THE ADVANTAGES OF AN ALL-METAL VACUUM FURNACE HOT ZONE

COMPANY PROFILE ///
Super Systems Incorporated
SOLUTIONS THROUGH INGENUITY

Some say it's thinking outside the box, we call it Ingenuity. 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.

Give us a call to learn more about our vacuum furnace ingenuity.
Backed by 70 years of experience, it is our mission to strengthen materials through expert-driven solutions. We are committed to delivering proven technology for a range of applications that enable you to transform space exploration, improve titanium medical implants and develop more efficient cars and jet engines.
THE ADVANTAGES OF AN ALL-METAL VACUUM FURNACE HOT ZONE

An all-metal hot zone is necessary for processing certain materials that require a super-clean, non-contaminating environment.

FREEZING OUT THE COMPETITION

Cryogenics is an exciting frontier that has already led to major discoveries and holds much promise for the future.

COMPANY PROFILE

SUPER SYSTEMS INCORPORATED

Since it opened its doors in 1995, Super Systems Incorporated has worked to make heat treaters more efficient using today’s technology.
**UPDATE ///**

New Products, Trends, Services & Developments

- Lindberg/MPH ships electric mesh belt conveyor furnace.
- Mazak acquires MegaStir to advance HYBRID technology.
- Bodycote opens facility, announces further expansion.

**Q&A ///**

**GUIDO LOCATELLI**

VICE GM OF TAV VACUUM FURNACES SPA;
PRESIDENT OF FURNACARE INC., A TAV
GROUP COMPANY

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**Industrial Heating Equipment Association (IHEA)**

In this section, the national trade association representing the major segments of the industrial heat processing equipment industry shares news of the organization’s activities, upcoming educational events, and key developments in the industry.

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We’re doubling the heat treat

The heat-treat industry continues to grow by leaps and bounds, and Thermal Processing is growing with it in order to get the best information we can to our readers.

Starting with this issue, Thermal Processing is doubling its annual heat-treating coverage by going to 12 issues a year.

We have been excited about this leap forward since we made the decision almost a year ago, and we have been planning for it ever since.

To further enhance this change, we have launched an all-new print product redesign that also serves to take our magazine to new heights.

We felt as we made the move to 12 issues, it was the perfect time to modify our look and push it forward, while also improving the overall readability of the editorial content. We’re all very proud of it, and I hope you enjoy it as well. Please let me know what you think.

And speaking of editorial content, I hope you enjoy what we’ve included in our first issue of 2019.

An article from Solar Atmospheres explains the advantages of the all-metal vacuum furnace hot zone and how it has evolved through the years.

When it comes to heat-treating, the first thing that comes to mind is getting something hot, but it also means getting something cold — really cold.

An article from CryoPlus’ Kathi Bond shares her expertise on how cryogenics has led to major discoveries and what the process holds for the future of heat-treating.

We also have some really fascinating information coming from our monthly columnists, including a look at Nadcap certification and hardening furnaces.

We are so pleased to have you join us on our journey into 2019 and beyond. We believe in the importance of heat treating, and Thermal Processing will be sharing even more of it with you as we move into the new year.

Happy New Year, and, as always, thanks for reading!

KENNETH CARTER, EDITOR
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Lindberg/MPH ships electric mesh belt conveyor furnace

Lindberg/MPH announced the shipment of one continuous mesh belt conveyor furnace to the computer market. This conveyor furnace is configured for soldering process applications and provides a heating and cooling process environment under a nitrogen/hydrogen blended atmosphere.

The electrically heated mesh belt conveyor furnace features a 6” wide belt and 6’ long chamber. The parts will be continuously loaded onto the belt, heated to the customer’s specified temperature (maximum of 1000°C), and then cooled while under a nitrogen/hydrogen protective atmosphere prior to exiting the conveyor. This process atmosphere environment allows parts to be thermally processed and remain clean.

The mesh belt conveyor furnace features an alloy belt capable of withstanding process temperatures along with a full alloy muffle welded gas tight and pressure tested. The integrated control panel includes an advanced process controller that controls zone temperature, belt speed, atmosphere, and historical data. Each heating zone is individually controlled providing specific temperature gradients.

“This conveyor furnace utilizes a nitrogen/hydrogen atmosphere in the cooling section to ensure that the parts being processed remain clean,” said Bill St. Thomas, business development manager.

Features of this continuous mesh belt conveyor furnace include:
- Full alloy muffle is welded gas tight and pressure tested.
- Inert gas purge chambers at entrance and exit.
- Water-cooled cooling section.
- Advanced process controller with touch screen.
- Multiple individually controlled heating zones.
- Belt-speed sensing and belt-jam alarm.
- Atmosphere burn off.

Mazak acquires MegaStir to advance HYBRID technology

Mazak Corporation has announced its acquisition of MegaStir, a supplier of friction stir welding (FSW) tools and technology located in Provo, Utah. With the acquisition, Mazak continues to expand and build upon its HYBRID Multi-Tasking Machine Technology.

The new Mazak MegaStir will provide further system advancements and evolve into an FSW technology center. A resident FSW machine in Provo as well as in other Mazak Technology Centers will provide customers the potential for real manufacturing solutions in a Done in One capacity.

Through several key developmental collaborations and now the MegaStir acquisition, Mazak continues to pioneer the HYBRID Multi-Tasking concept. One that extends beyond the combination of additive and subtractive processes to also include others such as FSW capabilities for complete part processing on one machine tool platform and often in one setup.

Mazak first collaborated with MegaStir on the development of the Mazak VTC-800 FSW vertical 5-axis machining center and they recently introduced the Mazak VTC-300C FSW at the IMTS show in Chicago. Designed and manufactured in Kentucky, the VTC-300C FSW features Mazak’s MAZATROL SmoothG CNC, a powerful 40-taper spindle, full traveling-column design, and a fixed table for the machining of extremely long and heavy workpieces (or multiple workholding fixtures). The FSW package adds friction stir welding capability to the spindle via a unique tool holder and includes closed-loop FSW process control as well as FSW programming software that enhances the speed and capability of the process.

Dan Janka, president of Mazak Corporation, said the MegaStir acquisition is a testament to Mazak's rock-solid commitment to furthering the HYBRID Multi-Tasking Machine concept.

“Our goal is to continuously explore and develop new technologies, processes and product innovation that will keep our customers productive, competitive and profitable,” he said, “and the various Mazak FSW machines are perfect examples of that, as are the other various machine models within the Mazak HYBRID Machine Series.”

Since 2002, MegaStir has led the industry with improved FSW tool material innovation...
and applications. Designed for endurance and quality welding, MegaStir tools consistently produce top quality, high strength welds in a single pass.

Dale Fleck will head up operations as the general manager of the new Mazak MegaStir and said that all those at MegaStir are extremely thrilled to now be part of the Mazak team. “Together with Mazak, we will advance FSW’s applications not only within the oil and gas industry sector but also into other new and dynamic high-tech segments as well.”

FSW is a solid-state joining process that uses frictional heat and forging pressure to create full-penetration, defect-free welded joints with greater strength than conventional welding methods. The process uses a non-consumable tool to join two metal plates without melting the workpiece. Commonly considered a forging process, FSW is well-suited for joining alloys with low melting points, including aluminum, copper and brass, among others.

MORE INFO  www.mazakusa.com

Bodycote opens new facility, announces further expansion

Bodycote, the world’s largest provider of heat treatments and specialist thermal processing services, held an official opening ceremony recently at its new facility on the Advanced Manufacturing Park (AMP), Rotherham, Yorkshire.

The new advanced heat-treatment center, now fully operational and supporting customer requirements, offers a range of heat-treatment services and has been established to support the aerospace and power generation markets in the U.K. and Europe.

The Rotherham facility was officially opened by Andy Greasley, executive vice president of Rolls-Royce’s Turbines Supply Chain Unit, in recognition of the enduring partnership between Bodycote and Rolls-Royce. Greasley said, “Heat treatment and processing are a vital part of our supply chain and Rolls-Royce is delighted to be supported by Bodycote on the Advanced Manufacturing Park in Rotherham. Close coupling of this capability to our own Rolls-Royce business is critical for our future suc-
cess and our relationship with Bodycote is one that we truly value.”

Also speaking at the event, AMRC (Advanced Manufacturing Research Centre) CEO Colin Sirett said the new center will bring a key capability to the Advanced Manufacturing Park. “We’ve got everything from aircraft parts through to carbon fiber chassis for supercars all being manufactured on this site; the one piece of the process that was missing was materials processing. We can cast; we can forge; we can assemble; we can machine, but the one key element that was missing is exactly what Bodycote brings to the park. So, it’s great to welcome the Bodycote team here and we are looking forward to working with them for many years to come.”

VIP delegates were also the first to hear about Bodycote’s plans for significant expansion of the new site, which includes the securing of extra units on the Advanced Manufacturing Park. (Courtesy: Bodycote)

Grieve No. 839 oven handles high-temp batch paint baking

Grieve No. 839 is an electrically heated, 850°F walk-in oven, currently used for heat-treating and high-temperature batch paint baking. Workspace dimensions measure 72” W x 120” D x 72” H. 120 kW are installed in Incoloy-sheathed tubular heating elements, while a 12,500 CFM, 10-HP recirculating blower provides a combination horizontal/vertical airflow to the workload.

