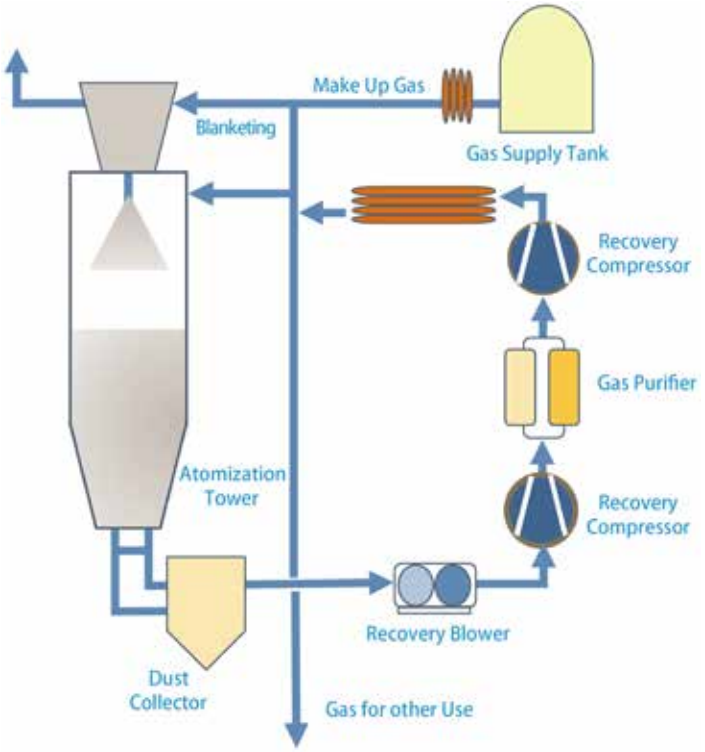


Figure 2: Gas recycle system in metal powder production.

Powder Storage Conditions		Powder Characteristics	
Storage method	Storage period	Assessment	Flowability*
a) After opening	Immediately	○	15.5 s
b) Atmospheric storage	1 month	×	–
c) Cabinet storage	1 month	⊙	12.5 s

* JIS Z2502 standards

* Fluidity measurement using Hall flow meter

Table 1: Powder flowability under various powder storage conditions.

to make up for gas lost to atmosphere and during the purification process thereby maintaining the required volume of gas supplied to the process.

A gas recycling system reduces gas requirements, and thus its environmental footprint in the form of energy to manufacture, storage and handling systems, and its distribution. It also lowers the cost to manufacture metal powders, contributing to the lower cost of additively manufactured parts and contributing to growth in environmentally greener manufacturing.

A key problem with the current state of metal additive manufacturing is the uniform part quality and part-to-part consistency. Powder contamination is a critical source for contaminants such as oxygen and moisture in additive manufacturing.

Powder contamination occurs during powder handling processes and storage containers. Oxygen and moisture come in touch with the powder from exposure to the surrounding atmosphere. Even with the powder container cap closed tightly, moisture permeates through the container wall to contaminate the powder. To avoid contamination, it is crucial to minimize contact with atmosphere and store powders in sealed containers.

In many climates, the amount of moisture in the air fluctuates greatly throughout the year, with a dew point of below freezing in the winter and 30°C in the summer. If powder is not suitably stored in a tightly controlled environment, the powder's moisture concen-

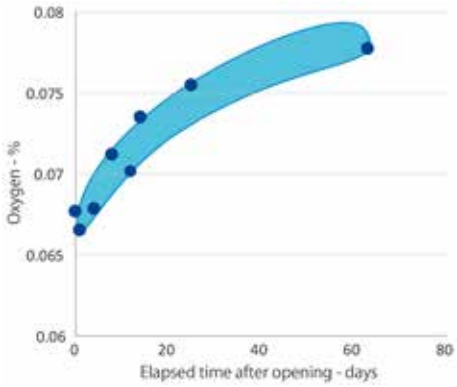


Figure 3: Change in oxygen in Al alloy powder after opening.

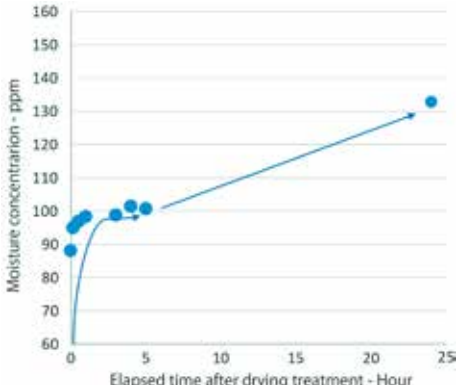


Figure 4: Change in moisture in Al alloy powder after drying.

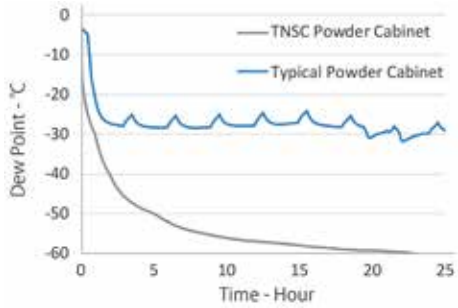


Figure 5: Dew point inside the storage cabinet.

tration could fluctuate by the season.

Moisture in powder causes numerous quality effects, including altering the concentration of oxygen in the part, TIP and strength reduction in aluminum alloys, and diminished re-coating property. This can cause a variation in part properties due to season, making it difficult for a production facility to manufacture consistent and equivalent products. To guarantee part quality, it is critical to ensure a suitable powder storage environment.

There are currently no established standards for the oxygen concentration in powders with varying concentration difference between various manufacturers' samples. In addition, the powder characteristics of different manufacturers are quite different in other ways as well, including a difference in sphericity of approximately 1.5 times. Because powder degradation occurs with powder reuse and its storage environment, even more variation in powder characteristics can occur in reused powders. To stably achieve high-quality printing, it is necessary to be cautious in the selection and storage of suitable metal powder.

Results of the effects on powder flowability are measured using Al alloy powders stored under various conditions as shown as Table 1. There were three types of powder storage conditions: a) immediately after opening the powder container, b) one month of atmospheric storage (with air conditioning management) after opening the container, and c) one month of storage in an inert atmosphere after opening the container. Compared to the powder measured after immediately opening the powder container, the flowability of the powder that underwent one month of atmospheric storage was clearly worse.

Storing the powder in an inert-gas atmosphere for one month not only maintained the flowability but also resulted in a clear flowability improvement. This is attributed to lower friction between particles with low moisture content of powder as well as less oxide film formation on the particle surface.

Figure 6: 3DPro® metal powder cabinet.

A good dry powder cabinet for AM accurately and automatically manages cabinet oxygen concentration and dew point to provide clean dry storage conditions.

