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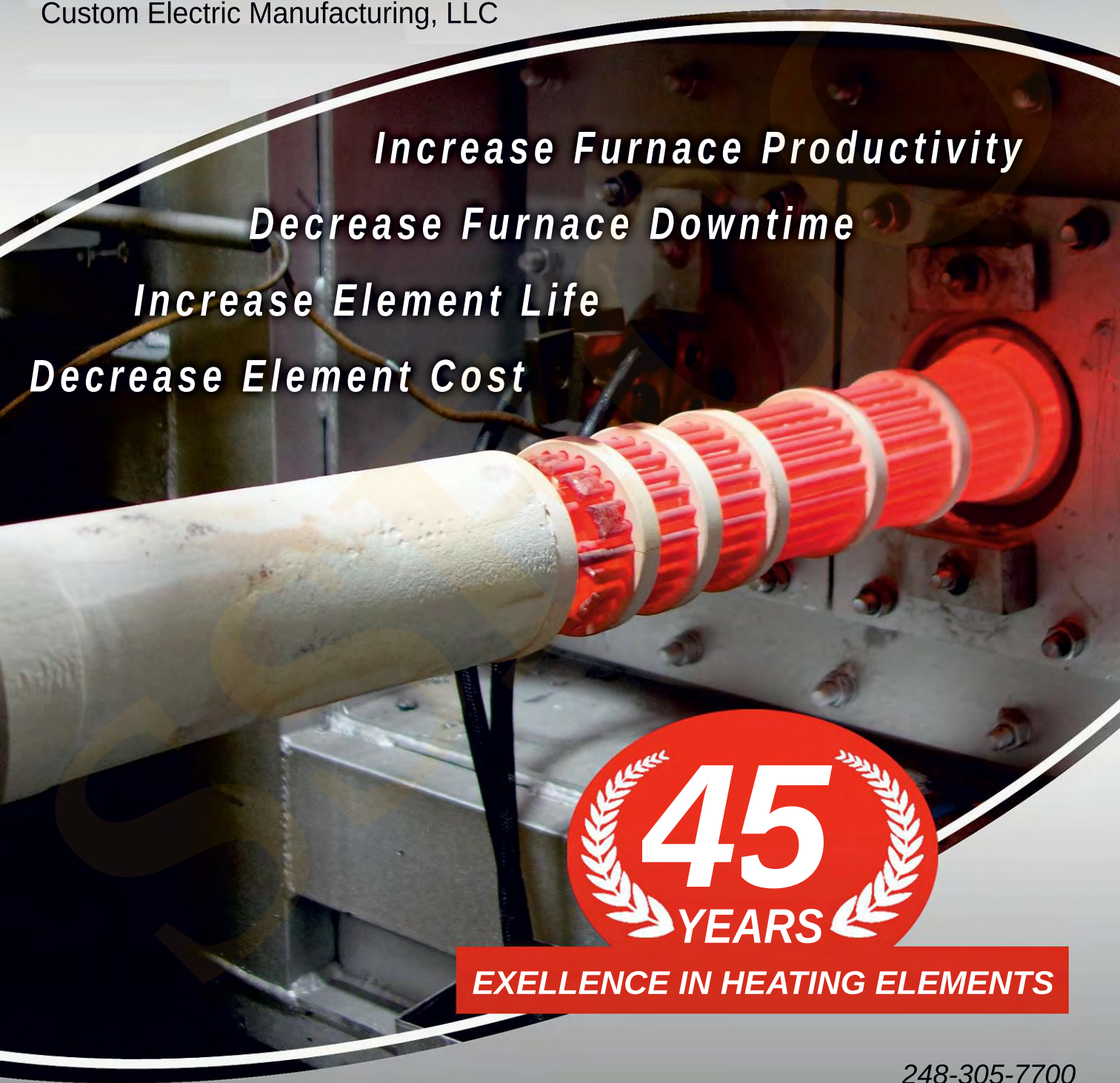

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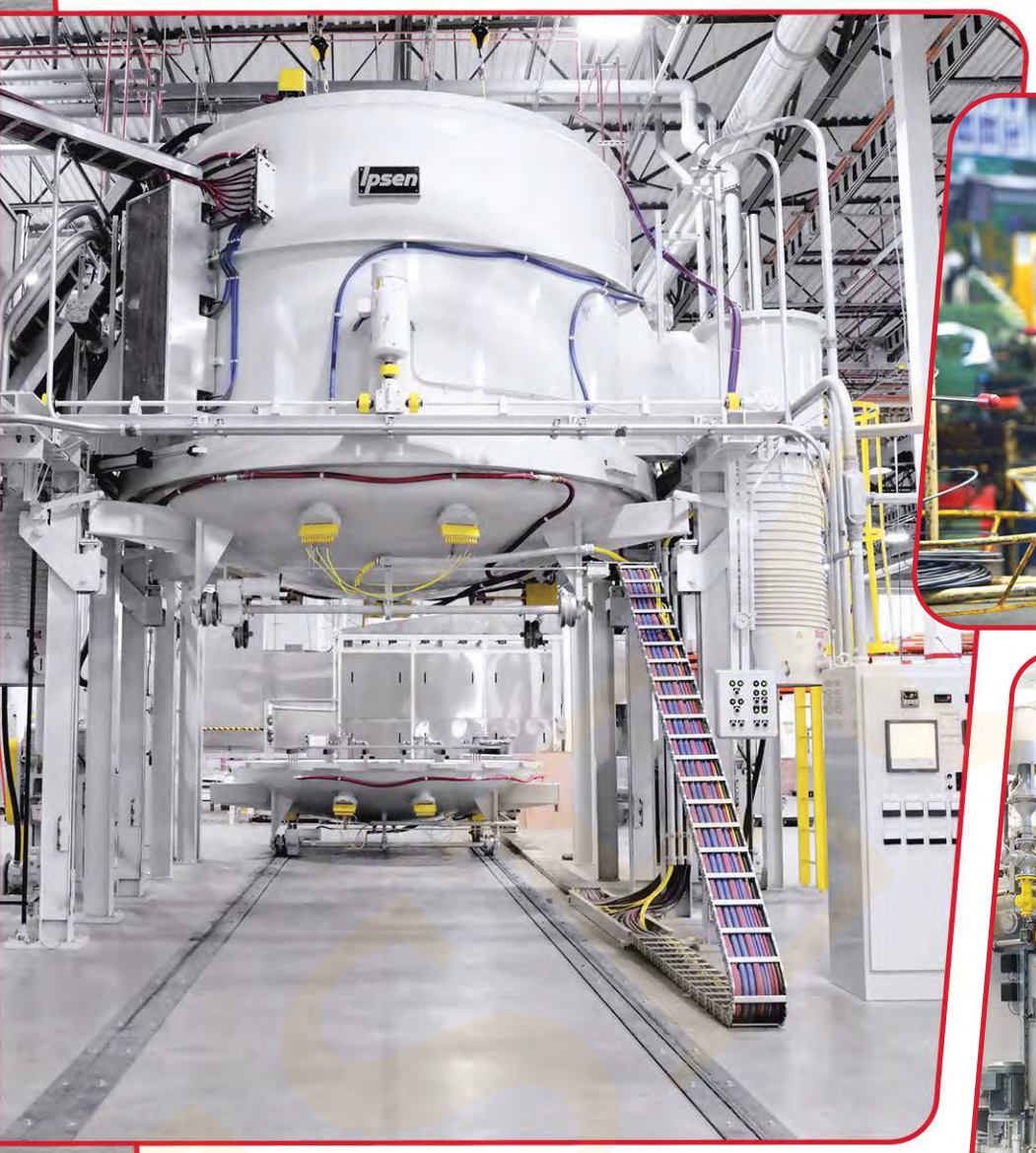

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Our Technology Future

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This issue begins a new year, and it brings us a little closer to technologies in our future. As we have previously mentioned, it is impossible for us or anyone to know how artificial intelligence (AI) and the Industrial Internet of Things (IIoT) developments will affect our businesses in the future.

I'm reminded of a projection made by then-Postmaster General Arthur Summerfield in 1959 (no, I did not personally hear him say it). Anyway, he predicted the future of mail delivery being guided missile systems, the new tech of the day. Never did they anticipate electronic delivery in spite of the computer developments taking place at the time.

As promised in 2017, "We will continue to report on these technologies though our magazine, e-newsletters, social media and website. In some cases, we will report impact, but sometimes you will need to decide how the technology impacts your business. We are your media partner to help keep you in the know."

We realize that many of our readers are too busy doing their jobs to try to figure out how to do them better. To that end, we encourage you to read some of the high-tech articles and editorials presented in the past year. You can check these out by going to www.industrialheating.com and looking through our archives. Here are a few.

- In January, our editorial presented a discussion of disruptive but necessary technology, and Tom Morrison's column discussed the growth potential afforded by technology in the coming decades.
- In March, we featured an article discussing an innovative heat treatment for material weight reduction. In our editorial, we also discussed the need for more industry-university collaborations, and The Heat Treat Doctor continued his two-part column on simulation software.
- In April, one of our articles discussed an advanced carburizing technology, and we took a look at how additive manufacturing (3D printing) is reshaping the auto industry in May.
- Throughout 2018, our column "Academic Pulse," contributed by Carnegie Mellon University, offered some cutting-edge material inspection discussions. These included May's column, "A 3-D View of Modern Engineering Materials."
- An article in the August issue discussed smarter furnaces and instrument IoT.
- In September, two articles and our editorial added to our knowledge of AM/3D printing, which is certainly technology in action in our materials world.
- Reader-favorite AM/3D-printing articles were highlighted in October, and The Heat Treat Doctor discussed AM as the next industrial revolution in November.

While perusing our website for these resources, don't forget to have a look at posted videos, podcasts and webinars currently on-demand. Our news tab will keep you in touch with the latest industry-related happenings on a daily basis. We understand that consuming information looks different for different people.

In 2019, we will continue to bring you articles and editorial that help you to know which direction technology is moving and driving the industry with it. In this issue, be sure to check out a new column we call Next-Gen Leaders. Each month we will provide contributions from our industry's younger generation to see the future through their eyes. Once again, Tom Morrison takes a looks at 2020 and beyond to help us gain some future perspective. Don't miss The Heat Treat Doctor's expanded column, which takes a look at the future of the heat-treat industry.

Academic Pulse continues in 2019 with a new contributing professor. This is the third year of this quarterly column, which gives us a view into some of the cutting-edge technology available to us. Be sure to watch for Dr. Bryan Webler's first column next month. He will discuss advancements in additive manufacturing.

As this decade of the teens is drawing to a close, technology will continue to develop in 2020 and beyond. We will be here to talk about it. Stay tuned!

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Lean on Congress

BARRY ASHBY
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The Articles of Confederation was the first definition of our national government. Finalized in 1777, it was not until 1781 that all 13 states ratified the document. After independence from England in 1783, the constitutional convention in 1787 set the stage for our new American government, and the Articles became effective on March 4, 1789.

Correcting the Articles' various faults was an objective of the Constitution, which has been amended 27 times, but it began with the first 10, known as the Bill of Rights. These were survivors of 19 original changes proposed, which passed and became the law of the land in early 1790. Provisions of the Constitution are on our doorstep this month as the 116th Congress convened Jan. 3 for a two-year term.

True genius of the nation's founders was creation of an Electoral College, which assures citizens of nationwide equity in Legislative and Executive branch representation. This is defined in the 12th Amendment to the Constitution and became law in 1804.

Readers may not know the following facts, which demonstrate the imbalances that are avoided because of this addition. As a modern example, there are 3,141 counties in our 50 states – Trump won 3,084 of them in the last election and Clinton won 57. In the five counties that encompass New York City, Clinton won four. The vote in these four counties accounted for three-quarters of Clinton's popular-vote win nationwide. These five counties comprise 319 square miles, while the U.S. is composed of 3,797,000 square miles.

This is important to know and remember about Presidential elections. However, citizen's concerns in the last several years of Congressional meetings have centered on abysmal failures in accomplishments for benefit of the citizenry. Regardless of political persuasions, Congress has shown repeated instances of failure to perform. This situation must change before calamity strikes.

Congress is not popular with the public, and its stature is rapidly declining. For example, tax bills have been poorly drafted and filled with loopholes and errors. Congress is unwilling to tackle matters like federal debt or the many ethics and legal charges against incumbent members.

It is distressing that the voting public returns so many of these corrupt and inept members to Congress without knowing how bad things really are. Know also that solutions to most national problems resolvable by law are the province of Congress and not the Executive branch (the President).

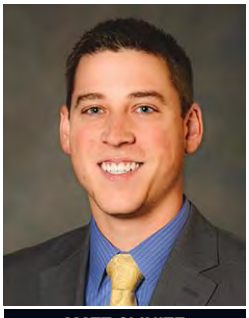
A consolidation of various outlooks made by economic forecasters is provided here. Congressional action/inaction is a key uncertainty factor in these forecasts. It is likely (55% probability) that consumer spending will continue to grow through 2019. Stimulus from the tax bill pushed growth in 2018, but it might be offset in 2019 due to tariff impacts and foreign responses to trade-policy changes. Since the economy is near full employment (of available, qualified employees), GDP growth will tend to increase inflationary pressures. The Federal Reserve interest-rate policy may have some effects this year, but the economy in general will benefit from trade-policy changes and lower regulatory costs.

There is a 25% probability that the beginnings of a recession will begin to weaken the economy by late 2018 and into 2019. Most economists predict that GDP will begin to fall by the second half of 2020. Slower growth this and next year (10% probability) is thought to prevail because business tax cuts are not the major driver for investment spending.

Regardless, advances in manufacturing technology will continue to lower U.S. corporate costs, allowing economic growth of over 3% through 2019. It will stay above 2% over the 2020-2023 timeframe while inflation stays subdued. Business interests in some sectors, mostly not in this readership base, may be affected by immigration reform, but know that illegal immigrants in the labor force are but 5% of the total workforce with the bulk employed in agriculture (17%) and construction (13%).

All things considered, it is a good outlook that could be substantially improved if Congress made meaningful and needed legal changes to benefit the nation's industry and public safety.

Implementation, Uses and Optimization of a CRM



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Customer Relationship Management software, or CRM as it is more commonly known, has traditionally been recognized as a sales tool. Salesforce.com tells us, "A Customer Relationship Management (CRM) system helps manage customer data. It supports sales management, delivers actionable insights, integrates with social media and facilitates team communication. Cloud-based CRM systems offer complete mobility and access to an ecosystem of bespoke apps."

In recent years, CRM software, like Salesforce, has morphed into a companywide tool integrating with departments such as finance, field service, customer service and aftermarket sales, among others. Let us take a top-level look at the basic features of a CRM and the specific ways this tool can improve your organization.

The most basic advantage to implementing a CRM is better connectivity between your sales staff and management. CRM tools allow sales staff to report customer interactions. These may be in the form of calls, e-mails or meetings. These documented communications are easily viewed by management, allowing them to better connect with the "boots on the ground."

A core feature when implementing a CRM into your sales department is the ability to track business opportunities. Salespersons can enter an opportunity and fill in fields such as timeline to close, probability, dollar value, primary competitors and next steps (to name a few). This opportunity can then be linked directly to an account and specific customer contact. Other items such as quotes, budgets and supporting documents can be attached to the opportunity.

Perhaps the most underutilized feature in any CRM is the ability to incorporate non-sales functions. Departments such as marketing, technical support, customer service and finance may all have a place in your CRM. Marketing might use the CRM to identify a target audience when launching certain ad campaigns. Technical support and customer service can use it to log conversations with customers or reference historical data. Finance can use opportunity information to forecast projections and track progress toward goals.

Typically, CRM systems have dashboards or home screens that can be customized. For sales staff, this page might display fields such as "year-to-date sales" or "hot opportunities." For management or finance, you could have a list of opportunities projected to close in a given quarter. Field-service departments could see information on billable versus non-billable time or track upcoming jobs. The dashboard for a technical-support hotline may have a list of unresolved or pending "cases" that need further action.

As you can see, the usefulness of the CRM tool is only limited by your own creativity. In its most basic form, a CRM is a platform that encourages and enables information sharing throughout your organization.

At Ipsen, the primary goal in using our CRM is to provide a world-class experience for our customers. We provide CRM access to over 200 users. This ensures that anyone with customer contact can become educated about a specific account, case or opportunity.

For example, a service technician is scheduled to fix a machine at a customer site, or a new salesperson is asked to stop in and introduce himself or herself. Maybe an executive is working to establish a strategic partnership with a company that has multiple locations. In any of these situations, the individual can access a plethora of account information with a click from any phone, tablet or connected device.

This allows an employee to quickly come up to speed on an account. The ability for someone in an organization to be capable of visiting a customer for the first time and be well informed is really quite powerful. Being knowledgeable about the customer builds trust, rapport and ultimately earns long-term customers.

Learn more about Matt, Ipsen and Salesforce by reading this column online at www.industrialheating.com/next-gen.

Esoteric Heat-Treatment Industry Critique: 2019 and Beyond

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Just how clear is *your* crystal ball? Over the past two years, The Doctor has had the good fortune of interacting with a large number of industrial clients and industry professionals from all over the globe. After listening, questioning and interpreting what they've had to say about the future of our industry, it's time to share this information and my vision of where we are, where we're going and how we will get there. Let's learn more.

Heat-Treatment Market: Where We Are and Where We Are Headed

The Industry

Today, the global heat-treatment industry is estimated to be in the range of $90-100 billion (Fig. 1). Four methods, each independent of one another, were used to arrive at both the total dollar value of the industry and how it is distributed geographically.

