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MARCH 2018

Industry, Universities Collaborate 11

INSIDE

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With the unique designs and advantages of each heat-treating system, you may find yourself wondering, “How do I choose the best one for my needs?”

Essential Questions to Ask When Buying a Furnace

Buying a vacuum or atmosphere heat-treating system is much like purchasing a new car or a home – a lot of thought, research and careful consideration should go into the decision. However, unlike buying a car or home, it might be difficult to know all of the key items you should consider before making such a purchase.

Our Ipsen experts have compiled a list of 11 essential questions every furnace buyer should ask themselves before committing to a furnace, as well as a few key considerations for reducing downtime and extending the lifespan of the furnace.

Buying a Furnace

1. How many parts do you want to process per month?
2. What type of parts are you putting into the furnace?
3. What specifications are you trying to comply with?

Find out more …

Read the full technical article:
go.IpsenUSA.com/FurnaceBuyingConsiderations

Choosing a Hot Zone

When it comes to graphite and all-metal hot zones, it may be difficult to decide which type best fits your needs. After all, each has its own unique designs and advantages. The first post in Ipsen’s blog series, *A Look Inside the Furnace*, will:

- Examine the reasons behind the shift to graphite hot zones
- Compare the different benefits of graphite and all-metal furnaces
- Identify three basic questions that can help users choose the best hot zone for their vacuum furnace

Read the full technical article:
go.IpsenUSA.com/ChoosingAHotZone

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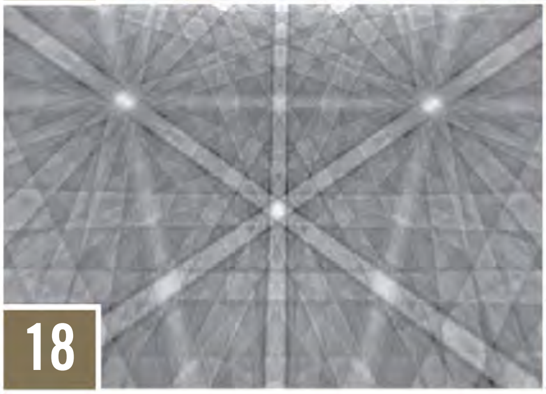
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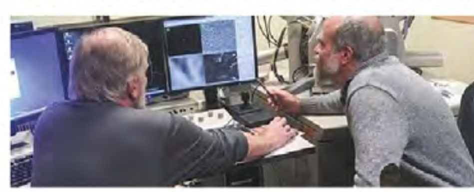

On the Cover:
The Quanta 600 field emission environmental scanning electron microscope is one of several instruments in the Materials Characterization Facility at Carnegie Mellon University (p. 18). This microscope can be used for the study of materials that are sensitive to electron-beam damage.

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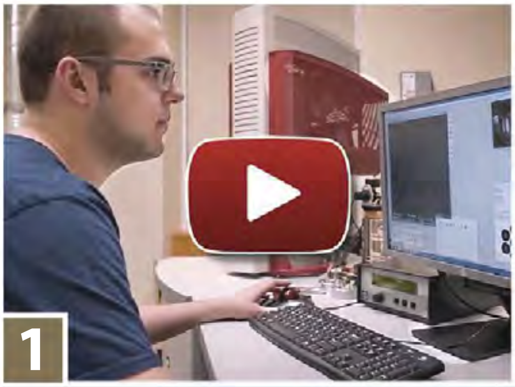

ONLINE

1 Video

Advancing the Science of Electron Microscopy

A Carnegie Mellon University research group develops and applies advanced electron microscopy methods for quantitative microstructural characterization and in-situ analysis of nanoscale materials, devices and novel alloys, including high-carbon and heat-treated steels.

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2 Web Exclusive

AI, IoT to Drive Service Sector Toward Data-Driven 2018

There's currently explosive growth in new technologies to gather and use data. The Internet of Things (IoT), AI-powered service organizations and equipping users to service their own assets are key trends that will impact the service industry in 2018. IoT, in particular, is poised to have a huge impact.

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Industry-University Collaborations

REED MILLER
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A recent *Harvard Business Review* article indicates that in the last decade, "There has been an explosion in the number of research deals between companies and universities." We have noticed this in our industry circles, but I hadn't really considered that it was a "movement" of sorts.

What has driven this change? It's a combination of reducing corporate R&D budgets and more limited government support of academic research. There has always been some collaboration on single projects of particular interest to the company involved, but what we are seeing today is an effort to develop long-term, collaborative relationships.