EFFECT OF POWDER STORAGE ATMOSPHERE ON OXYGEN AND MOISTURE ADSORPTION

It has been shown that the oxygen concentration of metal powders increases immediately after the container is opened and continues to increase over time. Since powder oxygen concentration is directly linked to metal oxidation, it is important to manage the powder storage environment.

As shown by Figure 3, when a powder container was opened, the oxygen concentration was approximately 0.067 percent. Two weeks later, powder oxygen concentration increased to 0.07 percent and after 60 days, increased to more than 0.075 percent. It clearly demonstrates that atmospheric storage of metal powder increases oxygen adsorption in metal powders.

The moisture content of metal powder also increases when there is an increase in the amount of moisture in the storage environment. Powder moisture content increased by 50 percent when powder was stored for five days in atmosphere with a 10°C dew point. It

increased by more than 100 percent when the powder was stored in atmosphere with a 20°C dew point. However, the powder moisture increase was less than 10 percent when powder was stored in an atmosphere with a minus-60°C dew point. It was clear that the powder storage atmospheric dew point has a major effect on powder moisture adsorption.

Compared to the powder immediately after it is dried, the included moisture concentration increased by approximately 10 percent after one hour of atmospheric storage and more than 50 percent after 24 hours of such storage, shown in Figure 4. This makes it clear that moisture adsorption occurs quite a bit more quickly than powder oxidation.

DRY POWDER STORAGE CABINET

It is clearly apparent that clean dry storage of metal powders is a necessity to manufacture high quality and consistent parts, which is required to gain widespread commercial additive manufacturing acceptable to the industry. The risks associated with high oxygen and moisture lead to inferior and inconsistent part quality.

A good dry powder cabinet for AM accurately and automatically manages cabinet oxygen concentration and dew point to provide clean dry storage conditions. This cabinet achieves low oxygen and moisture concentration by continually replacing cabinet atmosphere with low dew point dry inert gas inside the cabinet. In TNSC's powder cabinet, the concentration of oxygen inside the cabinet is less than 1 percent after one hour of storage, which is eventually reduced to 20 ppm. The moisture inside the cabinet is a minus-30°C dew point (375 ppm) after one hour of storage, which can eventually be reduced to about a minus-70°C dew point (2.58 ppm). (See Figure 5)

TNSC dry powder cabinet is also superior to conventional powder storage cabinets in terms of achieved dew point and the speed of dew point reduction. In addition, the dew point of an unopened polyethylene metal powder bottle stored in TNSC dry powder cabinet for two weeks and then stored in a 20°C dew point atmosphere for two weeks after that. Storing the powder container in a TNSC dry powder cabinet reduces the container's internal dew point and is effective for preventing the deterioration of powder characteristics. Conversely, when the powder container is stored in uncontrolled atmospheric conditions, permeability occurs, and the powder characteristics deteriorate even in sealed containers. (See Figure 6)

Contaminants in the part-building process are one of the main causes of defects in built parts in metal additive manufacturing. In powder bed fusion (PBF) additive manufacturing machines, contaminants such as oxygen, nitrogen, and moisture enter the build chamber through the addition of metal powder. Part of the contaminants come adsorbed on the powder particle surface while others come through the machine's powder feed entry. Typical PBF print chamber atmospheres contain more than 1,000 ppm of impurities, mainly as oxygen and moisture. As mentioned previously, these impurities contribute to deterioration in various printing part properties.

EFFECT OF BUILD CHAMBER GAS IMPURITIES ON SPATTER

As the concentration of oxygen in the atmosphere build chamber was increased, the amount of spatter increased. Although there are reports that spatter can be managed with laser control, the operational parameters may not necessarily match the process conditions for specific parts to eliminate it.

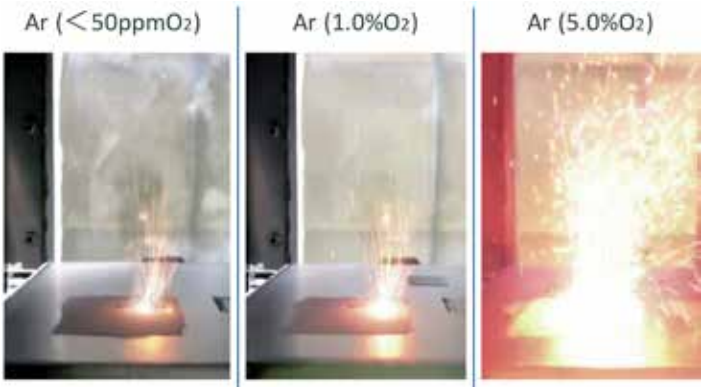


Figure 7: Spatter under various % oxygen contamination.

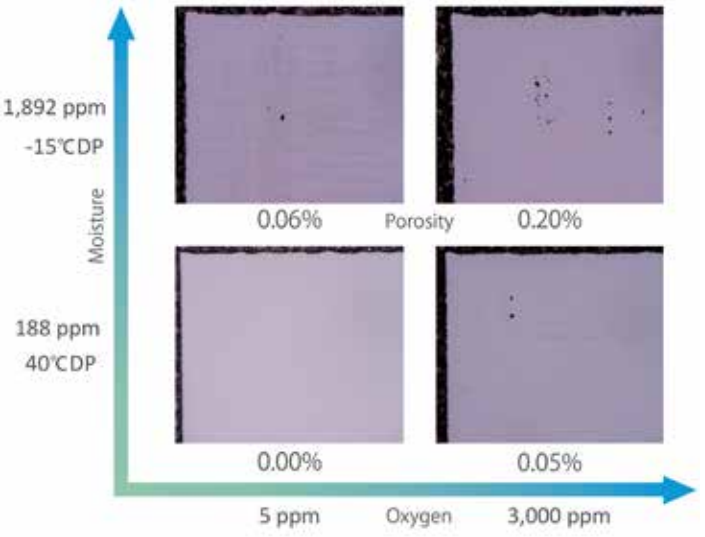


Figure 8: Effect of oxygen and moisture on porosity.

It is therefore important to control the chamber atmosphere to control spatter. (See Figure 7)

EFFECT OF BUILD CHAMBER GAS IMPURITIES ON POROSITY

Similarly, oxygen and moisture contamination in the build chamber affect the porosity of the part. Figure 8 shows how inert gas atmospheres under different oxygen concentration and moisture concentration affect porosity in a typical PBF printer.

The porosity in a part increases with the increase of either the oxygen or moisture contamination. Even higher porosity is seen when both the oxygen and moisture are high. Impurities in the printing atmosphere cause increased spatter and fumes, laser attenuation, and scattering. So, reducing impurities in the printing atmosphere is critical to reducing part porosity and improving its relative density.

