Technologies and Processes for the Advancement of Materials

Thermal processing

ISSUE FOCUS ///

INSULATING MATERIALS / BURNERS & COMBUSTION

HOW MODERN BURNERS ARE REDEFINING INDUSTRIAL COMBUSTION

COMPANY PROFILE ///

Vesco

FEBRUARY 2026
thermalprocessing.com

Technical Education. Career Development. International Networking.

Visit **www.stle.org/annualmeeting** for the latest updates and to register.

Save $100 with early bird pricing! Deadline is March 20.

80th STLE Annual Meeting & Exhibition: Innovating Through Tribology & Lubrication

May 17-21, 2026
Hyatt Regency New Orleans
New Orleans, Louisiana (USA)

stle 20 Annual Meeting & Exhibition 26
INNOVATING THROUGH TRIBOLOGY & LUBRICATION

Whether you work in the field or lab—in industry, academia or government—STLE's Annual Meeting has programming designed specifically for you. Please join your peers from around the globe for five unique days of technical training and industry education that could change your career and save your company money.

Program Highlights:

- Over 400 Technical Presentations and Posters
- 9 Lubrication-Specific Education Courses
- Trade Show
- Commercial Marketing Forum
- Business Networking

For the list of technical tracks, visit **www.stle.org/AMTracks.**

Make sure to download the STLE Mobile App:

Available on the App Store

GET IT ON Google Play

stle
• connect • learn • achieve

Society of Tribologists and Lubrication Engineers
840 Busse Highway, Park Ridge, Illinois 60068 (USA)
P: (847) 825-5536 | www.stle.org | information@stle.org
Follow us on:

THERMOCOUPLE TECHNOLOGY

CUSTOM SENSOR MANUFACTURER

Proudly Made in the USA

ACCURACY. RELIABILITY. SOLUTIONS.

PRODUCTS

- THERMOCOUPLES & RTD ASSEMBLIES
- THERMOWELLS
- PROTECTION TUBES
- THERMOCOUPLE WIRE / MULTI CABLE
- THERMOCOUPLES & RTD ACCESSORIES
- ALLOY PIPE & TUBING

SERVICES / CAPABILITIES

- ENGINEERED SOLUTIONS FOR YOUR PROCESS
- ALLOY APPLICATION ENGINEERING
- GTAW CERTIFIED TECHNICIANS
- CALIBRATION & CERTIFICATION

TTEC®

WWW.TTECONLINE.COM • SALES@TTECONLINE.COM

215-529-9394

CONTENTS ///

COVER PHOTO: SHUTTERSTOCK

DEPARTMENTS ///

UPDATE ///

New Products, Trends, Services & Developments

Q&A ///

JASON CILLO

DIRECTOR OF INTERNATIONAL SALES
GRUENBERG AND BLUE M

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. **8**

Industrial Heating Equipment Association (IHEA)

The national trade association representing the major segments of the industrial heat processing equipment industry shares news of its activities, training, and key developments in the industry. **10**

HOT SEAT ///

These high-performance alloys are usually based on nickel, cobalt, or iron, with additional alloying elements; they are specifically developed for times when resistance to oxidation is required. **12**

QUALITY COUNTS ///

Finding the "flow" at work can mean hitting the balance of feeling challenged and invigorated. Work should be recognized as a chance to feel individual success. **14**

Thermal Processing is published monthly by Media Solutions, Inc., 266D Yeager Parkway Pelham, AL 35124. Phone (205) 380-1573 Fax (205) 380-1580 International subscription rates: $105.00 per year. Postage Paid at Pelham AL and at additional mailing offices. Printed in the USA. POSTMASTER: Send address changes to *Thermal Processing* magazine, P.O. Box 1210 Pelham AL 35124. Return undeliverable Canadian addresses to P.O. Box 503 RPO West Beaver Creek Richmond Hill, ON L4B4R6.

FROM THE EDITOR ///

Is it February already?

It looks like 2026 is moving at a brisk pace to match the brisk weather. It's hard to believe we're already two months into the quarter-century mark. Didn't the '80s just end 10 years ago?

To help push us into reality, this month's *Thermal Processing* is packed with expert advice as well as insider knowledge and know-how from some of the best the heat-treating world has to offer.

In this issue, we take a deep dive with articles looking at new and exciting insulating materials being developed, while also discussing burners and combustion.

Burners and combustion are cornerstones of the thermal processing industry, and our main feature focuses specifically on these subjects. In the article, Dunphy Combustion Limited's James Kuligowski shares his insights on how today's industrial burners combine mechanical robustness with digital precision, enabling manufacturers to deliver consistent heat, lower emissions, and measurable energy savings.

Our second article is from frequent contributor and insulating material expert NUTEC. In the article, NUTEC's Jonathan Whaley looks at how high-temperature insulation, particularly ceramic fiber, is an indispensable component of modern industrial thermal processing. Its versatility, efficiency, and cost-effectiveness make it valuable for various applications.

I hope you these stories and more help you enjoy *Thermal Processing* as well as find it informative and timely.

And one last thing: Please remember that I'm always looking for fresh, informative articles to share with our readers. Hit me up if you're interested in having your work published.

And, as always, thanks for reading!

KENNETH CARTER, EDITOR
editor@thermalprocessing.com
(800) 366-2185 x204

CALL FOR ARTICLES Have a technical paper or other work with an educational angle? Let Thermal Processing publish it. Contact the editor, Kenneth Carter, at *editor@thermalprocessing.com* for how you can share your expertise with our readers.

Thermal processing

David C. Cooper
FOUNDER

Teresa Cooper
PUBLISHER

EDITORIAL

Kenneth Carter
EDITOR

Jennifer Jacobson
ASSOCIATE EDITOR

Joe Crowe
ASSOCIATE EDITOR | SOCIAL MEDIA

SALES

Ben Keaten
VICE PRESIDENT I SALES & MARKETING

DESIGN

Michele Hall
GRAPHIC DESIGNER

CONTRIBUTING WRITERS

JAMES KULIGOWSKI
D. SCOTT MACKENZIE
TONY TENAGLIER
JONATHAN WHALEY

media solutions

PUBLISHED BY MEDIA SOLUTIONS, INC.
P. O. BOX 1987 • PELHAM, AL 35124
(800) 366-2185 • (205) 380-1580 FAX

David C. Cooper
FOUNDER

Teresa Cooper
PRESIDENT

Plibrico®

Refractory Material and Services Centered Around Your Needs

Powered by knowledgeable experts with genuine experience

312-337-9000

www.plibrico.com

REFRACTORIES | SERVICES | ENGINEERING

Six Ipsen service technicians were recognized at the Ipsen Vacuum Technology Excellence Center for completing the Ipsen Field Service Engineer (FSE) Academy. (Courtesy: Ipsen)

Six techs graduate from Ipsen Field Service Academy

Six Ipsen service technicians were recognized at the Ipsen Vacuum Technology Excellence Center in Cherry Valley, Illinois, for completing the Ipsen Field Service Engineer (FSE) Academy: Todd Jones, Casey Guinn, Craig Monaghan, Eric Gould, Alfredo Mendoza, and Dom Wirthlin.

The Ipsen FSE Academy is a 14-week, intensive, hands-on training program for field technicians who specialize in servicing Ipsen vacuum furnaces. The program began with three weeks of classroom instruction, where participants learned from engineers, designers, and technical service professionals about the design, assembly, operation, subsystems, and functions of vacuum furnaces.

From there, technicians transitioned to field training. Each participant was paired with a mentor and gained hands-on experience with specialty Ipsen furnaces, hot zone replacements, new equipment installations, and a variety of retrofits, each presenting unique challenges and requiring different skill sets. After several weeks in the field, participants returned to Cherry Valley for calibration training, final evaluations, and a graduation ceremony.

"As a technical trainer we naturally have strong passion for teaching others the skills required to be successful in this industry," said Cavan Cardenas, Ipsen technical training lead. "When we get a group of technicians that matches our passion level, it makes it real easy for us to get excited about the training program."

"One of the best things I learned at the FSE Academy was to network with others in the field," said Gould. "The training gave me the ability to take the time and learn the job so that I can figure out an issue by myself, but also know that I have a team of experts I can reach out to with specialized skills who can help."

"The experience I've had working at Ipsen has been overwhelmingly positive," Jones said. "The FSE Academy, the instructors and the FSEs we've met in the field cement this as a place I want to work for in the very long term. This program helped us develop, giving us what we need to provide value to the company and our customers well into the future."

Participants are paid throughout the program and gain real-world experience by working with key customers at leading companies across a wide range of industries. Ipsen is currently seeking Field Service Engineers to join the next academy class, projected to begin in the second quarter of 2026.

MORE INFO www.ipsenusa.com

Bodycote acquires Spectrum Thermal Processing

Bodycote, the world's leading provider of advanced heat treatment and specialist thermal processing services, announced the acquisition of Spectrum Thermal Processing, a respected heat-treatment provider based in Cranston, Rhode Island. The acquisition expands Bodycote's North American footprint, enhances regional capacity in critical process categories, and reinforces the company's ability to support aerospace, defense, space, and industrial customers across the Northeast.

Spectrum brings established Nadcap-accredited and ITAR-compliant capability, including vacuum heat treatment, low pressure carburizing, and gas nitriding services. The site's strong technical reputation, highly skilled team, and strategic position within one of the nation's most dense aerospace and defense corridors make it a natural fit

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.

for Bodycote's growing U.S. network.

"This acquisition reflects our ongoing commitment to invest in high-growth, high-value sectors and to expand our capability in regions where customers need us most," said Jim Fairbairn, chief executive officer of Bodycote plc. "Spectrum's proven technical expertise and strong local relationships enhance our service offering and strengthen our position as the most experienced thermal-processing network in New England."