Evidence of this change is the goal of companies to have their R&D presence near major research universities. This has resulted in companies like Pfizer and Philips Healthcare moving their technology headquarters to the Boston/Cambridge area. General Electric also transferred its world headquarters and 600 tech-focused jobs to Boston in 2016.

There are a number of models for how companies collaborate with universities. Companies can fund or co-fund individual researchers working on projects of interest to the company. Instead of funding individuals, companies can connect themselves to an institution in order to develop a long-term research relationship. Sometimes these cooperative relationships are in the form of a consortium of companies that can take advantage of a larger pool of research through their participation in the consortium.

Materials Characterization Facility

Enter Carnegie Mellon University in Pittsburgh, Pa. This month, we begin our quarterly "Academic Pulse" (AP) column in 2018 with a new contributor. Dr. Marc De Graef is a professor of Materials Science and Engineering, the department from which I hold my master's degree. This series of columns will discuss the Materials Characterization Facility (MCF), which is involved in an industrial consortium comprised of about seven companies. The basic concept is that the consortium companies have access to all of the research being done at MCF and have input into future projects. This is a perfect example of what we discussed earlier about these industry-university collaborations.

In his column, Professor De Graef will shed some light on the type of research being done and help us better understand this type of collaboration. Perhaps someone reading this column will decide to take advantage of this opportunity. The AP column on page 18 introduces us to MCF, its capabilities and current projects.

Months ago, I was invited to visit the university and meet with Dr. De Graef to see the facility. We took a number of photos, and you can find them in the slideshow accompanying this column on our website. The resources at MCF are impressive and fairly unique. They have six SEMs, which use either a gallium or Zenon focused ion beam to see a 3-D micro. The Zenon unit is one of only three in the U.S. Other equipment at their disposal are TEMs as well as scanning-probe microscopy.

The iDome (pictured here with yours truly) is a device used to view things in 3-D using glasses similar to what you use for 3-D movies. This unique device is one of only two in the U.S. The other is at Baylor University.

Check out the videos on our website (www.industrialheating.com/videos) for more information about other research being done at CMU. This includes additive manufacturing (AM), which will certainly help industry by sorting out the process and better learning how to produce quality parts. CMU recently announced that they created a new master's-degree program in AM to equip graduates to move this process forward.

A Call for Term Limits

BARRY ASHBY
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Roger Sherman, a Founding Father of the U.S., wrote in 1788: "Nothing renders government more unstable than a frequent change of the persons that administer it." Sorry, sir, but you have not been to the U.S. Capitol lately.

Voters favor congressional term limits (74% according to a liberal Brookings Institution study), and legislation has been introduced to add a term-limit amendment to our Constitution in almost all Congress sessions since 1943. This 115th Congress is no exception. Representative Mike Gallagher (R-WI) initiated such an amendment legislation in 2017, but there has been no action on his bill to limit House terms to six years and Senate terms to 12 years. He has opined that Congress has a 96% re-election rate but has a "lower approval rating than cockroaches, colonoscopies and Genghis Khan."

This type of issue arises often in Congress – one that requires a two-thirds majority (290 votes) to pass a Constitutional amendment, which then must be ratified by 38 states. All of this is sham gamesmanship since the U.S. Supreme Court ruled 5-4 in May 1995 that states cannot impose term limits on elected Representatives and Senators. The concept of term limits is common within state and local government; 36 states impose limits for their governors, and 15 states limit their elected legislator time in office. Remember that of the 33 Constitution amendments contemplated by Congress, of which 27 were ratified by the states to become part of the law of our land, at no time has any state(s)-initiated change been enacted via the convention route.

But the views held by the public, which support term limits, are consistent. They are only rejected by a majority of Congressional aides, corporate lobbyists and federal bureaucrats as an opposition group, according to repeated analyses. Actually, polls of term-limit supporters favor three terms (versus up to six terms) in the House by a margin of 82% (versus 14% for six terms). A plurality of American citizens favors two-term limits.

A National Taxpayer Union study documented that the longer people serve in Congress, the bigger spenders and regulators they become. The bottom line, according to a CATO Institute study, is that "Americans believe that career legislators and professional politicians have created a gaping chasm between themselves and their government." A Gallup poll from five years ago cited that 75% of Americans would vote for any term-limit law, and 11% cited this issue as their "first choice" to fix Washington.