This Grieve walk-in oven features an aluminized steel exterior and interior with 7-inch thick insulated walls, plus a 4-inch thick insulated floor with built-in truck wheel guide tracks. Inner and outer door gaskets are provided, with the inner gasket sealing against the door plug, while the outer gasket seals directly against the front face of the oven.

All safety equipment required by NFPA Standard 86 for handling flammable solvents are onboard No. 839, including explosion-venting door hardware, powered forced exhauster air flow safety switch, and purge timer. Also featured on this walk-in oven are a recording and programming temperature controller.

Solar Atmospheres’ Paponetti Southeast sales manager

Solar Atmospheres’ South Carolina facility announces that Mike Paponetti has accepted the position of sales manager. Before accepting this position, Paponetti was the regional sales manager at the Hermitage, Pennsylvania, facility. Paponetti will lead the sales efforts to maintain and promote sales for Solar Atmospheres in the Southeastern United States and confidence is high he will provide customers with exceptional support.

Solar Atmospheres Southeast President Steve Prout said, “We are excited to have Mike as a part of the Solar Atmospheres Southeast team. With more than 20 years of thermal-processing experience, his heat treating and brazing expertise will be a tremendous resource for our customers.”

This promotion opens a vacancy for a regional sales manager position at the Hermitage, Pennsylvania, facility. For more information on this career opportunity and to discuss joining a stable, growing company who partners with each of our customers to meet or exceed their expectations, contact Mike Johnson at mikej@solaratm.com.

Seco/Warwick’s CAB technology fuels company in India

Karnavati Car Air Conditioners Pvt. Ltd, Ahmedabad (KCP) will produce a wide variety of high-quality products with the addition of Seco/Warwick Controlled Atmosphere Brazing (CAB) Line for their greenfield project in Gujrat, India.

Seco/Warwick will provide KCPL a complete line including the CAB brazing furnace and related equipment to complete the pro-
cess: thermal degreaser, fluxer, dry-off oven, air quality, and cleaning. The system will be used for aluminum heat exchangers of all types for the automotive market.

“KCPL is one of the fastest growing companies in India, dealing in automotive radiators, condensers, cooling coils, and fan assemblies. We have selected the complete Seco/Warwick’s CAB brazing line because the system versatility will enable our company to produce a wide variety of high-quality products with the lowest possible cost – our goal is to continue our rapid pace of growth and improve profitability by modernizing our brazing operation,” said Kartik Jethwa, chief engineer, KCPL.

“We are proud technology partners with KCPL and look forward to their continued success. Since 1984, Seco/Warwick has been the leader in the evolution and innovations in CAB technologies ensuring our customers that they will receive the finest system value and professional technical services to keep their equipment online and operating efficiently for many years in the future,” said Piotr Skarbinski, vice president, aluminum process and CAB Technology, Seco/Warwick.

Seco/Warwick CAB line for brazing, using a noncorrosive flux, is the preferred solution for manufacturing aluminum heat exchangers in the automotive industry.

Due to the unique process benefits, the CAB process is rapidly finding new applications in industrial, power plant, and HVAC manufacturing.

Registration opens for Metal Injection Molding Conference

Registration has opened for MIM2019: International Conference on Injection Molding of Metals, Ceramics and Carbides – the only international powder and metal injection molding conference of the year. MIM2019 is a global conference and tabletop exhibition that highlights advances in the powder injection molding (PIM) industry. The conference will take place in Orlando, Florida, at the Hilton Orlando Lake Buena Vista, February 25–27, 2019.

Conference highlights include:

› Keynote speaker, Robert Dowding, U.S. Army Research Laboratory.
› Tabletop Exhibition & Networking Reception (refreshments sponsored by PIM International).
› The annual PIM Tutorial presented by industry veteran Randall M. German, FAPMI, Prof. Emeritus, San Diego State University, February 25, will provide a basis for determining options, uses, properties, applications, and opportunities for cost-effective PIM manufacturing.

The annual MIM conference is an excellent place for product designers, engineers, consumers, students, and more, to network and broaden their industry knowledge,” said...
Jim Adams, executive director/CEO, Metal Powder Industries Federation (MPIF).

MIM2018 attendance continued an upward trend with more than 180 attendees representing 104 companies from 16 countries. Attendees consisted of 35 percent parts manufacturers; 23 percent equipment & service providers; 17 percent powder and feedstock suppliers; 14 percent consumers; and 11 percent other. A similar attendance base is expected for 2019.

The PIM industry is composed of metal injection molding, ceramic injection molding, and cemented carbide injection molding—an advanced manufacturing industry with sales assessed at nearly $2 billion globally. This conference will provide a venue for the latest technology transfer.

This conference is sponsored by the Metal Powder Industries Federation, APMI International, and the Metal Injection Molding Association, a trade association of Metal Powder Industries Federation.

MORE INFO www.mim2019.org

Solar Manufacturing installs GFQVHP for Arizona company

Solar Manufacturing has successfully completed the installation and startup of a 100-ton force Vacuum Hot Press that includes a 2-Bar Gas Fan Quench cooling system (GFQVHP) for Refrac Systems’ commercial and aerospace diffusion bonding operation in Chandler, Arizona.

Working with Solar’s engineering team, Refrac Systems selected a derivative of the Solar Manufacturing standard HLF-5748-2IQ internally quenched 2-Bar vacuum furnace as the base design. The furnace hot zone was modified to contain a 100-ton load hydraulic ram centered over the zone which is configured to diffusion bond parts up to 36” wide x 48” long x 30” tall.

Besides being specifically designed to diffusion bond large plastic injection molding dies, and concurrently quench hardening them, the system is finding applications in bonding advanced superalloy heat exchangers where the quench cooling offers significant improvement on performance.

Norm Hubele, president of Refrac Systems, said, “We really drew on the extensive engineering experience base that Solar Manufacturing has for building large gas fan quench cooled vacuum furnaces coupled with our own vacuum hot pressing experience to build this very unique hot press system.”

Along the course of system design and development, a number of new and complex engineering solutions were needed in order to reduce the operational and ownership risks for the new type of furnace system. “Solar’s engineering team really helped out with a lot of great design ideas and manufacturing experience, and the system really contains the most robust and reliable furnace engineering content that both companies could muster.”

William Jones, CEO of the Solar Atmospheres family of companies, said, “Norm put together a team of engineers to design and build this state-of-the-art GFQVHP, and it contains many innovations. Throughout the entire process, Norm personally reviewed all aspects of the design and added considerable insight to the development of this unique vacuum furnace system.”

MORE INFO www.solamfg.com
www.refrac.com

100-year-old Proos Manufacturing under new ownership

Grand Rapids, Michigan-based, Proos Manufacturing has announced the completion of the company’s sale to Bryan Howard. In addition to the sale, Proos also made public its plans to increase manufacturing capacity and add jobs.

Howard takes over the role of owner and CEO from Amy Proos, who has been with the company for 37 years and was the third generation and first woman CEO and owner of the nearly 100-year-old company.

Howard joined Proos in 2015 as general manager and became president in 2017. He has 20 years of experience across a wide range of manufacturing discipline including operations, quality control, and business development. Since taking over many of Proos’ development functions, the company has seen continued growth in both sales and profitability, including additional sales of $10 million through the third quarter of 2018.

“Bryan has been doing so many great things for the company,” said Proos. “His leadership is giving me an opportunity to
step aside at a time where I can enjoy more time with my family and being involved in other activities.”

Amy Proos will remain part of the company’s leadership and has taken on the role of chief thought officer, where she will influence corporate wide initiatives that focus on growth and operational improvements.

“Through initiatives set in place by Amy, the company has become a leading provider of manufacturing and engineering solutions for the material handling, automotive, industrial, and office furniture industries,” Howard said.

Due to the company’s growth, and by working with the Michigan Economic Development Corporation, Proos has secured a $998,000 loan from the Michigan Strategic fund to increase capacity and employment. The facility expansion includes the purchase of an existing 60,000-square-foot facility at 2140 Oak Industrial Drive, where it will relocate its office and assembly functions, while increasing manufacturing at its current location. Proos, which employs 140 individuals, will add 25 employees over the next 24 months.

In recent years, Proos has diversified its product and service offerings, from being a stamping facility for the auto parts industry to providing engineering services, sheet metal fabrication, welding, and wire harness assemblies to multiple industries throughout the United States.

“It is an exciting time in manufacturing,” Howard said. “Our team has paid close attention to market trends and made adjustments where necessary. In this industry, it is important to diversify and be able to offer products and services for multiple industries.”