The addition of Spectrum complements Bodycote's broader network of Nadcap-accredited facilities across the Northeast and Mid-Atlantic, including Connecticut, Massachusetts, New Hampshire, New Jersey, and Pennsylvania — creating a tightly connected regional platform of high-integrity thermal-processing capacity.

This expanded footprint provides customers with improved proximity, shorter ramp-up times, and enhanced supply chain resilience.

"Spectrum brings unique equipment, specialist processing capability, and a highly respected team into the Bodycote family," said Heidi McNary, president Aerospace and Defense at Bodycote. "Their expertise strengthens our advanced heat-treating portfolio and further enhances the value we provide to aerospace engine manufacturers, defense primes, and leading industrial customers in the region."

Spectrum will be integrated into Bodycote's Aerospace, Defense & Energy (ADE) division, with no immediate changes to customer contacts or service levels. Existing customers will continue to work with the same Spectrum team and will benefit over time from access to Bodycote's broader global network and specialist technologies.

The transaction closed on January 14 and integration activities are under way.

MORE INFO: www.bodycote.com

Ceramics Expo set for May 2026 in Cleveland

Registration is now open for Ceramics Expo 2026 to be held May 5-6 in Cleveland, Ohio. It brings together the full technical ceramics supply chain in the center of North America's manufacturing corridor with breakthrough materials, cutting-edge processes, and the technologies shaping high-performance industries and the future of technical ceramics.

Attendees will be able to explore new materials and processes, meet suppliers and customers, and find practical solutions to take back to their factory, lab, or design team.

What to expect at Ceramics Expo:

» A packed expo floor with raw materials, powders, components, machinery, and processing technologies from across the ceramics value chain.

» Conference sessions that link manufacturing and applications, with case studies spanning automotive, aerospace, electronics, energy, and more.

» Opportunities to benchmark suppliers, compare solutions side by side, and accelerate decision-making.

» Networking with engineers, product designers, and technical leaders facing similar production, performance, and sustainability challenges.

» New for 2026 is the "Innovation Hub", including Start-Up Zone, student poster competition, and the return of the Solutions Innovation Stage.

» A refreshed downtown venue, surrounded by world-class dining, hotels, and entertainment, making it easier than ever to mix business and leisure.

MORE INFO www.ceramicsexpousa.com

Farewell message from the IFHTSE president

Dear friends of IFHTSE,

It has already been two years since I took office as president, and my term is coming to an end. These have been two intense years, full of meetings and events, which have allowed me to get to know the national associations, companies, and many colleagues working in the sector better. On many occasions, I have been welcomed as a guest of honor, a situation I was not used to, thank you!

I am very grateful for the opportunity I have been given and would like to thank everyone who has helped me to carry out the Federation's work and share important choices and decisions. I would like to mention Lesley Frame, who became the new president January 1; Stefan Hock, our secretary general; Imre Felde, for his valuable work as treasurer, and the entire executive committee. I leave my position knowing that my successor will be up to the challenges that await IFHTSE, and I will continue to collaborate passionately to make my contribution.

My warmest regards — Massimo Pellizzari

IFHTSE WELCOMES NEW PRESIDENT FOR 2026 -2027

Dr. Lesley Frame is now serving as the new president of IFHTSE for 2026-2027. Dr. Frame is associate professor of Materials Science and Engineering, past-UTC Professor of Innovation, and director of the Center for Materials Processing Data at the University of Connecticut. Dr. Frame received her BS from the Department of Materials Science Engineering at MIT, and she received her MS and Ph.D. from the University of Arizona in the same field. Upon completion of her Ph.D., she held postdoctoral positions at The Arizona Research Institute for Solar Energy, and then at Cardiff University and the Rutherford Appleton Laboratory as a Fulbright Scholar where she studied residual stresses using neutron diffraction.

Dr. Frame spent five years in the industry at Thermatool Corp. leading product development projects, the materials characterization lab, customer technical training seminars, and process improvement efforts for the tube and pipe industry. Her current research focuses on materials processing-structure-property relationships and failure analysis related to metals manufacturing processes, residual stress formation, corrosion, and transient materials properties. She is actively involved in ASM International; she is a past president of the Heat Treating Society, and she was the vice president for the International Federation for Heat Treatment and Surface Engineering (IFHTSE) for 2024-2025.

Lesley Frame is associate professor of Materials Science and Engineering, past-UTC professor of Innovation, and director of the Center for Materials Processing Data at the University of Connecticut.

NEW IFHTSE TREASURER TAKES THE REINS

At the beginning of 2026, Sabina Kuntzmann will assume the important role of treasurer of the IFHTSE.

Following her studies in languages, economics and law, she began her career in the heat-treatment industry more than 20 years ago. This field has remained as her professional.

For approximately 17 years, she has been actively involved with the Swiss Heat Treatment Association (SVW). Within SVW, she initially served as secretary and subsequently as head of the Association Office. In these roles, Kuntzmann was responsible for a wide range of tasks, including communication, marketing, event organization and the management of the association's financial transactions.

This extensive experience and solid expertise will enable her to contribute to the stable financial position of the IFHTSE; to ensure the up-to-date financial planning and control in cooperation with the executive committee, and to provide transparent and reliable reporting to all key stakeholders.

CONFERENCE UPDATES

BHTS'2026
April 16-17
Istanbul, Turkeye

BHTS'2026 – the 3rd Bosphorus International Heat Treatment Symposium will be April 16-17, 2026, at the Sabancı University Performing Arts Center in Istanbul, in collaboration with the Metal Heat Treatment Industrialists Association (MISAD) and UCTEA Chamber of Metallurgical and Materials Engineers' Training Center (METEM). The chairman of the event is Nuri Kiziltan.

The symposium will provide a comprehensive platform to discuss heat treatment, one of the strategic fields of manufacturing, considering the latest technological and scientific developments. The goal is to bring together all stakeholders, including industry leaders, engineers, researchers, academics, and end users, to exchange knowledge, build collaborations, and shape the future of the field.

›› **For more info:** info@bhtsheat.com or www.bhtsheat.com/en

7th Asian Conference on Heat Treatment and Surface Engineering
September 18-21, 2026
Chengdu, China

The 7th Asian Conference on Heat Treatment and Surface Engineering is a quality event, with typical attendance at more than 1,000 attendees. The location is very walkable, beautiful, and unique. Chengdu is the capital city of Sichuan and is noted for its spicy food and hot pots. More details to come.

31st IFHTSE World Congress
October 13-15, 2026
Cologne, Germany

Organized by AWT – Arbeitsgemeinschaft Wärmebehandlung + Werkstofftechnik e. V., the 31st IFHTSE World Congress will be October 13-15, 2026, in Cologne, Germany, at the International Conference and trade fair. It will include three events: HK 2026, ECHT 2026, and the 31st IHTSE World Congress

This will truly be a huge event. If you have never attended the AWT HK (HärtereiKongress) event, this is one of the largest (if not the largest) heat treating trade show in the world. This, combined with ECHT 2026 and the 31st World Congress, will be the ONE event to attend.

(Courtesy: Cathay Pacific, www.cathaypacific.com/cx/en_TW/inspiration/travel/travel-guide-chengdu-china.html)

This large conference is organized in cooperation with the International Federation for Heat Treatment and Surface Engineering (IFHTSE) as well as the European heat-treatment associations from France, Austria, Switzerland, the Czech Republic, Slovakia, and the Benelux countries. Due to the expected number of lecture registrations, the congress event is planned as a three-day event. The language of the conference will be English.

Abstracts are due March 15, 2026.

›› **More info:** www.hk-awt.de

FREE PARTICIPATION AT THE NEXT IFHTSE WORLD CONGRESS

Young researchers are invited to participate at the IFHTSE World Congress.

The International Federation for Heat Treatment and Surface Engineering (IFHTSE) is dedicated to promoting the international exchange in the field. To this end, the Federation will invite some researchers younger than 35 to participate for free at the IFHTSE World Congress in Cologne in 2026. The Federation will reimburse them for the travel, accommodation, and attendance provided they present a paper in the World Congress.

After the IFHTSE Executive Committee has selected the candidates, they still need to submit an abstract to www.hk-awt.de/vortragsanmeldungen by March 15, 2026.

Once they have presented their papers at the World Congress the Federation, the candidate's actual costs will be reimbursed upon presentation of the tickets, invoices, etc, within the margin of the travel plan.

Knowledgeable support, timely service for industrial combustion systems

Thermal Energy Engineering Company (TEECO) is a service company focused on supporting industrial combustion systems across numerous disciplines. Whether it's baking cheesecakes, melting metals, milling minerals, or drying fertilizers and pet foods, TEECO's combustion professionals have experience in a wide range of process heating applications that uniquely equips them with not only the knowledge of the combustion systems themselves, but also an eye to understand the whole process to provide the best service possible, no matter the customer or the application.

While the industrial combustion industry is undergoing many changes with market volatility, personnel limitations, and manufacturer reliability, TEECO aims to support its industry partners by bridging knowledge gaps and providing field support to ensure the most reliable equipment operation. Their approach to success is to earn the trust and confidence of both OEMs and end users by providing dependable services that are knowledgeable, professional, and timely, to strengthen combustion and process reliability industry wide.

OEM SUPPORT

Industry trends over recent years have shown opportunities for OEMs to leverage the experience of vendors and contractors for specialized engineered systems and service to provide the most reliable equipment to their end user customers. TEECO's combustion background allows them to support OEMs from multiple approaches, including:

BURNER APPLICATIONS ENGINEERING

TEECO's engineering team helps OEMs with:

- Burner selection.
- Gas train application and sizing.
- Control system design.