There are several aids for remedy and, as always, all require that you do something. First, think about it and decide if this is an issue that you and your country should address. Get more information. One place to look is a non-profit organization dedicated to work on this topic: U.S. Term Limits, 1250 Connecticut Avenue NW, Suite 200, Washington, D.C. 20006, 202-261-3532 (www.termlimits.com).

Second, contact your state legislature via elected representative to assure that term limits are an accepted topic at a Constitutional Convention, which 36 states have agreed is needed and 44 have provisions for joining a convention call. Only two-thirds, or 34 states, are needed to call for such a meeting. This is all defined under Article V of the Constitution but has never been used as a means to change the nation's Constitution. Every state except Hawaii has at one time or another called for a "Con-Con," and 35 states have an active call today that has not been rescinded. You are urged to take these actions within your state.

In closing, one of the most significant events in our republic's history occurred in Williamsburg Va., on Sept. 29, 2016, when 137 legislators from all 50 states met to discuss a Con-Con, something never before completed in our history. This meeting was motivated by thoughts of George Mason, another American Founder, who believed that no branch of government should have the power to determine the extent of its own power. The meeting was significant because it brings a term-limit solution closer to reality.

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Simulation Software (Part Two: Low-Pressure Carburizing)

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The acceptance of low-pressure (vacuum) carburizing (LPC) technology in manufacturing is due in large part to the ease of recipe development and modification made possible by the use of simulators designed specifically for this purpose. Let's learn more.

Simulator Basics

Today's LPC simulators are highly accurate, often being able to develop the proper recipe without test loads for most common steels (this is especially useful for the commercial heat-treatment industry). Custom steels or chemistry modifications often require only one or two test loads prior to starting production runs. Inputs for simulator calculations usually include material type, part geometry, carburizing temperature, hardening temperature, target effective case depth, surface area of the load and targeted final surface carbon content.

Based on this input data, a carburizing recipe is established complete with the number and duration of hydrocarbon gas injection steps during the boost stage and the number and duration of evacuation or gas dilution steps during the diffusion stage. Gas flowrates are precisely determined and controlled via mass flowmeters. The program output is displayed graphically, illustrating the carbon profile as a function of depth as well as the surface carbon concentration at various steps in the process (Fig. 1).

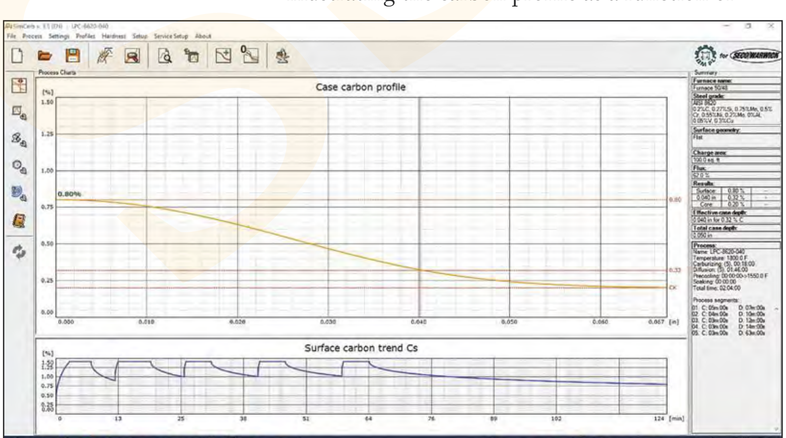

Fig. 1. Typical output screen from an LPC simulator *(courtesy of SECO/Vacuum Technologies)*

Material selection is typically done either from a lookup table of common steels (U.S. and/or European grades) or through the input of a custom chemistry. This chemical composition data (often in conjunction with Jominy data) is also used by some simulator packages to help determine proper quench response. These process simulators can also provide anticipated hardness profiles as a function of depth from the surface. It should be noted that when a carbon profile is converted into a hardness profile, part geometry and quenching variables may skew the final result.

One of the simplest ways in which to determine the effectiveness of a particular manufacturer's simulator is to review various material choices available and ask if the output recipe has been confirmed by extensive empirical trials. In other words, have loads been run and results analyzed via testing or just through scientific calculation?

Part geometry is usually limited to simple shapes (cylindrical, spherical, rectangular, etc.) rather than asking the user to input sophisticated geometries. On the other hand, calculation of load surface area must be more accurate (within about ±10%) so that the proper amount of hydrocarbon gas is added. Surface carbon values are lower than their atmosphere counterparts – 0.70-0.75% C being typical.