The first method involved an analysis of changes to the manufacturing portion of the gross domestic product (GDP) of countries around the world, based on data from 1995 to the present. The second method looked at the manufacture of passenger cars and commercial vehicles worldwide, while the third focused on the manufacture of commercial aircraft and more generally the fields of aeronautics and astronautics. Finally, military/defense spending was analyzed, both from the standpoint of historic and, more importantly, projected budgetary expenditures for capital projects. Also, the skill level (education) of the workforce in each country served as a check as to whether growth in the manufacturing sector was sustainable over time.

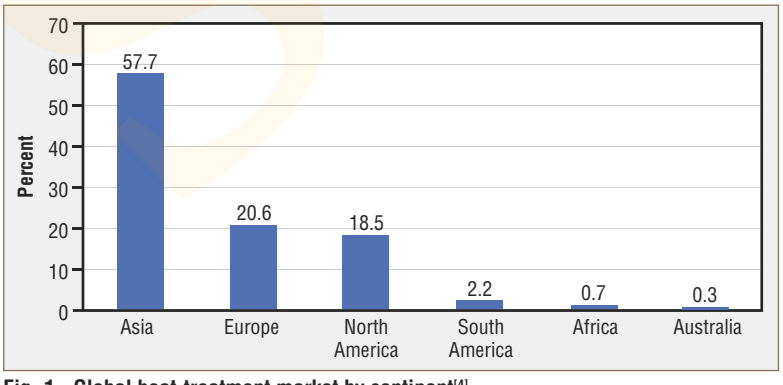

Fig. 1. Global heat-treatment market by continent[4]

Of this total, heat treatment in North America is estimated to be an $18-18.5 billion industry servicing some 17,000+ manufacturers. It should also be noted that this study differentiated and excluded that portion of the thermal-processing industry dealing with primary metal production (e.g., iron, steel, aluminum) and other material production (e.g., glass) to focus exclusively on the heat-treatment industry (i.e., processing of semi-finished goods/component parts).

Finally, the study of economic forecast models suggest that the global heat-treatment market will grow to around $130-150 billion by 2030 and to around $200-220 billion by 2040 barring a significant or sustained global economic event. This forecast anticipates several minor downturns in the economy of various countries and in manufacturing segments due to economic and geopolitical factors in the coming decades.

Heat-Treatment Market Shift

A fundamental shift in the makeup of the heat-treatment equipment segment of the North American market began in the late 1990s and early 2000s as the industry transitioned from older, long-established practices and policies to embrace the demands for technological innovation, standardization (for cost containment) and changes in manufacturing methods and methodology. This trend is not only expected to continue but accelerate (Figs. 2-3).

The demand for higher-performance products, different end-of-life expectations (in some but not all products) and emphasis on systems with single-piece flow or small-batch productivity are just a few of the factors fueling this change. Other factors such as equipment obsolescence, predictive (as opposed to preventive) maintenance and the speed at which the manufacturing landscape is changing reinforce these conclusions.

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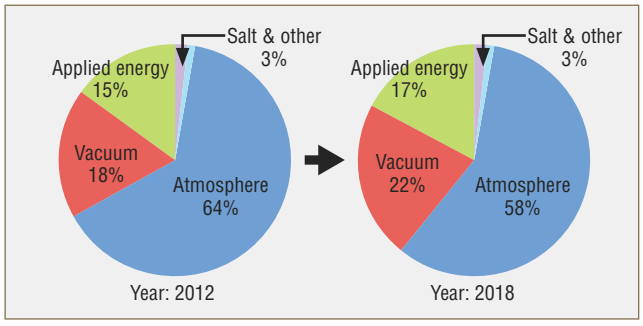


Fig. 2. North American industry by equipment segment, 2012-2018[4]

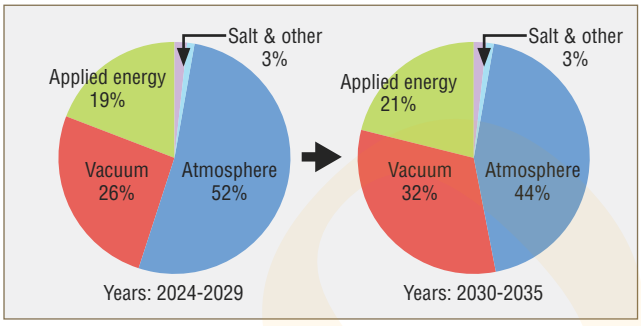


Fig. 3. North American industry by equipment segment, 2024-2035[4]

From an equipment standpoint, vacuum furnaces and applied-energy systems will continue to experience rapid growth at the expense of more traditional atmosphere furnaces. Industrial ovens used primarily in the heat treatment of metal components have been included in the percentages of each identified category. Salt-bath treatment, a specialized niche, will remain essentially unchanged.

For example, the driving force behind the development, use and integration of vacuum technology into manufacturing is not only due to the fact that it is a lean, green and agile footprint but that it best addresses the identified needs of the heat-treatment industry,[3] namely:

- Energy-efficient equipment
- Processing with minimal part distortion
- Optimization of heat-treatment processes (especially diffusion-related processes)
- Environmentally friendly by-products and emissions
- Adaptability/flexibility for new and advanced materials
- Process controls incorporating intelligent sensors
- Designs based on heat-treat modeling and simulation
- Equipment/process integration into manufacturing

Change: Its Pace and Form

A paradigm shift in the workforce coupled with the growing role of automation and communication in manufacturing is principally responsible for accelerating the pace of change in the heat-treatment industry from what has traditionally been slow-moving and slow-to-adapt to the rapid deployment of new products and innovations.

Today, equipment manufacturers and suppliers to the industry are either looking at product standardization to maximize profitability and thus drive the industry to "cookie-cutter" solutions or, in a diametrically opposite philosophy, looking to provide highly customized solutions, often with risk factors incorporated into the pricing as specialized solutions with high profit margins to application-specific needs.

Technology/Innovation Drivers and Industry Trends

Heat treatment is a core manufacturing competency. As such, decisions continue to be made to either heat treat in-house (85-90% of companies) or outsource to commercial heat-treatment shops. What is more prevalent today than ever is the tremendous pressure being exerted on manufacturing from senior management to increase product velocity and reduce unit cost.

As a result, the most significant trends in today's North American heat-treatment industry are:

- Growing the manufacturing portion (percentage) of GDP through mobility and adaptability
- Obsoleting older equipment and technologies and replacing them with innovative, new and/or high-productivity heat-treatment systems. Examples include:
  - Transition of carburizing/carbonitriding from atmosphere to low-pressure (vacuum) processes with either oil or high-pressure gas quenching or both
  - Use of single-piece heating and quenching of parts and/or small-batch (versus large-batch) processing
  - Change of design to allow more low-temperature atmosphere treatments (e.g., nitriding, nitrocarburizing)
  - Expansion of hybrid technologies (e.g., combining both vacuum and atmosphere features)
- Using advanced quenching techniques and quenching technologies
- Implementing artificial-intelligence-based modeling and simulation software capable of equipment control and process optimization
- Implementing next-generation intelligent sensors, real-time data-collection methods and analytics (including cloud-based computing)
- Changing the focus of companies from generalization toward specialization with respect to products, services, processes (proprietary or unique) and new or innovative technologies so as to capture greater market share or present greater opportunities to generate higher profit margins
- Accelerating the implementation of lean manufacturing strategies and applying these strategies to heat treatment
  - Eliminate high labor costs (via automation and controls), simplify operations (i.e., reduce the number of manufacturing steps) and adopt build-to-order strategies.
  - Conservation of energy, on-demand part production, shortening of process cycles and the move toward smaller lot sizes is the order of the day.

- Continuing the transition from heat-treatment departments to integrated manufacturing cells

Of particular note is that these forecasts do not reflect revolutionary changes (e.g., additive manufacturing) and/or global technology shifts (e.g., gasoline to electric-powered vehicles, alternative materials not requiring heat treatment). Should these occur, heat-treatment growth will level off or decline proportional to their impact, but the relative percentages (with respect to the installed equipment base) will remain proportionately the same.

Two Key Differences Between North American, Global Markets

People often wish to know why a technology or innovation introduced in one marketplace or region cannot be easily and quickly ported to another location. Two examples of fundamental philosophical differences between the North American market and other global markets are:

- Initial investment cost remains a key driver of equipment purchases in North America as compared to use of total-cost-of-ownership models, a view adopted elsewhere in the world.
- Energy efficiency and reduced emissions are viewed from the standpoint of regulatory compliance (the principal driver in the North American market) versus a desire to accomplish these goals through a more holistic approach as adopted elsewhere.

Conclusion

The heat-treatment industry is alive and well. The future is bright as we find that the only constants are evolution and change. Adapting to the rapidly evolving needs of manufacturing will be a key to growth and profitability.

Some of the key criteria for successful heat-treatment-system users include: meeting ever-more stringent product performance criteria; exceeding reliability, flexibility and quality standards; achieving fitness for purpose; and reducing manufacturing steps through the avoidance of introducing non-value-added operations.

Other key metrics include: strengthening aftermarket parts and service support; improving metallurgical, engineering and technical expertise; enhancing practical skills; finding and educating a workforce; and creating a support network focused on building personal and industry-wide relationships.

References available online

2019: Make or Break for 2020 and Beyond

TOM MORRISON
CEO MTI Management
tom@heattreat.net
904-249-0448

If you watch the news, you would never know we are on the front end of one of the largest economic booms in our history. The real numbers no one talks about show the economic expansion will last through the end of the 2030s. How do we know that? Two reasons:

- Just like the 79 million Baby Boomers drove record growth in the 1980s and 1990s, the Millennials (with over 100 million) will drive massive economic expansion in the 20s and 30s of this century.
- With healthcare technology keeping Boomers living into their 90s (longer than ever), adding 10-15 years into a demographic group's life adds 10-15 more years of economic impact by Baby Boomers.

The combination of the above two scenarios creates a perfect storm of spending and growth by each of these two demographic segments to many of the industries that heat treaters service. Every industry that caters to either segment will grow in record numbers, including:

- Housing
- Healthcare
- Medical devices
- Cell phones
- Food and beverage
- Electronics
- Travel
- Automotive

You name the industry. If 30-year-olds and 70-year-olds are their target market, plan on 20 years of record growth.

As a company, however, you must be smart about key influences that will have radical impact on each industry. Two elements driving how business models will evolve in the next 20 years are:

- Rapidly developing emerging technologies
- Change in consumer buying habits

With the growth of the Internet of Things and Industry 4.0, which connect people, machines, information, processes and technology, market disruption is causing change in business models at a record pace. Failure to adopt new technologies and embrace consumer buying-habit changes will likely cause your company to disappear. Forbes is predicting that 40% of today's Fortune 500 companies will not exist by 2030. Market disruption is real, so take it seriously.

Technologies that are going to have a dominating impact on industries are:

- Shared mobility (will change the transportation industry)
- 3D printing (will change manufacturing industries)
- Artificial intelligence (will change every professional industry)
- Robotics (will change retail, food-service and hospitality industries)
- Blockchain (will change any industry that serves as an intermediary)

The hardest element for many people to realize is the urgency they need to have in changing their business models. It's important to embrace new technologies, leverage them and take advantage of the growth coming in 2020 and beyond.

On consumer buying-habit changes, your company needs to pay close attention to trends like:

- Rentals/shared models (Airbnb and Uber)
- Swap commerce (online barter sites)
- Chemical revolt (do it yourself)
- Subscriptions services (product delivered in a box for a monthly fee)

Consumer buying habits shift fast due to how connected everyone is. If consumer buying habits shift in your industry and your company is not out in front of it, you may quickly lose market share and not be able to recover.

It is critical as a company that you stay tuned into the best and most current information on these changing trends so you can ensure your customer's business model is ahead of the market disruption running toward every industry. Don't wait another year.

Study the impact of demographic shifts in your customers' markets, implement Industry 4.0 models in your operations and embrace new smart technologies to maximize customer service and throughput.

Make 2019 a breakthrough year for your company so you can seize the growth that will take place in 2020 and beyond. The future of your business depends on it.

Lindberg/MPH

Going Strong After 100 Years

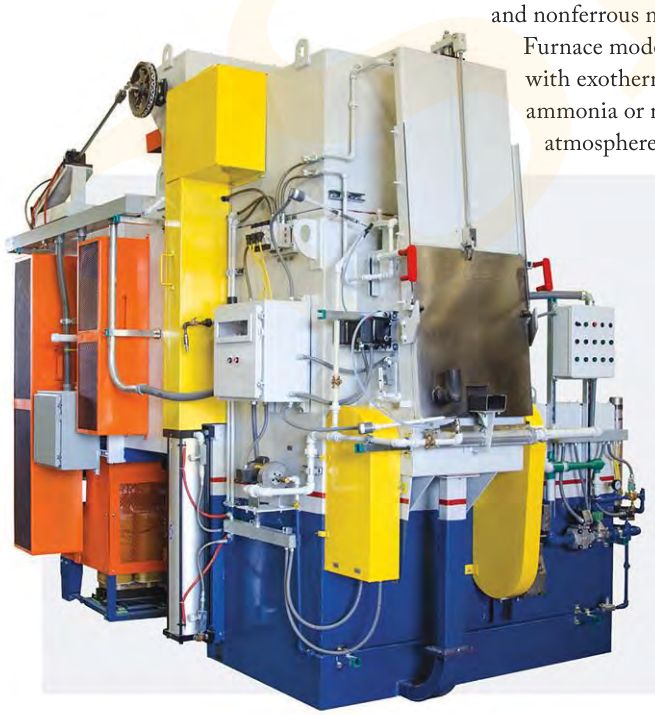
MTI
Metal Treating Institute
904-249-0448
www.HeatTreat.net

Founded way back in 1912 as the "Replaceable Heating Elements" company in New York, Lindberg/MPH was named after the owner's patented, replaceable heating elements for research heating applications.

In 1924, the company was renamed Hevi-Duty Electric Company and moved to Milwaukee, Wis. It wasn't until 1963 that Lindberg was added to the name after the acquisition of Lindberg Engineering, leading to the renaming of the company to Lindberg/Hevi-Duty. The MPH brand was combined with Lindberg in 2005 under the ownership of Thermal Product Solutions LLC.

Today, more than 100 years since its founding, the Riverside, Mich.-based company manufactures a range of industrial furnaces that are capable of processes such as aging, annealing, carburizing, drying, sintering and tempering. In fact, Lindberg/MPH has more than 75,000 industrial furnace installations worldwide. This equipment is backed by a full range of customer-support services and an extensive replacement-parts inventory.

This associate member's range of furnaces includes pit, box, IQ and belt-type for the ferrous and nonferrous markets. Furnace models are available with exothermic, dissociated ammonia or nitrogen atmosphere systems.



Lindberg/MPH also manufactures melting and holding furnaces for nonferrous alloys. The company's customers cover a range of industries, including aerospace, automotive, military, mining, heavy equipment and medical.

Lindberg/MPH prides itself on designing its industrial furnace systems to use the most energy-efficient components. Most of its equipment is built to utilize low-NO_2 combustion systems and afterburners or converters to reduce harmful emissions.

The company does much more than design and manufacture furnaces. Lindberg/MPH's factory-trained experts can help diagnose issues, order parts, install equipment and upgrades, and perform annual maintenance and testing. Services include: calibrations, preventive maintenance, SCADA systems and control upgrades, temperature uniformity surveys (TUS), training classes, and turnkey installation and commissioning. Whatever the case may be, Lindberg/MPH tailors its services to customer needs and equipment because there are no one-size-fits-all solutions.

After 106 years, the company is still investing and evolving. In early 2017, Lindberg/MPH invested in the future by purchasing an Emrak press brake and hydraulic swing beam shear to maximize its production capabilities. The company also added an Amada computer-controlled hydraulic punch to its Riverside facility later in the year.

As for the future, Lindberg/MPH will be focused on continued growth of custom-engineered equipment along with increased sales in standard products to all industries it serves. The company plans to be around for at least another century.

Lindberg/MPH is owned by Thermal Product Solutions LLC (TPS), a leading American manufacturer of custom industrial ovens used for heat treating, finishing, drying, curing, manufacturing automation and process control. TPS is a global leader in thermal-processing products and test solutions with brands including Baker Furnace, Blue M, Gruenberg, Tenney, Lunaire and Wisconsin Oven.

Executive Officers Recognize the Value of IHEA

IHEA
Industrial Heating Equipment Assoc.
859-356-1575
www.ihea.org

The Industrial Heating Equipment Association represents major segments of the industrial heat-processing equipment industry. Established to meet the need for effective group action in promoting the interest of industrial furnace manufacturers, the organization currently includes designers, manufacturers, corporate end users, professional service and consulting members.

IHEA is thankful to have the leadership of dedicated members. Hear from IHEA's executive officers about the importance of the association's work and its value to the industry.

Michael Stowe, P.E., C.E.M., Advanced Energy; IHEA President


Michael Stowe, IHEA President

Stowe is an energy consultant and has been involved with IHEA for over a decade. He has been an invaluable member of IHEA's education committee and served as the chairman of the Infrared Division and the Induction Division.

Q: In your time on the IHEA board, what do you think is IHEA's most significant accomplishment?

A: Providing exceptional technical, economic and leadership information – as well as wonderful social networking opportunities – to our members, year after year.

Q: What is your vision for IHEA moving forward?

A: I see IHEA as the central clearinghouse for all things about industrial heating. IHEA should be the leader in communicating heating technology development, sharing the state of the heating industry, ensuring the safety of heating equipment and providing conferences and events for networking and education.