EQUIPMENT PROCUREMENT AND ASSEMBLY

Design and assembly of:

- Gas trains.
- Control panels.
- Auxiliary components.

FIELD SERVICE

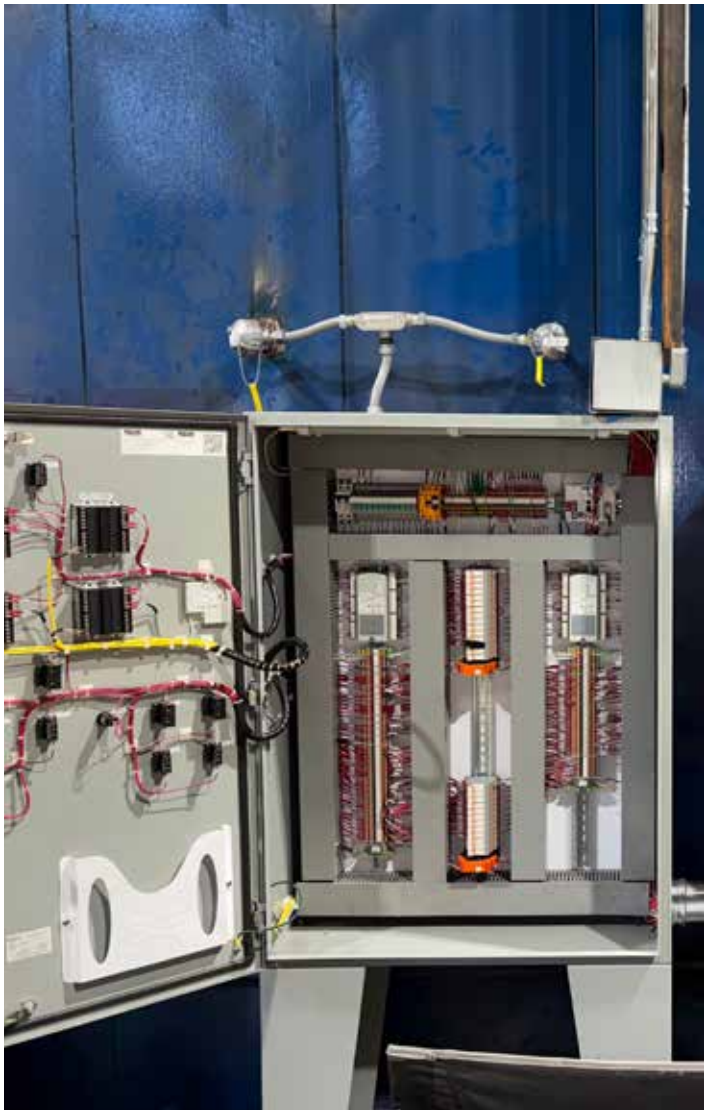
TEECO's service department travels nationwide to help OEMs perform:

- Equipment startups.
- Safety inspections.
- Troubleshooting.
- Burner tuning.
- Instrument calibration.

END USER SUPPORT

- **Safety audits and service:** TEECO travels to end user sites nationwide to provide annual NFPA safety inspections and troubleshooting on various types of onsite equipment, as well as burner tuning to help customers achieve their gas efficiency and carbon emissions goals.
- **Process engineering consultations:** Leveraging years of experience with numerous applications to understand the entire production system upstream and downstream of the burner and lend expertise and advice to improve equipment efficiency, throughput, quality, and emissions.
- **Turnkey retrofit projects:** Providing engineered systems and installation services to replace outdated or failing equipment in the field, including gas trains, control panels, and more.

For more information on services offered, or to begin a partnership with TEECO's team, contact them at info@thermeng.com or 864-832-2238.



D. SCOTT MACKENZIE, PH.D., FASM
SENIOR RESEARCH SCIENTIST–METALLURGY, RETIRED

These high-performance alloys are usually based on nickel, cobalt, or iron, with additional alloying elements; they are specifically developed for times when resistance to oxidation is required.

Superalloys maintain strength, resist heat

Superalloys are used in a wide variety of applications that require oxidation resistance, high temperature creep resistance, and strength at elevated temperature. They are found in jet engines and turbine applications.

INTRODUCTION

Superalloys are high-performance metallic materials engineered to retain strength, resist creep, and withstand oxidation and corrosion at temperatures where most alloys would rapidly fail. They are indispensable in gas turbines, jet engines, nuclear systems, and other extreme environments where reliability at high temperature is critical [1].

Superalloys are generally defined as alloys that maintain excellent mechanical properties, oxidation resistance, and corrosion resistance at temperatures typically above about 0.6 of their absolute melting temperature. They are often called high-performance alloys and are usually based on nickel, cobalt, or iron, with additional alloying elements such as chromium, aluminum, titanium, molybdenum, tungsten, niobium, and others to tune microstructure and performance.

These alloys have been specifically developed for high strength at elevated temperatures above 600°, where resistance to oxidation is required [2].

NICKEL-BASED SUPERALLOYS

Nickel-based superalloys are the largest class of superalloys due to excellent high-temperature strength and oxidation resistance. They are most often used in the hottest sections of gas turbines, and include the turbine blades, vanes, and hubs. These are applications where the temperatures can approach 1,100°C.

The earliest superalloys were based on a composition of 80Ni-20Cr, with minor additions of titanium and aluminum [3]. These alloys worked because of the formation of fine γ' precipitates. However, due to limitations in microscopy, this precipitation was not discovered until the 1940s [3].

Gamma prime (γ') has the composition of $Ni_3(Al,Ti)$ and has an ordered FCC structure (LI_2). This phase is an intermetallic, and is coherent with the matrix (γ), and provides needed ductility [4]. This precipitate appears as very fine spheres, or as the precipitates grow, the morphology changes from spheres to cubes or plates, depending on the size of the matrix/precipitate lattice mismatch [3].

With the addition of niobium (Nb), another strengthening phase is formed — gamma double prime (γ''). This precipitate is coherent with γ', but dissolves at temperatures above 650°C. It is an ordered

Nickel-based superalloys are the largest class of superalloys due to excellent high-temperature strength and oxidation resistance. They are most often used in the hottest sections of gas turbines, and include the turbine blades, vanes, and hubs. (Courtesy: Shutterstock)

body-centered tetragonal structure with a DO_{22} structure. Nickel superalloys are produced in wrought and cast forms, with advanced turbine blades often fabricated as directionally solidified or single-crystal components. Wrought age-hardenable alloys are typically vacuum-melted and thermos-mechanically processed, then solution treated and aged to precipitate γ' or γ''. Cast and single-crystal alloys are engineered to minimize grain boundaries and control solidification segregation, improving creep life and fatigue resistance in the blade environment.

COBALT-BASED SUPER ALLOYS

Cobalt-based superalloys exhibit excellent hot-corrosion and oxidation resistance due to a high chromium content [5]. Their thermal fatigue resistance and creep strength can exceed nickel-based superalloys [5].

Cobalt-based superalloys rely on solid solution strengthening and carbide precipitation for strength. This is different from nickel-based superalloys, which rely on a precipitation-strengthening mechanism.

The primary solid solution-strengthening elements used in cobalt superalloys are chromium, molybdenum, tungsten, columbium, and tantalum. These solid solution alloying elements are also strong carbide formers. These alloys provide a stable face-centered-cubic (FCC) matrix over a wide range of temperatures [1] [3].

Recently, Stato *et al* [5] discovered that some compositions of cobalt-based superalloys can be strengthened by a γ' precipitation mechanism. In this case, the γ' also had an LI_2 structure, with the composition of $Co_3(Al,W)$. These alloys exhibited higher temperature strength than those of conventional nickel-based super alloys.

IRON-BASED SUPERALLOYS

Iron-based superalloys are often used to reduce costs, as they are significantly less expensive than either nickel- or cobalt-based superalloys.

These iron-based superalloys are based on the ternary Fe-Ni-Cr, and can be either austenitic (at least 25% Ni face-centered-cubic) or ferritic (body-centered-cubic), depending on composition. For austenitic and ferritic iron-based superalloys, the strengthening mechanism is predominantly through the precipitation of order intermetallics, such as γ' with compositions Ni_3Al, or Ni_3Ti. Further strengthening of the ferric grades is accomplished by five Laves-type phases dispersed in the matrix.

Iron-based superalloys are used in applications where nickel or cobalt based superalloys would be too expensive. Applications for Iron-based superalloys are often found in the chemical and petrochemical industry, where high resistance to chemical attack is needed in high-temperature environments. These alloys are often used in automotive applications.

CONCLUSIONS

This article provided an overview of the basic strengthening mechanisms in the three classes of superalloys, namely iron-, nickel-, and cobalt-based superalloys.

Should you have any comments or questions regarding this article, or have suggestions for further articles, please contact the writer or editor.

REFERENCES

[1] A. Kracke, "Superalloys, the most Sucessful Alloy System of Modern Times - Past, Present and Future," in 7th Int. Sym. on Superalloy 718 and Derivatives, Pittsburgh, PA, 10-13 Oct, 2010.

[2] B. M. a. C. I. Center, Handbook of International Alloy Compositions and Designations, Vols. II - Superalloys, Columbus, OH: Battelle Laboratories, Dec. 1978.

[3] C. T. Sims, "A History of Superalloy Metallurgy for Superalloy Metallurgists," in 5th Int. Sym. Superalloys, Oct 7-11, , Champion, PA, 1984.