MORE INFO www.proos.com

ASM International offers new slate of courses for 2019

In the ever-changing and expanding market of heat-treating, it is important to stay up to date with the newest procedures and trends. Stay current and be at the forefront of the industry by taking a heat-treating course with ASM. Upcoming courses include:

- Troubleshooting and preventive maintenance
- Final testing with calibrated helium mass spectrometer
- New pump sales - Rotary pumps, Roots type blowers, rotary vane pumps, and more

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**Basics of Heat Treating**  
›› February 11-13, 2019; ASM Headquarters; 2.0 CEUs

Heat treating is considered the least understood, but most integral part of the manufacturing processes. An efficient heat-treating process reduces the overall manufacturing costs associated with energy use, scrap, re-work, and quality issues. Heat treating is critical for your business and industry.

The Basics of Heat Treating course provides an interactive approach to learning the basic elements associated with the heat treating of metals. The course includes a variety of real-life manufacturing situations for discussion. There is also an interactive question and answer sessions integrated throughout the course.

Hands-on activities and demonstrations are integrated throughout the course to help guide you. These activities will take place in a newly renovated and state-of-the-art lab and will focus on:

›› Hardness testing.
›› Steel hardening.
›› Tensile testing and Impact testing.
›› Microstructures including a demo of the newly acquired SEM scope.
›› Thermocouples.

**Heat Treating Furnaces and Equipment**  
›› February 14-15, 2019; ASM Headquarters; 1.5 CEUs

Heat treating is key to most manufacturing processes, so the equipment used is just as important as the process itself. This course provides an overview of essential aspects associated with various furnace units used to heat treat metallic parts. This will give you an inside view of the world of heat-treating furnaces and equipment.

**NBR Cooling Systems selects CAB system from Seco/Warwick**

NBR Cooling Systems, an independent heat exchanger manufacturer for the domestic automobile industry, recently purchased a Seco/Warwick signature CAB Brazing system for automotive heat exchangers to reduce energy costs as well as improve production quality and operate within the latest environmental regulations in India.

“We selected Seco/Warwick because they provided a high-quality production assurance which we needed to keep our plant running efficiently along with low atmosphere consumption, minimum maintenance, and repeatable process results, all at a low capital cost investment. A Seco/Warwick CAB system was definitely our first option – the company leverages many years of experience and guarantees continuous trouble-free operation at a high technological level and provides local contact, care, and service,” said Aarif Hussain, NBR Cooling Systems Managing Director.

“The government has put greater emphasis on the environmental impact issues, therefore our goal with this purchase is to put NBR Cooling Systems on track for sustainable development in the future.”

“Seco/Warwick is a well-known CAB Brazing technology creator and one of the world’s most experienced suppliers. Dozens of patents and R&D projects, thousands of deployed solutions and CAB Brazing customers in more than 30 countries are proof of our technological expertise, and the reason why companies like NBR choose Seco/Warwick. Together with professional technical services, we can support our customers from the beginning until the end of the product life. We are pleased to support NBR Cooling Systems’ vision to become the leader in the national and international market for commercial heat exchangers and air conditioning systems for the automotive industry,” said Liu Yedong, managing director, Seco/Warwick RETECH (China).

**Heat Treat 19 now accepting technical papers**

Heat Treat 19, the 30th Heat Treating Society Conference & Exposition, is October 15-17, 2019, in Detroit, Michigan. Position your research and organization as heat-treating thought leaders by submitting original, previously unpublished, non-commercial papers for oral and poster presentations for the Heat Treat 2019 technical program.

Heat Treat 2019 will feature new technologies, new market trends, and new market segments. Be a part of the change and help shape the future of the industry by submitting an abstract.

Completed manuscripts that are of suffi-
cient quality may be selected to be published in a special issue of the Journal of Materials Engineering and Performance (JMEP). Please indicate your interest in that option when submitting your abstract, and note that earlier manuscript deadlines will apply to allow for the peer review process.

Complimentary full conference registration will be offered to all presenting authors who submit a full manuscript (6-10 pages) for the proceedings.

Abstract Deadline is February 8, 2019.

**Topics**

The Heat Treating Society encourages submissions relevant to thermal processing of materials, including the following topic areas:

- Additive Manufacturing / 3D Processing.
- Applied Technology/Processes and Applications.
- Atmosphere Technology and Surface Engineering.
- Automotive Lightweighting.
- Induction Heat Treating.
- Internet of Things.
- Low Temperature Surface Hardening of Stainless Steel.
- Materials Durability/Mechanical Testing.
- Microstructural Development/ Characterization.
- Powder Metallurgy.
- Quenching and Cooling.
- Residual Stress.
- Thermal Mechanical Processing.
- Thermal Processing of Non-Metals (ceramics, composites, polymers).
- Vacuum Processes and Technology.
- Welding/Joining.

**MORE INFO**  [www.asminternational.org](http://www.asminternational.org)

**Customized tank will quench multiple metal stamping dies**

L&L Special Furnace Co., Inc., has supplied a custom designed and manufactured oil quench tank to a metal stamping manufacturer in the Midwest. The quench tank is specifically used to quench metal stamping dies that are heated to 1,550°F.

Usable dimensions are 12” wide by 12” high by 24” long. The parts are placed in a basket prior to being quenched. They are then manually placed into the quench oil.

The quench tank has an oil media that is agitated by a 1 horsepower pump that is directed up under the parts basket. There is an oil to water cooling heat exchanger to control the oil temperature. The system is designed to run one cycle per hour with 35 pounds of material.

A resting stand is designed with the quench tank to allow the parts to drain after quenching.

The oil flows back into the quench tank through an integrated drip tray that is attached to the stand. Ball valves on the inlet...
and outlet of the quench tank allow further control of the quench media.

L&L offers a wide selection of quench tanks for various applications. This quench tank is a great companion for an L&L QD or QDS Series dual chamber hardening and tempering furnace. Please contact L&L direct to discuss any of your heat treating and quench tank needs.

**MORE INFO** [www.llfurnace.com](http://www.llfurnace.com)

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**eldec revamps manufacturing website**

In an effort to serve customers in the United States, Canada, and Mexico better, eldec LLC unveiled a new website for manufacturing professionals who use induction heating, brazing, shrink fitting, pre-heating for laser welding or annealing in their manufacturing processes.

The new site includes company and product information and trade show updates as well as manufacturing and equipment maintenance tips. Designed for easy navigation whether using a desktop, laptop, notepad, or cell phone, it also contains links to technical data on eldec’s worldwide site, making information easier to find.

**MORE INFO** [www.inductionheatingexperts.com](http://www.inductionheatingexperts.com)

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**U.S. manufacturer orders ZeroFlow® gas nitriding furnace**

A growing American manufacturer has recently ordered a new precision gas nitriding furnace with ZeroFlow® from Seco/Vacuum (SVT), a Seco/Warwick Group company. The furnace will allow the company to offer engineered steel surfaces that exceed, in many cases, its competitors’ product performance, giving it an edge via heat-treating that few other companies in their competitive sphere can replicate. The customer is involved in high-end manufacturing of various transportation components.

Lower operating costs, attractive return-on-investment (ROI), precise control of case depth, and control of nitride layer formation (including compound zone white layer) are only few of the benefits that the proprietary ZeroFlow® control technology has to offer.

“ZeroFlow refers to precision gas nitriding, but the Seco/Vacuum retort line of furnaces offers so much more,” said Piotr Zawistowski, managing director of Seco/Vacuum Technologies. “The vacuum purge affords inexpensive processing atmospheres, and the vacuum-tight construction assures clean heat processing for tempering, annealing and precipitation hardening. This retort furnace can be paired with a Seco/Vacuum oil quench hardening and low-pressure carburizing furnace for extreme flexibility. Quality processing and equipment flexibility are hallmarks of all of Seco/Vacuum’s furnace designs.”

The furnace is equipped with all options, including accelerated turbo cooling. In addition to gas nitriding, it also has ferritic nitrocarburizing capability and pre- and post-oxidation. Unique to Seco/Vacuum’s design is the ability to clean temper and clean anneal to temperatures up to 1,400F.

Seco/Vacuum Technologies LLC (SVT) is a fully-owned entity of Seco/Warwick Group in Europe. Through technological leadership, SVT offers unmatched vacuum furnace innovation and performance. Through its commitment to service, SVT provides its customers with the best support in the industry and the lowest cost of ownership.

**MORE INFO** [www.secovacusa.com](http://www.secovacusa.com)

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**Paulo Products celebrates milestone 75th anniversary**

St. Louis, Missouri-based Paulo Products Company observes its 75th year in business as a thermal processor of critical components used in a wide array of industries.

The company was founded in 1943 in St. Louis by husband and wife Ben and Pauline Rassieur. The two had previously worked for Central Mine Equipment Company. Pauline, after whom Paulo is named, was one of the first women to earn an engineering degree from the University of Missouri.

Paulo Products Company was originally conceived as a manufacturer. Heat treatment was intended as a secondary business that would pay the bills while the firm’s product
manufacturing operations were developed. Paulo did manufacture some products in the early days, but helping customers succeed by offering thermal-processing solutions is where the company excelled.

“I think that most people are surprised, maybe even shocked, to know that my grandfather and grandmother would have given up everything that they had done professionally to start a heat-treat shop,” company President Ben Rassieur III said.