Q: What advice would you give non-members about joining IHEA?

A: IHEA covers the spectrum of heating in manufacturing processes. IHEA members are oven and furnace equipment OEMs, electrical utilities, combustion burner manufacturers, various magazine publishers and even energy consultants. The widely varied membership provides an excellent opportunity for networking. IHEA membership provides access to exceptional training opportunities, heating-related national standards updates, up-to-date economic news and thought leaders across the heating industry.

B.J. Bernard, Surface Combustion; IHEA Vice President


B.J. Bernard, IHEA V.P.

As testimony of his dedication, Bernard has made his way through the IHEA officer rotation twice and continues to provide significant support to the association in countless ways. His guidance in the board room carries through to the overall industry.

Q: In your time on the IHEA board, what do you think is IHEA's most significant accomplishment?

A: One of the core values of IHEA is education. We provide high-quality training from industry experts at our Combustion, Induction and Safety Standards and Codes Seminars. We've also completely updated IHEA's online course, Fundamentals of Process Heating.

Q: What is your vision for IHEA moving forward?

A: I would like IHEA to continue to be a place where the industry gathers to push the industry forward by jointly improving technology and safety and providing training opportunities to our stakeholders.

Q: What advice would you give non-members about joining IHEA?

A: For non-members, the relationships forged at IHEA will serve you well. Knowing and having a relationship with vendors, competitors and customers gives you a broader view of the industry and gives insight into key issues that affect us all.

Don't let another year pass without becoming an IHEA member. Join now at www.ihea.org.

EQUIPMENT NEWS

Vacuum Furnace

TAV Vacuum Furnaces manufactured a customized vacuum furnace for a research center in the nuclear field. The furnace, which has useful dimensions of 13.8 inches (350 mm) wide x 15.7 (400 mm) inches high x 13.8 (350 mm) inches long, has a maximum temperature rating of 3992°F (2200°C). It represents a solution for advanced ceramics and metallic parts already realized with the additive-manufacturing process. The furnace also includes: a compact cooling system that guarantees high cooling performances; a large-dimension pumping group that allows fast chamber evacuations and high-vacuum working levels; a computerized SCADA system that allows complete control and installation supervision.

www.tav-vacuumfurnaces.com

Gas Nitriding Furnace

SECO/VACUUM, a SECO/WARWICK Group company, received an order from a U.S. manufacturer for a precision gas nitriding furnace with ZeroFlow technology. The furnace will allow the company to offer engineered steel surfaces that exceed, in many cases, its competitors' product performance. The company manufactures a range of transportation components. In addition to gas nitriding, the furnace has ferritic nitrocarburizing capability and pre- and post-oxidation. It also has the ability to clean temper and clean anneal to temperatures up to 1400°F. www.secovacusa.com

Nitriding, Tempering Furnaces

JGEF Furnace of China shipped six furnaces to a Japanese heat-treating company. Four horizontal, front-loading nitriding furnaces are designed specifically for precision gas nitriding in a retort style with vacuum purge. This gas nitriding method precisely controls the case depth and nitride layer formation (including white layer) to achieve high surface hardness, improved wear resistance and longer fatigue life. Two horizontal tempering furnaces are designed to temper workloads after hardening. These furnaces, which are capable of achieving ±10°F at temperatures of 400-1300°F through nine points, extend the heat treater's capabilities by offering greater capacity. www.jgeffurnace.com

Convection Oven

Lucifer Furnaces supplied a forced-air recirculating oven to a manufacturer of medical and aerospace parts. The oven, which has a chamber size of 12 inches high x 18 inches wide x 36 inches long, will be used to heat treat 17-4 stainless steel. It heats quickly with side-mounted element holders housing coiled, low-watt-density resistance wire. The convection-style oven is equipped with a programmable controller and two-pen chart recorder. Features include 4.5 inches of multilayer insulation, a 16-gauge stainless steel liner and a horizontal swing door with safety switch. A rear-mounted high-volume fan directs air past heating elements then throughout work chamber for uniform heating. www.luciferfurnaces.com

Heat-Treating Oven

Wisconsin Oven Corp. shipped a stress-relieving oven to a company in the technology industry. The natural-gas-fired oven will be used for stress relieving fabricated steel tanks. With a maximum operating temperature of 1250°F and work-chamber dimensions of 10 feet, 1 inch wide x 7 feet, 6 inches long x 6 feet, 8 inches high, the batch unit has the capacity to heat 6,060 pounds of steel from 70° to 1130°F in approximately 120 minutes. The recirculation system utilizes combination airflow to maximize heating rates and temperature uniformity. The vertical lift door is pneumatically operated, and two sets of carbon-steel skid rails are used for forklift loading. www.wisoven.com

Oil-Quench Tank

L&L Special Furnace Co. Inc. supplied a custom-designed 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 1550°F. Usable dimensions of the tank are 12 inches wide x 12 inches high x 24 inches long. The parts are placed in a basket prior to being quenched then manually placed into the quench oil. The quench tank has an oil media that is agitated by a 1-HP pump that is directed up under the basket. The system is designed to run one cycle per hour with 35 pounds of material. www.llfurnace.com

Industrial Furnaces

Andritz received an order from China's HBIS Group Co. Ltd. to supply two strip processing furnaces. One furnace is for a continuous annealing line and will be used to produce the latest generation of advanced high-strength steels (AHSS). The annual capacity of the line is 825,000 tons. The second furnace is for a continuous hot-galvanizing line to produce hot-rolled products up to 6 mm thick. The annual capacity of the line is 412,000 tons. Production of the first coil on these two lines is scheduled for the first quarter of 2020.
www.andritz.com

BUSINESS NEWS

UPC Relocates U.S. Headquarters

United Process Controls Inc. (UPC) plans to relocate its U.S. headquarters from West Chester, Ohio, to Oak Creek, Wis., in December. The relocation is the second phase of the company's initiative to unify its U.S. operations to one centralized location.

UPC completed the first phase earlier this year, which saw its two Wisconsin facilities come together under a larger facility in Oak Creek. The 30,000-square-foot plant accommodates the flow controls business and will provide additional manufacturing space for the company's product lines. It will also house an expanded laboratory as well as engineering, manufacturing, sales and service personnel.

Century Aluminum Expanding in Kentucky

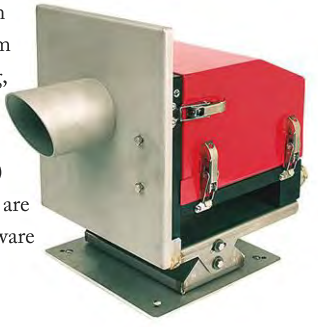
Century Aluminum Sebree LLC announced two expansion programs at its Sebree, Ky., smelter that will increase the smelter's production of both value-added and secondary aluminum. The programs, which are expected to be completed in the first quarter of 2019, will improve the smelter's product mix by adding approximately 90,000 metric tons of additional billet production to the Sebree casthouse and increase the smelter's overall output by adding 20,000 metric tons of additional secondary (scrap reprocessing) capacity. Sebree is now expected to produce approximately 230,000 metric tons of aluminum (both primary and secondary) products in 2019, including approximately 175,000 metric tons of billet. As a result of the programs, Sebree plans to add nearly 50 new employees.

Steel Dynamics to Invest in EAF Flat-Roll Steel Mill

Steel Dynamics Inc. will construct a new state-of-the-art, electric-arc furnace (EAF) flat-roll steel mill in the U.S. The facility is anticipated to have an annual production capacity of approximately 3 million tons with the capability to produce the latest generation of advanced high-strength steel products. The current estimated investment is $1.7-1.8 billion, with anticipated direct job creation of approximately 600 positions. The project will include a galvanizing line with an annual capacity of 450,000 tons.

Ametek Land, Danieli Partner for EAF Tapping System

Ametek Land collaborated with **Danieli** on an automatic tapping system to increase operational safety and improve process control for steel plants. With the Danieli automatic electric-arc furnace (EAF) tapping system, it is possible to execute a complete furnace tapping remotely from the main pulpit of a steel plant. The system starts furnace tilting in automatic mode, controlling the furnace position during the complete tapping process. Embedded within the system are two thermal-imaging systems from Ametek Land: its slag detection system (SDS-E), branded as Danieli's Q-Slag, and a near-infrared (NIR) fixed thermal imager that is an integral part of the ladle level detection (LLD) system. The thermal-imaging systems are used in conjunction with Danieli software to control steel flow in real time.



Novelis Expands Aluminum Production, Adds Jobs in Brazil

Novelis Inc. announced an investment of $175 million at its Pindamonhangaba plant in Brazil. The project, which should create more than 50 new jobs, includes an increase in sheet-ingot, hot-mill and recycling production. The expansion of the company's flagship facility in South America will benefit the organization's beverage-can and specialty customers by bolstering capacity with 100,000 metric tons of additional rolling production and 60,000 metric tons of increased recycling.

Nucor Acquires Precision Castings Company

Nucor Corp. acquired Corporacion POK S.A. de C.V. (POK), a fully integrated precision castings company with a facility in Guadalajara, Mexico. POK produces complex castings using steel, bronze, iron and specialty exotic alloys and precision-machined products used by the oil-and-gas and mining industries. The company complements Nucor's acquisition of a cold-finish facility in Monterrey last year.

State of the Industry 2018

Job Satisfaction, Skill Development and Company Challenges

Bill Mayer, Managing Editor

How many hours per week do you work on average? How satisfied are you with certain elements of your job? What will be the biggest challenge for your company in the next 12 months? See how thermal-processing employees from across the country answered these questions and more.

For the fourth year in a row, *Industrial Heating* – with help from Clear Seas Research – polled qualified subscribers on a variety on job- and industry-related issues. The goal of this project is to find out more about the current state of employment in the thermal-processing industry.

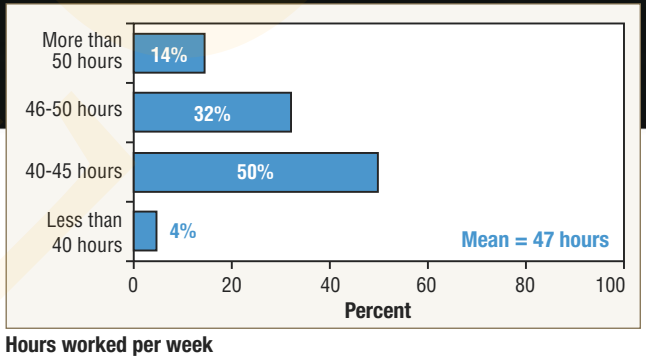
How many hours per week do you work on average?

This question has become a "State of the Industry" staple and always produces interesting results. While 50% of respondents said they work 40-45 hours per week, 46% said they work over 45 hours per week. Only 4% of respondents said they work less than 40 hours per week. The average among respondents was 47 hours per week, which is up 2 hours per week from last year's survey. In 2017, 40% of respondents said they work over 45 hours per week, a number that increased significantly this year.

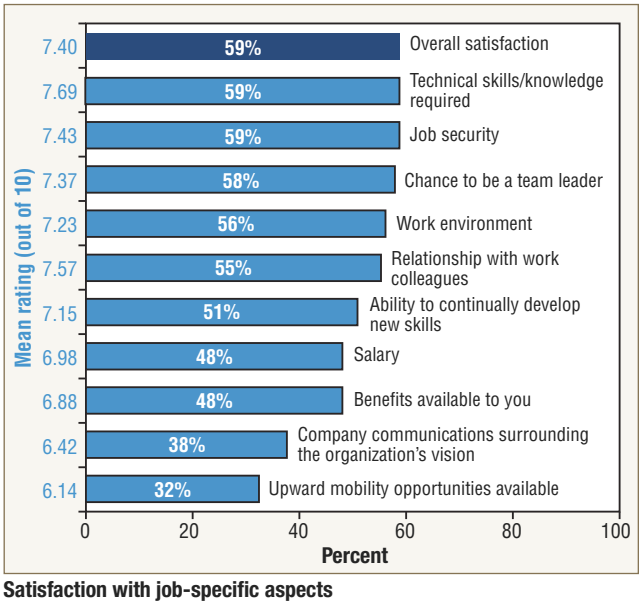
It should be noted that 96% of respondents are full-time employees and 93% are salaried.

How satisfied are you with certain elements of your job?

This was a question with many options for respondents to choose from. The most important takeaway here is that three-



Hours worked per week



Satisfaction with job-specific aspects

in-five respondents rated their overall job satisfaction highly, indicating there is some room for improvement. Satisfaction is the lowest for availability of upward mobility opportunities and company communications surrounding the company vision, while there is room for improvement on various aspects including satisfaction with technical knowledge, job security and chance to be a team leader.

To be precise, 48% of respondents are highly satisfied with their salary and/or benefits, and 56% are satisfied with their work environment.

What skills would you like to develop during the next 12 months?

In this ever-changing and evolving business climate, it's more important than ever for workers to expand their skill set and advance their education. According to our results, time management (42%) and problem-solving (40%) appear to be priority skills respondents plan to develop in the next year.

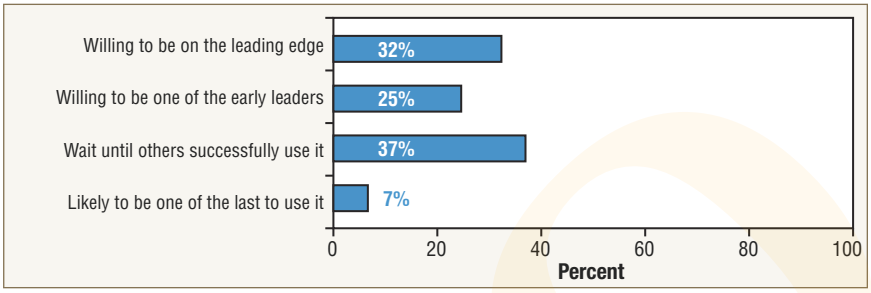
Other personal-development goals that garnered a large response were teamwork (32%), certifications (27%) and employee supervision (22%).

By the Numbers

32%
of companies willing to be on the leading edge when it comes to embracing new technology

50%
of respondents work 40-45 hours per week

94%
of respondents are involved in some way in purchasing decisions



Company culture on embracing technology

Which best describes your company's approach to embracing new technology?

Another survey standby, we want to find out how willing thermal-processing companies are when it comes to investing in new processes and/or equipment. With technologies like 3D printing/additive manufacturing and the Industrial Internet of Things (IIoT), this question is even more relevant.

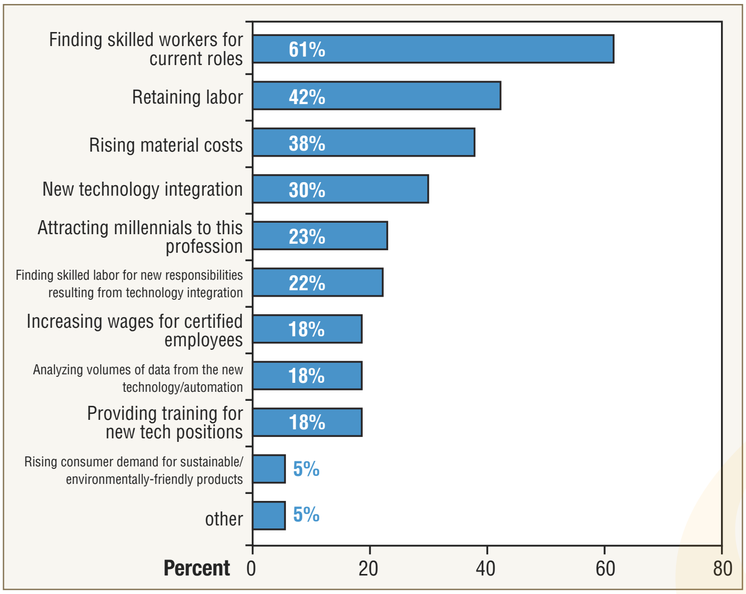
Over half of respondents indicated their company will be either on the leading edge or an early leader when it comes to embracing new technology. To be specific, 32% said their company would be on the leading edge and 25% said their company would be willing to be an early leader. Perhaps more concerning, however, is that 37% of respondents said their company would wait until other, successfully utilize new technology and 7% said their company would likely be one of the last adopters.

When compared to last year's results, the 57% of respondents who was either willing to be on the leading edge or an early leader is down 10% from 2017. Perhaps some companies have lost their nerve when it comes to embracing new technologies, or maybe they are more willing to just take a wait-and-see approach.

What will be the biggest challenge for your company in the next 12 months?

According to our poll, companies will be most challenged with finding skilled workers for current roles and retaining labor over the next 12 months. By far the biggest concern, 61% of respondents said finding skilled workers would be an obstacle for their company. Meanwhile, 42% said retaining labor would be an issue.

On a positive note, only 18% of respondents said providing training for new positions would be a challenge, a sign that companies are training their workers for the roles of the future.



Biggest future challenges

This article is based on information from the October 2018 "Industrial Heating State of the Profession Study" conducted by Clear Seas Research. The entire report, including additional details regarding industry challenges and technology adoption, is available to purchase and download. For details, visit https://bit.ly/2zYGgWg

Demographics

You may be asking yourself: Who participated in this survey? We can answer that question right now. Over a quarter of respondents are primarily involved with captive in-house heating treating, and 15% are employed with a furnace/oven manufacturer. Just over 10% of respondents work for engineering or consulting firms.

Individually, the average age of respondents was 54, and 83% of respondents have at least a bachelor's degree. As for experience, 63% of respondents have worked in the industry for more than 20 years. Perhaps most important to note is that 94% of our survey takers are involved in purchasing decisions at their respective companies.