[4] R. Bowman, "Superalloys: A Primer and History," 2000. [Online]. Available: https://www.tms.org/meetings/specialty/superalloys2000/superalloyshistory.html. [Accessed 14 January 2026].

[5] J. Sato, T. Omori, K. Oikawa, I. Ohnuma, R. Kainuma and K. Ishida, "Cobalt-Base High-Temperature Alloys," Science, vol. 312, no. 5770, pp. 90-91, 2006.

[6] P. A. Ferreiros, P. R. Alonso and G. H. Rubiolo, "Coarsening process and precipitation hardening in Fe2AlV-strengthened ferritic Fe76Al12V12 alloy," Materials Science and Engineering: A, vol. 684, pp. 394-405, 2017.

ABOUT THE AUTHOR

D. Scott MacKenzie, Ph.D., FASM, Quaker Houghton Research Scientist Fellow, retired. He is the past president of IFHTSE, and a member of the executive council of IFHTSE. He can be reached at kb0fhp@gmail.com.

TONY TENAGLIER
QUALITY MANAGER /// ALCUMET

Finding the "flow" at work can mean hitting the balance of feeling challenged and invigorated. Work should be recognized as a chance for creation and a chance to feel individual success.

The paradox of work and happiness

There are obviously a lot of factors that go into making a company successful. Probably the biggest factor is the people who work there. There are employees who love their jobs, employees who don't love their jobs, and employees somewhere in between. Finding a company culture that encourages all employees to feel invested, valued, and productive is a tricky prospect.

There is a known paradox in the psychology world based on psychologist Mihaly Csikszentmihalyi's famous studies on the concept of "flow" — a state of total being consisting of joy, creativity, and total involvement in life. He found a contradiction of the opportunities of this concept of flow at work, with the perception of what work actually was to the participants. What most of American culture generally considers "work" — a 9 a.m. to 5 p.m., Monday through Friday, retire in 40 years model — provides ideal characteristics that can bring about this state of flow. It provides structure, rules, objectives, development of skills/talents, and competition — a game, in a sense.

However, when interviewing the participants about the study after statistically showing more states of flow at work than at leisure, participants contradicted their own results indicating they would rather be on vacation than at work as they had convinced themselves there was more joy, creativity, and total involvement on the beach. They were supposedly happier.

DEFINING FLOW

Flow is the state in which runners reach what is called a runner's high after long miles and miles. Or, it is described by the superstar athlete from the championship game in an interview stating he or she "was in the zone" after a record-breaking game. Flow could arguably be described as partying on the beach.

What is interesting is people find this zone and flow state more times at work than they do while performing leisure activities. But when asked where they would rather be, the answer wasn't "at work." It was wanting to be doing more leisure activities. Work provides structure with meetings and expectations; sitting at the beach does not (aside from the cooler needed for partying). Work provides a test of skills; sitting at the beach does not (aside from the occasional jump in the water to cool off). Work provides challenges, a chance to make something (aside from the sand castle with a water moat).

So, why the misperception?

DEFINING WORK

"Work" is a noun when used in the context of "the place you work." Work is a verb when used as, "I would rather work on my truck." Our bodies work every day to move us around from the bed, to the car, to the office, back to the car, and back to the bed. Our lives every day consist of getting up, playing out the meetings, activities, and events of the day, and going back to bed. This describes most American lives in its most bleak description. Work is seemingly boring; certainly it's often perceived as boring. Work is painted as something to dread due to the misalignment of the company goals and one's own life goals. The idea that an employee at a company is "making money for someone else's dream" can cripple an employee's psyche if the workplace culture isn't properly set up to prevent that.

Work must be recognized as a chance for creation, a chance for individuals to feel success (and not just the paycheck being cashed in every pay period).

DEFINING PLAY

"Play" is a noun when used in the context of "we saw the play." Play is a verb when used as, "I like to play golf, but don't like playing those political games at work."

After failing to make the college golf team my freshman year in college, I was very humbled and convinced that I would never be a professional golfer. Knowing I had to "go pro" in something other than sports, I couldn't get away from the idea of me being the lucky one on TV playing a game of golf for money and the other idea of facing this supposed game of life called "going to work." At first, it was crippling to know I had to shuffle in and find my cubicle where my employee number potentially identified me if I somehow drowned in the sea of work and papers on my desk.

TOWARD A NEW TYPE OF WORK

Let's face it. No athlete who becomes a superstar in the sport they play does it without putting in a great deal of hard work. In the same vein, no company employee becomes a great worker without bringing a sense of play to the challenges and skills required at the company. The language of a company is insight as to the values it imposes through the culture it hopes to create. There isn't one task or event that automatically makes a company be seen as a great company to work for, where people want to work on the actual business.

And if the company culture could design the meetings, the dialogues, the activities both in the office and out of the office to make work also seem like play for every team member involved, the company can begin to really grow. Employees would be engaged, excited to show up. Who would have thought of that? The sense of a challenge — the thrill of the game — can be energizing.

Work must be recognized as a chance for creation, a chance for individuals to feel success (and not just the paycheck being cashed in every pay period). Csikszentmihalyi convinced me that if I could recognize challenges and anticipate success, make games to excel, I would get more out of life and out of the work that I do. That work would feel more like play and — as the cliché goes — "love what you do, and you never work another day." I could find the zone with whatever I was doing, be it hitting a golf ball or sending out a report.

That is the work and play we need to develop as a workplace culture. That vacation can still be taken and enjoyed (and, yes, drinking beers and building the epic sand castle still counts), but viewed as halftime shows after which employees are excited to get back into the game. This type of game isn't finite, though. It is an infinite game, as Simon Sinek suggests in his book *The Infinite Game*. Employees don't win at business. People don't win at life. We win (and the company wins) when we think of it as developing a mindset of work and play for each and every individual at the company.

FOR MORE READING

» Csikszentmihalyi, Mihaly. *Flow: The Psychology of Optimal Experience.* New York: Harper & Row, 1990.

» Sinek, Simon. *The Infinite Game.* Portfolio Penguin, 2020.

ABOUT THE AUTHOR

Tony Tenaglier is the quality manager at AlCuMet. He earned both a B.S. in material science engineering and M.A. in psychology. He is the author of two self-help books and is currently pursuing his Ph.D. in Industrial Organization Psychology. Contact him at ttenaglier@alcumet.com

EFFICIENCY AND EVOLUTION:

HOW MODERN BURNERS ARE REDEFINING INDUSTRIAL COMBUSTION

Today's industrial burners combine mechanical robustness with digital precision, enabling manufacturers to deliver consistent heat, lower emissions, and measurable energy savings.

By JAMES KULIGOWSKI

Industrial combustion systems remain at the heart of process heating across manufacturing, energy generation, and infrastructure. As energy prices fluctuate and environmental standards tighten, burner technology has quietly evolved into a high-precision field where control, safety, and sustainability must coexist.

In the U.K. and across Europe, companies such as Dunphy Combustion have spent decades refining industrial burner design to balance reliability with efficiency and low emissions. The shift from conventional on/off systems to digitally integrated combustion control has turned what was once a purely mechanical process into an intelligent, monitored, and adaptive operation.

FROM FIXED FLAME TO FLEXIBLE FUEL

Industrial burners once relied on narrow fuel parameters, simple mechanical air registers, and manual tuning. Modern plants now demand multi-fuel flexibility, continuous operation, and instantaneous load response.

Advances in burner design — including multi-fuel, biogas, hydrogen, and renewable-fuel burners — are enabling users to meet both production and sustainability targets. Systems developed in the U.K. demonstrate this range clearly: A single burner platform may operate on natural gas today and be converted to hydrogen or bio-methane in the future with minimal modification.

Hydrogen-capable burner technology is a major step in preparing process plants for a lower-carbon energy mix. Engineers are now designing combustion heads, nozzles, and flame monitoring systems that maintain stable operation even when hydrogen's higher flame velocity and different ignition characteristics come into play.

CONTROL IS EVERYTHING

The combustion process is inherently dynamic. Variations in fuel quality, air temperature, and load demand can push a burner off its optimum point within seconds. Intelligent control systems — such as those using integrated combustion management, oxygen trim, and variable-speed drive fan control — have become critical to maintaining efficiency.

Where older installations relied on mechanical linkages between air and fuel valves, digital servo control allows each actuator to move independently with repeatable precision. The result is fine-tuned, air-to-fuel ratios across the full firing range, reducing excess air and the associated heat loss up the stack.

Pressure control also plays a decisive role in combustion stability. Industrial gas boosters, often operating in conjunction with combustion control systems, help maintain consistent fuel supply pressure when upstream conditions fluctuate.

Designed for demanding industrial environments, modern booster sets support reliable burner operation at higher capacities and are increasingly treated as an integral part of the overall combustion system rather than a standalone accessory.

EFFICIENCY THROUGH DATA

Digital monitoring has changed the way maintenance teams interact with combustion systems. Integrated sensors feed live data on temperature, pressure, and oxygen levels to PLC-based control panels or plant SCADA networks. This information allows engineers to perform trend analysis, optimize start-up and shutdown sequences, and schedule maintenance before performance drifts.

Manufacturers offering burner consultancy and upgrade services report many industrial sites still operate burners installed decades ago. Retrofitting those units with modern control packages — or replacing mechanical linkages with electronic servo drives — can deliver measurable improvements in combustion efficiency and operational stability.

In many cases, these upgrades reduce excess air, improve flame consistency, and enhance overall thermal performance. The resulting fuel savings and reliability improvements often allow plant operators to justify investment over relatively short operating periods, particularly in energy-intensive processes.