Additionally, when the concentrations of oxygen and moisture in the printing atmosphere increase, the part-internal oxygen concentration increases. Surprisingly, TNSC confirmed that the concentration of moisture in the printing atmosphere has a greater effect on the part-internal oxygen concentration than the oxygen itself. Since

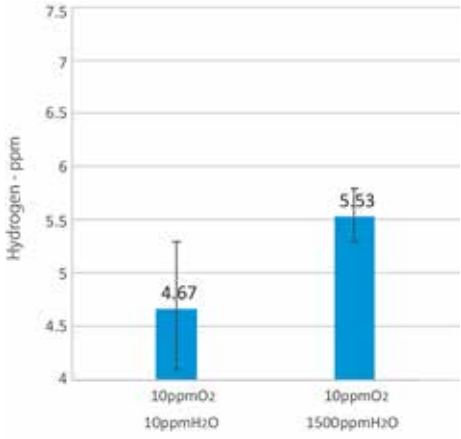


Figure 9: Hydrogen content in built part due to contaminants.

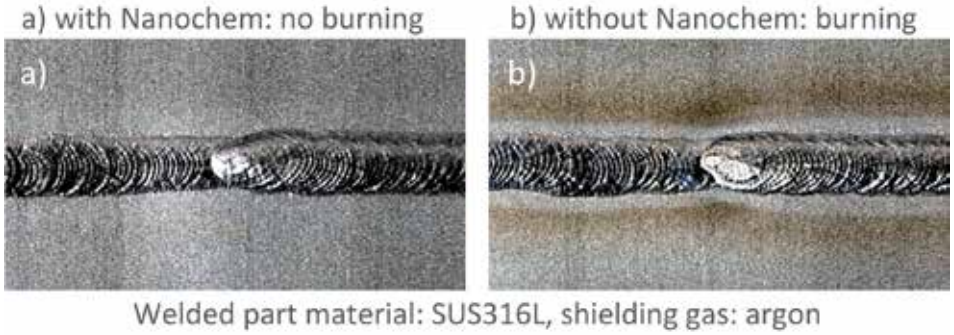


Figure 11: Comparison of burn in welded part with Nanochem® purifier.

oxygen concentration must be strictly regulated in titanium alloys Grades 5 and 23, the effects of impurities in the printing atmosphere become even more crucial. In addition, increases in fumes or spatter also affect the concentration of oxygen in the recycled powder as well as the recyclability of the powder. From the perspective of metal oxidation, it is clearly necessary to manage both the oxygen and moisture in the atmosphere.

EFFECT OF BUILD CHAMBER GAS IMPURITIES ON BLISTER AND THERMAL INDUCED POROSITY (TIP)

One typical defect of aluminum and aluminum alloys is the occurrence of blisters on the alloy surface swelling after heat treatment. Blisters are surface defects caused by the internal pressure of inherent hydrogen and hydrogen absorbed from the atmosphere. In addition, even in cases where the problem does not advance to surface swelling, TIP micropores often occur because of heat treatment and reduce the mechanical characteristics of alloys.

Figure 10: 3DPro® PrintPure™.

Our research shows that it is hydrogen that causes TIP in the part. The more impurities in the printing atmosphere, the more hydrogen on the part. Hydrogen increased approximately 20 percent when the chamber moisture was increased, showing moisture has an especially strong effect. When the powder was dried, the included hydrogen concentration decreased by 33 percent. Based on this data, it can be concluded that the moisture in the printing atmosphere and moisture that gets on the metal powder results in the generation of hydrogen. Since hydrogen can cause delayed fracture in most metals, it is extremely important to manage moisture in the atmosphere as well as moisture in the powder. (See Figure 9)

THE ADVANCED BUILD CHAMBER GAS PURIFICATION SYSTEM

It is evident that any contaminants in the build chamber can cause part quality and part-to-part consistency problems. These contaminants continually enter the chamber as part of the powder or through the powder-feed openings and must be removed continuously as the part is built. TNSC's 3DPro® PrintPure™ addresses the problem by collecting, purifying, and re-circulating the printing atmosphere gases. (See Figure 10)

This system is an add-on gas recirculation and purification system for PBF printers. Circulating and refining atmosphere gas in a printer makes it possible to remove the oxygen and moisture down to low ppm levels.

The system can additionally include the proprietary Nanochem® unit that makes it possible to remove oxygen, moisture, and other impurities in the supply gas line and provide ultra-high purity gas to the chamber. A Nanochem® unit can easily be installed in a gas supply line. In the welding industry, a key field of expertise, TNSC has extensive experience using similar inline gas purifiers all over the world.

Figure 11 illustrates the big difference in a welded part burn with and without the use of the gas purification system. When Nanochem® purification was not used, the gas dew point was -37.9°C, and there was a lot of welded part burn. In contrast, when Nanochem® was used, the gas dew point was reduced to minus-81.6°C, an extremely low dew point, and hardly any gas burn was noticed. Reduced oxidation also improves the print part characteristics, so Nanochem® is valuable not only to additive manufacturing atmosphere gas but also for the shield gas in WAAM and DED technologies.

CONCLUSION

The importance of employing sustainable gas strategies in the production cycle of the PBF process is recognized by industry leaders such as TNSC, which have employed them in the production of metal powder, storage of metal powder, and printing of final components, further reducing the environmental footprint of the additive manufacturing process. These strategies have allowed for an improved industrial ecology of the PBF process and can be leveraged and improved upon as the industry continues to grow.

ABOUT THE AUTHORS

Yushi Ono is Research Technologist – AM Innovation Center | Innovation Unit. Tomohiro Oyama is General Manager – AM Innovation Center | Innovation Unit. Ashok Mathur is Senior Adviser – Innovation Division | Innovation Unit. Hirotaka Mangyo is General Manager – Business Development Innovation Division | Innovation Unit. Tadaharu Watanabe is Senior General Manager – Innovation Division | Innovation Unit. This article reprinted courtesy of Taiyo Nippon Sanso Corp. (TNSC). TNSC was founded in 1910 and based in Tokyo, Japan; it is a global supplier of industrial gases. TNSC is a "single source" for industrial, welding and safety supplies, medical, specialty and electronic gases, gas handling equipment, high performance purification systems, engineering and gas management services, as well as onsite gas generation. Its mission is to deliver innovative solutions that meet global customer requirements. TNSC is one of the five largest suppliers of industrial, specialty, and electronics gases in the world. The Additive Manufacturer Green Trade Association (AMGTA) is a global organization with the purpose of promoting environmental sustainability with AM technology applications. TNSC is a founding member of AMGTA and cooperates with AMGTA companies, research institutions, and industrial organizations to promote education, enlightenment, and research.