Conclusion

You can take what you will from the survey results presented in this article. What is certain is that *Industrial Heating*, while attempting to find out more about the state of the thermal-processing industry, has compiled a number of interesting talking points that can be discussed around the office or on the shop floor. IH

The Evolution of Clean Steels

(above) Gerdau SBQ bars on a cooling bed

Eduardo Scheid and Denise Correa de Oliveira – Gerdau Special Steel North America; Monroe, Mich.

Improvements in steel manufacturing processes have yielded advancements in the purity of steel that, in turn, yield higher-quality end-use products. Clean steel is produced by judiciously controlling parameters in melting, refining, degassing and casting operations. The demand for clean steels will continue to increase due to the global push for energy efficiency and stricter CO_2 emission regulations.

Steel is an amazing material when you consider its versatility. Steel can achieve the needed characteristics for a vast array of end products; it is relatively low cost compared to many other materials; it is endlessly recyclable without loss of property; and it can be mass produced, with annual global production of over 1.5 billion tons.

What is clean steel?

Compared to just a couple of decades ago, improvements in steel manufacturing processes and advancements in the science of steel evaluation have substantially improved steel quality. These advancements have resulted from extreme chemistry and property control, as well as enhanced refinement techniques to raise the purity of steel. This high level of purity is what the industry refers to as clean steel. Simply put, clean steels contain limited nonmetallic inclusions in terms of size, shape, composition, distribution and frequency. As a result, clean steels are capable of outperforming other materials and excel in applied high-stress states, such as those used in transportation equipment and other applications.

Nonmetallic inclusions are particles formed in the steelmaking process. Those particles can be classified into two groups: exogenous and endogenous. Exogenous inclusions are formed from unintended chemical or mechanical interactions and re-oxidation of the liquid steel with its surroundings, such as slags, mold powder and refractories. They are larger than endogenous inclusions, which are normally formed due to the reactions during the refining process. Endogenous inclusions are usually classified as sulfides, aluminas, silicates and other oxides. They can be of very small sizes, thereby making them more difficult to float out of the liquid steel.

The composition, size, amount and distribution of inclusions have a large effect on a part's properties. The role of clean-steel producers is to minimize inclusions and consequently reduce their detrimental effect on final products.

Steel parts, particularly moving parts for applications within transportation equipment, are especially susceptible to the effects of nonmetallic inclusions. These inclusions may contribute to reduced fatigue life on parts exposed to continuous rotation, such as wheel hubs, transmission gears and shafts, crankshafts and camshafts. Premature failures in these highly stressed components have driven this push for developing cleaner steels.

Many studies on the composition and shape of inclusions have been conducted to understand the relation between inclusion type, inclusion and steel interface, and crack initiation. For example, the bonding effect at the inclusion and steel interface has been of particular interest. Sulfides, aluminas and other oxides have different bonding behaviors and will have different effects in the steel. Research shows that inclusions with an easy de-bonding behavior, such as alumina, are the ones that will generate a quick initial microcrack, consequently reducing fatigue life.

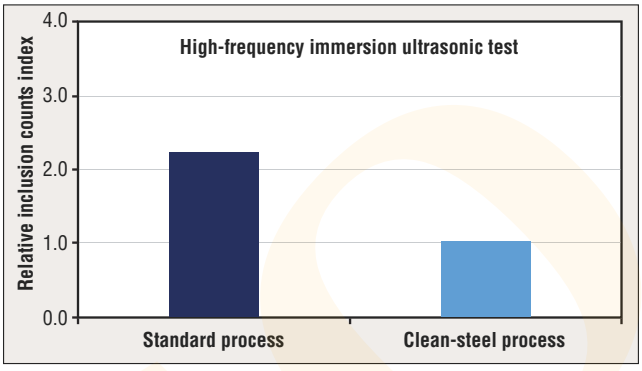
How is clean steel made?

The process of producing clean steel begins in the scrapyard. Scrap with limited amounts of certain elements, such as copper, tin, sulfur and phosphorous, will yield cleaner steels. The alloys used in clean-steel production also need tight quality controls regarding their chemistry and residual elements.

Several key process parameters in melting, refining, degassing and casting are then appropriately controlled to produce the liquid steel with the right attributes. These include controlling the oxygen level in the steel (from tapping to final product), slag engineering and chemistry control. It is also important that minimal slag carryover occurs when the liquid steel is transferred from the furnace to the ladle, where secondary refining begins.

Secondary refining is composed of two stages: ladle refinement and degassing. During ladle refinement, the chemistry, slag and temperature of the steel are adjusted until the desired results are achieved. The steel is then sent to the vacuum degassing station, where it is stirred under vacuum to remove undesired gases, such

Immersion ultrasonic testing provides a sophisticated analysis of potential steel defects in the representative sample material.



An example of a test result from immersion ultrasonic testing equipment.

as hydrogen, nitrogen and oxygen. At this stage, it is important to monitor the pressure, flow rate and time in order to achieve proper slag and steel interaction.

Once the vacuum-degassing process is complete, the focus is to avoid re-oxidation and promote inclusion flotation at the caster before solidification. This "tertiary metallurgy" has become an important aspect in clean-steel production. Recent developments in casting technology, such as computer fluid-dynamics (CFD) simulations and water modeling, have been used to study flow behavior. The objective is to study the best tundish designs and flow modifiers to increase inclusion flotation and avoid steel re-oxidation while decreasing turbulence.

Additionally, refractories used in tundish linings, shrouding devices and submerged-entry nozzles have been improved by way of materials and design. Significant effort is put into preventing re-oxidation resulting from the contact of air and steel during casting. Clean steels are cast under a protective atmosphere using inert gases such as argon and sometimes nitrogen to protect the steel from contact with air. Tundish argon inertization technologies, mold and tundish powders, and new flux addition-control devices are constantly evolving to achieve this protection.

How is clean steel measured?

Nondestructive testing of the steel bars prior to their use, using automatic ultrasonic inspection and magnetic-flux leakage testing, is the first filter to understanding steel cleanliness and offering feedback for process improvement.

Even the cleanest steels produced will have some small level of impurity, which is inherent to the process. Therefore, it is important to understand the cleanliness of the steel and its ability to satisfy the fit and function of the end product. Both size and location of inclusions can influence the final performance. The level of steel cleanliness that is acceptable to a certain product may not be acceptable to others.

For instance, bearings, gears and shafts each have unique production processes with their own particular product testing needs. Fatigue testing is a good example. In addition to traditional bending, torsion and push-pull fatigue testing, more specific tests, such as rolling-contact fatigue testing for bearing products and tooth-bending fatigue testing for gears, may be required.

Historically, indirect methods were used as a correlation to cleanliness, such as oxygen content in steel and nitrogen pickup. The concept is that the less exposure steel has to the atmosphere, the lower the oxygen and nitrogen pickup, thus

About Gerdau

Gerdau's North American special-steel division specializes in producing special-bar-quality (SBQ) steel for the automotive, commercial vehicle, agricultural and energy markets. The division is headquartered in Jackson, Mich., and has steel manufacturing plants in Jackson and Monroe, Mich., and Fort Smith, Ark. The company also has a steel heat-treating facility in Huntington, Ind.

Gerdau is focused on clean-steel technologies and continues to make significant strides in sustainable steel cleanliness. By utilizing enhanced melt-practice developments and strict process controls, Gerdau is producing bearing-quality steels in its continuous casters. Gerdau's Monroe facility is expanding to a 240-mm bloom, which will result in a greater reduction ratio, improved surface quality and cleaner steel with fewer inclusions. Gerdau is also investing more than $70.3 million over three years to upgrade Monroe's electric-arc furnace and ladle-refining technologies.

the cleaner the steel. Today, this concept has evolved to include different types of characterizations and has created more discussion around this correlation.

Traditional measurements of steel cleanliness, such as ASTM E45, ISO 4967 and JIS G 0555, have been complemented by acid dissolution tests, spark-dat (OES-PDA) testing, automated scanning electron microscope (SEM) analysis, extreme value analysis (EVA) and immersion ultrasonic testing.

Recent investigation techniques are now considering inclusions as small as 1 micron. Additionally, the inclusion composition can be determined by automated SEM features, which plot the inclusions' chemistries and sizes in customized ternary diagrams. This is being used as a tool for process feedback and research.

Another good example is immersion ultrasonic testing. Frequencies from 10-100 MHz are used to investigate the amount of inclusions in a certain volume of steel. This is a significant development, considering these microscopic inclusions were previously determined with polished cross sections and microscopes. Now a much larger volume with a true representation of the lot of steel can be reliably evaluated.

The Future of Clean Steel

The demand for clean steels will continue to increase due to the global push for energy efficiency and stricter CO_2 emission regulations. OEMs (particularly automotive) will continue developing lightweight designs that have better fuel efficiency and higher performance expectations, thus leading to increased quality demands throughout the supply chain, including steel producers.

Future technologies to produce clean steel will include having more product-testing visibility in real-time. The emergence of high-frequency immersion ultrasonic testing has created the ability to detect very small nonmetallic inclusions that were not possible to detect in the past. Being able to control these small inclusions and combining different techniques may hold the key for quicker advancement.

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INDUSTRIAL HEATING

Learn more about Gerdau Steel using this QR Code or www.industrialheating.com/Gerdau.

Improving Wear with a Novel Heat-Treatment Method

Leo Porkka – Service Heat Treating; Milwaukee, Wis.
Daniel H. Herring – The HERRING GROUP, Inc.; Elmhurst, Ill.

Service Heat Treating, a commercial heat-treating company located in Milwaukee, Wis., has developed an alternative heat-treatment process known as WearAll™* that has shown to provide better wear resistance than carbonitriding for a number of critical-service components. The company's goals are to help customers optimize part performance and to service customers in the Midwest by having the latest technology in batch integral atmosphere quench, vacuum and gas nitriding/nitrocarburizing furnaces.

Fig. 1. Brake lever processed using WearAll™

This article will focus on an example of plain-carbon steel component parts that require added strength and wear resistance while being prone to distortion during carbonitriding. The WearAll™ process substantially reduced distortion and provided wear properties not otherwise achievable.

The Problem

Plain-carbon steel stampings such as brake levers (Fig. 1) require added strength and wear resistance but are prone to distortion during the relatively high-temperature process of carbonitriding. The manufacturer of this part initially specified the carbonitriding process, but the part distorted to an unacceptable level. Alternatively, ferritic nitrocarburizing (FNC) was used to minimize distortion, but the wear resistance was insufficient to prevent loss of material on the critical slot edge.

The Challenge

Transforming the case of low-carbon steel to a fully martensitic and wear-resistant structure is commercially performed with the carbonitride and oil-quench process. This process, however, does not always optimize wear characteristics and is highly dependent on the grain size, the specific percentage of elements making up a particular heat of steel and the severity of the quench. In addition, holding close dimensional tolerances using carbonitriding is not always possible.

To meet the challenge of providing maximum wear protection while minimizing distortion, a specialized austenitic nitrocarburizing (ANC) process was developed. FNC is often thought to be a solution to this type of problem since its benefits include less distortion, added wear resistance and strength. However, it is not always robust enough for parts requiring maximum wear protection.

The Solution

The lever was processed using WearAll, which provided the needed wear resistance and dimensional stability. Additionally, WearAll provided enough corrosion protection to eliminate the need for a zinc-phosphate coating. This is one of many parts being processed at Service Heat Treating with WearAll. A new furnace (Fig. 2) is being installed to add capacity.

Confirmation

Two separate sets of SAE 1018 parts and test coupons were prepared to compare the hardness (Fig. 3) and wear resistance (Fig. 4) of the WearAll, carbonitriding with a total case depth of approximately 0.30 mm (0.012 inch) and ferritic nitrocarburizing processes with a compound layer thickness of 0.013 mm (0.0005 inch). Wear was measured by volume of

Fig. 2. Integral-quench furnace running the WearAll™ process

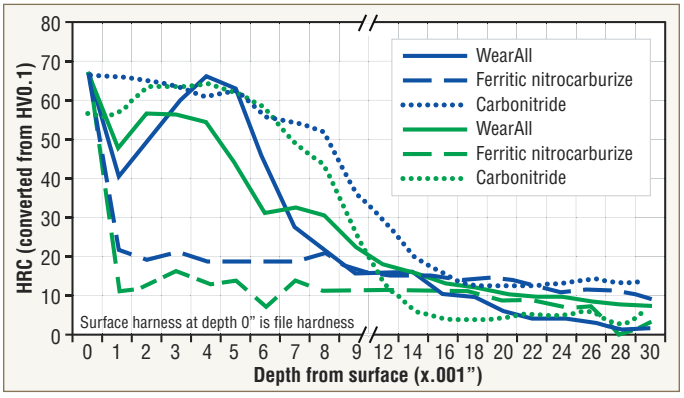


Fig. 3. Hardness test data

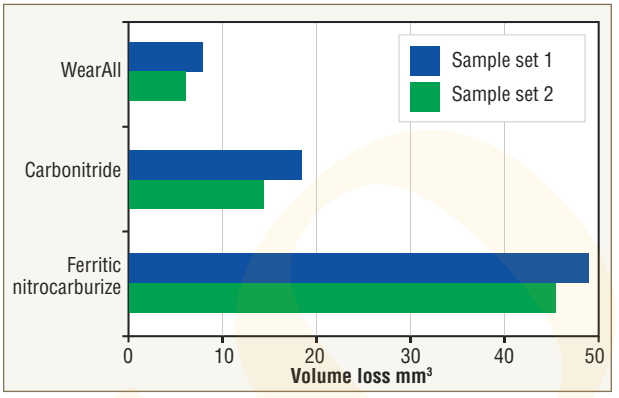


Fig. 4. Wear test data per ASTM G65

material lost during a dry-sand rubber-wheel abrasion test per ASTM G65 (Procedure E).

What is ANC, and how does it differ from similar case-hardening processes?

Austenitic Nitrocarburizing (ANC)

The low-temperature austenitic process associated with nitrocarburizing is performed in the 675-775°C (1250-1425°F) temperature range. The ferrite-to-austenite transformation temperature for the iron-carbon system is 723°C (1333°F). ANC can be controlled to produce a compound layer of iron, nitrogen and carbon. Upon quenching, a beneficial subsurface layer of austenite is retained, which can be subsequently transformed to martensite by freezing and/or tempering to provide a good support structure for the hard surface. It should be noted that there was almost no difference in the wear test result of a sample that was transformed with freezing and tempering and a sample that was tested as-quenched.

The microstructure produced by the austenitic process (Fig. 5) results in a matrix of tempered martensite with a relatively thick white layer, which is particularly useful in providing wear resistance and anti-galling in intermediate-stress applications.

Carbonitriding (CN)

Carbonitriding is a modified carburizing process, not a form of nitriding. This modification consists of introducing ammonia into the carburizing atmosphere in order to add nitrogen to the carburized case as it is being produced (Fig. 6).

Typically, carbonitriding is done at a lower temperature than carburizing in the range of 790-900°C (1450-1650°F) and for a shorter time. A CN case is usually between 0.075 and 0.75 mm (0.003 and 0.030 inch) deep. The CN temperature range is not arbitrary. At higher austenitizing temperatures the thermal decomposition of ammonia is too rapid, limiting nitrogen availability.

The nitrogen in CN steel enhances hardenability by making it more likely to form martensite in plain-carbon steels that initially have low hardenability. Examples include SAE 1018, 12L14, 1117 and 1026. The nitrides formed contribute to a high surface hardness.

The influence of prior austenite grain size on the microstructure of CN steels has been documented.[4] Intermediate transformation products are softer than martensite and form initially at grain boundaries if cooling is not sufficiently fast enough to produce complete martensitic transformation. As the grain size decreases, the grain-boundary area increases as do the sites for intermediate-transformation products. It is difficult

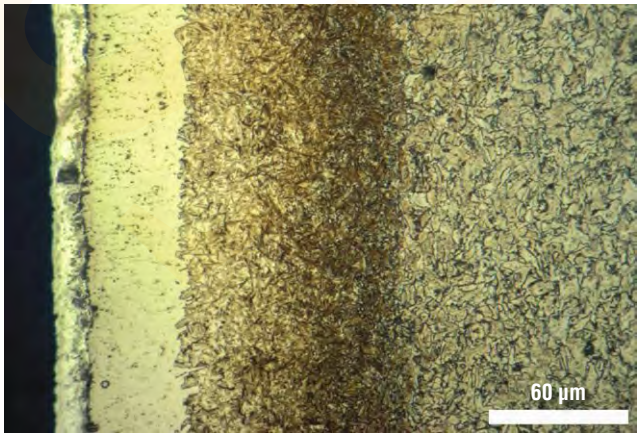


Fig. 5. Microstructure resulting from the WearAll™ process (400X, 3% Nital)

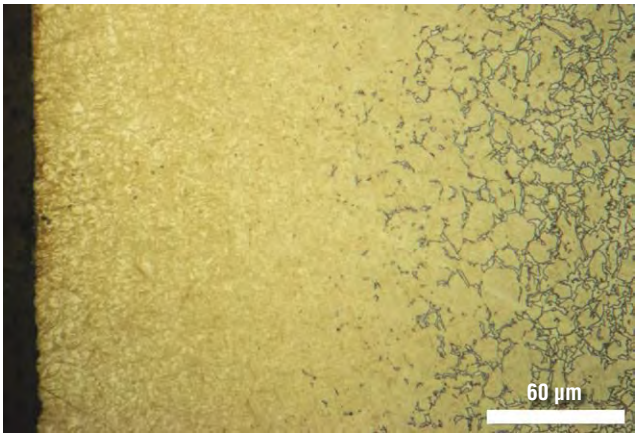


Fig. 6. Carbonitrided sample used for comparative analysis

to get complete transformation when carbonitriding low-carbon steels with small grains (ASTM 8-10) and minimal alloying elements, which can make the process very unpredictable.