Service providers now approach burner optimization as part of a wider energy strategy rather than an isolated task. By auditing plant load profiles, heat exchanger performance, and exhaust composition, engineers can calculate precise tuning adjustments to reduce emissions while maintaining output.

ALTERNATIVE FUELS AND THE ROAD TO NET ZERO

The combustion sector faces the same decarbonization challenge confronting every industrial energy user. The transition to hydrogen, biogas, and synthetic fuels is accelerating innovation in burner design, materials, and control logic.

Renewable-fuel and biogas burners introduce new variables — differing calorific values, moisture content, and flame stability — that demand adaptive control algorithms. Flame sensors must detect lower luminosity flames, while burner management systems need to handle mixed-fuel operation without compromising safety interlocks.

For some manufacturers, modular multi-fuel burners have become the preferred solution. These units can operate on natural gas today and switch to renewable fuels tomorrow, reducing downtime and capital expenditure when plant operators transition their energy source.

Combustion specialists are also re-examining burner geometry and airflow patterns to maintain efficiency while reducing carbon impact. Modern design approaches combine engineering experience with advanced analysis and testing to optimize flame shape, mixing characteristics, and heat transfer.

These refinements contribute to more compact and stable flames, lower NOx formation, and improved consistency across the firing range, supporting both efficiency and emissions compliance.

INTEGRATING BURNERS INTO SMARTER PLANTS

The wider move toward Industry 4.0 is pushing burner and boiler

Advances in burner design — including multi-fuel, biogas, hydrogen, and renewable-fuel burners — are enabling users to meet both production and sustainability targets. (Courtesy: Dunphy Combustion Limited)

Burner upgrades and consultancy services have become essential in extending equipment life while meeting modern emission standards. (Courtesy: Dunphy Combustion Limited)

systems into the digital ecosystem of the plant. Combustion control panels can now communicate with site-wide automation systems using standard industrial communication architectures.

This level of integration enables real-time load matching between the burner, boiler, and downstream process equipment, allowing heat input to respond dynamically to changing production demands. In a food-processing line, for instance, burner output can automatically modulate to match the load of steam kettles or dryers. In district heating, network sensors feed back temperature and flow data to adjust firing rates for optimum efficiency.

In larger installations, such as packaged plant rooms or skid-mounted energy centers, burners, gas boosters, and control systems are now being pre-engineered as fully integrated modules. This approach simplifies commissioning, ensures compliance, and enables more consistent combustion performance across multiple heat sources These advances also enhance safety. Automated

Combustion control panels can now communicate with site-wide automation systems using standard industrial communication architectures. (Courtesy: Dunphy Combustion Limited)

For some manufacturers, modular multi-fuel burners have become the preferred solution. These units can operate on natural gas today and switch to renewable fuels tomorrow.

sequencing, flame detection, and fault diagnostics now meet rigorous international standards while simplifying operator interfaces. Maintenance staff can view performance dashboards remotely, reducing physical intervention in hot or hazardous areas.

SERVICE AND LIFECYCLE SUPPORT

Burner performance is not static. Over time, combustion characteristics drift as components age and environmental conditions change. Burner upgrades and consultancy services have become essential in extending equipment life while meeting modern emission standards.

A typical upgrade might include a new modulating control panel, replacement of pneumatic linkages with servo motors, and the introduction of flue-gas oxygen monitoring. Each step incrementally improves combustion stability and efficiency, aligning legacy systems with current expectations.

Long-term service partnerships also support compliance documentation and operator training — areas increasingly demanded by insurers and regulators.

CONCLUSION

Combustion technology continues to evolve quietly but decisively. Today's industrial burners combine mechanical robustness with digital precision, enabling manufacturers to deliver consistent heat, lower emissions, and measurable energy savings.

From hydrogen-ready designs to data-driven optimization, the sector's innovation is reshaping how heat is produced and controlled in industry.

Organizations such as Dunphy Combustion exemplify this evolution, demonstrating how engineering expertise and continuous development can keep a mature technology both efficient and relevant in a rapidly decarbonizing world.

ABOUT THE AUTHOR

James Kuligowski, MEng, is the business development manager at Dunphy Combustion Limited. With a Master's in Mechanical Engineering, he has built his career using data, analytics, and software to solve complex problems for blue-chip companies. After roles in banking and strategy consulting, Kuligowski now leads growth initiatives at Dunphy, focusing on helping industries navigate the transition to net zero.

HIGH TEMP INSULATION:

VERSATILE AND EFFICIENT CERAMIC FIBER SOLUTION

High-temperature insulation is designed to withstand extreme heat, typically exceeding 1,000°F (538°C). (Courtesy: NUTEC)

High-temperature insulation, particularly ceramic fiber, is an indispensable component of modern industrial thermal processing – its versatility, efficiency, and cost-effectiveness make it valuable for various applications.

By JONATHAN WHALEY

High-temperature insulation is a critical component in industrial thermal processing, maximizing efficiency, reducing energy costs, and extending equipment lifespan. As industries seek increasingly effective solutions, the demand for specialized thermal insulation is growing rapidly.

This article will explore the benefits of high-temperature insulation, focusing on ceramic fiber products. It will analyze their properties, key applications, and their impact on improving industrial operations, ensuring long-term optimal performance.

UNDERSTANDING HIGH-TEMPERATURE INSULATION

High-temperature insulation is designed to withstand extreme heat, typically exceeding 1,000°F (538°C). At NUTEC, for example, the company categorizes high-temperature insulation materials based on their temperature resistance:

- **LBP (low biopersistent fiber):** Capable of withstanding temperatures up to 2,200°F (1,200°C). This material is classified as a non-RCF (refractory ceramic fiber) product.
- **RCF (refractory ceramic fiber):** Offers temperature resistance up to 2,300°F (1,260°C).
- **Zirconia-containing RCF:** Provides enhanced temperature resistance up to 2,600°F (1,425°C) due to adding zirconia.
- **Polycrystalline fiber (PCW):** Also referred to as polycrystalline wool, this material boasts the highest temperature resistance in this category, reaching up to 3,000°F (1,650°C).

IMPORTANCE IN INDUSTRIAL SETTINGS

High-temperature insulation is indispensable in industrial settings for a multitude of reasons, including:

- **Versatility:** It seamlessly complements refractory products such as insulating bricks and castables, offering a comprehensive insulation solution.
- **Weight reduction:** Ceramic fiber insulation is significantly lighter than traditional refractory materials, simplifying installation and reducing structural loads.
- **Thermal performance:** It exhibits superior thermal conductivity compared to many alternatives, ensuring efficient heat management.
- **Availability and cost-effectiveness:** Ceramic fiber is readily available and often more cost-effective than other high-temperature insulation options.
- **Energy efficiency:** It dramatically reduces heat loss in industrial processes, leading to substantial energy savings.
- **Environmental impact:** Improved energy efficiency translates to a reduced carbon footprint, contributing to ecological sustainability.
- **Process stability:** Effective insulation maintains consistent temperatures in industrial processes, enhancing product quality and process control.

CERAMIC FIBER – A PREMIER HIGH TEMP INSULATION MATERIAL

For many compelling reasons, ceramic fiber is a leading high-temperature insulation material.

Ceramic fiber is typically more affordable than many alternatives, and numerous manufacturers in North America, including NUTEC, ensure a stable supply. With proper maintenance, ceramic fiber delivers exceptional performance throughout its lifespan.

Its versatility is reflected in its availability in various forms, such as blankets, modules, papers, and coatings, catering to diverse applications.

Its low thermal mass enables rapid heating and cooling, and many types demonstrate good resistance to chemical attack. Moreover, it often provides effective acoustic insulation. Compared to traditional refractory materials, ceramic fiber is also easier to install.

Consider evaluating ceramic fiber products for high-temperature insulation needs to reduce costs and potentially enhance efficiency.

THE HTIW COALITION AND INDUSTRY STANDARDS

The High Temperature Insulation Wool (HTIW) Coalition plays a critical role in setting standards for ceramic fiber insulation in the U.S. It actively promotes the safe production and use of high-temperature insulation wool.

HTIW collaborates closely with manufacturers to ensure products meet stringent safety and quality standards, encompassing:

- Product performance.
- Safety considerations.
- Environmental impact.
- Installation guidelines.
- Disposal and recycling.

Initially established in 1992 as the Refractory Ceramic Fibers Coalition (RCFC) by U.S. manufacturers of Refractory Ceramic Fibers (RCFs), the organization has evolved to include high-temperature vitreous low biopersistent (LBP) wools and polycrystalline wools (PCW) within its purview.

Now, let's explore the diverse world of ceramic fiber products.

PRODUCT RANGE AND APPLICATIONS

Ceramic fiber is available in a variety of forms, each tailored to specific applications:

- **Blankets:** Offered in various densities, thicknesses, and formulations to suit diverse needs.
- **Modules:** Compressed and banded ceramic fiber blocks for convenient handling and installation.
- **Macromodules:** Prefabricated ceramic fiber panels designed for easy installation in high-temperature furnaces and kilns.
- **Papers:** Thin sheets of ceramic fiber are used for various applications requiring a flexible, lightweight insulation material.

› **Coatings and mixes:** Provide additional protection in specialized applications requiring specific properties.

› **Vacuum formed products:** Uses various fiber types and binders to create wet-formed products, including:

› **Custom special shapes:** Designed for unique and intricate applications.

› **Versatile insulation boards:** Offer a combination of insulation and structural support.

› **Bulk and engineered fiber:** Loose ceramic fiber to fill irregular spaces or for custom fabrication on-site.

› **Textiles:** Woven ceramic fiber products like cloth, tape, and rope, providing flexibility and ease of use in specific applications.