The company started humbly, renting a small storefront space in downtown St. Louis. Its first heat-treating equipment was pieced together from spare parts bought from junk yards. Three-quarters of a century later, Paulo operates plants in Kansas City, Missouri; Cleveland, Ohio; Nashville, Tennessee; Murfreesboro, Tennessee; and Monterrey, Mexico in addition to its flagship St. Louis operation.

“I think if you look back to the very beginning of Paulo, people would be astounded to see where we are right now,” said Executive Vice President Terry Rassieur.

The Rassieur family’s commitment to innovation and customer service has spurred a rich tradition of developing unique treatments and building custom equipment that allows customers in key industrial sectors to take their components to new heights.

The spirit of innovation also led the company to be the first of its kind to adopt computers for ordering and invoicing in 1966. And in 1996, Paulo unveiled PICS, the Product Information and Customer Service system.

This proprietary quality assurance software monitors and records treatment parameters and ensures treatments are executed consistently.

Today, some of the biggest names in aerospace, automotive, power generation and other key sectors rely on Paulo to provide advanced heat treatment for their critical components. That reliance has fueled the next stage of Paulo’s growth as the company’s first international division in Monterrey, Mexico is now online.

“I envision Paulo in the future to be not just one of the largest commercial heat treaters in the Midwest, but I see us having more of a global footprint,” said Emily Rassieur, an HR Management Associate and part of the fourth generation of Rassieur family leadership.

“We’ve already taken steps in that direction by opening the plant in Mexico. We’ll have new opportunities in places outside of the U.S. to make an impact and have a presence.”

The Rassieur family credits the company’s success to the employees whose hard work made it possible. “Without our people, we’re nothing. They bring so much to the table,” said Emily Rassieur.

“We want to thank all the dedicated employees over the past 75 years,” said Will Rassieur, vice president of sales. “We thank those who have worked with us in the past, work with us today, and will work with us in the future.”

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The Industrial Heating Equipment Association (IHEA), the Chemical Coaters Association International (CCAI), Products Finishing magazine, and Southern Company have teamed up to provide a comprehensive training course. The Powder Coating and Curing Processes Seminar is March 5-6, 2019, at the Georgia Power Customer Resource Center (CRC) in Atlanta, Georgia.

The day and a half introductory course includes classroom instruction and hands-on lab demonstrations. Attendees benefit from personal interaction with the speakers who are seasoned experts in all aspects of powder coating and curing processes. They will receive technical resources to complement the program and gain valuable experience by spraying and curing a part during the course.

The classroom agenda will cover a variety of topics presented by members of the presenting organizations who are dedicated to the education and growth of the industry. Also included is a section on curing, which reviews the basics of infrared technology, several use-
ful applications both electric and gas, and helpful case studies to prove the benefits for those who use it. Members of IHEA’s Infrared Division will lead the curing segment and demonstrate the technology in the resource center:

- **Infrared Basics:** Wayne Pettyjohn, Georgia Power
- **Applications:** John Podach, Fostoria Process Equip.
- **Gas Catalytic/Complex Applications:** Lee McWhorter, Heraeus Noblelight
- **Case Studies:** Scott Bishop, Alabama Power Co.

The seminar combines the perfect mix of technical information, classroom involvement, hands-on practice, and social interaction for attendees to receive the best overall training value. You won’t find a more cost-effective powder coating and curing training seminar anywhere. Learn from industry experts in this state-of-the-art facility.

Registration fee includes classroom and lab sessions, breakfasts, breaks, lunch, a networking reception, CCAI’s Powder Coating Training Manual ($65 value), and IRED’s Infrared Process Heating Handbook ($20 value).

This seminar always receives outstanding reviews from attendees. Former participants’ feedback includes:

- “Speakers are very knowledgeable and helpful. Very impressed.”
- “I am new to the industry, and this course provided very good information and perspective to me.”
- “I really enjoyed the reception. It was nice to talk with others in the industry and find out what they do and how they do things. I learned a lot from other attendees.”

To register: [www.ccaiweb.com/event/PCCSpring19](http://www.ccaiweb.com/event/PCCSpring19)

IHEA members can register at a discounted rate. For additional information on the Industrial Heating Equipment Association and becoming a member visit [www.ihea.org](http://www.ihea.org).

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**IHEA 2019 CALENDAR OF EVENTS**

**MARCH 5–6**

Powder Coating and Curing Processes Seminar
Georgia Power Customer Resource Center (CRC) | Atlanta, Georgia

**APRIL 29–MAY 1**

IHEA 2019 Annual Meeting
The Industrial Heating Equipment Association (IHEA) will celebrate its 90th anniversary at the 2019 Annual Meeting. Complete meeting details and registration information can be found at [www.ihea.org](http://www.ihea.org).

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Any heat-treating processes cannot tolerate appreciable variations in steel hardenability. For an established in-control process, deviations in chemical composition and starting microstructure may result in a variety of issues including quench cracking, out-of-spec hardness, low ductility, and excessive distortion. Consequently, a hardenability tolerance should be assessed and defined for all new processes to ensure incoming material is properly controlled without being over specified.

HARDENABILITY DEFINED

Hardenability is often used synonymously with “end-quench” or “Jominy” hardenability, a reference to a standardized test that quantifies the hardness of a steel as a function of distance from an austenitized and water-quenched surface [1, 2]. This test has both beneficial and detrimental aspects. It is beneficial in that it allows the chemical composition variation of the raw material (e.g., bar or billet) to be characterized for quality control purposes with relative ease, but is detrimental in that it is limited in translating those results to components processed through a specific heat treatment process. As a result, for the remainder of this discussion, hardenability will be defined generally as the suppression of ferrite/pearlite formation upon cooling from austenite [1]. This definition encompasses those additional effects that are directly dependent on a specific heat treatment process.

CHEMICAL AND MICROSTRUCTURAL INFLUENCES

Chemical effects on hardenability are typically calculated using chemical ideal diameter (DI) – which is defined as the diameter in which the center of a round bar contains 50 percent martensite when quenched from austenite [3]. Grossmann used brine for his quenchchant, but ideal diameter typically assumes an “ideal” quench rate, which is infinite [3]. Figure 1 shows the effect of different alloying elements on hardenability through multiplying factors used to calculate DI. The danger with this multiplying factor comparison is that the data represent only one austenite grain size (ASTM grain size 7) and does not take into consideration effects related to the form of the alloying elements in the steel.

In plain carbon steels, a smaller austenite grain size has been shown to markedly, and negatively, influence hardenability [3]. The generally accepted mechanism for this observation is that increasing grain size decreases the grain boundary surface area and, therefore, the number of inhomogeneous nucleation sites for ferrite and pearlite [1]. However, this grain-size effect can be confounding in both low alloy and microalloyed steels. In these steels, the amount of alloying still in precipitate form can be significant at common austenitizing temperatures. In general, having the alloying in solid-solution yields the greatest influence on diffusional transformations, increasing hardenability.

Figure 1. Multiplying factors for most common alloying elements (other than carbon) used to determine ideal diameter in steel. Data plotted from equation provided in ASTM A255-10 [2].
Figure 2 shows the solubility of chromium carbide (Cr$_{23}$C$_6$) in austenite with nominal chemical compositions for AISI 4140, 5160, and 52100 indicated. Solubility product data from Ashby and Easterling [4].

Figure 3 shows the influence of vanadium (V), a common microalloying element in steel, on hardenability as a function of austenitizing temperature (from Grossmann [3]) as well as data currently used in ASTM A255 for determining the hardenability of steels [2]. Although the current ASTM standard indicates austenitizing temperature has no dependence, Grossmann showed a clear effect. At V levels typical of modern medium carbon microalloyed steels (approx. 0.08 wt.%), the influence of austenitizing temperature may be significant. Since Grossman’s work, the influence of microalloying elements such as V and niobium (Nb) has been investigated in great detail, and the mechanisms found to be relatively complex [5-9]. Therefore, their influence on hardenability is mentioned briefly for awareness only.

**CONCLUSION**

Fraction of alloy carbides dissolved upon austenitizing may have a significant influence on hardenability, thus requiring careful monitoring of the starting microstructure as well as the chemistry. Each heat-treatment process should be evaluated to determine its acceptable hardenability range to remain a capable process. Influence of both variation in microstructure and chemical composition should be examined independently, if possible.

**REFERENCES**


This article first appeared in the September/October 2017 edition of Thermal Processing magazine.

**ABOUT THE AUTHOR**

Lee Rothleutner is a principal development engineer with The Timken Company. He received his Ph.D. in Metallurgical and Materials Engineering from the Colorado School of Mines. He can be reached at lee.rothleutner@timken.com.
When selecting neutral or case hardening furnaces that require pits and have vertically mounted radiant tubes, facility managers must make sure that the equipment will fit within the space selected. Oil and salt hardening systems require quenching in tanks connected to the hot zone either directly, separated by an intermediate chamber, or completely stand-alone.