Ferritic Nitrocarburizing (FNC)

A complex sequence is involved in the formation of a ferritic nitrocarburized case. Of importance here is that a very thin layer (typically less than 0.025 mm or 0.001 inch) of single-phase epsilon ( ) carbonitride is normally formed between 450°C and 590°C (840-1095°F). The thickness of this "white" or "compound" layer is a function of gas composition and gas volume (flow). Associated with the compound layer is an underlying diffusion zone containing iron (and alloy) nitrides and absorbed nitrogen.

The compound layer has excellent wear and anti-scuffing properties and is produced with minimum distortion. The diffusion zone – provided it is substantial enough – improves fatigue properties, especially in carbon and low-alloy steels. The diffusion zone is also responsible for some of the increased hardness of the FNC case, especially in the more highly alloyed steels that contain strong nitride formers. Nitrocarburizing is often followed by an oxidizing treatment to enhance both corrosion resistance and surface appearance.

Fundamental Differences Between the Various Case-Hardening Processes

The FNC process is a low-temperature process that results in a high concentration of nitrogen in the case. Carbonitriding, which is run at higher temperatures, results in a smaller percentage of nitrogen added to the subsurface layer. This nitrogen is in solution and primarily used to promote transformation of the case region to martensite. By contrast, ANC can be considered a hybrid of these two processes, used to produce both a case rich in nitrogen and a martensitic structure underneath.

Conclusion

The use of a modified austenitic nitrocarburizing process offers a new direction for companies hoping to avoid part distortion and improve wear characteristics on low-carbon steels. Stampings, drawn-over-mandrel components and many others are good candidates for this technology.

Service Heat Treating is currently processing production parts with the WearAll™ process. These parts have traditionally been processed by carbonitriding.

* The trademark for WearAll is in the application process.

For more information: Contact Paul Armitage, president, or Leo Porkka, director of metallurgy, sales; Service Heat Treating, 9320 north 107th Street, Milwaukee, WI 53224; tel: 414-355-1020; fax: 414-355-0308; e-mail: sales@serviceht.com; web: www.serviceht.com.

References available online

Connected Approach to Thermal-Processing Applications

Amy Davidson – Honeywell Process Solutions; Houston, Texas

For thermal-processing industries that need to maximize their productivity in a sustainable way, it's important to think ahead before investing in new process-automation systems. The goal is to replace purpose-built solutions with an integrated, cloud-based platform for enhanced combustion control and performance monitoring.

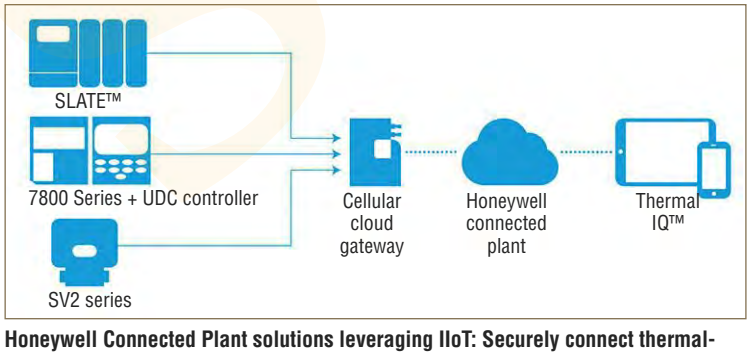
(above) The SLATE™ integrated burner control combines configurable safety with programmable logic – all in one platform, connectable to the cloud.

Companies that don't make the leap to a modern, integrated automation system risk high energy costs for day-to-day operations, plus penalties for failing to meet environmental standards. Isolated, purpose-built solutions for process control also make it difficult to increase production to meet customer demand.

This article describes how the latest integrated technology solutions help optimize thermal processes by securely connecting production assets in the cloud for enhanced control and performance monitoring, which makes critical asset data available anytime and anywhere.

Demands on Manufacturers

With rising energy costs, reduced profit margins and increased demands for product quality, manufacturers with thermal-processing operations need to increase productivity and reduce operating expenses. Their primary objectives include:



Honeywell Connected Plant solutions leveraging IIoT: Securely connect thermal-processing systems to the cloud to make critical data available anytime so users can optimize operations, predict plant failures and eliminate unplanned downtime.

- Increased plant efficiency
- Reduced maintenance costs
- Lower energy consumption
- Less unplanned downtime
- Fewer emissions
- Enhanced safety

However, the retirement of engineers, operators and technicians familiar with thermal manufacturing processes is creating a shortage of proven know-how, also known as the skills gap. There are fewer specialists across the industry, and the remaining plant personnel are responsible for more tasks than ever before.

Need for Effective Controls

Process control is the ability to meet certain parameters over time by using inputs from the process and controlling outputs for desired results. Today's sophisticated automation technology allows users to make better decisions related to the process itself, productivity, quality and safety.

Thermal-processing personnel must implement real-time controls to measure and control critical process variables, develop methods to remotely monitor these variables and find ways to predict future behavior of thermal processes.

Industrial heating operations of all types depend on state-of-the-art automation technology to stay

competitive. Those who resist change will be left behind, wondering why their business is declining, and will be surpassed by growing global competition. Those who embrace the opportunity that advanced systems provide will continue to grow and prosper.

Value of a Connected Solution

Many companies in the thermal-processing industry continue to rely on disparate, purpose-built solutions to run their critical production processes. They use individual components from multiple vendors, as well as separate platforms and protocols. Complicated wiring schematics and programming sequences are the norm in this environment.

With multiple vendor systems in place, each step of the process may involve manual data exchange between systems, which increases processing times and the risk of failure. In that case, it is hardly possible to monitor and control the entire process because it is fragmented across incompatible solutions.

Conversely, the implementation of a single, connected architecture for industrial heating reduces the control "footprint" in most facilities and enables remote monitoring and troubleshooting of crucial production equipment. With control strategies supported by one integrated solution, all stakeholders are connected in one automated workflow with access to the same consistent data. The process is continuously monitored, and potential deviations can be alerted in time.

By taking a single integrated-system approach, manufacturers can realize the benefits of improved operator effectiveness, increased plant availability, reduced maintenance costs and lower lifecycle costs. They can also leverage the Industrial Internet of Things (IIoT) to improve the safety, efficiency and reliability of operations across a single plant or across several plants.

An IIoT infrastructure provides secure methods to capture and aggregate data and apply advanced analytics. Furthermore, it leverages domain expertise and allows end users to utilize this information to determine methods to reduce or even eliminate manufacturing upsets and inefficiencies.

With a larger, consolidated set of useful data – provided by experts who understand the unique characteristics of thermal-processing applications – manufacturers can apply higher analytics for more detailed insight and scale the data to meet the varied needs of single-site or enterprise-wide operations.

A connected automation solution delivered by a single, experienced supplier can include everything from combustion controls, thermal-transfer solutions, fuel-delivery systems and complete engineered-to-order systems to post-installation training and services. This ensures the best possible overall solution for a given industrial heating application.

Putting the Technology to Work

Thermal-processing companies can harness the power of greater connectivity and information-sharing to transform their operations. They can use connected devices and integrated systems to capture real-time process information to:

Thermal IQ™ for remote process and equipment monitoring is part of the Honeywell Connected Plant portfolio, which is turning data into actionable insight to help customers manage and operate hundreds or thousands of assets, from a single site or across an enterprise.

- Understand their equipment to improve asset productivity
- Identify variability across production processes
- Establish remote monitoring and operations capabilities
- Implement manufacturing best practices
- Enhance safety and regulatory compliance

Industrial heating operations now have access to innovative automation solutions, which are focused on turning data into insight to help improve their bottom line.

For example, the new breed of flexible combustion system combines configurable safety features with programmable logic in a single, modular burner control platform. This type of system reduces the footprint on control-room panels and is easily customized for virtually any combustion application – in less time and with far less complexity than traditional solutions. Instead of utilizing separate controllers for different functions, plants can purchase only the modules they need for combustion control and choose how to use them with simple wiring commands. With fewer assets to support and maintain, they also have a lower total cost of ownership.

In conventional control systems, a control panel often contains a programmable logic controller (PLC) combined with separate safety devices such as burner controls. In this case, the safety devices are separately responsible for the operation and safety of critical equipment. Safety modules operate as discrete and self-contained controls.

Previously, data produced by safety devices was connected to what the control is doing. If the control function included communication, then the PLC captured and interpreted this information using specialized customer software. In the latest generation of combustion control systems, all safety-module status data and all non-safety control of safety modules are fully integrated into the programmable logic. The base module

provides communication and user-programmable logic, and non-safety digital and analog I/O modules provide inputs and outputs for that logic. The programmable logic can be used to create any non-safety features needed by the equipment that the combustion control system is controlling. This allows an application designer to implement customized and differentiating features in their controller using a configurable touch-screen display.

Thermal-processing operations also have the option of employing microprocessor-based burner-control platforms, including SIL-3-capable solutions for sequencing multiple burners. Additionally, they can incorporate DIN-mounted universal digital controllers, which provide functionality for setpoint programming, fast scanning and on-board diagnostics.

Some current combustion-management solutions are prepared for remote monitoring. It is now possible to connect thermal-processing equipment in a secure cloud environment, making critical data and performance analytics available when and where they are needed. This approach enables engineers and operators to receive real-time alerts on a smart phone or tablet when key parameters are outside normal limits and track historical data over time to identify when and why something happened.

The visualization of current operating values in both text and graphic form ensures there is a comprehensive overview of the thermal-processing asset, as well as convenient and cost-effective remote monitoring. The availability of combustion-focused data helps non-seasoned staff troubleshoot problems more effectively. This thermal-related information contrasts with current remote-monitoring solutions, which provide non-contextualized data as opposed to truly insightful and actionable information.

Getting the right thermal-specific information into the right hands via remote monitoring helps keep thermal processes running as safely and efficiently as possible. Troubleshooting is more effective since maintenance technicians can bring the right parts and tools the first time. Furthermore, technical experts can more easily provide remote guidance and stay ahead of problems by identifying nuisance fault trends and potentially predicting impending failures.

Finally, some major automation suppliers now provide engineered-to-order offerings, which include thermal-processing systems and expert services, all incorporated in a complete turnkey solution from start to commissioning while ensuring compliance with local codes and standards. This solution allows heat-treating facilities to focus on core competency and save valuable in-house resources.

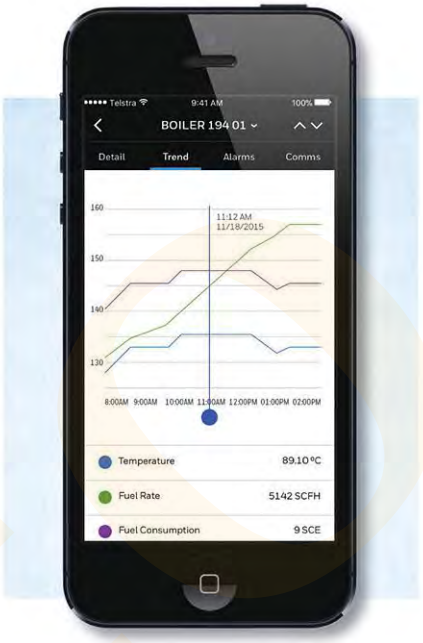
Benefits to End Users

The deployment of an integrated control and monitoring solution for thermal-processing applications delivered by a single competent supplier makes combustion part of an overall connected strategy aimed at a smarter and safer facility. Industrial organizations can now see, analyze and improve the competency and productivity of their people, the efficiency of their processes and the performance of their assets.

With a connected-plant solution, manufacturers are able to bring together historical and real-time process data from different systems and connect to cloud technologies. The data is then easily accessed, retrieved and analyzed by all key stakeholders.

Thanks to this approach, end users can reduce the complexity of their thermal-processing control installation – and optimize its performance – and thus realize valuable benefits such as:

- Lower energy and environmental costs
- Reduced risk of related taxes and fines
- Increased availability of heating systems
- Reduced likelihood of process downtime
- Increased productivity to meet customer demand
- Faster ROI due to significant operational savings



Transform process data into real-time key performance information regarding process performance, equipment health, energy consumption and emissions monitoring.

In an age where there are fewer skilled resources to engineer, operate and maintain combustion controls, the connected approach provides manufacturers with a system that is more intuitive, less complex, easier to maintain and more integrated across the enterprise.

Conclusion

The latest technology developments are providing powerful potential to connect people, assets and information across the industrial enterprise. Now, rather than having to integrate, support and maintain purpose-built solutions for combustion control and monitoring, thermal-processing operations can utilize proven connectivity solutions to optimize their production capabilities and business results.

For more information: Contact Amy Davidson, Connected Products Offering Leader, Honeywell Connected Plant; Honeywell Process Solutions, 1250 West Sam Houston Parkway South, Houston, TX 77042; tel: 800-822-7673; e-mail: honeywellthermalsolutions@honeywell.com; web: www.honeywellprocess.com/hts

Across International

For over 25 years, Across International has been an industry leader in heat-treatment, material-processing and laboratory equipment manufacturing. Our mission is to empower those advancing science by providing innovative, high-quality equipment, along with the best customer support.

Customer service is our top priority. We pledge to respond to all inquiries on the same business day. All items purchased come with lifelong technical support. Know too that our friendly and knowledgeable sales team is standing at the ready to provide information and recommendations in order to help bring your operation up to the next level.

As a result of our approach, we've had the privilege of providing equipment to some of the top universities, corporations and research centers worldwide. These include NASA, Tesla, Toyota, GM, GE, Lockheed Martin, Oak Ridge National Laboratory and many more. First established in New Jersey, we've since expanded, establishing a West Coast center in Nevada and another in Victoria, Australia.

Our product line includes induction heaters, vacuum ovens, ball mills, laboratory furnaces, pellet presses and a wide variety of other items. So how do you know if the piece of equipment you're interested in is right for you? We offer recommendations for getting the most out of our products and can assist you with selecting the right type of equipment. For instance, we offer equipment pairing services, where one of our trained, professional salespeople helps you select the perfect unit for your application.

Another service we offer is sample testing. We can test samples with a wide variety of our machines, including furnaces, induction heaters and ball mills. We do heat-treatment testing or mill your materials within one of our ball mills to help you decide whether the unit will fit your process.

Lastly, we offer custom designs, such as placing access ports on forced-air ovens to your specifications or fashioning unique, custom-made induction heater coils.

Ajax TOCCO Magnethermic Corp.

Ajax TOCCO induction heating systems are used throughout the world for hardening, annealing, stress relieving, tempering, brazing, bonding, shrink fitting and many other processes requiring fast, efficient, economical heating. These processes are being applied to virtually any metallic shaped parts, ranging in size from fractions of an inch to substantial lengths and diameters.

As pioneers in induction heat treating, Ajax TOCCO continues to shape the future of induction. Our group of companies will analyze customer requirements to provide the most reliable, efficient and cost-effective solutions to meet their needs.

Ajax TOCCO has over a century of combined, proven technical development and experience and specializes in a wide range of heat-treating applications, including:

- Axles
- Bars
- Bearings
- Camshafts/ crankshafts
- C.V. joint components
- Cylinder liners
- Gears/sprockets
- Hand tools
- Mill rolls
- Pins
- Pistons
- Shafts/rods
- Tubes
- Valve seats
- Wheels, hubs/ spindles

Ajax TOCCO Magnethermic®, a subsidiary of ParkOhio Holdings Corp.®, designs and manufactures world-class induction heating and melting equipment for various industries and applications throughout the world.

ALD Thermal Treatment

Improved Materials, Enhanced Fatigue Resistance for Gear Components

To answer the demand for fuel-efficient vehicles, modern gearboxes are built much lighter. Improving fatigue resistance is a key factor to allow for the design of thin components to be used in advanced vehicle transmissions. The choice of material and the applied heat-treat process are of key importance to enhance the fatigue resistance of gear components.

By applying the technology of low-pressure carburizing (LPC) and high-pressure gas quenching (HPGQ), the tooth root bending strength can be significantly enhanced compared to traditional heat treatment with atmospheric carburizing and oil quenching.

Besides heat treatment, significant progress has been made over the past years on the steels being used for gear components. The hardenability of case-hardening steels such as 5130H, 5120H, 20MnCr5, 27MnCr5 and 18CrNiMo7-6 has been increased in recent years. An important factor for fatigue resistance is the grain size after heat treatment. Therefore, grain size control is a key goal when developing new modifications of steel grades.

After enhancing grain size control, it was possible to increase the carburizing temperatures over the past years from 930°C to 980°C (1700°F to 1800°F), which resulted in shorter heat-treatment cycles and significant cost savings.

With the introduction of new microalloyed steels for grain size stability, carburizing temperatures can now be even further increased to temperatures of up to 1050°C (1920°F), leading to even more economic process cycles. By adding microelements such as niobium or titanium in the ppm-range, nitride and carbonitride-precipitates are formed. These precipitates effectively limit the grain growth during the heat-treatment process.