› **Engineering services:** Companies such as NUTEC can offer innovative and custom-engineered solutions for high-temperature applications.

CHEMISTRY AND TEMPERATURE RATINGS

The chemical composition of ceramic fiber products directly influences their temperature ratings and performance characteristics. For instance, LBP (low biopersistent) products are based on calcium, silica, and magnesium.

On the other hand, RCF (refractory ceramic fiber) is primarily comprised of alumina and silica, with precise ratios that vary depending on the specific grade and intended use temperature. Higher temperature grades often incorporate additional components such as zirconia to enhance heat resistance.

When selecting a ceramic fiber product, it is essential to consider the following factors:

› Maximum use temperature.

› Temperature limits for specific properties (e.g. strength, thermal conductivity).

› Chemical compatibility with the operating environment.

› Thermal shock resistance.

› Crystallization behavior.

The chemistry and composition of these materials play a crucial role in determining their temperature ratings and overall performance.

A thorough evaluation of these fundamental properties, including maximum use temperature and compatibility, ensures selecting the optimal solution for specific needs.

POLYCRYSTALLINE FIBER AND ITS APPLICATIONS

As mentioned, it's essential to recommend polycrystalline fiber for extremely high-temperature applications.

Polycrystalline fiber becomes the material of choice for applications with continuous use temperatures of 2,912°F (1,600°C) and above. It offers:

› Reduced shrinkage.

› Longer lifespan.

› Improved stability.

› Enhanced insulation performance.

› Chemical resistance.

Typical applications include industrial furnaces operating above 2,450°F (1,343°C), high temperature laboratory equipment, aerospace applications such as heat shields, glass and metal processing industries, petrochemical reformers, and crackers.

While polycrystalline fiber offers superior performance at extreme temperatures, it costs more than standard ceramic fiber.

Did you know investing in polycrystalline fiber can safeguard your industrial equipment in extreme temperature applications? Its superior performance and longevity ensure optimal operation, even in the harshest conditions.

INNOVATIVE SOLUTIONS: HYBRID MODULES

Hybrid modules represent a cutting-edge advancement in high-temperature insulation technology. These innovative solutions offer optimized performance and cost-effectiveness by combining different ceramic fibers within a single module.

A typical hybrid module incorporates polycrystalline fiber (such as Maxwool 3000) and low-rated refractory ceramic fiber. This approach offers a multitude of benefits:

› **Optimized performance:** Leverages the strengths of each fiber type for exceptional thermal performance in demanding environments.

› **Cost-effectiveness:** Strategically combines materials to achieve high-temperature resistance without the cost of using polycrystalline fiber exclusively.

› **Tailored solution:** These can be customized to meet various applications' specific temperature and performance requirements.

› **Weight optimization:** Reduces overall weight compared to using solely high-temperature fibers.

› **Improved energy efficiency:** Minimizes heat loss, leading to significant energy savings.

› **Extended lifespan:** The combination of fibers contributes to increased durability and longevity of the insulation system.

EFFICIENCY AND COST SAVINGS

Implementing ceramic fiber insulation, particularly in well-designed modules, can lead to significant efficiency gains and cost reductions. Benefits include decreased fuel consumption, lower emissions, and extended equipment lifespan.

Moreover, ceramic fiber insulation enhances process efficiency by minimizing heat loss, accelerating startup times, lowering maintenance costs, and improving worker safety.

To quantify these advantages, industries can use key metrics such as:

› Energy savings per unit of production.

› Reduction in greenhouse gas emissions.

› Increase in equipment lifespan.

› Decrease in maintenance frequency and associated costs.

› Improvements in product quality and consistency.

Pro tip: Conduct a thorough analysis of the potential long-term operational cost savings and improved process efficiency to justify the investment in high-quality ceramic fiber insulation.

CHALLENGES AND SOLUTIONS IN HIGH-TEMPERATURE ENVIRONMENTS

High-temperature environments pose challenges to refractory materials, including ceramic fibers. These include shrinkage, chemical attack, mechanical stress, thermal shock, fiber degradation, and dust generation.

To combat these issues, manufacturers and users employ a multifaceted approach:

› **Material selection:** Careful selection of materials with appropriate properties for the specific environment.

› **Innovative designs:** Designs that mitigate thermal and mechanical stresses.

› **Surface treatments:** Coatings and treatments to enhance resistance to chemical attack and fiber degradation.

› **Advanced installation techniques:** Proper installation to minimize gaps and ensure optimal performance.

› **Continuous improvement:** Ongoing evaluation and refinement of materials and processes.

› **Layered systems:** Using multiple layers of insulation to address different challenges.

Ceramic fiber is typically more affordable than many alternatives, and numerous manufacturers in North America, including NUTEC, ensure a stable supply. (Courtesy: NUTEC)

›› **Encapsulation methods:** Enclosing the fibers to reduce dust generation and improve safety.

›› **Regular monitoring and maintenance:** Routine inspections and maintenance to identify and address potential issues.

›› **Computer modeling:** Using simulations to predict and optimize performance under various conditions.

Implementing these strategies can significantly enhance the performance and durability of ceramic fibers in demanding high-temperature environments.

SUMMARY

It's crucial to address potential challenges through careful material selection, innovative design, and proper installation and maintenance practices to ensure reliable and efficient performance in high-temperature environments.

INSTALLATION AND MAINTENANCE BEST PRACTICES

Ensuring the long-term performance and efficiency of ceramic fiber insulation systems requires proper installation and diligent maintenance. Adhere to these best practices for optimal results:

Installation

›› **Proper handling:** Handle ceramic fiber materials carefully to minimize fiber release and damage. Use appropriate personal protective equipment (PPE) during installation.

›› **Correct sizing:** Ensure accurate measurements and proper fit of insulation components to avoid gaps or compression issues.

›› **Compression considerations:** Avoid over-compression, as it can compromise the insulation's thermal performance.

›› **Anchoring systems:** Select and install appropriate anchoring systems to secure the insulation and prevent sagging or displacement.

›› **Joint treatment:** Seal joints and gaps effectively to prevent heat loss and air infiltration.

›› **Facing materials:** Choose suitable facing materials that are compatible with the operating environment and provide additional protection to the insulation.

Maintenance

›› **Regular inspections:** Conduct routine inspections to identify any signs of damage, wear, or deterioration.

›› **Planned maintenance:** Establish a preventive maintenance schedule to address minor issues before they escalate.

›› **Documentation:** Maintain detailed records of installation, inspections, and maintenance activities for future reference.

Implementing these best practices can maximize a ceramic fiber insulation system's performance, lifespan, and safety.

FUTURE DEVELOPMENTS IN CERAMIC FIBER INSULATION

Ceramic fiber insulation is a dynamic field, constantly evolving through ongoing research and development. These efforts aim to boost performance, durability, and sustainability. Key areas of focus include:

›› The development of advanced fiber compositions and nano-engineered fibers with improved properties.

›› The use of bio-based binders to enhance eco-friendliness.

›› The creation of intelligent insulation systems capable of real-time monitoring and adaptation.

In addition, strides forward in manufacturing processes, enhanced recycling methods, and the innovation of hybrid materials are shaping the future of ceramic fiber insulation technology and its diverse applications.

By staying abreast of these developments, you can ensure you can leverage the latest advancements in ceramic fiber insulation technology for your industrial needs.

ENVIRONMENTAL AND HEALTH CONSIDERATIONS

While ceramic fiber insulation offers significant benefits, it's essential to be aware of associated environmental and health factors:

» **Dust management:** Proper handling and installation procedures are crucial to minimize dust generation and potential exposure.

» **Long-term health studies:** Ongoing research examines the long-term health effects of ceramic fibers, ensuring safety aligns with the HTIW Coalition's responsible production and use standards.

» **Product lifecycle:** The industry is developing improved methods for safely disposing and recycling used ceramic fiber materials.

» **Energy efficiency benefits:** Though ceramic fiber production has an environmental footprint, its use typically yields substantial energy savings over the insulation's lifetime, contributing to a net positive impact.

» **Regulatory compliance:** Manufacturers collaborate closely with regulatory bodies to ensure their products adhere to all relevant health and safety standards.

Prioritizing proper handling, installation, and disposal practices is essential to minimize ceramic fiber insulation's environmental and health impacts.

KEY TAKEAWAYS

Understanding temperature ratings and materials: It's crucial to grasp the different temperature ratings and material types in high-temperature insulation to make informed choices for your needs.

» **Recognizing the benefits of ceramic fiber:** Ceramic fiber and low biopersistent insulation offer exceptional versatility and advantages in industrial settings, including energy efficiency, cost savings, and improved process stability.

» **Exploring innovative solutions:** Hybrid modules exemplify cutting-edge advancements in insulation technology, optimizing performance and cost-effectiveness through the strategic combination of different ceramic fibers.

» **Prioritizing proper installation and maintenance:** Adhering to best practices in installation and maintenance is paramount to ensuring an insulation system's long-term performance and efficiency.

» **Staying informed:** Stay updated on the latest research and development efforts to address challenges and leverage future improvements in product performance.

» **Considering environmental and health factors:** Prioritize proper handling, installation, and disposal practices to minimize environmental and health impacts.

THE FUTURE OF HIGH-TEMPERATURE INSULATION

High-temp insulation will remain a critical area of focus and innovation as industries strive to enhance efficiency, reduce energy consumption, and meet increasingly stringent environmental regulations. Advancements in ceramic fiber technology will continue to shape the future of industrial thermal management, enabling more efficient, sustainable, and cost-effective processes.