When load heights exceed approximately 18 inches, quench tanks will likely be located in pits to ensure that the floor to tray height does not exceed 50 inches. Why 50 inches? I can only guess, but I believe it provides the maximum ergonomic working height when load heights of the most popular batch furnaces are 36 inches. If the quench tank was to sit directly on the floor, the tray would be six feet above the floor and much too high for storage tables and associated equipment. AFC-Holcroft’s 36-48-36 UBQ batch furnace requires a 24-inch deep pit to facilitate the 50-inch hearth height. Higher load heights will require deeper pits sometimes in the 6-foot depth range. In addition to requiring a pit, furnaces with vertically mounted radiant tubes must have enough elevation to lift the tubes out of the hot zone for maintenance, thus the furnace hot zone must be located under an overhead, or jib crane. In some cases, a jib can be mounted on top of the furnace to facilitate the task.

Overhead clearance is one of the two critical constraints one must consider when positioning furnaces within the plant space. The second is what’s located under the concrete floor when a pit is required; high water table, unmarked pipes, etc.

In an effort to solve a decades old maintenance problem associated with endothermic generators, AFCH identified that overhead clearance could become a marketing advantage for AFC-Holcroft’s endothermic generators; that concept led to the development of the EZ™ Endothermic generator.

Traditional endo generators must have their process gas retort removed through the top of the casing, necessitating the extra elevation, many times exceeding 24 feet of total height from the floor. However, the EZ endo generator has a door that provides easy horizontal access for removal, allowing the generator to be placed in almost any plant location. Since they were introduced to the market 14 years ago, they’ve become a very successful product for AFC-Holcroft. Recently, other manufacturers have begun to offer their version of a door, so I guess the cliché “imitation is the sincerest form of flattery” even exists in the heat-treating world.

When an OEM or commercial heat treater makes the decision to purchase a hardening furnace system, they know their production requirements, and they know which hardening process they need—carburizing being the most popular process. Typically, the decision makers will create a comparison spreadsheet itemizing the critical parameters they require for their particular situation.

Following are some features that a heat treater might desire:
1. Endo generator, nitrogen/methanol or LPC (low pressure carburizing).
2. Oil, salt for austempering or HPGQ (high pressure gas quench).
3. If it’s a commercial heat-treat process flexibility may be a necessity.
4. Overall load size that will accommodate production requirements.
5. What’s the pit depth required for each manufacture?
6. Type of refractory in the hot zone; brick or fiber.
7. Gas or electric heat.
8. Ceramic or heat-resisting alloy radiant tubes.
9. Vertical or horizontal heating tubes.
10. Slow cool chamber in addition to the oil quench; a flexibility issue.
11. Automation:

**Control system:**
- Brand of PLC, AB, Siemens, etc.
- Integrated or stand-alone temperature and carbon potential control.
- Atmosphere flowmeters, analog or digital.
- Recipe management, discrete or a SCADA system.

**Lights-out or manual tray manipulation:**
- Material handing such as programmed load manipulation is primarily a consideration for OEMs and large commercial heat treats.
- Finally, what does the equipment cost?
  - Cost of installation.
  - Cost of operation, overall efficiency.
  - Cost of spare parts.
  - Availability of spare parts.
- Can spare parts be purchased commercially or from the OEM only?

These are just some of the more common considerations that factor into the buying decision. But actually, how much does the necessity for a pit and overhead clearance play or not into that decision? If a 36 wide x 48 long x 36 high batch IQ furnace was to be offered by an OEM that still maintained the 50-inch hearth height and required, like the EZ, no extra overhead clearance and did not require a pit and would still accommodate a standard tray footprint, would those features get a heat treater’s attention?

Is this actually possible? We’ll find the answer and more in columns to come.

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**About the Author**

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AMG Advanced Metallurgical Group N.V.
think it is safe to assume that the majority of Thermal Processing readers have, in some capacity and at some point in their career, been exposed to Nadcap in either one or multiple commodities. Throughout my consulting career, I’ve had discussions regarding many aspects of the Nadcap organization as well as its process. These conversations can at times, turn negative. In this article I would like to present an argument in support of Nadcap.

HISTORY
Before explaining my argument, I feel it’s appropriate to give some background on Nadcap’s (formerly NADCAP) formation as well as its current mission.

It was identified in a conference in 1985 that redundant prime process audits conducted on process suppliers could be greatly reduced if they could find a way to consolidate the efforts. In 1990, SAE launches PRI as a separate nonprofit (501(c)(6) organization to govern Nadcap. In the beginning, Nadcap had conducted five NDT audits by the end of 1990. By 1994, Welding, Heat Treat, Materials Testing Laboratories, Chemical Processing, and Coatings were added as commodities. In 2002, Nadcap launched its business support software, eAuditNet. Now, Nadcap is spread through the Americas, Europe, and Asia and includes Transportation and Power Generation, Medical Devices, Nuclear (2011), as well as the institution of the MedAccred program (2014). Nadcap is based in Pittsburgh, Pennsylvania, but also has a European and Asia office as well. Alongside Nadcap, PRI has branched out in areas such as eQuaLified and eQuaLearn (I am a contracted Lead eQuaLearn Instructor). Nadcap has grown into an industry standard that, as far as I can see, isn’t going anywhere.

THE CON ARGUMENT
Arguments I hear against Nadcap are, as an example, “it is a monopoly.” I understand that the word “monopoly” is either associated with a competitive business monopolizing a market or simply the board game (maybe we’ll see a Nadcap version soon). It is true, PRI/Nadcap is a monopoly, but remember, the intention was to centralize requirements and accreditation to achieve consistency in processing and quality systems, not to create a new product for American consumption that will become competitive in the market. There is no other way to accomplish this aside from establishing a monopoly. This seems logical to me. It would be like having multiple direct managers. You would receive conflicting requirements from each manager, causing any meager amount of consistency to disappear, and in the end, it would detrimentally affect your performance. We need to achieve quality through consistency and centralized requirements. Nadcap has achieved that.

Another argument against Nadcap is that suppliers who are receiving their Nadcap accreditation for the first time are doomed to fail. An article written by Christopher Paris, published September 7, 2018, states: “First, just get it into your head that no matter how bulletproof you think your special process is, and even after you’ve conducted the mandatory self-audit beforehand, the Nadcap auditor is going to fail you on the first try. It’s so prevalent, I am convinced it’s hard-baked into some internal PRI procedure. The auditor will always find something wrong that requires a 1-day follow up audit. Just be prepared for that, check your ego, and let them do it. Consider it a cost of doing business, and it won’t be that expensive anyway. But you are not going to pass your audit on the first try. Consultants who tell you otherwise either don’t have actual experience in this, or are just lying.” [1]

I realize this may seem as though it is an extreme example, but in conversations I have in which the other person is speaking negatively, this idea comes up often. Nadcap’s operating procedures are public. Any Nadcap approved supplier or even someone who has gained access to eAudit.net and is not a supplier (yes, you can do this) can easily read the Nadcap operating procedures as they apply to both PRI staff and Nadcap auditors.
On another note, stating that you will, no matter how well you prepare, fail your first audit is just not the case. I have worked with countless potential suppliers, both commercial and captive (in-house) processors, who have gained Nadcap accreditation on the first try (even in heat treat). Of course, I am sure there are some who are simply not well prepared, but this should not be seen as a reflection of Nadcap or PRI; this is due to the potential supplier not being prepared in one way or another.

This same theory can translate to the notion that, no matter how well you prepare, you will receive a finding because the auditor “has to find something.” Again, this is not the case. I’ve been through audits and received zero findings (again, yes, in heat treat). The irony behind this is that, a year later when performing an internal audit, I found two items that were missed that would have constituted two minor findings on the initial audit. Auditors are humans, too.

A PERSONAL POSITION
PRI and Nadcap, as well as the eQuaLearn team, have designed systems which allow both primes and suppliers to have input on the checklist requirements as well as handbooks. When I try and imagine performing this task, I can’t see any easy route. Organizing prime requirements and industry standard requirements all the while filtering “experts’” opinions out of the mix ... it must have been a task that seemed to have no light at the end of the tunnel.

If you have ever been to the annual PA Nadcap conference you will gain, at the very least, a small amount of respect for how PRI governs the Nadcap program. Anyone in the room has an opportunity to voice their concerns and questions and they are addressed, if not immediately in that setting, they are documented and addressed at a later time. PRI staff engineers are also available via email to answer questions, which they do often. Their emails can be found on the contacts tab at the top right-hand side of the eaudit.net page.

SUMMARY
PRI manages a monster that is ever-changing and growing. This is a tough task. It’s very easy to voice armchair opinions, but ask yourself this: Is it PRI that does not govern Nadcap well, or is it suppliers who are simply not prepared for their audits? PRI may have areas they could improve on, but all organizations do. Areas where suppliers feel PRI could improve should be voiced in the annual meeting.

I commend PRI for its governance of Nadcap. The institution of eQuaLearn is also a step forward as you can enroll in courses, sponsored by PRI, with content that is reviewed by PRI staff engineers; I can’t think of anything further PRI could have done to help suppliers navigate the gauntlet.