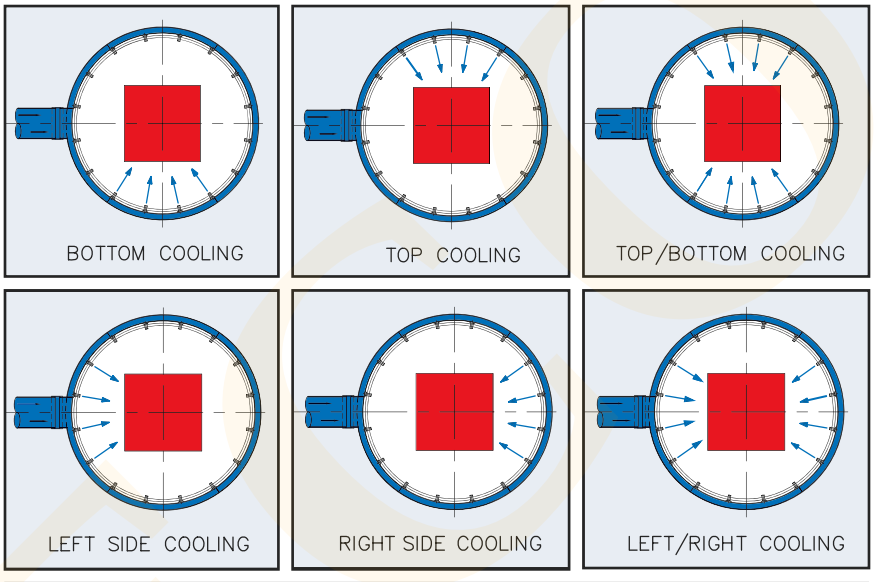
G-M Enterprises

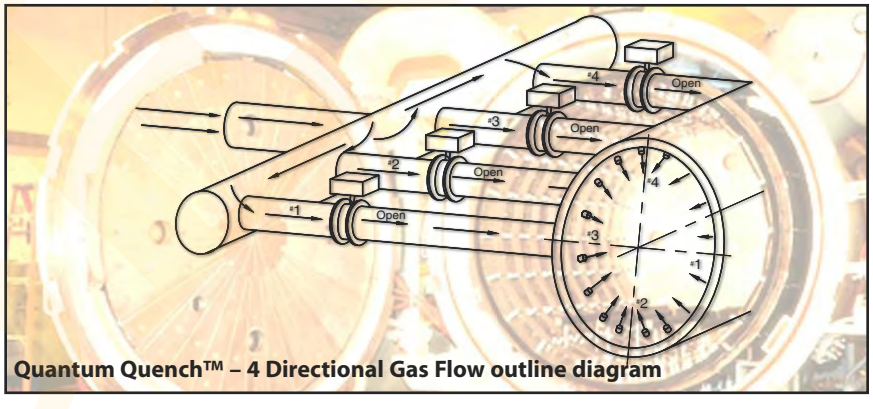
The technological advancement in controlled and directional flow of cooling gases in a vacuum furnace without internal moving parts provides unparalleled metallurgical and physical results.

The Quantum Quench™ – 4 Directional Gas Flow without internal moving parts is a breakthrough in controlled and uniform cooling while controlling distortion. Generally, gas flow direction affects how heat is extracted from the part.

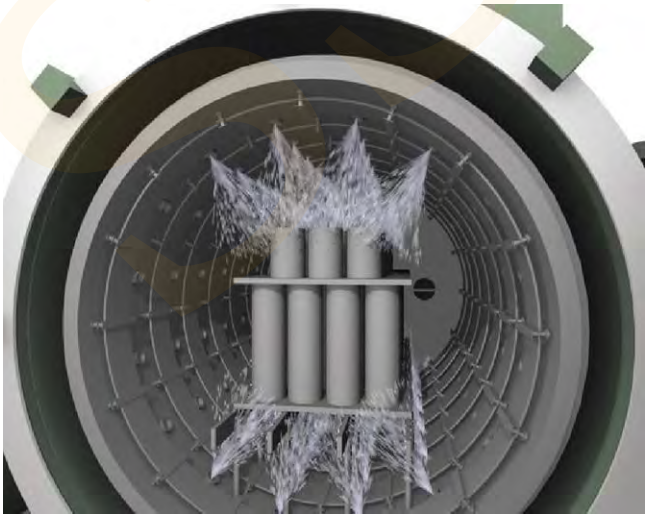
- A part exposed to top to bottom cooling gas flow will have a cooler top surface
- A part exposed to bottom to top cooling gas flow – the bottom surface is cooler
- A side-cooled part will be cooler on the gas-admission side

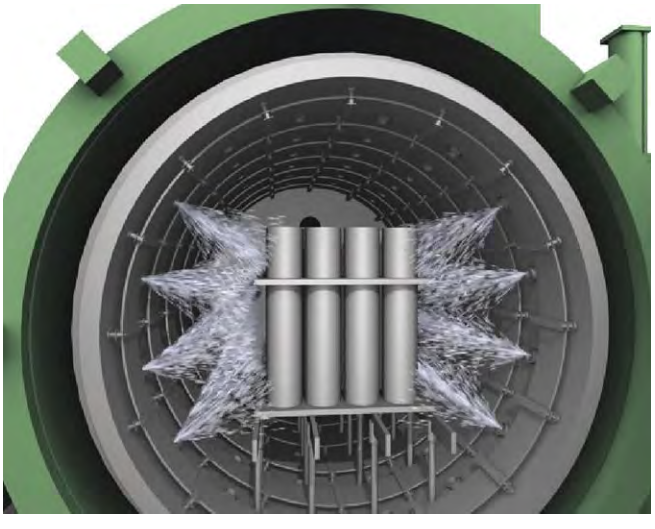
G-M Enterprises has the resources – developing new products, timely manufacturing and prompt service – to consistently meet its customer's heat-processing needs. G-M's experience, field-service maintenance, installation and aftermarket parts support helps add value to every system it designs and builds.





Quantum Quench™ – 4 Directional Gas Flow outline diagram





TECHNOLOGY SPOTLIGHT

ADVERTORIAL

DMP CryoSystems

DMP CryoSystems continues to offer customers maximum process flexibility with its complete line of combination furnace/freezers and loaders. Full in-house design and flexible manufacturing capabilities permit custom integration with existing production lines. Our new Level 2 HMI control package offers recipe management, data logging and complete system integration.

TECHNOLOGY SPOTLIGHT

ADVERTORIAL

Graphite Metallizing Corp.

Graphite Metallizing Corp. announces GRAPHALLOY® Type 163 Pillow Block Assemblies for high-temperature and submerged environments that do not require the use of grease or oil. GRAPHALLOY Type 163 Pillow Block is a rugged, easy-to-install design for moderate speed applications that will operate successfully under high or low load conditions. This heavy-duty unit is available in cast iron or stainless steel. A cast iron split-angle housing is also available.

Pillow Block Type163 is suitable for high-temperature applications such as ovens, drag-line conveyors and dampers. This pillow block also performs well in wet applications such as wash downs and submerged applications like plating tanks and industrial washers.

All GRAPHALLOY pillow blocks have a low coefficient of friction, can withstand submerged conditions and are chemically resistant and non-galling. Since the self-lubricating properties of GRAPHALLOY are constant throughout the material, these pillow block assemblies will provide long life and reliable operation.

TECHNOLOGY SPOTLIGHT

ADVERTORIAL

Grieve Corp.

No. 954 is an electrically heated 2000°F (1093°C) inert-atmosphere, heavy-duty box furnace that can be used for heat treating titanium. To heat the load, 57 kW are installed in nickel chrome wire coils, supported by vacuum-formed ceramic fiber. Workspace dimensions measure 30 inches wide x 48 inches deep x 30 inches high. The oven's 7-inch-thick insulated walls comprise 5 inches of 2300°F ceramic fiber and 2 inches of 1700°F ceramic fiber, while the 6.5-inch floor insulation comprises 4.5 inches of 2300°F firebrick and 2 inches of 1200°F block insulation. Controls include a digital programming temperature controller, manual reset excess temperature controller with separate contactors and a strip chart recorder.

TECHNOLOGY SPOTLIGHT

ADVERTORIAL

I Squared R Element Co.

Developed in response to customers' increasing needs for higher-performing SiC heating elements for use in more technically challenging applications, we are proud to introduce Starbar-type HDS and HDS-LMA.

Starbar HDS and HDS-LMA are high-density (2.65-2.7 g/cc), high-strength recrystallized silicon carbide rod-type heating elements that exhibit exceptional oxidation resistance, which leads to extremely slow aging in service and very long element life.

HDS-LMA is an HDS element infused with LMA glaze coating for even higher levels of protection for use in chemically aggressive furnace atmospheres containing water vapor, alkali metal species and flux vapors and in applications that utilize oxygen enrichment.

HDS-type elements have a very strong, robust crystal structure that has been developed for optimum performance.

INEX Incorporated
Composite Radiant Tubes

INEX

The Obvious Choice Around the World

Don't take our word for it, read what one of our customers has to say...

September 23, 2008

Attn: Mike Kasprzyk

We want you to know that we are very pleased with the quality burner tubes that your company has provided us. As you know we have been using your Inex composite radiant tubes since 1997 with great success.

The life of the alloy tubes was typically only 18 to 30 months. We have a total of 98 straight Inex tubes in service and many of those are 7 to 11 years old. With the ability of being able to transfer more Btu's per sq. inch than alloy, we are able to heat loads faster and increase the throughput of our furnaces. The burner tubes have also reduced Natural gas consumption to our furnaces by the increased heat transfer.

We sincerely appreciate your responsiveness and the way you conduct business. We have recommended your company to others because of our satisfaction with your products and service. We look forward to doing business with you for years to come.

Sincerely,

Chris Zubroski
Operations Manager
Donohoo Steel Treating Co.

TEN YEARS AGO

Chris Zubroski then operations manager and now owner of Donohoo Steel Treating wrote the letter above to INEX. *Guess what?*

Now **TEN YEARS LATER** nearly all of those tubes are still in service. **TWENTY YEARS** and still providing outstanding performance and savings.

INEX
9229 Olean Road
Holland, NY 14080
Phone: 716-537-2270
Fax: 716-537-3218
inex@buffnet.net
INEXinc.net

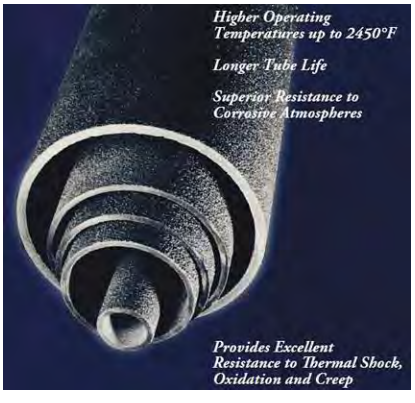
It's all about the bottom line.

Why would any heat treater spend more for composite (silicon/silicon carbide) radiant tubes? The answer is really very simple. All metal alloy (nickel/chrome) tubes fail. Metal tubes are also limited in their ability to transfer heat at high flux rates. These two factors are overcome by using the advanced technology of composite radiant tubes.

The true cost of limited alloy tube life is more than just the tube replacement costs. Realistically, the labor to replace the tubes also has to be considered. Far more significant is the loss of production time. Often, tube failures can also result in quality problems.

Nearly all heat treaters worldwide would like to improve the throughput of their furnaces. Often, the recovery time of batch furnaces can be dramatically shortened by the high flux capability of INEX tubes. Similarly, continuous furnaces of all types can be sped up if more heat can be transferred in the first zones. The ability to effectively transfer at heat fluxes twice the rate of metal tubes makes this possible.

The long-term durability and superior heat transfer of composite radiant tubes translate directly to the bottom line.



TECHNOLOGY SPOTLIGHT

ADVERTORIAL

The Bright World of Metals

THERMPROCESS 2019, the 12th International Trade Fair and Symposium for Thermo Process Technology, will take place June 25-29 at the fairgrounds in Düsseldorf, Germany. As the leading international trade show for the thermal-processing industry, THERMPROCESS 2019 will provide a complete overview of the latest developments and technologies for this sector – ranging from industrial furnaces, industrial heat-treatment installations, thermal processes, equipment and components to occupational safety and ergonomics. The THERMPROCESS Symposium will complement the exhibits.

THERMPROCESS will be a business platform for over 300 exhibitors from 30 countries and visitors from around the world to exchange knowledge and ideas.

Held concurrently will be the three thematically related trade fairs GIFA, METEC and NEWCAST. Forming the "The Bright World of Metals," the four trade fairs will focus on foundry, castings, metallurgy and thermal-processing technology.

Metallurgical High Vacuum

We remanufacture systems, large or small chambers, their pumps and controls. We also design and build pumps. Our technology and knowledge was gained from over 33 years of vacuum experience. Metallurgical High Vacuum (MHV) earned a reputation for high-quality engineering and manufacturing. Customers depend on MHV for keeping their operations running and costs under control.

Faster Parts Delivery from Large In-Stock Inventory

MHV's Parts Express can get you the valves, gaskets, shafts, eccentrics and other parts to keep you running. MHV has a record of experience and high quality for long-lasting pump rebuilds regardless of original manufacturer: Stokes/BOC Edwards, Kinney, Oerlikon/Leybold, Aerzen, Agilent/Varian, Tuthill MD or Dresser Roots.

Technical Support

Customers and others in the thermal-processing industry are looking for answers to their problems. From "leak checking" to "how to" to "what causes" issues, we do our best to resolve them quickly.

MHV is an ISO 9001:2015-certified supplier.

MHV-designed chamber, traps and blower pumping system ready to be installed for decades of production.

Pfeiffer Vacuum

Pfeiffer Vacuum is one of the world's leading providers of vacuum solutions for industrial applications. The product portfolio comprises a wide range of vacuum pumps, gauges, gas analyzers and leak detectors. Pfeiffer Vacuum has over 125 years of experience in building pumping stations.

What sets us apart?

Pfeiffer Vacuum's innovative magnetic coupling available on our Roots pumps eliminates the shaft seal to provide more reliable operation. Since the shaft seal is eliminated, there are no unexpected process interruptions due to oil leaks. This technology offers a safer environment – no oil on the floor. It also reduces downtime since there is no radial shaft seal to maintain.

Vacuum Pumping Stations

Pfeiffer Vacuum CombiLine™ pumping stations offer solutions in low, medium and high vacuum with a pressure range of up to $5\text{-}10^{-4}$ mbar. CombiLine pumping stations are a combination of individual vacuum pumps and components that are mounted on the same frame with interconnecting piping.

Standard and Gas-Cooled Roots Vacuum Pumps

Pfeiffer Vacuum OKTA G series Roots pumps with pumping speeds from 210-12,000 m^3/h offer solutions in the low and medium vacuum range. The air-cooled pumps provide high differential pressures with lower power consumption.

Mobile Helium/Hydrogen Leak Detectors

The ASM 310 helium/hydrogen leak detector is the lightest (just 46 pounds), smallest footprint (133 in^2), and fully configured helium mass spectrometer leak detector available.

PFEIFFER VACUUM

PUMPING STATIONS FOR INDUSTRIAL APPLICATIONS

Robust and with exclusive magnetic coupling technology

With our robust Roots pumping stations featuring various backing pumps, we provide the optimal solution for your industrial applications. Pfeiffer Vacuum has decades of experience in building custom pumping stations and providing technical support, training and on-site service.

Benefits of magnetic coupling:

- Reliable operation – no unexpected process interruptions due to oil leaks
- Eliminate downtime – no radial shaft seal maintenance required
- Safer environment – no oil on the floor

Are you looking for a complete vacuum solution? Please contact us:
Pfeiffer Vacuum, Inc. · USA · T 800-248-8254 · F 603-578-6550 · contact@pfeiffer-vacuum.com · www.pfeiffer-vacuum.com

Plibrico

Fast Refractory Repair Solution for Steel and Aluminum Producers

As domestic production of steel and aluminum continues its upward trajectory, the furnaces used in mills to process these metals are running at near capacity to meet surging demand. This ramped-up production is taking a toll on the refractories installed to protect furnace linings against mechanical stress, abrasion and corrosion brought on by temperatures that could approach 3000°F. At peak production, few mills have the opportunity to perform time-consuming refractory repairs.

Plibrico, a leader in the design, fabrication and installation of industrial refractories, is helping steel and aluminum makers significantly reduce the time and labor costs required to repair furnace refractory linings with its Redi-Shapes™ line of precision precast shapes.

In general, precast refractory shapes are precisely manufactured for specific locations within a furnace or boiler. Due to the precision needed to produce quality shapes, precast shape technology has become a very specialized field within the refractory industry. Plibrico Redi-Shapes are engineered refractories that are tailor-made to the exact specifications of a furnace, in any size or intricate configuration, from 10 to 15,000 pounds.

"Redi-Shapes are a customized, quality refractory solution that lets managers at steel and aluminum plants isolate a repair in a recurring high-wear zone and get their furnaces back to service faster," said Ed Christian, Plibrico Company's Midwest Operations general manager. "Confining replacement work to high-wear areas eliminates costly, time-consuming tear-outs of major portions of the adjacent refractory lining. Quick installation of Redi-Shapes reduces downtime and saves on labor costs. Repair work that may have taken days using traditional refractories can be performed in hours thanks to Redi-Shapes."

For steel and aluminum producers, precast shapes can be used in a number of applications and high-wear areas including: wall and roof panels, hearth block, lintels, door jambs, door sills and ramps, aluminum troughs, dry skid block, burner block and doors and blades.