CARBON-NEUTRAL INSULATION

FOR HIGH-TEMPERATURE APPLICATIONS

A new family of carbon-neutral ceramic products can help customers reduce the thermal mass of their kiln cars by replacing older, denser refractories with lightweight insulation materials.

By STEWART SAUNDERS

In January 2022, Mantec Technical Ceramics, based in Stoke-on-Trent, U.K., launched carbon neutral versions of its super-insulative Ultralite material, and this has been met with early success in user industries. To the best of the company's knowledge, this is the first example of a U.K.-precision ceramics/refractories manufacturer attaining such certification.

Ultralite grades ULF 10, 12, and 14 have been assessed carbon neutral by one of the principal certification organizations in this area, ClimatePartner (Figure 1). In this case, carbon neutrality means the carbon footprint of the product has been calculated based on internationally recognized standards and fully offset by supporting certified carbon offset projects.

This is an extremely thorough and lengthy process, in this case taking about 12 months to complete. The analysis conducted by ClimatePartner followed a "cradle-to-customer plus waste" approach.

During the process, emissions were assessed according to several product lifecycle stages. These included extraction and preprocessing of raw materials and packaging, manufacturing, supply of the product up to customers' factory gates, and relevant disposal emissions for the product and its packaging. These carbon footprint calculations included all the raw materials, packaging, and energy required to manufacture the product, transportation, and waste treatment. The final calculation was then used to determine the carbon offset that had to be funded in order to gain carbon-neutral certification.

ClimatePartner's carbon neutral label (see Figure 2) certifies that residual greenhouse gas emissions have been offset. For the sake of clarity, all emissions are referred to as CO_2 emissions and measured in tons of CO_2. This means CO_2 equivalents, i.e., all relevant greenhouse gases. Offsetting CO_2 emissions is an important step in effective climate action, alongside avoidance and reduction.

CERAMIC TECHNOLOGY FOR PERFORMANCE AND SAFETY

Ultralite is seen as a modern substitute for more traditional insulation materials across several quite distinct high-temperature applications, predominantly those involving furnaces and kilns. For instance, it can replace expanded minerals. Most naturally occurring expanded minerals used for insulation applications — such as perlite and vermiculite — are chemically foamed, which can lead to a final product that is problematic in terms of extremely variable pore size and limited thermal stability at elevated temperatures above 1,650°F (900°C).

While Ultralite does involve the use of a proprietary chemical foaming agent, crucially it is mechanically not chemically foamed, and this imparts uniform pore size. This means a much more stable and closely graded product and a combination of reproducible results and very good service life. High-volume manufacturers using this material have noted long-term consistent product performance allied to sustained cost and energy savings. Many installations are still using their original material after 10 or more years.

Other notable features include:

- Use of abundant and relatively low-cost raw materials.
- Novel, scalable processing route.
- High porosity.
- Low mass.

Figure 1: Carbon Neutrality 2022 Certificate.

Figure 2: Ultralite loose fill product with new label confirming carbon neutrality.

›› Low permeability.
›› Low thermal conductivity.
›› Low thermal mass.
›› Lightweight.
›› Free flowing.
›› No ceramic fiber or free silica.
See Figures 3 and 4.

MANUFACTURING ROUTE

The material recipe principally comprises carefully selected processing aids, ball clays, bentonite, and an organic foaming agent.

Bentonite has extremely fine grain sizes (all less than 0.5μm) and will absorb large quantities of water so is a preferred swelling/expanding agent. The use of an effective deflocculant is important as a heavyweight, dense slip is required to achieve the optimum mix for the mechanical foaming part of the process.

Once the foamed clay aggregate is in the desired state, it is then dried in a carefully controlled environment. This takes place in an infrared dryer. After drying to the correct percentage moisture content, the material is then fired in a kiln. This is necessary as the refractory aggregate needs to be fully calcined to prevent shrinkage when in use. The mix of clays imparts dry strength to the formed granules (known in the ceramic industry as prill). (See Figure 5)

The final product — which is either supplied in IBCs as loose fill insulation or which is formed into shaped products (bricks, tiles etc.) — is an inert material. Other important characteristics include:

›› No special handling is required.
›› Free flowing and stable.
›› Creates a fiber-free environment.
›› Non-carcinogenic.
›› No volatiles produced.
›› Disposal at end-of-life is problem-free — standard landfill disposal is acceptable.

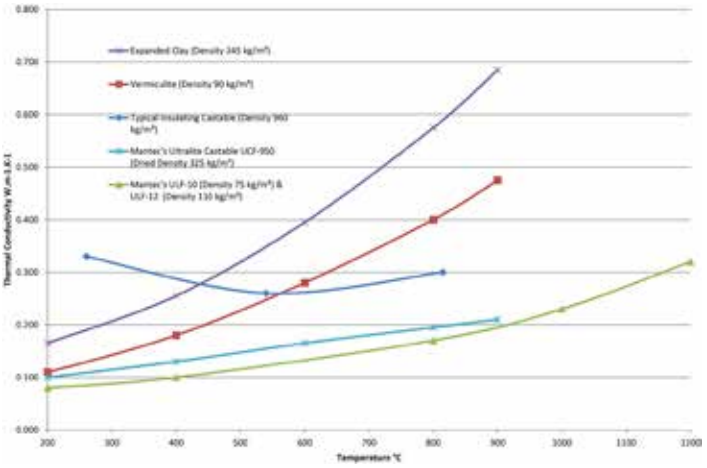


Figure 3: Thermal conductivity chart showing Ultralite against alternative products (kiln firing heavy clay).

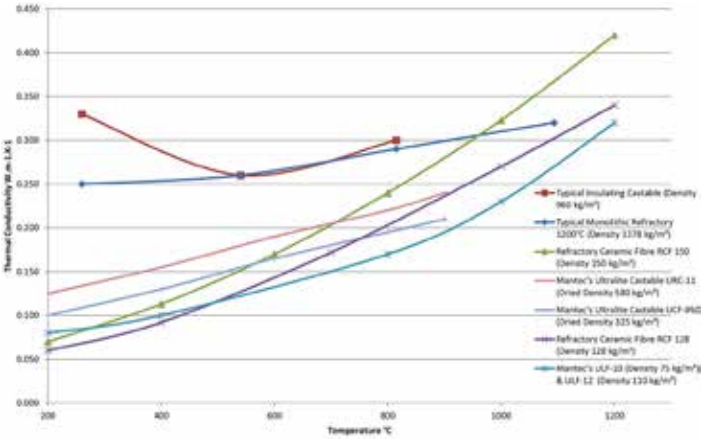


Figure 4: Thermal conductivity chart showing Ultralite against alternative products (kiln firing ceramic sanitaryware).