REFERENCE

ABOUT THE AUTHOR
Jason Schulze is the director of technical services at Conrad Kacsik Instrument Systems, Inc. As a metallurgical engineer with 20-plus years in aerospace, he assists potential and existing Nadcap suppliers in conformance as well as metallurgical consulting. He is contracted by eQuaLearn to teach multiple PRI courses, including pyrometry, RCCA, and Checklists Review for heat treat. Contact him at jschulze@kacsik.com.
THE ADVANTAGES OF AN ALL-METAL VACUUM FURNACE HOT ZONE
An all-metal hot zone is necessary for processing certain materials that require a super-clean, non-contaminating environment.

By WILLIAM R. JONES and REAL J. FRADETTE

For more than 70 years, the vacuum furnace has been available for metal processing requirements, and is widely accepted as the ideal equipment for solving all types of critical metallurgical requirements in the industry, and for producing clean and non-reacted work.

The “Hot Zone,” or furnace internal, on vacuum furnaces has evolved throughout the years, from an all-metal shielded design to insulated, employing various forms of thermal insulation. Both types of hot zones — the all-metal and the insulated — have their acceptable use based on final vacuum and thermal requirements. Though most modern furnaces in operation today use some type of graphite insulated hot zone, the all-metal hot zone is still necessary for processing certain materials which require a super-clean, non-contaminating environment. In this article, we will highlight some of the essential design requirements needed to provide the proper all-metal furnace for these critical applications.

ALL-METAL VS. INSULATED FURNACES
Figure 1 illustrates the variance in use of this type of vacuum furnace hot zone over the past 60 years. Initially, more than 80 percent of the furnaces incorporated an all-metal hot zone. However, toward the middle of the 1980s, that number was reduced significantly, with both types of hot zones (insulated vs. all-metal) earning approximately 50 percent of the processing industry.

By 2005, the insulated hot zone surpassed the all-metal hot zone in industry usage, peaking at approximately 87 percent insulated, compared to 13 percent all-metal. Since then, however, the all-metal furnace has made a comeback, thanks in part to new critically clean application requirements. It now represents just over 20 percent of new furnace installations.

THE MODERN INSULATED FURNACE HOT ZONE
A typical modern graphite insulated hot zone, as shown in Figure 2 consists of:

a) A graphite foil hot face.

b) Layers of PAN or rayon graphite felt insulation — 2” to 2.5” for 2,400°F applications.

Note: Our studies indicate that rayon felt is cleaner and less moisture-absorbing than PAN felt, providing better vacuum and producing cleaner work. The early use of carbon felt in graphite-type insulation is no longer acceptable, due to its tendency to rapidly absorb air during furnace loading and unloading.

c) A stainless-steel supporting ring structure.

d) Curved graphite heating elements.

Typical operating performance of graphite insulated hot zone, as seen in Figure 3:

a) Slower vacuum pump down than all-metal hot zone, due to higher surface area of felt insulation and air entrainment

b) Normal ultimate vacuum — low 10⁻⁵ Torr range

c) Any retained water from felt insulation could result in forma-

tion of CO and CO₂ which could affect some workload properties.

d) Acceptable for most vacuum processing applications.

THE MODERN ALL-METAL HOT ZONE
The typical all-metal hot zone for 2,400°F operations, (Figure 4), includes:

a) Metallic shields – three molybdenum inner shields backed by
The typical operating performance for an all-metal hot zone, shown in Figure 5:

- **a)** Faster and deeper vacuum performance due to much lower surface area of all-metal shields versus graphite insulation.
- **b)** Ultimate Vacuum – Low $10^{-6}$ Torr range or better.
- **c)** Reduced water retention results in minimal formation and contamination of carbon gasses.
- **d)** Produces clean, non-reacted work.

### OTHER FEATURES INCLUDED IN THE ALL-METAL FURNACE FOR HIGH PURITY PROCESSING

The modern vacuum furnace incorporates a gas cooling system to rapidly cool the workload for metallurgical requirements, and to return the load to room temperature for unloading. This cooling system can be either internally attached at the rear of the furnace (Figure 6), or in a separate housing outside of the chamber (Figure 7). The following explains why the external system provides for cleaner performance.

### AN EXTERNAL GAS COOLING SYSTEM WITH ISOLATION VALVES

The external gas cooling system with isolation valves provides for isolating the cooling gas blower motor/heat exchanger assembly during the vacuum pumping and heating portions of the cycle. This provides for better and deeper vacuum, resulting in an overall cleaner cycle needed for critical workloads.

### LOCATION OF ISOLATION VALVES

The isolation valves are located on the cooling gas exit piping and the gas inlet piping. During initial pump-down, valves are open, then closed with blower housing kept under vacuum with a separate holding pump. This design reduces overall pumping surface areas for faster and deeper vacuum performance. Backfill gas introduced simultaneously to blower housing and furnace chamber at cooling initiation to balance pressure prior to opening valves.

### PUMP DOWN COMPARISON WITH AND WITHOUT COOLING SYSTEM ISOLATION VALVES

The next curve (Figure 8) shows the relative pump-down performance of a furnace with and without the gas cooling isolation valves. As is illustrated, the pump-down speed of the furnace is at least 30 percent faster when the isolation valves are included on the system.
Additionally, we are able to achieve a deeper vacuum level.

**COMPARING RESIDUAL GAS TRENDS OF TWO DIFFERENT HOT ZONES**

Laboratory studies were conducted to establish the relative residual gasses of the all-metal versus the insulated hot zones at different vacuums and temperatures. The results, illustrated in Figures 9 and 10, were as follows.

Analyzing the above we can state:

1) Water vapor is the dominant gas remaining at ambient temperature.
2) Approximately 20 percent less water vapor in all-metal design.
3) Above 1,500°F, carbon monoxide begins to exceed water as dominate gas.
4) Approximately 50 percent less carbon monoxide for all-metal versus graphite insulated.
5) All-metal furnaces have inherently lower vacuum levels.
6) Both hot zones capable of producing contaminate-free work with proper techniques, including:
   a) Initial clean work.
   b) Low furnace leak rate.
   c) Initial pump down level.
   d) Pre-cycle bake-outs.

**PURER PROCESSING – DEDICATED CLIMATE CONTROLLED ROOM**

Another aspect of keeping the product as clean as possible is to isolate the front-loading part of the furnace from the pumping system and cooling components. Figure 11 shows one of our dedicated humidity and temperature-controlled rooms.

**MATERIALS, COMPONENTS, AND INDUSTRIES REQUIRING THE ALL-METAL FURNACE**

Based on our many years of vacuum furnace processing, we can state the following:

Critical materials that must be processed in the all-metal hot zone:

a) Reactive metal parts with any finished machine surfaces, especially those to be welded after heat treatment. This includes all types...
b) Medical implant parts of any material with surfaces that may not be machined after heat treatment.

Other materials which should be processed in the all-metal hot zone:

a) Semi-finished reactive metal parts having cosmetic requirements.

b) Medical implement parts (surgical and diagnostic tools) requiring good cosmetic appearance. Materials include 15-5, 17-4, 17-7PH SS, Carpenter 304, 420, 440, 455, 465, etc.

c) Anything to be metallically boxed or wrapped in order to remain bright in a graphite hot zone.

ELIMINATES WRAPPING REQUIRED IN INSULATED FURNACES

In order to maintain a pristine product in an insulated furnace, very often the entire tray of components must be wrapped in thin stainless-steel sheet to protect the load from possible contamination. This not only adds additional processing cost but can be dangerous to the person wrapping, due to the very sharp corners of the sheet when folded. The all-metal hot zone furnace eliminates this type of wrapping (Figure 12).

SUMMATION

The all-metal shielded furnace undeniably has an important place in the vacuum processing world. Providing the purest environment available, it produces a pristine end product to meet the most critical applications.

ABOUT THE AUTHOR

TWICE THE HEAT

With the January issue, Thermal Processing is now monthly. That’s 12 issues each year.

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Cryo treating can be used for coated as well as uncoated tools.
(Courtesy: CryoPlus, Inc.)
ost companies are looking for a secret that can help them keep a step ahead of the competition — a little edge to run faster, cheaper, and more efficiently than the competitor. That secret is cryogenics.

Cryogenic processing — the deep chilling of tool steel so that the molecular of the metal is brought to “cryogenic stillness” in order to improve wear characteristics — is not a new technology. In the past, toolmakers would bury components in snow banks for weeks or even months to improve their wear resistance. Castings were always left outside in the cold for months or years to age and stabilize. Swiss watchmakers noticed that extreme cold changed the properties of their metal clock parts for the better. They would store them in cold caves and let them freeze during the winter.

DEVELOPED BY NASA
The process was originally developed by NASA. The cryogenic treatments involve cooling temperatures of minus-300°F using liquid nitrogen, replacing dry ice and mechanical refrigeration treatments. Today’s dry process is computer controlled, using a prescribed schedule and maintained at minus-300°F for a particular time before slowly returning the parts to room temperature. The dry process means the material is not exposed to any cryogenic liquids, eliminating the risk of thermal shock. A microprocessor is programmed according to size, weight, and configuration of the parts being treated. It controls the flow of the liquid nitrogen into the dispersal system where the liquid is dispersed as a gas, and the boil off vapor is spread throughout the chamber.