Plibrico's deep expertise in precast shape manufacturing ensures perfectly contoured, dimensionally accurate blocks molded from the company's high-quality castable and plastic refractory materials to withstand the most demanding thermal conditions. Custom firing optimizes shape properties for specific application challenges, such as abrasion, erosion, thermal shock or metal and slag penetration. And because they are custom made to precise sizes, Redi-Shapes eliminate the need to tear-out major positions of the refractory lining adjacent to the damaged zone. The precast shapes are ready for immediate installation when delivered and can be kept in inventory and used when emergency repairs are needed.

Superior refractory properties and ready to install – Plibrico Redi-Shapes can reduce your downtime and get your heat-processing equipment back into operation faster.

Solar Manufacturing

As one of the nation's premier developers of innovative vacuum furnaces, Solar Manufacturing strives to deliver energy-efficient hot zone designs, feature-rich SolarVac® automation and controls and high-performance gas quenching systems. Our trail-blazing engineering offers commercial and captive heat treaters the most technically advanced furnaces designed for a wide range of vacuum heat-treating processes. At Solar Manufacturing, we are constantly looking for ways to improve furnace performance.

Our ability to create outstanding value is fueled by our experienced staff and our unique relationship with our affiliate company, Solar Atmospheres, a progressive commercial heat treater with four U.S. facilities and a vast number of operating vacuum furnaces. Our affiliation affords us an unparalleled testing ground for improving furnace design, operation, repair and maintenance. Together, every day, we develop new solutions to vacuum thermal-processing applications and advance the art and science of vacuum furnace technology. The benefit to all our customers is that Solar Manufacturing is uniquely qualified to assist you in choosing the right vacuum furnace or replacement hot zone for your needs.

When you do need a new furnace, we've got you covered with a wide range of horizontal front-loading and vertical bottom-loading furnace models and sizes. Solar Manufacturing is certainly known for its very large HCB series of vacuum car-bottom furnaces, uniquely designed to process large, heavy workloads of up to 150,000 pounds and 48 feet long. But large, custom furnaces are not all we do.

Our Mentor® is not your typical lab furnace. Compact but by no means short on capability, the internal quench Mentor is loaded with standard production furnace features and rugged enough to perform without compromise. The Mentor's work zone size (12" x 12" x 18" deep) allows heat treaters the convenience of running smaller workloads economically. The graphite-insulated hot zone is rated to 2800°F. And new for 2019 is the option of a refractory metal shielded hot zone for the processing of sensitive work. The stainless steel chamber and all other components are mounted on a single, portable platform for easy shipment and maneuverability. Like our larger production furnaces, the Mentor is complemented with SolarVac® Essentials for best-in-class automation and controls.

Solar Manufacturing has also developed a name throughout the industry in aftermarket support for replacement hot zones, spare parts and prompt professional service. Whether you need a durable, energy-efficient replacement hot zone, fast responsive spare parts, field service or a maintenance contract, we are ready to provide you with reliable support.

All Solar Manufacturing furnaces and replacement hot zones are designed for long life, easy maintenance and minimal downtime. Not only is every furnace fully tested prior to shipment, a factory service engineer starts-up and field tests after installation. Every new furnace and replacement hot zone carries a full one-year warranty.

Some say our success is from thinking outside the box. We call it ingenuity.

TECHNOLOGY SPOTLIGHT

ADVERTORIAL

Super Systems Inc.

Super Systems Inc. provides a worldwide presence supporting thermal applications with offices around the globe. Stemming from our expertise in atmosphere control and engineering services, we have brought flow control and measurement to our suite of products. Covering applications such as atmosphere furnace control, nitrogen methanol mixing systems, endothermic generator demand systems and a plethora of standalone flow meters, we are now addressing control and monitoring gas and liquids used in heat treating worldwide.

*e*Flo 2.0 is SSi's newest electronic flow measurement instrument. *e*Flo 2.0 is designed for the harshest industrial environments, allowing for easy replacement of manual flow meters and seamless integration into existing control systems. *e*Flo 2.0 features Bluetooth connectivity, pressure and temperature compensation, inlet/outlet pressure display and more in a compact footprint.

For endothermic generator control, SSI's AutoGEN represents the latest technology in controls utilizing sophisticated flow loop algorithms to perform demand-based control. AutoGEN is designed to fully automate generator control including temperature, dew point, air/gas flow and automatic turndown. AutoGEN is easily configured for single or multi-tube generators and provides an easy-to-use interface with visibility of all configuration parameters, process variables, current/historical charts, alarms and inlet/outlet gas flows.

Surface Combustion Inc.

RX® Endothermic and DX® Exothermic Controlled Atmosphere Gas Generators

Surface® Combustion pioneered the development of RX endothermic gas to be used as the atmosphere for modern gas carburizing. This revolutionized the heat-treating industry and enabled boost/diffuse carburizing, as well as carbon control instrumentation and sensors.

With the largest installed base of RX endothermic atmosphere generators in North America, Surface Combustion proves the rugged reliability of their products. Built-in maintenance features and online diagnostics provide maximum uptime and process repeatability.

To improve uptime, we offer online burnout, where a retort can be taken offline and reconditioned by passing air through the retort while at temperature, and a backup mixture pump, which allows for switching on and off to allow for continuous operation when maintenance is required.

Control features include our ESATM system, which employs dual, commercially available automotive oxygen probes to control the dewpoint (e.g., carbon potential) of the RX endothermic atmosphere.

Today, we are expanding online diagnostic capabilities that monitor each retort for equalized flow, pressure, temperatures and utilization.

Depending on the height of the alloy retort, maximum flow rates of 2,000 cfh (cubic feet per hour) or 3,000 cfh can be produced in each retort. Our standard modular designs range from one to five retorts. As furnace demand for RX gas changes, our generators have a 6-to-1 turn down maintaining quality gas composition.

Surface® Combustion leads the way with a versatile DX exothermic atmosphere gas generator design that is used in metallurgical processes including annealing, normalizing, and bluing. Applications include the pipe, tube, wire and motor industries.

Many customers want the flexibility of higher combustibles in the range of 10% CO (carbon monoxide) and hydrogen (rich exothermic) AND lower combustibles in the range of 4% CO and hydrogen (lean exothermic). Surface Combustion offers both capabilities in the same generator with a simple change of the burner air/gas ratio and/or increased second or third stage gas cooling for batch and continuous furnaces. All of this is necessary for properly balancing the CO/CO_2 and H_2/H_20 ratios in the presence of steels of different carbon potentials.

Capacity ranges from a minimum of 2,000 cfh up to a maximum of 30,000 cfh. Typical DX generators have 2-to-1 turn down capabilities to allow for reducing flow when furnaces are taken offline or when furnace vestibules need to be purged with higher flows.

For further information or assistance in selecting and sizing your heat-treat atmospheres, contact Surface Combustion. We have a knowledgeable staff backed by our customer-service team and full inventory of RX and DX atmosphere generator parts.

Let us show you the Value of Surface.

TECHNOLOGY SPOTLIGHT

ADVERTORIAL

Protection Controls Inc.

Combustion Safeguards

Protection Controls Inc. offers this comprehensive Service Manual covering all PROTECTOFIER combustion safeguard units. It provides important and valuable information on installation, service guides, testing and troubleshooting, as well as specifications, features and application on Protection Controls' single and multi-burner units.

Protectofier provides continuous, automatic protection against buildup of combustible fuel mixtures due to flame failure or other faults in furnaces, ovens, boilers and other heating equipment. The system is used in any application where gas or oil burners are used. This includes heat-treating furnaces, paper and textile dryers, glass and brick kilns, dryers, air make-up heaters, thermal oxidizers and afterburners, crematories, and many more.

TECHNOLOGY SPOTLIGHT

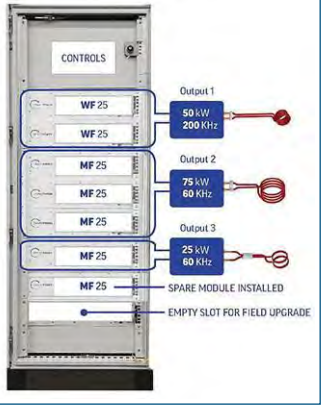
ADVERTORIAL

UltraFlex Power Technologies

The advantage of Smart Power™ is that it is field-upgradable and reconfigurable. This provides flexibility and allows for rapid switching from one process to another with minor changes. Smart Power provides users the capability to purchase based on their current requirements. When production demands increase, another module can be added.

The modular system's significantly reduced size and weight saves floor space and shipping cost. Also, the cooling system's size can be reduced, resulting in additional energy and space savings.

Adding extra capacity as spare power modules to a Smart Power system will reduce production downtime and maintenance costs.



T-M Vacuum Products

A pioneer in the high-vacuum heat-treating industry, T-M has been manufacturing high-vacuum furnaces and ovens since 1965 in our New Jersey facility. Our furnaces come in a work-zone sizes ranging from 2-36 cubic feet with operating temperatures from 200°C (392°F) up to 2000°C (3632°F) with ±3°C temperature uniformity available in most models. We offer vacuum/pressure levels to 10^{-8} torr/6 bar.

Our furnace systems come with full computer control and data logging, and our ovens come with PLC/color touch-screen interface control and data logging. We offer a wide range of sizes and options to fit your budget.

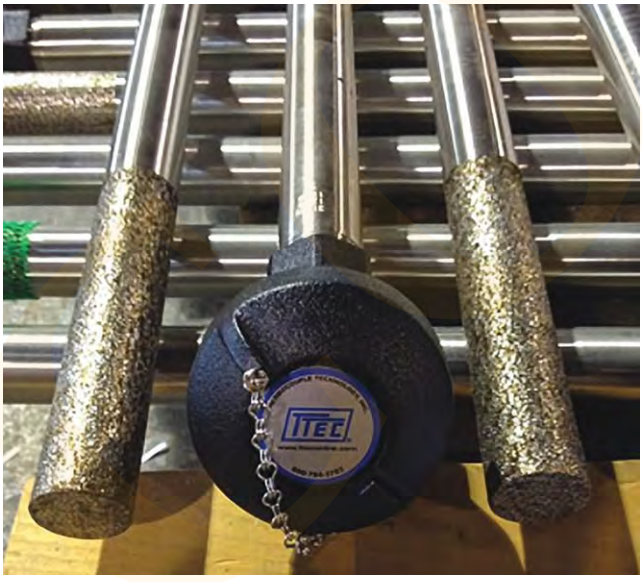
Thermocouple Technology

Thermocouple Technology offers a revolutionary MVD Tungsten Carbide Treatment for thermowells, protection tubes and other critical components.

The product is used to create a stronger, long-lasting product. The Tungsten Carbide is fused with the thermowell material and becomes an integral part of the mass of the well, resulting in a substantially harder and more durable product. The treatment is specially designed for highly abrasive/erosive environments with temperatures ranging from 0-2000°F in typical applications and as high as 2350°F when utilizing their highest performance alloys as the substrate.

The MVD Treatment increases the life of the elements by 2-4 times in most applications, with some applications lasting more than 10 times as long. MVD has been tremendously successful in extending the lifespan of protection tubes, thermowells and multipoint assemblies found in coal-fired power plants across the world.

Thermocouple Technology uses this superior product upon request and is capable of treating applications up to 50 feet in length.



Wisconsin Oven
Horizontal Quench System

Wisconsin Oven Corp. designs and manufactures horizontal quench systems for heat-treating applications. These systems are a cost-effective alternative to a drop-bottom furnace for applications requiring a quench time of 7-15 seconds (depending on load size and customer requirements). It is available in 10 standard sizes, has maximum temperature ratings up to 1400°F and provides excellent temperature uniformity. The horizontal quench system has standard load capacities of up to 6,000 pounds. These features, combined with its range of quench times, make it ideal for a wide range of solution heat-treating applications.

The standard operating procedure for a horizontal quench system is similar to that of a drop-bottom furnace. Parts are loaded on a work grid located on the rollers (quench platform). An electric pusher/extractor mechanism pulls the load into the furnace for heat treating. After the heating cycle is completed, the pneumatically operated vertical lift door is opened and the extractor mechanism pushes the load onto the quench platform. Then the load is quenched. An optional two-tier quench platform will allow one load to be charged into the furnace while another load is quenched. These systems can be designed for manual or automatic operation.

There are many benefits to a horizontal quench system compared to a drop-bottom furnace. Horizontal quench systems are easier to service and maintain due to the fact that most components are on or near floor level. They also cost, on average, 25-50% less when compared with a similar-sized drop-bottom furnace.

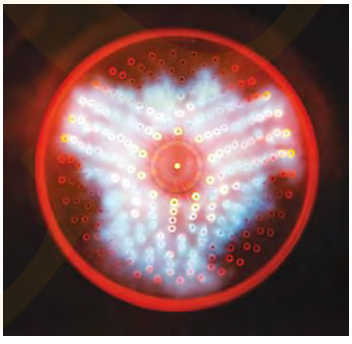
WS Thermal Process Technology Inc.

REKUMAT: Energy-Efficient Self-Recuperative Burners

Recognizing the deficiencies of conventional gas burners, WS developed the REKUMAT high-velocity self-recuperative burner series. Ranging from 15,000 to 1,100,000 BTU/hour, REKUMAT burners are equipped with an integrated heat exchanger of either metallic or ceramic composition. The recuperator uses hot exhaust gases to preheat combustion air in counter-flow and can thereby achieve efficiencies up to 75%.

REKUMAT burners with metallic recuperators are suited for temperatures of up to 2100°F in direct-fired applications and up to 1900°F in radiant tubes, whereas our burners with ceramic recuperators can withstand temperatures up to 2350°F.

All REKUMAT burners are capable of using the FLOX® combustion principle invented and developed by WS. This award-winning technology enables complete combustion of fuel gas without a visible flame and thus avoids peak combustion temperatures. In spite of high air preheat rates improving the efficiency, FLOX prevents an increase of NOx emissions usually associated with high air preheat ratios. In addition, the improved temperature uniformity reduces the wear of the burner and increases the product quality.



With over 80,000 REKUMAT burners installed worldwide since 1982, WS has proven that energy-saving combustion systems have become increasingly important. The potential for emission and fuel savings remains huge, and the payback times are short even at today's low energy prices.

LITERATURE & WEBSITE SHOWCASE

Materials Testing Equipment

Applied Test Systems

This brochure gives an overview of ATS' extensive line of affordable yet uncompromising materials testing equipment. ATS is large enough to offer an extensive line of standard products. However, it is and always will be flexible enough to custom-tailor any systems for a specific application.

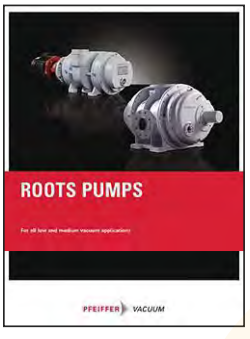
www.atspa.com

Vacuum Pumps

Metallurgical High Vacuum Corp.

Three recently introduced pumps include a 430 CFM model and two 300 CFM models, available with high-pressure lubrication, oil filtration and a full gauge package. These high-quality pumps are American-made. MHV provides in-depth service, design and engineering on a wide range of high-vacuum equipment.

www.methivac.com



Roots Vacuum Pumps and Stations

Pfeiffer Vacuum

Pfeiffer Vacuum OktaLine series Roots pumps feature pumping speeds from 145 to 27,400 m^3/h. The pumps achieve very high compression values and high pumping speed at very low gas exit temperatures. OktaLine Roots pumps offer low operating costs at high uptime, since electrical power and a gaseous purge medium are all that they require.

www.pfeiffer-vacuum.com

Combustion Safeguards

Protection Controls Inc.

This comprehensive Service Manual covers all PROTECTOFIER combustion safeguard units. It provides important and valuable information on installation, service guides, testing and troubleshooting as well as specifications, features and application on Protection Controls' single and multi-burner units. For a free copy, fax 847-674-7009.

www.protectioncontrolsinc.com

Hardness Testing

Sun-Tec Corp.

Sun-Tec Corp. specializes in Rockwell-type, Brinell, Vickers and Knoop, Leeb, tensile/compression, ductility testing and sample preparation equipment. We also supply hardness standards, indenters and anvils. Clark Instrument, Detroit Testing Machine and Service Physical Testers are divisions of Sun-Tec, which is a 17025-accredited company.

www.sunteccorp.com

Carbon Atmosphere Analyzer

Super Systems Inc.