Outputs for simulator calculations usually include recipe/program, carbon profile, carbon flux/mass flow and surface carbon content.

While the final surface carbon content always corresponds to the setpoint value, it is important to recognize that most simulators estimate the carburizing case depth within about ±5% of this value. For this reason, an initial trial run is always recommended. It should also be noted that these simulators have now become more and more precise and should be able to produce specification requirements with little testing.

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Once a process has been successfully simulated, repeatability of results is almost a foregone conclusion (provided one has control of the equipment-induced variability).

Most simulator packages are run remotely on an office computer, and process recipes are uploaded to the furnace with a few keystrokes. They can also be manually input through a setup Wizard following instructions and dropdown menus (Fig. 2).

Tweaking the Cycle

In some instances, the data obtained by running test parts indicates that the recipe needs to be modified to fine-tune the results. Common reasons for this include issues with:

- Carbide formation and/or carbide necklacing. This indicates that either the surface carbon content is too high during the boost portions of the cycle, the diffusion time was insufficient, the soak time at temperature was too short or the final hardening temperature was too low. Possible recipe changes include either shortening the boost times or reducing the number of boost steps. Additionally, adding more diffusion steps or increasing soak times and/or temperature will eliminate the problem.
- Retained austenite. One possible reason for this is that the surface carbon content of the steel in question is too high, so lengthening the last diffusion step will help reduce the final surface carbon value. Another cause is direct quenching from carburizing temperature, so reducing the temperature before quenching is recommended.
- Carbon content too high/low. The surface area of the load should be carefully calculated to see if the gas flowrate value is too high/low. Some manufacturers offer a limited number of flowrates (e.g., high, normal, low) that are not ideally matched to the actual surface area present, resulting in a higher/lower surface carbon content than anticipated.
- Surface pitting. This indicates that the surface carbon was too low during processing and should be increased. Pitting on gear teeth is a common example.
- Over-carburizing. In areas where the geometry influences carbon absorption (such as the tips of gear teeth), reducing the flowrate during the boost stage or adding more but shorter-duration boost steps helps minimize this effect.
- Part distortion. There are numerous factors that influence part distortion, including the type and hardenability of the steel, the type of quench medium (oil or high-pressure gas) and the final hardening temperature, to name a few. One wants to select a material with the lowest hardenability that will achieve the required mechanical properties, including surface and core hardness. Quenching from a lower temperature may also help, and the recipe should be adjusted so that there is enough time for the core/surface temperature of the parts (load) to equalize before quenching.

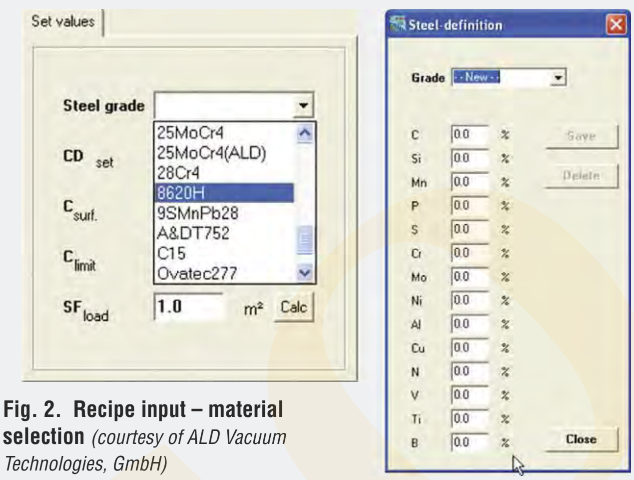


Fig. 2. Recipe input – material selection *(courtesy of ALD Vacuum Technologies, GmbH)*

Universal LPC Simulation Software

Until recently, LPC simulators were captive to the type of equipment being purchased. The principal limitation was that (as designed) the software would work only on a particular manufacturer's furnaces running one type of hydrocarbon gas in a defined pressure range. In essence, the OEMs had proprietary software designed to work only with their systems. Today, at least one manufacturer has developed LPC simulation software that will produce recipes for all types of carburizing furnaces running all of the common hydrocarbon gas mixtures in use (e.g., acetylene, acetylene + hydrogen, actelyene + nitrogen and acetylene + ethylene + hydrogen).