CONCLUSION

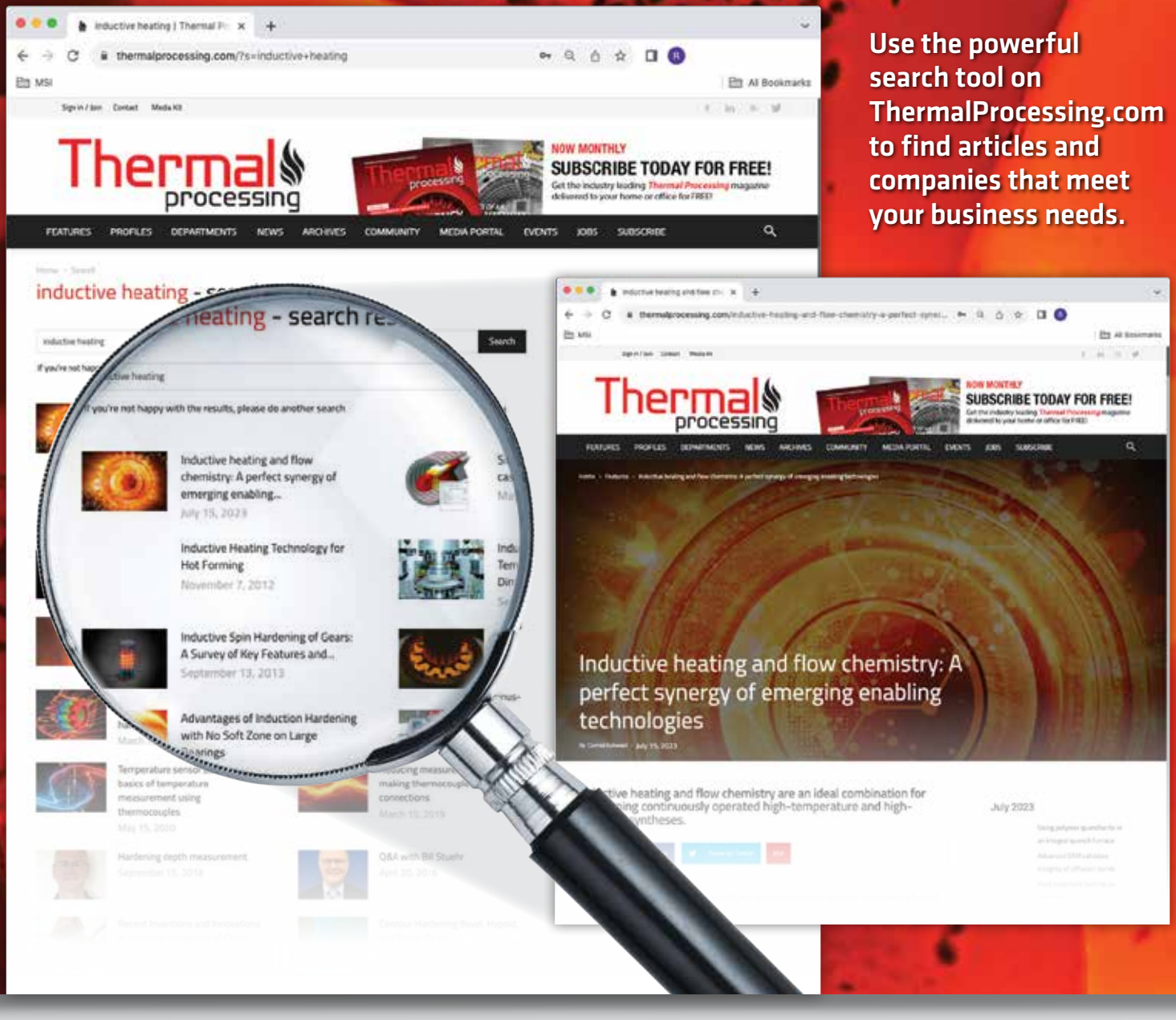
High-temperature insulation, particularly ceramic fiber, is an indispensable component of modern industrial thermal processing. Its versatility, efficiency, and cost-effectiveness make it valuable for various applications.

As manufacturers continue to innovate and refine their products, even more efficient and durable insulation solutions in the future are expected.

ABOUT THE AUTHOR

Jonathan Whaley is sales manager – U.S. & Canada for NUTEC. The NUTEC Heat Transfer Program 2.0 enables users to analyze thermal results based on their specific data. This powerful software facilitates the investigation of insulation designs using NUTEC products. Boost efficiency, reduce costs, and enhance sustainability in your industrial processes with NUTEC's advanced insulation solutions. Contact NUTEC for a tailored solution that meets your specific needs. For more information, go to: www.nutec.com.

FIND THE HEAT TREATING INFORMATION YOU NEED



Use the powerful search tool on ThermalProcessing.com to find articles and companies that meet your business needs.

ThermalProcessing.com has a wealth of information about the heat-treat industry. And our search tool gives you access to an extensive range of articles and businesses covering all aspects of heat treating. It's there to help you find the information you need to support the success of your business.

Thermal processing

SUBSCRIBE FOR FREE

Use the QR code or go to www.thermalprocessing.com

COMPANY PROFILE ///

VESCO

A PARTNER FOR VACUUM FURNACE, HOT ZONE, AND VACUUM PUMP SERVICES

VESCO is a heat-treatment service provider that, combined with Busch, has more than 60 years of experience providing tailored service and product solutions to companies of all sizes in the heat-treatment industry.

By KENNETH CARTER, Thermal Processing editor

The installation of an industrial heat-treating furnace is no small undertaking. From initial planning to construction and ongoing maintenance, every step is critical to ensuring the system operates at peak efficiency.

Keeping a furnace running often means coordinating with a network of different businesses, each playing a role in building and sustaining a fully operational system.

The team at VESCO takes on the challenge of folding those complex tasks into one simple go-to solution.

"Our intention as we grow is to be a true one-stop shop for the wide variety of services the heat-treat industry depends on," said Sean Collins, service center manager for VESCO, Busch USA LLC. "Looking at vacuum-furnace maintenance, for example: the furnaces themselves. This covers everything from hot zone rebuilds, repairs, and replacements to helium leak detection, plus performing extensive ultrasonic thickness testing on pressure vessels. Through our partner company, VFE in the U.K., we've also been working on expanding into full control panel integrations, rebuilds, new panel builds, and installations in North America."

NEW FURNACE INSTALLATION FOR OEMS

VESCO is also making new furnace installs for OEMs, according to Collins. As the OEMs get busier upscaling their workforce, VESCO serves as their field service and installation partner.

"We've been doing this nationwide — installing new furnaces, commissioning furnaces, startups, and furnace relocations," he said. "We've been doing a lot of big moves. We just moved a large number of furnaces out of the Carolinas up into Connecticut, which is basically their whole heat-treat shop of six vacuum furnaces, start to finish. That's been a major area of growth for us. As these manufacturers expand, whether through acquisitions or new facilities, they're consolidating equipment, and we've seen strong demand as a result. We service water cooling systems, and whenever we see a need in the market, we cross-train our technicians so they're equipped to handle it. Altogether, that makes up the full suite of services we provide."

RELIABILITY PARTNERS

Being able to take charge of a furnace build with optimum efficiency has a lot to do with how VESCO works with its customers, according to Collins.

"We really strive to be reliability partners with our customers because in a manufacturing environment, machine availability is everything. That means understanding the challenges faced by production, engineering, and maintenance teams," he said. "Our goal is to be the vendor you can trust. Someone who is reliable, results-driven, and able to deliver. Reliability partnership is our philosophy. It's not just about calling us when equipment goes down, but about preventative maintenance, design builds, and anything that helps keep operations running smoothly. We aim to not only get customers back online but also improve efficiency, shorten cycle times, and reduce pump-down times. We don't want to just be the fire department that shows up when something's gone wrong. We want to be a partner in long-term reliability."

Technological advancements in the industry have been a major catalyst in VESCO's business model, according to Collins.

"As technology has advanced, I think the demands on manufacturers have increased, specifically toward on-time delivery and delivering on budget," he said. "A lot of these large-scale projects, or even repairs, need the multidisciplinary skills of different groups to complete any repair, whether it's electricians, plumbers, riggers, all of that. This means having a company that's able to bring all those resources in, under us, so that the customer has one point of contact to manage the entire project from start to finish. It's a lot easier when you bring VESCO in because we manage the entire project. We coordinate the subcontractors, so you have one quote, one timeline, and, when the project is complete, one point of contact."

CUSTOMER CONTROL

This gives the customer much greater control over their project as well, according to Collins.

"They're not a ping-pong ball getting bounced around between the different vendors," he said. "A customer will have one group that they're dealing with. We handle all those details for them. VESCO has the agility in this business to be able to offload a lot of that extra work and time and communication and give that time back. These people are already dealing with, let's say down equipment, and having to retool, or move production off site. The last thing they need is to have to get into the minutia of a repair or project. That's really how we've evolved — getting away from the a la carte principle, which we can do — to having an all-in-one, solution-based answer."

Because of VESCO's expertise in bringing multiple plans of action into one job, it's important that Collins and his experts use a multi-step approach they use with each customer.

"That starts with our technical staff, whether it be myself, our service manager, or our technicians," he said. "The first step is always listening, without assumptions, because there's a lot of little details there that sometimes get left out — whether that's past repairs or failure modes or engineering changes to the equipment that might get overlooked. After that, we really want to gather whatever available data we have, whether it's system-specific maintenance logs and what temperatures they're running and more to try to build out the picture of their current state, and where they want to be. At that point, we can start thinking about solutions."