BENEFITS OF OFFSET

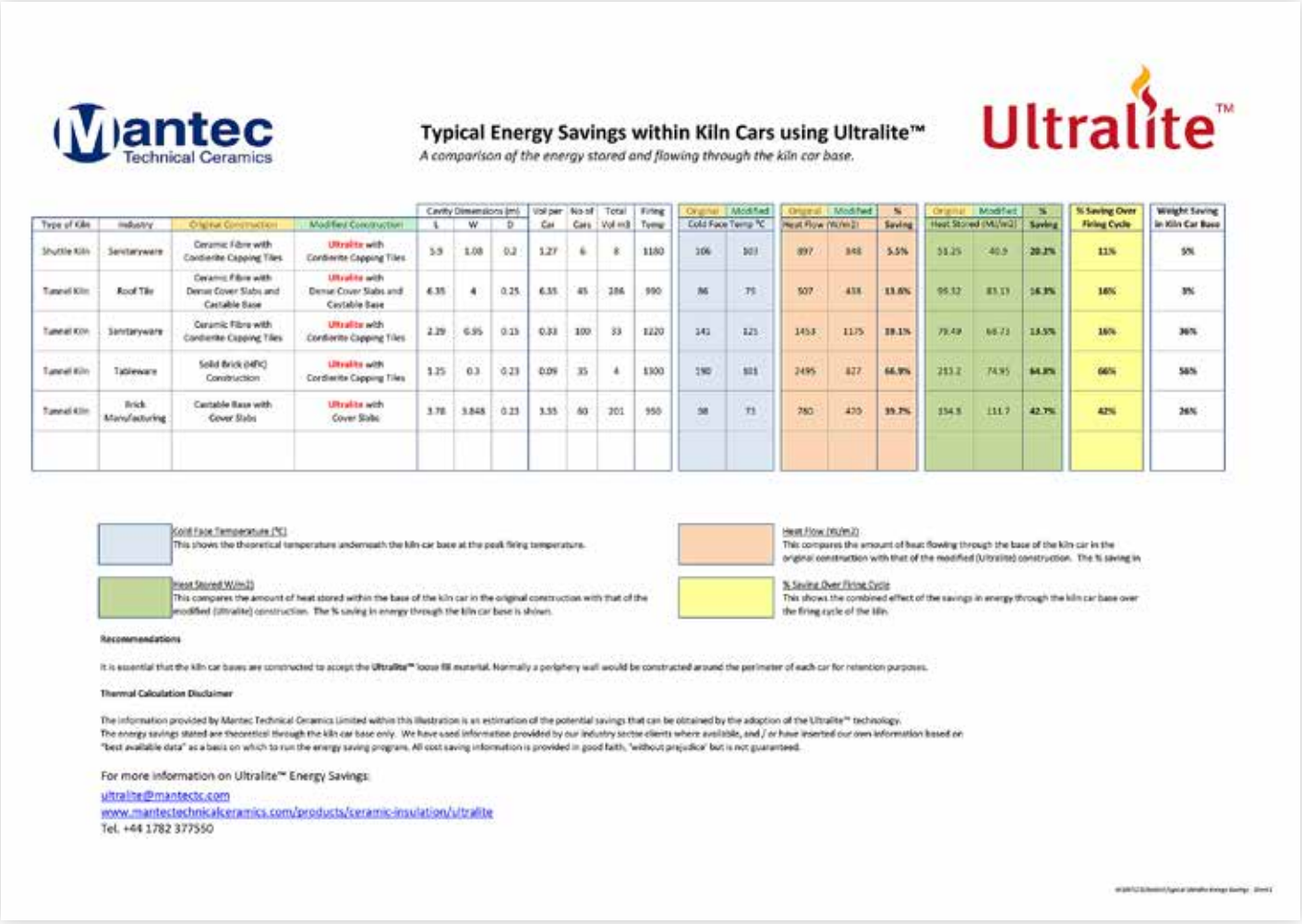
Mantec Technical Ceramics' offset is being "spent" on an exciting afforestation project in Rio Kama, eastern Nicaragua. Afforestation involves the creation of forests in areas where there was no previous tree cover. The team operating in Rio Kama has, to date, planted more than 1 million plants of a native species of giant clumping bamboo. It has transformed a degraded landscape into a flourishing and biodiverse ecosystem.

Bamboo is one of the most efficient biological tools for fighting climate change. The project contributes to mitigation by preventing deforestation and capturing CO_2, as well as to adaptation by reducing temperatures, creating microclimates, supporting a low-carbon economy, and creating livelihoods for vulnerable communities. Annual CO_2 capture in Rio Kama is estimated at 37,000 tons.

Crucially, in contrast to cutting down trees, harvesting giant clumping bamboo does not kill the plant. Once fully mature, selective poles are harvested from each bamboo clump annually, leaving enough time for others to regenerate. In this way, the carbon stored within the bamboo becomes

Figure 5: Fully calcined Ultralite loose fill granules (prill).

This family of ceramic products helps customers to reduce the thermal mass of their cars by replacing older, denser refractories with lightweight insulation materials.



Mantec Technical Ceramics

Typical Energy Savings within Kiln Cars using Ultralite™

A comparison of the energy stored and flowing through the kiln car base.

Ultralite™

Type of Kiln	Industry	Original Construction	Modified Construction	Cavity Dimensions (m) L	W	D	Vol per Car	No of Cars	Total Vol m3	Firing Temp	Original Cold Face Temp °C	Modified Cold Face Temp °C	Original Heat Flow (W/m2)	Modified Heat Flow (W/m2)	% Saving	Original Heat Stored (MJ/m2)	Modified Heat Stored (MJ/m2)	% Saving	% Saving Over Firing Cycle	Weight Saving in Kiln Car Base
Shuttle Kiln	Sanitaryware	Ceramic Fibre with Cordierite Capping Tiles	Ultralite with Cordierite Capping Tiles	5.9	1.08	0.2	1.27	6	8	1180	106	103	897	848	5.5%	51.25	40.9	20.2%	11%	5%
Tunnel Kiln	Roof Tile	Ceramic Fibre with Dense Cover Slabs and Castable Base	Ultralite with Dense Cover Slabs and Castable Base	6.35	4	0.25	6.35	45	286	990	86	75	507	438	13.6%	95.32	83.13	16.3%	16%	3%
Tunnel Kiln	Sanitaryware	Ceramic Fibre with Cordierite Capping Tiles	Ultralite with Cordierite Capping Tiles	2.29	0.95	0.13	0.33	100	33	1220	141	121	1453	1175	19.1%	79.49	68.71	13.5%	16%	36%
Tunnel Kiln	Tableware	Solid Brick (HFC) Construction	Ultralite with Cordierite Capping Tiles	1.25	0.3	0.23	0.09	35	4	1300	190	101	2495	827	66.9%	213.2	74.95	64.8%	66%	58%
Tunnel Kiln	Brick Manufacturing	Castable Base with Cover Slabs	Ultralite with Cover Slabs	3.78	3.848	0.23	3.35	60	201	950	98	73	780	470	39.7%	154.9	111.7	42.7%	42%	26%

Cold Face Temperature (°C)
This shows the theoretical temperature underneath the kiln car base at the peak firing temperature.