The CAT-100 atmospheric carbon potential analyzer provides a measurement of carbon potential in a furnace with a carbon-bearing atmosphere. The easy-to-use product provides a fast reading based on analysis of a metal coil soaked in the furnace for about 30 minutes. The CAT-100 has a color touch screen with features that include logging stored readings and furnace settings.

www.supersystems.com/CAT

Temperature Measurement

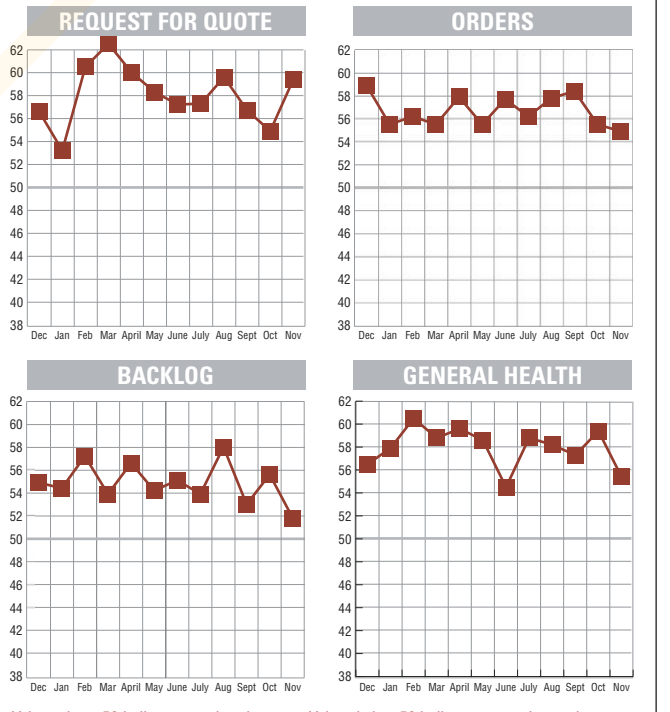
Thermocouple Technology

Thermocouple Technology (TTEC) manufactures a full line of industrial temperature measurement products, including thermocouples, RTDs, thermowells, transmitters, thermocouple wire, indicators, controllers and accessories. TTEC's experienced engineers specialize in custom-built temperature sensors for applications exceeding 4000°F.

www.tteconline.com

Lit/Web Showcases: Every month, *Industrial Heating* provides a way for you to get your literature or CD into the hands of the entire industry. Qualifying advertisers get a FREE literature showcase! Paid showcases are always available for $750/month for a full-color brochure cover reproduction. Max. 50 words. Contact Kathy Pisano: kathy@industrialheating.com

ECONOMIC INDICATORS



Values above 50 indicate growth or increase. Values below 50 indicate contraction or decrease. To participate in this survey, please contact Bill Mayer at bill@industrialheating.com

Parts, Service & Consulting Aftermarket

PARTS • SERVICE • CONSULTING

Contact: Becky McClelland • Phone: 412-306-4355 • Fax: 248-502-1076 • becky@industrialheating.com

2019 Rates: Just $150 per month for a single card, $295 for a double card. We'll post your ad online for an additional $30.

INDUSTRIAL HEATING
offers high-impact packages so you can find the most qualified job candidates!

Contact Becky McClelland at: 412-306-4355 or becky@industrialheating.com
2018 Print Rates: $150 per column inch for 1x frequency; $140 for 3x; $125 for 6x; $120 for 12x
▶ **Print ad PLUS online posting:** Add $49.00
▶ **Print ad, Online Ad PLUS IH Daily News Brief Eblast:** Add $75.00
Web ONLY! Need Maximum Exposure Right Away? Online Ad Posting, IH Daily Newsbrief and Listing: $250.00

EQUIPMENT FOR SALE

We Have Over 500 Pieces of Equipment in Stock
If your needs are not listed below, please let us know and we will locate a furnace/oven to suit your needs. We have all the ancillary equipment available for the above such as Tempering Furnaces, Washers, Charge Cars and Endo Generators.

Price is what you pay. Value is what you get. –*Warren Buffett*

NEW **SELAS**
Selas Gas Fired Car Bottom Furnace, 6'W x 7'H x 10'L, 1,800°F, 3,000,000 BTUH, 6 North American Tempest Burners, 460V/3Ph/60Hz, variable speed drive, combustion blower complete with free-standing panel and controls.

WISCONSIN
WISCONSIN GAS FIRED BATCH OVEN, 6' x 6' x 6', 1,250°F, 10,000 lbs, 1.2 MBTUH complete with vertical rising door, insulated floor with tracks for load cart, cart included and controls.

SHERWOOD
Sherwood Gas Fired Mesh Belt Furnace, 5'W x 10'H x 30'L (Heated), 500°F, 500,000 BTUH c/w controls.

VACUUM INDUSTRIES (CENTORR)
Vacuum Industries (Centorr) VII Metallurgical Vacuum System, 6"W x 5"H x 15"L, 2,400°F, 460V/3 PHASE/60 CY/55 AMPS/38 KVA c/w controls, pumps etc

CAR BOTTOM FURNACE
Gas Fired Car Bottom Furnace, 10' wide x 25' long x 8' high, 1,650°F, 18,000,000 BTUH, 16 North American Burners, 3 zones of control, 440V, 3 Phase, 60 Cycle complete with controls.

ABAR
ABAR HORIZONTAL VACUUM FURNACE, 2 BAR, 24"W X 18"H X 36"L, 2,400°F, 1,000 LBS, 150 KW complete with Nitrogen or Argon Atmosphere, Spencer Blower, Varian Diffusion Pump, Stokes Mechanical Pump, Roots Blower Moly Elements, controls, circular hot zone and loader.

ABAR
ABAR HORIZONTAL VACUUM FURNACE, 2 BAR, 24"W X 24"H X 36"L, 2,400°F, 1,000 LBS, 150 KW complete with Nitrogen or Argon Atmosphere, Spencer Blower, Varian Diffusion Pump, Stokes Mechanical Pump, Roots Blower Moly Elements, controls, circular hot zone and loader.

INDUSTRIAL HEATING EQUIPMENT
Industrial Heating Equipment Gas Fired Mesh Belt Furnace, 24"W x 10"H x 22'L, 500,000 BTUH, 950°F c/w controls.

PARK THERMAL
Park Thermal Electric Salt Bath Nitriding System complete with 30" Dia. X 36" deep Pre-Heat Furnace, Nitriding Salt Bath, 38" x 38" x 30" deep Oxidation Quench Tank, 30" x 40" x 36" deep Oxidation Quench Tank, 2 Wash Tanks, 3 Rinse Tanks, 4 Air Cool Stations and Controls.

PARK THERMAL
Park Thermal Gas Fired Mesh Belt Furnace, 17-1/2"W x 7"H x 15' 8"L, 375,000 BTUH, 900°F c/w controls.

SURFACE COMBUSTION
Surface Combustion Gas Fired Mesh Belt Furnace, 42"W x 12"H x 36'-6"L (heated), 1,350°F, 2,000,000 BTUH, 2 zones, 3 fans and controls.

SURFACE COMBUSTION
Electric Batch/Oil Quench Furnace, 30" W x 30" H x 48"L, Max. Temp. 1,950°F, System 1 Rear Handler, 3500 Gal. Quench Tank, 2 Agitators & Controls.

AFC - HOLCROFT
(2) INTEGRAL QUENCH FURNACES, 36"W x 30"H x 48"L, 1,800°F Max, Recuperated with Top Cool, Rear Handler, Oil Heaters (54kW), Re-Circ. Fan, Control System.

SURFACE COMBUSTION
(2) INTEGRAL QUENCH FURNACES, 30"W x 30"H x 48"L, 1,750°F, 1,000,000 BTUH, Trident Tubes, Endo/Natural Gas/Ammonia, SSI Atmosphere Controllers, SSI Gold Probes, Oil Filters And SBS Coolers. System Comes Complete with a Gas Fired Temper, Washer and Charge Car.

SURFACE COMBUSTION
INTEGRAL QUENCH FURNACE, 10,000 lb. payload, 87" W x 87" L x 36" H, 1,850°F, 4,600,000 BTUH, 12,500 Gallons, 6 Agitators, Eclipse Burners, 3 Rear Handlers & Controls with PLC.

HUBER
Huber Gas [illegible] x 8'H x 12'-8"L, 1,800° [illegible]
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HOLCROFT
Holcroft Gas Fired Mesh Belt Furnace, 24"W x 9"H x 14' 8"L, 400,000 BTUH, 750°F c/w controls.

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Batch

C0052 Surface Combustion Temper Furnace (30"W x 48"L x 30"H, 1200°F, gas-fired)
C0068 Despatch Aluminum Aging Box Furnace (60"W x 72"D x 66"H, 395°F, electric)
U3624 Lindberg Nitrogen Temper Furnace (24"W x 36"D x 18"H, 1350°F, gas-fired)
V1010 Dow Batch Temper Furnace (30"W x 48"L x 20"H, 1250°F, gas-fired)
V1024 PIFCO Batch Temper Furnace, Skid Hearth (36"W x 48"L x 30"H, 1200°F, electric)
V1068 Surface Combustion Oil Quench Furnace (30"W x 30"D x 48"H, 1950°F, gas-fired)
V1095 Surface Combustion Temper Furnace (30"W x 48"D x 30"H, 1250°F, gas-fired)
V1096 Surface Combustion Temper Furnace (30"W x 48"D x 30"H, 1400°F, gas-fired)
V1106 Dow Batch Normalizer Furnace (45"W x 84"D x 32"H, 1800°F, gas-fired)

Batch High-Temp Furnaces

U3556 Pacific Industrial Batch High-Temp Furnace (24"W x 36"L x 18"H, 2800°F, electric)
U3637 Pacific Scientific Batch Temper Furnace (30"W x 48"D x 24"H, 1600°F, gas-fired)
U3643 Surface Combustion Temper Furnace (30"W x 48"D x 42"H, 1400°F, electric, 81kw)
V1013 Thermolyne High-Temp Batch Furnace (10"W x 14"L x 9"H, 2000°F, electric)
V1067 Seco Warwick High-Temp Batch Furnace (24"W x 36"D x 24"H, 2000°F, electric)
V1130 Onspec Slot Forge Furnace (72"W x 96"D x 48"H, 2400°F, gas-fired)

Car Bottom Furnaces

C0086 Huber Car Bottom Furnace (10'4"W x 12'8"D x 8'H, 1800°F, gas-fired)
U3653 Thermal Dynamix Car Bottom Furnace (5'W x 10'D x 5'H, 1650°F, gas-fired)
V1144 Selas Car Bottom Furnace (72"W x 120"D x 84"H, 1800°F, gas)

Drop Bottom Furnaces

C0069 Enviro-Pak Drop Bottom Furnace (48"W x 48"D x 48"H, 1200°F, electric)
U3543 Despatch AL Quench Drop Bottom Furnace (48"W x 72"L x 48"H, 1200°F, electric)

Internal Quench Furnaces

C0064 Lucifer IQ Furnace (18"W x 24"D x 18"H, 1900°F, electric)
U3569 Surface Combustion IQ Furnace (24"W x 36"D x 18"H, 1750°F, gas-fired)
V1046 Surface Combustion IQ Furnace (87"W x 87"L x 36"H, 1850°F, gas-fired)
V1082 Holcroft IQ Furnace with Top Cool (36"W x 48"D x 30"H, 1850°F, gas-fired)
V1093 Surface Combustion Allcase IQ Furnace (30"W x 48"L x 30"H, 1850°F, gas-fired)
V1111 Surface Combustion IQ Furnace (30"W x 48"D x 30"H, 1850°F, gas-fired)

Mesh Belt Brazing Furnaces

C0102JL Becker MB Brazing Furnace w/Exo & Dryer (30"W x 24'5"heated L x 10"H, 2050°F, electric)
U3529 CI Hayes Mesh Belt Brazing Furnace (18"W x 6"H x 8' heating, 2100°F, electric)
U3592 JL Becker Mesh Belt Brazing Furnace (12"W x 6"H, 2100°F, electric)
V1035 Seco Warwick Mesh Belt Brazing Furnace (18"W x 12"H x 8'heated, 2100°F, electric)

Mesh Belt Tempering Furnaces

C0044 CGS Moore Mesh Belt Curing Oven (22"W x 20'L x 10"H, 500°F, gas-fired)
C0073 Heat Machine Mesh Belt Tempering Furnace (24"W x 10'L x 4"H, 1000°F, gas-fired)
C0075 Industrial Heating Mesh Belt Tempering Furnace (24"W x 22'L x 10"H, 950°F, gas-fired)
C0080 Surface Combustion Mesh Belt Temper Furnace (18"W x 11"H, 13' long, 1000°F, gas-fired)
C0081 Park Thermal Mesh Belt Temper Furnace (17.5"W x 7"H, 15'8" long, 900°F, gas-fired)
C0083 Eltropuls Plasma Furnace System (56"Dia x 80"D, 1022°F, electric)
C0090 Hengli Mesh Belt Sealing Furnace - Atmosphere (6"W x 3.5"H, 2100°F, electric)
U3638 American Gas Furnace MB Temper Furnace (31"W x 5'H, 17' heated length, 1200°F, gas-fired)
V1022 Surface Combustion Mesh Belt Tempering Furnace (42"W x 12"H x 36'L, 1350°F, gas-fired)

Pit Furnaces

V1088 Leeds & Northrup Pit Furnace (24"ID x 30"D, 750°F, electric)

Pusher Furnaces

U3648 Ipsen P-12 Pusher Furnace (30"W x 30"L x 30"H, 1650°F,gas-fired)

Roller Hearth & Rotary Furnaces

U3550 PIFCO Powered Roller Hearth Temper Furnace (21"W x 120"L x 18"H, 1000°F, electric)
V1009 Ipsen Continuous Temper Roller Hearth Furnace (24"W x 120"L x 18"H, 1350°F, electric)
V1091 Finn & Dreffein Rotary Hearth Furnace (13'3"ID x 5'3"ID x 4'W x 2'8"H, 2275°F, electric)

Salt Pot Furnaces

C0136 Park Thermal Salt Pot Furnace (16" dia x 30" deep, 1650°F-1750°F, elect)

Steam Tempering Furnace

U3616 Degussa Durferrit Steam Tempering Furnace (24"Dia x 48"D, 1200°F, electric)

Tip Up Furnaces

C0043 Industrial Furnace Tip-Up Furnace (8'W x 22'4"D x 6'H, 1800°F, gas-fired)

Vacuum Furnaces

C0013 CI Hayes Oil Quench Vacuum Furnace (24"W x 36"D x 18"H, 2400°F, electric)
C0027 Pacific Scientific Vacuum Temper Furnace (24"W x 36"D x 24"H, 1450°F, electric)
C0111 Lindberg Vacuum Furnace (15"W x 24"L x 12"H, 2400°F, electric)
C0137 Surface Combustion 2-Bar Vacuum Furnace (48"W x 60"D x 48"H, 2400°F, elect)
U3612 AVS Vacuum Annealing Furnace 2-Bar (18"W x 24"D x 12"H, 2400°F, electric)
V1004 CI Hayes Vacuum Furnace, Oil Quench (18"W x 30"L x 12"H, 2400°F, electric)
V1131 Abar Vacuum Furnace (24"W x 60"D x 24"H, 2250°F, electric)
V1135 Abar Vacuum Furn Vert Bottom Load 2 Bar (72"Dia x72"Deep, 2400°F, electric)
V1136 Surface Combustion Vacuum Furnace, 2-Bar (26"W x 36"L x 22"H, 2400°F, electric)
V1138 Ipsen Vacuum Furnace, 5-Bar (24"W x 36"L x 14"H, 2400°F, electric)
V1143 Surface Combustion Vacuum 2-Bar Furnace (48"W x 60"D x 48"H, 2400°F, elect)

Endothermic Gas Generators

U3594 AFC-Holcroft Gas Generator (3,000 CFH Endo, gas)
U3635 Lindberg Hydryzing Gas Generator (6000 CFH Endo, gas)
U3647 Lindberg Gas Generator (3000 CFH Endo, 2050°F, gas)
V1075 Lindberg Gas Generator (3,000 CFH Endo, gas)

Exothermic Gas Generators

C0103 JL Becker Exothermic Generator (8,000 CFH Exo, 2050°F, gas)
U3652 Surface Combustion Gas Generator (10,000 CFH Exo, gas)
V1036 Seco Warwick Gas Generator (3,000 CFH Exo, gas)

Material Handling - Conveyors

U3565 Conveyor - Roller (48"W x 20'L)

Ovens - Cabinet

U020 Blue-M Oven/Ref (20"W x 20"H x 18"D), (-4°F/400°F)
U3625 Lindberg Atmosphere Oven (38"W x 38"D x 38"H, 850°F, electric)
U3629 Cabinet Oven (30"W x 30"D x 36"H, 750°F, electric)
U3642 Blue-M Oven/Ref, 20"W x 18"D x 20"H, (-4°F/400°F)

Ovens - Walk-In

C0039 Gehnrich Walk-In Oven (72"W x 96"L x 72"H, 400°F, electric)
C0108 Park Thermal Walk-In Oven (90"W x 144"D x 72"H, 850°F, gas-fired)
U3654 Precision Quincy Walk-In Oven (60"W x 72"D x 72"H, 700°F, gas-fired)
U3655 Wisconsin Oven Walk-In Oven (61"W x 144"D x 97"H, 650°F, elect)

Freezers

V1129 Webber Freezer (-120°F, electric)

Blowers

U018 Twin City Blower (20 HP, RBA-SW, Class 22)

Charge Cars

U3621 Dow Charge Car, DEDP (66"W x 60"D x 54"H)
V1085 Holcroft Charge Car (DE/DP, 36"W x 48"D)

Scissors Lifts & Holding Tables

V1086 Holcroft Scissors Lift & (2) Holding Tables

Heat Exchanger Systems

U030 Graham Systems Heat Exchanger - Plate
V1104 SBS Heat Exchanger - Air Cooled

Holding & Cooling Stations

V1113 Surface Combustion Forced Cool Station (30"W x 48"D x 30"H)
Many other holding stations - ask for details

Water Cooling Systems

U3404 JL Becker Cooling Tower with Tank: Tower: (51"W x 36"D x 64"H, Tank: 72"W x 84"D x 66"H)
U3595 JL Becker 2-Tank Water Cooling System, 2 Dayton 1HP Motors
U3646 HydroThrift, Duplex Pump Base, Water Cooling System
V1038 Bell & Gossett Shell & Tube Heat Exchanger with Tank

Washers

C0134 Surface Combustion Washer (60"W 60"D 40"H, 180°F, gas-fired)
V1084 Holcroft Spray/Dunk Washer (36"W x 48"D x 30"H, 190°F, gas-fired)
V1101 Surface Combustion Spray Washer (36"W x 48"D x 30"H, 180°F, electric, 58kw)

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V1137 T-6 Annealing & Aging Furnace Line

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