Prior to the deep cryogenic step, many tool steels require a pre-conditioning step consisting of a short temper. Once the temperature reaches minus-305°F the cryogenic process enters the “soak phase,” which maintains this temperature for a period to allow for transformation on a molecular level. After being subjected to the deep freeze, the materials must be tempered to about 300°F to retemper the newly formed martensite. This temperature varies for different materials, and the processing time varies for different material cross sections.

CryoPlus uses a controlled dry thermal treatment, designed to more efficiently transfer cold from the liquid nitrogen to the metal parts being treated.

WHY CRYO TREAT?
The purpose of cryogenic treatment is to transform retained austenite and raise the tensile strength of the as-quenched structure. In addition, better dimensional stability is often achieved. This is especially important for progressive dies, where cumulative tolerances are critical. Subzero treatments have as their ultimate goal an increase in wear resistance, improved bending fatigue life, and minimizing residual stress. Stress is the enemy of steel, if it’s not imparted in a uniform manner. Stress boundary areas are susceptible to micro cracking which leads to fatigue and eventual failure. Residual stresses exist in parts from the original steel forming or forging operations and additional as a result of the many different machining operations to finish the part. They create a complex invisible random pattern in the steel.

Residual stresses are uneven and located variously throughout the structure. Austenite (a soft form of iron) is a solid solution of carbon and iron that is formed during the quenching phase of metal production. Austenite is weak and undesirable because it contains few molecular interfaces to help hold the metal together. When metal is cryogenically treated, the austenite structure is transformed slowly into a highly organized grain structure called martensite, a body centered tetragonal crystal structure. Martensite is a finer and harder material that brings high wear resistance that is very desirable in carbon steels. There may be as much as 40 percent residual austenite in heat-treat ferrous metals. That percentage can be lowered to as little as 1 percent in some cases.

MARTENSITE FORMATION
Martensite is also formed during the quenching phase. There is always a certain amount of martensite present, but prior to cryo, the ratio of strong martensite to weak austenite is less than favorable. This untransformed austenite is brittle and lacks dimensional stability, which allows the metal to break more easily under loads. To eliminate austenite, the quenching temperature has to be lowered. At very low temperatures, austenite is unstable and readily becomes martensite. The result is a much-improved part or tool with no cracking, warping or any other cryogenically imposed defect. Improvement in durability is about 100 percent. The typical increase in strength is 30-50 percent. Another advantage of cryo is the increase in efficiency to dissipate heat. Gears, engines, transmissions and disc brakes run cooler.

Cryogenic processing at minus-300°F can improve performance and increase the life of metal cutting tools, blades, punches, dies, slitters, shears, and knives. Cryo processing increases abrasive wear resistance, raises the tensile strength, and decreases brittleness with only one permanent treatment. There is no advantage to having an item treated more than once. It’s not something you can grind off. Subsequent refinishing or regrinding operations don’t
Cryogenic treatment changes the entire structure, not just the surface. The only way to reverse the cryo treatment is if you took the tool back up to a critical temperature, such as heat treating. It creates a denser molecular structure and closes the grains structure, resulting in a larger contact surface area that reduces friction, heat, and wear. The net result for the customer is lower manufacturing costs and superior product performance.

HSS cutting tools and dies are among the most frequently recommended applications for cryogenic treatment. This includes, drills, taps, endmills, reamers, broaches, circular saws, chipper knives, router bits, and molder knives.

DEEP VS. SHALLOW TREATMENT
The difference between deep and shallow cryogenic treatment should be considered. Taking a part to minus-120° F for a short period of time is called shallow cryogenics. This method does not transform all of the retained austenite to martensite and does not stress relieve. Deep cryogenics takes the parts to minus-300° F for many hours as LN2 is pumped into a well-insulated chamber at precise time intervals. Beware of those processors who are dipping and dunking parts into a barrel of liquid nitrogen. This will cause stress and fracturing to the part. It must be done gradually and precisely so the metal will be stronger and will not become brittle.

There are many theories as to why cryogenic treatment is effective; actual measurements of results have remained relatively difficult to obtain. Treated tools or parts show no visible change in color, size, or any other property that can be visually detected. A normal metallograph shows no changes nor do common tests like eddy current or ultrasonics. The benefits of the treatment can be supported by numerous examples, but there aren’t precise measurements that can prove the effectiveness. Most companies are not willing or able to undertake such testing to quantitatively measure such results. Companies keep their processing techniques a secret to maintain a competitive advantage. This is slowly beginning to change, but the industry as a whole is still reluctant to utilize the process.

Gage blocks, which are used as a length reference for precision measuring devices, are treated to stabilize their dimensions over time. They’re made of corrosion resistant steel alloys to prevent growth.

UNDERSTANDING THE TECH
Today’s limited acceptance and use of cryogenic treatment is basically attributed to a lack of understanding the technology. Changes to the material micro structure are not visible with a standard metallograph showing no changes or do common tests like eddy current or ultrasonics. There are many theories as to why cryogenic treatment is effective; actual measurements of results have remained relatively difficult to obtain. Treated tools or parts show no visible change in color, size, or any other property that can be visually detected. A normal metallograph shows no changes nor do common tests like eddy current or ultrasonics. The benefits of the treatment can be supported by numerous examples, but there aren’t precise measurements that can prove the effectiveness. Most companies are not willing or able to undertake such testing to quantitatively measure such results. Companies keep their processing techniques a secret to maintain a competitive advantage. This is slowly beginning to change, but the industry as a whole is still reluctant to utilize the process.

Gage blocks, which are used as a length reference for precision measuring devices, are treated to stabilize their dimensions over time. They’re made of corrosion resistant steel alloys to prevent growth.

When the cryo-treated tool does wear, the degree of wear reportedly is less severe, slower, and more uniform. Therefore, less material must be removed to re-sharpen it. Customers have reported a material removal rate of less than half the normal material removed in re-sharpening. Cryo treating reduces the cost of the product by having longer tool life, less scrap, fewer rejections and above all, less costly downtime. Gains between 50 and 500 percent may occur, depending on the component structure and previous heat-treating.

Every application is unique, and the benefits for each one are application specific. There is no blanket prediction that can be made or previous results used to guarantee the same results for every operation. Each one has to be tested.

Cryogenics is not a substitute for heat treating; instead, it simply adds the finishing touch to the heat-treating process. It completes the austenite-to-martensite conversion in tool steel.

Durability is the most important criterion used to define the quality of a gear. Cryogenic treatment will provide high quality products with superior performance. It allows an increase in fatigue life, load capacity and wear resistance of gears without an increase in weight or major modifications to component design. Racing teams will reduce costs and often prevent destructive failure. The process is not a coating, but a permanent irreversible change completely through the metal part. Gears may be new or used, sharp or dull, re-sharpening will not destroy the treatment. Potentially every gear that is heat treated is a candidate for the additional service of cryogenic treatment.

UNIFORM GRAIN STRUCTURE
Another benefit of cryo treating is its ability to make the grain structure more uniform, which ultimately improves dissipation of heat beneficial to the racing industry.

Cryo treating can be used for coated as well as uncoated tools. The coatings actually adhere better. Anodized surfaces or metals, such as aluminum, also obtain longer life. Cryo also creates a better conductor giving the metal better electrical conductivity.

One of the strangest aspects of cryogenic treatment is the thin layer about 0.0001” thick- on the outside of the tool that remains untreated. After this layer is removed by sharpening, the tools will get the added wear resistance.

It looks as if cryogenics finally will be getting the attention, in terms of metallurgical research that many of its proponents have been seeking. Cryogenics is an exciting and important frontier that has already led to major discoveries and holds much promise for the future. Deep cryogenic processing is now inexpensive and very cost effective due to recent developments, new cryo processors and computers.

A wide array of items such as racing engines, guns, knives, aluminum softball bats, punches, dies, golf club heads, high end audio equipment, brass instruments, guitar strings, vacuum tubes, CDs, and DVDs all benefit from the cryogenic treatment. New applications are being discovered regularly.

Until more companies commit themselves to taking, recording and making available exact results of cryogenic treatment, the industry as a whole is likely to remain somewhat reserved in its use of the process. Due to the efforts of the Cryogenic Society of America, misperceptions are slowly giving way to the cryogenic technology because of the scientific data and documented case studies. If you’re looking for a cryogenic provider, their web page would be an excellent place to start. www.cryogenicsociety.org.

ABOUT THE AUTHOR
Kathi Bond is founder of CryoPlus, Inc., which is based in Wooster, Ohio. She is a member of ASM International, as well as the National Association of Women Business owners and the Association of Women in the Metal Industries. Learn more at www.cryoplus.com.