Heat Flow (W/m2)
This compares the amount of heat flowing through the base of the kiln car in the original construction with that of the modified (Ultralite) construction. The % saving in

Heat Stored W/m2)
This compares the amount of heat stored within the base of the kiln car in the original construction with that of the modified (Ultralite) construction. The % saving in energy through the kiln car base is shown.

% Saving Over Firing Cycle
This shows the combined effect of the savings in energy through the kiln car base over the firing cycle of the kiln.

Recommendations

It is essential that the kiln car bases are constructed to accept the **Ultralite™** loose fill material. Normally a periphery wall would be constructed around the perimeter of each car for retention purposes.

Thermal Calculation Disclaimer

The information provided by Mantec Technical Ceramics Limited within this illustration is an estimation of the potential savings that can be obtained by the adoption of the Ultralite™ technology.
The energy savings stated are theoretical through the kiln car base only. We have used information provided by our industry sector clients where available, and / or have inserted our own information based on "best available data" as a basis on which to run the energy saving programs. All cost saving information is provided in good faith, 'without prejudice' but is not guaranteed.

For more information on Ultralite™ Energy Savings:

ultralite@mantectc.com
www.mantectechnicalceramics.com/products/ceramic-insulation/ultralite
Tel. +44 1782 377550

Figure 6: Typical energy savings using Ultralite.

a permanent sink, with the clumps having a lifetime of 80 years. The bamboo fiber from the plantations forms the base for a broad range of sustainable, deforestation-free products, such as fibers or building materials.

FUTURE OBJECTIVES

Mantec has a vision to become Net Positive by 2030 and, in stating this goal, is committing to continually reduce its carbon emissions by taking meaningful action year on year. So far, the company has switched to 100 percent renewable energy throughout the factory where Ultralite loose fill prill is manufactured.

By 2025, all the company's packaging will be reusable, recyclable, or compostable. Currently, 95 percent of all packaging is recyclable, and the complete range of Ultralite products are problem free at end-of-life — standard landfill disposal is acceptable.

It should be noted that it is not only the Mantec operation that benefits. This family of ceramic products helps customers to reduce the thermal mass of their cars by replacing older, denser refractories with lightweight insulation materials. In some cases, car weight reduction can be as significant as 40 percent. (See Figure 6)

Additionally, looking right across the kiln or furnace superstructure, the combined benefits of using lightweight insulation castables, low thermal mass firebricks, covers, and loose fill insulation products mean that users not only reduce thermal mass, but they can also cut installation labor, speed up the construction time, decrease heat loss, and therefore save energy and reduce costs. Typical energy savings range from 5 percent to 25 percent, depending on how the products are integrated into the refractory design.

Several international manufacturing corporations have already placed orders for the carbon-neutral Ultralite loose fill insulation and are receiving quotations for late fall 2022/spring 2023 project delivery. So far, deliveries are scheduled to plants based both in the U.K. and the EU.

ABOUT THE AUTHOR

Stewart Saunders is Group Technical & Quality Manager at Mantec Technical Ceramics Ltd.

COMPANY PROFILE ///

CAN-ENG FURNACE INTERNATIONAL LIMITED

DESIGN INNOVATION, QUALITY WORKMANSHIP, AND A DEDICATION TO SERVICE

T4, T5, T6, and T7 systems for HPDC. (Courtesy: Can-Eng)

For almost 60 years, Can-Eng Furnace International Limited has offered custom-made industrial thermal-processing and heat-treating systems while providing users the lowest cost of ownership benefits.

By KENNETH CARTER, Thermal Processing editor

Even though Can-Eng Furnace International Limited is a leading global designer and manufacturer of thermal processing equipment for ferrous and no-ferrous metal, the amount of knowledge and expertise the company offers goes far beyond that simple definition.

"We are a solutions provider," said Tim Donofrio, vice president of sales and marketing for Can-Eng. "We're not a standard furnace offering company. We invite opportunities that really allow us to demonstrate to our partners how we can set ourselves apart from others."

Those opportunities have paved the way for a wide variety of products. Can-Eng offers high-volume, capacity, automated continuous, and batch industrial thermal processing, and heat-treating technology that includes aluminum automotive light-weighting, heat-treating systems; safety critical automotive fastener mesh belt heat-treatment systems; salt-quench austempering heat-treatment systems; plate, API tube, bar quench, and temper systems; steel plant heat processing and treatment systems; aluminum and steel forge and foundry heat processing and heat-treatment systems; and automotive, aerospace, oil and gas, and energy sector heat-processing and treatment systems.

A mesh-belt furnace. (Courtesy: Can-Eng)

EQUIPMENT – TECHNOLOGY FOCUS

In a nutshell, Can-Eng focuses on niche areas of the thermal-processing market by focusing on three main product groups: high-volume, high-capacity, special quality fastener heat-treatment systems; light-weighting technology for the automotive and mobility markets; and custom-engineered special projects, according to Donofrio.

"Certainly, Can-Eng is well known for delivering very high-value-added heat-treatment production capacity through our mesh belt heat-treatment systems," he said.

Can-Eng has the largest mesh belt soft handling heat treatment system available to the market at 7,000-pounds-per-hour production capacity, according to Donofrio. Systems integration proven part mixing and part damages prevention features while also ensuring predictable mechanical properties are achieved for high-quality fasteners used in the automotive or the mobility market. While always focusing on technology development, Can-Eng has recently integrated continuous, inline phosphate removal systems as well as improved tempering furnace uniformity capability for the processing of high-strength fasteners.

"Can-Eng has enjoyed the opportunity to work with most major high-quality fastener manufacturers globally, allowing the Can-Eng nameplate to be easily distinguished at manufacturers around the world," he said. "Can-Eng is recognized as a systems integrator and not just a furnace builder. This is demonstrated through the integration of automated parts handling, product monitoring, automated guided vehicle (AGV) systems and robotic handling solutions that provide single part, lean manufacturing part flow, which has been applied to our Basketless Heat Treatment Systems (BHTS®)."