Technological advancements in the industry have been a major catalyst in VESCO's business model. (Courtesy: VESCO)

Technological advancements in the industry have been a major catalyst in VESCO's business model. (Courtesy: VESCO)

FINDING THE BEST OPTION

Those solutions often come with a multitude of options, according to Collins.

"A lot of times there's a choice where you have, let's say a short-term, quick fix, if the priority is getting back online," he said. "Then we have to get into priorities: What's the priority here? Is it time? Is it money? That goes along the lines of the different solutions. Then we have to execute the plan that we come up with, and we have to do that by setting realistic expectations, both of price and time, and we have to be accountable to that. If we're telling the customer that this is what we're going to do, and this is the quoted work and timeline, we need to stick to that."

After that, Collins emphasized one of the most important functions of VESCO: the follow-up and verification.

"Let's make sure we're running, and, if we can, let's go through first article inspection; let's make sure you're getting good parts out of this before everybody signs up," he said. "And that follow up is huge from us, because that's where we're going to learn: What worked well on this job? What didn't work well? What should we change? What things should we keep? That's a very important part. And I think, a lot of times, that step gets skipped. That could be keeping notes in your CMMS software and work orders so we can go back to it and see it in the future, but also for cross-training and new hire training."

VESCO'S LONGEVITY

This complex "dance" of efficiency has helped VESCO stay viable in a constantly changing industry, according to Collins.

"Our longevity is certainly an achievement — especially nowadays,"

he said. "The overarching theme here is our ability to onboard these services based on the needs of the industry. So, as we're seeing needs change and demands change, VESCO has the ability to add these services in and train our staff to be able to service the customer with these new services."

GENERAL FIELD SERVICE CENTER

The beginnings of VESCO's longevity began in the early 1990s, when the company was a general field service center in East Windsor, Connecticut. It mainly supported large aerospace, defense, and firearms manufacturers in the area, according to Collins.

"As VESCO grew through the '90s, they brought in some in-house engineering and were able to get into — not only the repair — but the design and building of both moly and graphite hot zones," he said. "That meant building complete weldments and complete design builds with both the customers and the in-house engineering. That's kind of what VESCO has always done." In March 2023, VESCO was acquired by Busch Group to help with its metallurgical market, according to Collins.

"Busch is very big in the semiconductor, pharma, and food packaging industries, and their dry screw pump technology was a great fit for vacuum heat treating and vacuum furnaces," he said.

BRINGING MANUFACTURING BACK TO THE U.S.

As VESCO continues to build and service furnaces across North America, Collins said that reshoring of manufacturing is going to be a major deal.

"They call it reshoring or onshoring, but it's bringing back a lot of manufacturing that was moved out of the country," he said. "We're seeing that in a couple of key geographic areas where a manufacturer is coming back in. There are a lot of furnaces at very large manufacturing sites that have been mothballed for the last few years. And, as that production and manufacturing capacity comes back to the U.S., being able to expand our operations to service these folks where they are is huge."

Due to this, VESCO is taking on a more national — and international — role, according to Collins.

"The Eastern Seaboard is very big for us," he said. "We've been doing a lot of work in Texas, in the Pacific Northwest, the mid-Atlantic, and in the Michigan area. And part of that, too, is developing a workforce that's willing to travel for weeks on end. I had two techs that were in South Dakota for almost three months doing six furnace installs for a large company there that bought furnaces out of New York and needed them set up and commissioned in South Dakota."

Another major part of VESCO's 10-year plan is to continue that expansion globally, according to Collins.

"We've already expanded into both Canada and Mexico; we're doing a lot of work in both of those countries, and we're really looking to expand to be a truly North American company —building those partnerships on both sides of the borders, both north and south," he said. "Luckily, Busch has both Busch Canada and Busch Mexico counterparts that's easing that transition for us. But they have the same needs that we have here in the U.S., as far as parts and service and engineering. That's really where we're looking to go as part of that expansion — to be able to service the manufacturing that seems to be coming back into the U.S."

MORE INFO vacuumengineering.com

MARKETPLACE ///

Manufacturing excellence through quality, integration, materials, maintenance, education, and speed.

Contact **Thermal Processing** at 800-366-2185 to feature your business in the Marketplace.

ADVERTISER INDEX ///

Q&A /// INTERVIEW WITH AN INDUSTRY INSIDER

JASON CILLO /// DIRECTOR OF INTERNATIONAL SALES /// GRUENBERG AND BLUE M

"We have a rigid set of standard tests that we run on every oven we manufacture."

Some of Thermal Product Solutions' ovens are used in semiconductor manufacturing. What types of oven configurations work best in this sector?

Thermal Product Solutions (TPS) has two lines of industrial ovens used for semiconductor manufacturing. One is our Gruenberg oven brand, which lends itself to being more custom in nature. Our Gruenberg ovens are built for a multitude of different industries: aerospace, semiconductor, electronics, medical device, pharmaceutical, you name it. And Gruenberg is the brand that fits when a standard offering isn't available to meet the process requirements. The other TPS oven brand that serves the industry is Blue M. Blue M was founded in the 1960s to meet the unique manufacturing needs of the emerging semiconductor industry. If you look at some of the different models and family series within Blue M, what you'll find is that the interior dimensions actually fit the form factor of the semiconductor products at that time. That's kind of how Blue M came to be. So, the majority of our semiconductor offerings that we have or that we fulfill for those needs are through the Blue M standard product line. They've got a heavy global presence and supply ovens to a wide range of customers. Blue M's customer base includes a lot of niche semiconductor companies, contract fab semiconductor players, along with some of the top-tier manufacturers in the industry.

The Blue M ovens are batch ovens. We sell those ovens for various semiconductor processes where they use very high heat to attach an IHS or integrated heat spreader to the device, and lesser heat KW models to cure epoxy or resins.

Why is a sterile environment needed in an oven?

A sterile oven environment is needed to prevent contamination from particulates during processing and ensure the products pass QA requirements. Sterilization is an area that Gruenberg does really well. Their sterilization technology was actually designed to meet FDA regulations in the pharmaceutical sector and is one of the oven brands that we have that will guarantee a class 100 sterile environment inside. We typically install a port on the front of the door where customers can install an electronic particle detector inside the oven and use HEPA filtration to minimize contaminants. While the unit is running, the detector samples the air to confirm the sterile classification of the oven interior. Airflow uniformity in an oven is important. All Blue M oven airflow is horizontal, but with Gruenberg, we can do three types of airflow: horizontal, vertical, or a combination of both.

How is a Gruenberg oven made compatible with a cleanroom and why is that necessary?

To achieve the clean room design, Gruenberg and Blue M fully weld the inner liner and direct the airflow through a filter box containing a recirculation HEPA filter. If we're drying the board, since most boards go through a washer, they'll come through our ovens. We also facilitate epoxy curing. Picture where they're administering that sticky epoxy. What you really don't want is any foreign material flying around inside the oven that's going to stick to that, because now you've got a quality issue that can cause failure to the chip. That's where the clean room models of our Blue M ovens — as well as our Gruenberg ovens —are needed.

We also offer ovens with inert atmosphere capabilities. Anytime you heat copper or some precious metals, it oxidizes, and with oxidation, the connectivity gets lost. That's a big no-no in electronics. With inert capability, the customer can connect gaseous nitrogen to the oven, which floods the interior of the oven to force most of the oxygen out of it. With our inert ovens, there's a 99.9 percent chance there's going to be no oxidation.

What types of continuous process options does Gruenberg offer?

Some companies want continuous process, where they will have an engineering house automate a loading and unloading device to just constantly keep feeding this conveyor. For our continuous ovens, design considerations include the speed of the conveyor, the width of the conveyor, and the total length of the conveyor. These factors are determined by the units per hour and the process parameters the customer needs to process through the oven. We do have the luxury at TPS to kind of bounce between the two product lines to cover a multitude of customers' products and/or production styles.

What types of applications for semiconductor manufacturing are met by Gruenberg's ovens?

We're helping to make chips for everything from wearable technology to microprocessors in your tablet or your laptop. We do have customers who deal in nothing but automotive electronics. There are so many custom Gruenberg ovens that are one of a kind and only built for that company and their product. We will take your product and work backwards to design an offering that fits your specific application.

Anything else you'd like to mention that we didn't talk about?

Temperature uniformity is very important so you can have even curing, even drying, and even processing throughout the entire rack. We have a rigid set of standard tests that we run on every oven we manufacture. This ensures the equipment leaves our facility performing to our customer's process specifications.

MORE INFO www.gruenberg.com


YOU'VE GOT THE PRODUCTS.
YOU'VE GOT THE SERVICES.
NOW, LET US SHARE YOUR STORY.
Thermal Processing wants to make sure the best possible audience knows your company. Through our print, online, and social media presence, our experienced staff can get your message to an industry that wants to know what you can do.
To learn more, contact our sales team at sales@thermalprocessing.com or call 800.366.2185
Thermal processing

VACUUM HEAT TREATING
FURNACES


Mentor®


Mentor® Pro


Internal and external quench

NEO™ oil quench


Vertical bottom loading


High capacity, car bottom loading

SOLUTIONS THROUGH INGENUITY

Solar Manufacturing designs and manufactures high performance, technically advanced and energy efficient vacuum heat treat furnaces. Models range from compact R&D size furnaces to mid-size horizontal production furnaces to huge car-bottom vacuum furnaces for large heavy workloads. No matter what the application or size of workload, Solar Manufacturing has the versatile, feature-rich vacuum furnace solution to fit your needs. We back it all up with outstanding Aftermarket support: spare parts, service and replacement hot zones.

SOLAR MANUFACTURING

267.384.5040
sales@solarmfg.com

solarmfg.com

Give us a call to learn more about our vacuum furnace ingenuity.