Cryo treating reduces the cost of the product by having longer tool life, less scrap, fewer rejections and above all, less costly downtime.
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COMPANY PROFILE ///
SUPER SYSTEMS INCORPORATED

APPLYING ADVANCED TECHNOLOGY TO THE MANUFACTURING PROCESS

An SSi customer does a furnace uniformity survey using the SSi SDS 8020 survey box.
(Courtesy: Super Systems)
Since it opened its doors in 1995, Super Systems Incorporated has worked to make heat treaters more efficient using today’s technology.

By KENNETH CARTER, Thermal Processing editor

It might be a cliché, but the path to a successful business can often be summed up in six words: Be good at what you know.

For Super Systems Incorporated, that expertise is evident in how it has become a prime player in thermal processing. “With our specific focus on the heat-treat industry only, it allows us a great deal of strength and expertise in that area for the technology we provide,” said Stephen Thompson, president of Super Systems.

By focusing only on the thermal processing market, which includes heat treat, atmosphere, vacuum, nitriding, and ferritic nitrocarburizing, Super Systems is able to offer its customers consistent quality products and services, according to Thompson.

Super Systems Inc. (SSI) was established in 1995 as a supplier to the thermal processing industry with a focus on sensor and control technology for protective atmospheres. The company was founded by Bill Thompson, who has a long history of servicing the heat-treating industry. Today, under the direction of Stephen Thompson, SSI provides a wide variety of products and services for the industry worldwide.

“Something unique to us is we only sell to the heat-treat market, and with this focus, we provide more solutions to the same customers, building our relationships, which are key in the growth of our company.” Thompson said. “It’s not just one sale; it’s a beginning of a long-term relationship.”

SSI’s philosophy for innovation and customer service is simple: They listen. According to Thompson, whether they are serving a customer who needs technology to maximize efficiency and deliver the highest quality services, or investing back into their Research & Development (R&D) team and challenging them to deliver innovative technology to the heat-treating industry, customer focus and innovation have always set them apart.

“Many of our customers believe our products have provided them with a foundation for intelligent heat treating, gaining and maintaining the competitive edge they need,” he said.

ISO9000 ACCREDITATION

“We are focused on our quality systems, which has allowed us structured growth in the organization,” Thompson said. “We use the quality standards to provide a foundation for continuous improvement in all areas of our business.”

SSI’s products include probes, controllers, software, analyzers, gas flow meters, and installation and engineering services covering all facets of heat treating. Super Systems is ISO 9001:2015 certified and ISO/IEC 17025 certified for the calibration of dew point, infrared analyzers, and temperature instrumentation. SSI participates in many industry forums as well, such as ASM Heat Treating Society, AMEC and Nadcap, and the company is a proud member of the Metal Treating Institute and IHEA, according to Thompson.

TECHNOLOGY AND SOFTWARE

“As a technology company, we develop software for multiple applications focusing on productivity, repeatability, and quality. Almost all of our products are complemented with software providing ease of use and accessibility,” Thompson said. “From configuration tools, backup utilities, mobile applications, and complete SCADA system, our software provides tools to enable heat treaters to do their jobs better and more efficiently.”

Data provides access to many key performance indicators that can be critical to the shop floor operating efficiently, according to Thompson.

“A heat-treat shop or department can easily capture 1 million data points in a day, and that data can be used to show compliance and, better yet, provide valuable information looking forward,” he said. “Both maintenance and operations can really see how to create efficiencies, predict compliance, and anticipate downtime with predictive maintenance.”

“Something unique to us is we only sell to the heat-treat market, and with this focus, we provide more solutions to the same customers, building our relationships, which are key in the growth of our company.”

Having the ability to see the operational efficiency of the equipment and staff helps in making better decisions on capital investments, training, and maintenance, according to Thompson.

SSI develops hardware with methodical process and procedures. It focuses on a good user experience, producing a technically sound product that addresses a specific need in the industry.

“Our instrumentation and controllers are built around addressing a customer need,” Thompson said. “This could be addressing an industry standard, a unique application that involves algorithms not readily available from other products, and most importantly, something that customers find valuable.”

CUSTOMER SATISFACTION

But you can’t have great products without treating customers right from the get go.

“We have established a worldwide footprint that gives us an opportunity to support heat treaters around the globe,” Thompson said. “Our team takes a lot of pride in helping heat treaters with everyday problems. Sometimes those problems are future investments in technology to address controls or SCADA, and sometimes those questions are customers looking for support on metallurgical results they have been getting. We have a team to address the customer needs.”
With thousands of furnaces and ovens using SSi products, it is important to have a sound process in place for getting resolution, according to Thompson. SSi has a support system in place that tracks incoming support calls with an escalation process to address potentially critical issues.

“Our engineering team has a methodical approach to ensuring our systems are supportable by all our staff,” he said. “With updated electrical drawings, well documented code with strict standards, we can easily support our install base both onsite and remotely.”

The end goal is the ability to provide the necessary support a customer needs.

In addition to Super Systems’ global footprint, Thompson is quick to point out the company’s excellent worker retention.

“We are proud of our team and the years of service accumulated,” he said.

THE FUTURE OF SUPER SYSTEMS

From a glance at the past to an eye on the future, as Super Systems enters the next phase of what’s cooking in the heat-treat industry, Thompson has a few prognostications as he looks into his crystal ball.

“Future demands for us will remain the same, innovating products to meet and exceed our customers’ expectations,” he said. “Automation, big data, and tighter heat-treat tolerances are all areas that we will integrate into our products. With a market place that will see changes in our future, we will continue to lead the technology trends in industry and plan on continue to work with commercial and captive heat treaters worldwide in delivering quality heat-treated products.”

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Tell us about your company.
The company was established in 1984 near Milan, Italy, in the city of Caravaggio, and since its inception the headquarters and plant have grown year over year. Flexibility, technology, and quality: These core values have been driving the company since 1984, making our company one of the most important players in the market of vacuum furnace engineering and manufacturing. Through the established trust obtained from small- and large-sized companies on the international scene, coupled with our core values, the company continues to gain market share.

This result has been achieved through our president, Giuseppe Tonini’s tenacity and entrepreneurship, the company’s high-engineering specialization, innovative design, and a customized production focused on the client’s needs and high quality.

What strengths does your company have?
Thanks to the company’s wide know-how in vacuum engineering, we provide our customers with a team of professionals who can manage and solve all issues, ranging from design to manufacturing, project management, installation, consultative technical support, training, and technical service. The R&D department in TAV Vacuum Furnaces is constantly working to ensure a tailor-made product according to customer needs, with regard toward innovative technologies.

Each furnace is designed according to specifications and meets the strictest criteria and procedures to ensure compliance with the most stringent international industry specifications.

What product and services does your company offer?
We design and manufacture customized advanced vacuum furnaces in a wide range of geometries and dimensions that are used in the heat treatment of steels, alloys, superalloys, advanced ceramic materials in hardening, tempering, solubilization, annealing, brazing, and sintering operations.

We support these processes mainly in the following fields: production of heat exchangers, aviation/aerospace, automotive, IGT (industrial gas turbine) industry, heat treatment of additive manufactured parts, commercial heat treatment, component sintering industry (medical, precision mechanics, optics,) and R&D laboratories.

We produce cart door horizontal vacuum furnaces for applications that require higher repeatability and reproducibility of the results. It is the cost-effective solution for large, dense loads, perfectly suitable to move massive loads up to 10,000-plus pounds with maximum safety.

The hinged-door horizontal vacuum furnace is the best solution to meet heat-treating needs in the various fields of vacuum application. Whatever speed, compactness, precision, and reliability are required, this vacuum furnace solution provides customers with the most suitable answer in terms of automation and operational flexibility. The constant deep-rooted dedication to innovation has driven TAV Vacuum Furnaces to work out solutions meeting all customer needs, becoming one of the few vacuum furnace suppliers to manufacture vertical furnaces for vacuum heat treatment, vacuum brazing, advanced ceramics, and UHV (Ultra High Vacuum) applications.

We also offer a highly qualified after-sales service that includes customer staff training, maintenance programs, remote troubleshooting with state-of-the-art computer analysis techniques, and consumables/spare parts supply. Since 2015, in order to enhance our relationship with the North America market, we established Furnacare Inc. in Spartanburg, South Carolina.

How did you get involved in Furnacare?
After a long experience in TAV Vacuum Furnaces, I joined Furnacare, becoming its president.

As Furnacare here in North America, we continue to grow our engineering, technical, and commercial staff, working to communicate to the market the high quality of the TAV Vacuum Furnaces coupled with the ability to reduce the customers cost and maximize efficiencies through delivering proven premium quality manufactured solutions that are durable, customized, and technologically advanced to carry our customers forward.

We take care of the maintenance throughout the entire lifecycle of the furnaces. Our aim is to facilitate the work of your engineers, operators, and maintenance team to have your furnaces always operative in the production process with top performance.

Our core service competencies include hot-zone refurbishment and replacement, repairs, spare parts, upgrades, TUS, SAT, calibrations, leak detection, preventive maintenance programs, new vacuum furnaces installations, and new vacuum furnaces sales.

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