LIGHT-WEIGHTING TECHNOLOGY

Can-Eng's aluminum heat-treatment systems allow the company to focus on light-weighting technology, according to Donofrio.

"Our aluminum heat-treatment systems have been very successful the last 25 years," he said. "And, more recently, we've been quite successful in developing state-of-the-art high-volume capacity systems that are used for heat treating very specialized, thin-walled, high-integrity castings."

These thin-walled castings are used as part of the structural frame, suspension, BIW, or battery housings, for example, according to Donofrio. These are products that require predictable metallurgical properties, but they also require a very uniform thermal process to ensure the dimensional stability of their products for final installation.

For the past 15 years, Can-Eng has been integrating robotic handling in its aluminum heat-treat systems. (Courtesy: Can-Eng)

"Heat treating is constantly evolving. We try to stay very close to the technologies that are being developed well before they're needed."

"When you're processing very thin-walled, three-millimeter-thick sections, they are quite prone to residual stresses and distortion potential as a result of non-uniform treatment," he said. "With our very specialized state-of-the-art systems, Can-Eng achieves very uniform heating, as well as quenching processes. As part of that, we've developed a very unique Precision Air Quench (PAQ™) system that's been used and integrated into over 20 aluminum heat-treatment systems."

These heat-treatment systems are used by tier-one and tier-two direct automotive manufacturers around the world, according to Donofrio.

"We have well over 50 installations in this market, making it a large part of our focus and business," he said. "This includes more conventional, continuous roller hearth and belt conveyor systems for aluminum forging and casting applications, as well as modular aluminum heat-treatment systems. We see greater requirements for modular heat-treatment systems where significant flexibility for product geometry is required, processing a wide range of processing parameters providing manufacturers the ability to be nimble and react quickly to changes in demand."

CUSTOM SOLUTIONS

The final area of expertise Can-Eng provides is the company's ability to offer custom-engineered solutions, where the answer begins with a blank piece of paper, according to Donofrio.

"We evaluate the customer's expectations and drill down in understanding their needs, some of which are hidden needs; the needs that they don't even realize they have," he said. "It is with this understanding and extraction of needs where we can develop a customized solution that will deliver to them the lowest cost of ownership in implementing a Can-Eng solution."

This might involve a very large steel application, according to Donofrio. An example of this is recent increasing forging demands from the marketplace for isothermal annealing and normalizing systems for the various new multispeed transmissions and drive-unit requirements for the up-and-coming electric vehicle market. These systems requirements could integrate anything from roller hearth, conveyor, rotary hearth, screw hearth, walking beam, or car bottom systems that use automated guided vehicles (AGV).

"We have many different tools available as well as different types of furnace concepts where we can apply our know-how," he said. "And not only that, we can bring a specialized talent that we have with automation."

ADVANCES IN AUTOMATION

For the past 15 years, Can-Eng has been integrating robotic handling in its aluminum heat-treat systems, according to Donofrio.

"We do have a very specialized system concept that we call our Basketless Heat Treatment System (BHTS®)," he said. "What we're doing in that application is essentially providing a continuous thermal process for aluminum components, whether they be forgings or castings, and handling these components through a step-by-step heat-treatment system without the use of any baskets or fixtures."

Donofrio pointed out that what this brings to the table is a tremendous energy reduction and energy savings that shows up in the overall operating costs of the system, as a result of there no longer being a need for continuously heating and cooling baskets, trays, and fixtures, while also eliminating the ongoing capital and repair costs of those fixtures that are constantly being degraded due to constant thermal deterioration. Beyond that, customers will see a considerable improvement in product-quality performance.

Rotary furnaces. (Courtesy: Can-Eng)

An aluminum-conveyor furnace. (Courtesy: Can-Eng)

"As a result of individually handling a part, you do not see the mass effect that you would normally see when you would process a number of parts in a fixture or a basket—resulting in a much tighter temperature control and mechanical performance range," he said.

RESEARCH & DEVELOPMENT

With Can-Eng's ability to offer custom solutions, the company has a capable R&D facility where it can run and develop thermal processes well ahead of production demands, according to Donofrio.

"We've done that work for many different customers over the years, and we've supported quite significant product launches," he said. "In the early days, when the aluminum engine blocks with cast and iron liners were being developed, we supported that, but also when the recent all-aluminum truck was introduced, we supported that as well with development work they required to achieve the mechanical property and dimensional stability requirements that were otherwise not achievable with conventional processes."

HEAT TREATING FOR 56 YEARS

Can-Eng opened its doors in 1964, and for almost 60 years, the company's designs have served commercial and captive heat-treaters, stamping and fastener companies, automotive component producers, the iron and steel industries, aluminum foundries, agricultural, construction, and appliance manufacturers, gaining an international reputation for design innovation, quality workmanship, and a dedication to service, according to Donofrio.

"We've done business in 17 different countries around the world," he said. "A lot of people out there don't really recognize that we are that engaged and that we have support and service capability globally to provide those services."

As Can-Eng has expanded through the decades, it has added a lot of innovative equipment to the heat-treating industry, not the least of which is the company's ability to provide development processing for light-weighting automotive structures, according to Donofrio.

"Can-Eng was the first industrial furnace manufacturer in North America to develop a high-integrity, structural-casting, heat-treatment system to be used for high volume processing for light-weighting automotive structures," he said.

CONTINUED INNOVATION

Moving into its next decade and beyond, Donofrio said Can-Eng will continue to push the envelope of heat-treating.

"Heat treating is constantly evolving," he said. "We try to stay very close to the technologies that are being developed well before they're needed. I think that is one of the things that we appreciate as having an R&D facility where we can work with customers that are developing these new processes and new products, so that we're ready long before they even come to the marketplace. With the mobility markets and the needs of electrified vehicles, we're certainly plugged into those areas and appreciate the battery technology needs within the thermal industry."

To that end, Can-Eng will continue to offer innovative heat-treating solutions to key areas of the thermal-processing market, and if that means being a bit selective, that's only because Donofrio emphasized it's the best way to serve the industry.

"We don't want to be everything to everybody," he said. "We have a very talented group of engineers here, and we like to use their talents in very specific and strategic ways."

MORE INFO www.can-eng.com

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ADVERTISER INDEX ///

Q&A /// INTERVIEW WITH AN INDUSTRY INSIDER

TOM SCHULZ /// SALES MANAGER /// L&L SPECIAL FURNACE CO., INC.

"All of our XLE furnaces come with many options so they can be used for multiple different applications."

What makes the L&L model XLE214 floor standing box furnace ideal for the aerospace industry?

L&L Special Furnace has grown to establish a major presence in the aerospace industry, and L&L has the ability to provide required uniformity for critical aerospace processes. Most aerospace specifications are written around a temperature uniformity specification along with strict thermal guidelines, and L&L prides itself in having high uniformity box furnaces. So, basically, what makes our furnaces ideal for the aerospace industry is temperature control and uniformity.

We used nickel chrome elements in this furnace just to help with the outgassing byproduct of this process. These elements are more resistive to many contaminants.

Then, we put heat shields on the case so the outside case temperature remains safe to touch. The furnace is sealed from inside out for use with inert atmospheres. What that does is displace all the oxygen that's within the furnace by using an inert gas, such as nitrogen. The nitrogen pushes all the oxygen out of the chamber. It gives us a better oxygen-free environment, thus giving better strength to the part and the coating, because there's less oxygen impregnation into the parts.

Oxygen basically equals weakness in that type of process. A manual inert flow panel controls the gas flow into the chamber.

How is the XLE214's curing and bonding process beneficial to aerospace parts?

It provides durability. It's more of a strengthening process for when there's friction between the parts. The bond goes on the metal to provide extra strength in parts that require it, and the advantage of putting a ceramic coating on a metal part is it provides abrasion resistance.

Basically, parts see fatigue over time, and this coating helps prolong the life of the part. So, they take an assembly, and coat it with proprietary ceramics. It provides overall strength to the whole assembly, especially where any wear or friction could be occurring.

Companies can use the furnace for curing and bonding a ceramic coating to steel bodies. The XLE214 furnace can provide extra-strength areas to parts that are subject to various heats and stresses under normal operating conditions.

Could you describe the XLE214's effective work zone?

The effective work zone is the area within the furnace where we will have the uniformity specified. In other words, we specify a work zone and then the required uniformity in the work zone. The XLE214's effective work zone is 22 inches wide by 16 inches high by 20 inches deep. These dimensions are slightly smaller than the actual inside of the chamber. What that allows us to do is to move the work zone around a few inches if needed to get the ultimate effective work zone.

Is that something unique to this model furnace?

Each model furnace has a unique effective work zone. That's what makes the XLE series so versatile; L&L manufactures models from as small as 2 cubic feet up to 72 cubic feet.

How does the Eurotherm program control work with the furnace?

The program control contains 10 individual programs with 24 segments. There are also outputs from the program control that would turn the Venturi evacuation system on and off as needed through the cycle. The Venturi system basically removes any outgassing that's occurring from the parts and has a motor control to adjust the speed at which the effluents are removed.

Can the XLE214 be tailored to specific thermal needs?

Yes. All of our XLE furnaces come with many options so they can be used for multiple different applications. The XLE is L&L's most popular model series, and is the most versatile of all our furnaces, that's for sure, as far as options that can be incorporated and processes that can be used in conjunction with various options to meet specific process needs.

Does L&L offer other furnaces equipped with pyrometry packages?

Yes. In an effort to keep in line with ASM 2750F, all L&L furnaces can be equipped with pyrometry packages.

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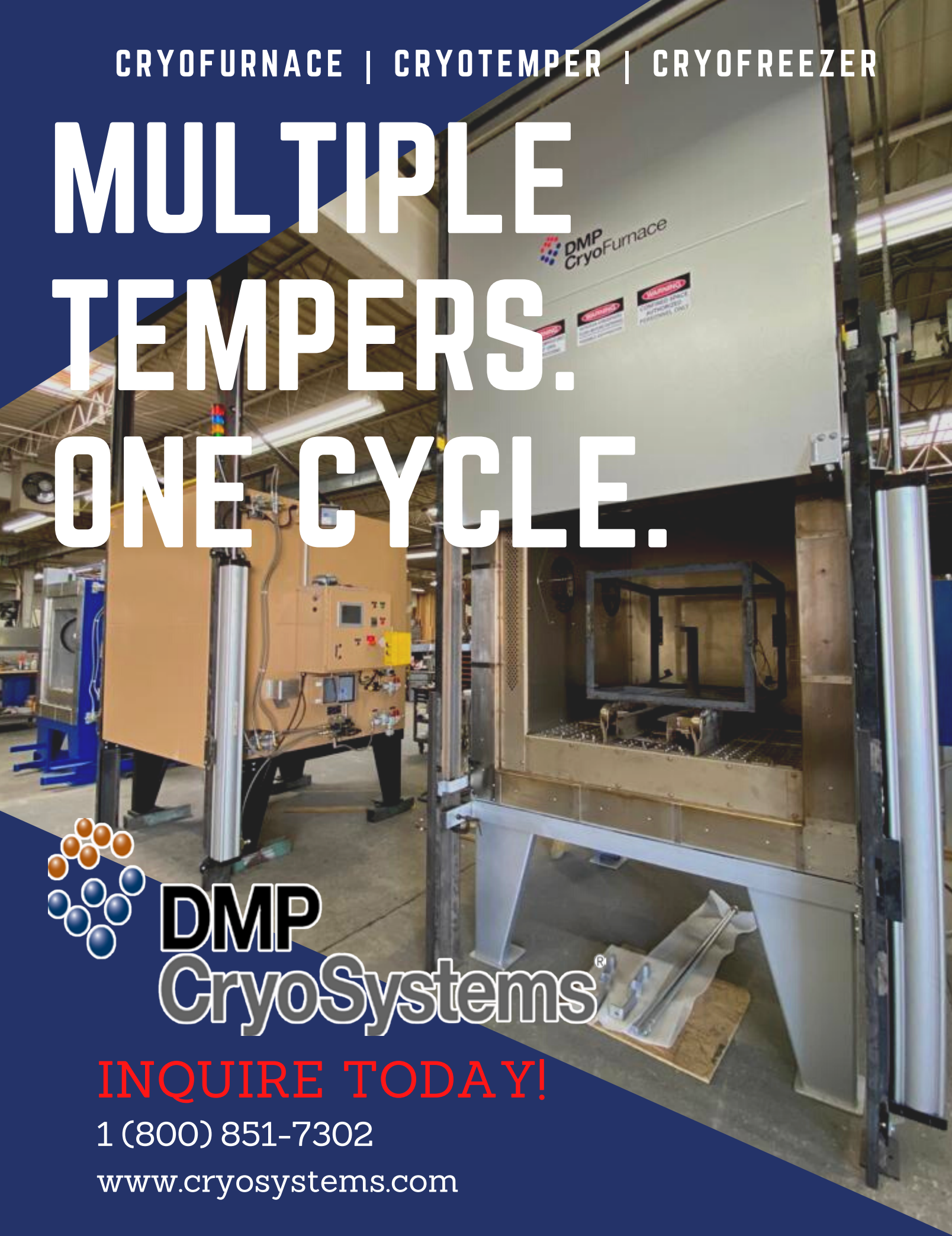

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