Summary

The inherent advantage of low-pressure carburizing is its consistency, repeatability and flexibility. As more and more LPC furnaces find their way into the heat-treat shop, the need for and convenience of a universal simulator will become paramount. One should expect to find, as a minimum, the following features on any LPC simulator:

- An extensive materials database
- The capability of creating and exporting a heat-treatment recipe (i.e., a sequence of cycle steps) showing the carbon profile (including surface, intermediate and limit carbon) as well as deviation from set values
- Save and load recipe functions
- The ability to edit recipes, add or delete alloys, add custom chemistries and change individual elements in the standard materials list (such as carbon content)
- Graphic displays for carbon and/or hardness profiles, carbon percentage at various stages in the process, and carbon flux and/or mass flow in addition to the process recipe inputs. For ease of use, a zoom function, scalable axes, historical record retrieval and the ability to save data to external files should be included.

If you are or will be using LPC in the future, be sure the equipment has or comes with one of these state-of-the-art devices.

References available online


ROTARY RETORT

Modern Materials Characterization

DR. MARC DE GRAEF
Professor of Materials Science and Engineering, Carnegie Mellon University

In the mid 1980s, when I was a physics graduate student in the Materials Department at the K.U. Leuven (Belgium), it was relatively rare to find a computer that was hooked up to a scientific instrument; computers were mostly used for word processing and spreadsheets, not for data acquisition. Scanning electron microscopes (SEMs) had a primitive single-color CRT screen and a device to transfer images to Polaroid prints.

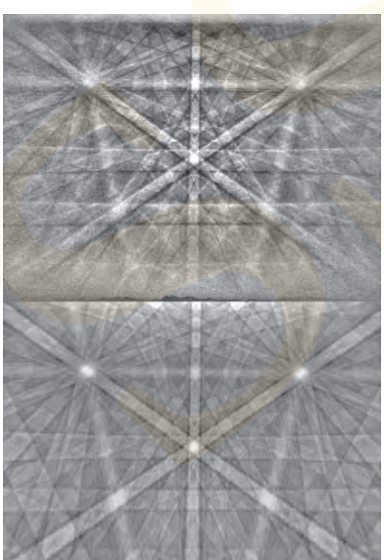
Other microscopes used negatives to record images, meaning that every materials department had an extensive darkroom to develop the plates and print them. Energy-dispersive spectroscopy (EDS) was just becoming available as an add-on to electron microscopes. These units were controlled by a very slow but large computer (in size) with very little memory (measured in kilobytes) and no internal storage.

Fast forward three decades to today's electronics (and labs without darkrooms). A simple smartphone has more capability than a 1980s desktop computer, and it is now possible to remotely operate and monitor scientific equipment using simple apps.

Modern electron microscopes can *only* be operated by computer. Depending on the level of instrument sophistication, some SEMs have simple graphical user interfaces that make them accessible to middle-school students.

Other instruments, such as transmission electron microscopes (TEMs), are also operated via a graphical user interface, but the complexity of these instruments requires significant user training. The amounts of data that can be produced by a modern microscope in a single session are astounding and are often measured in hundreds of gigabytes or more.

In addition to running my research group, I am also co-director of the Materials Characterization Facility (MCF) at Carnegie Mellon University in Pittsburgh, Pa. The MCF is a user facility, accessible to students and researchers from any college, as well as external users from other schools and local industry.



Comparison of an experimental 20kV EBSD pattern for silicon (top) and the corresponding simulated pattern (bottom).

We have about 250 unique users each year, and our instrument pool includes three TEMs, four SEMs, two focused ion-beam SEMs that allow for the controlled removal of thin slices of material, two X-ray diffractometers, a nano-CT system for X-ray-computed tomography, several probe microscopy instruments for surface analysis, and a centralized classroom equipped with hardware to enable remote operation of most of these instruments. The staff members in our facility are not only responsible for user training and keeping the machines running, but they must also have a decent knowledge of computer systems, networks and data storage to handle the large volume generated by our instruments.

The photographs accompanying this column online show several of our instruments as well as the central remote-control cluster. In upcoming quarterly columns, I will highlight several state-of-the-art research projects that make heavy use of our facility, including: 3D serial-sectioning reconstruction of material microstructures; tomographic analysis of solid-oxide fuel cells; and the modeling work that we carry out to support, quantify and explain our materials-characterization results.

A Deeper Dive into Professor De Graef's Research

Electron backscatter diffraction (EBSD) is one of several tools that can be used to determine the orientations of grains in polycrystalline and/or multiphase microstructures. To improve the capabilities of this technique, in particular for studying heavily deformed microstructures, Prof. De Graef's research group has developed a simulation technique that relies on basic physics to model the scattering of electrons in the material and the subsequent formation of the EBSD pattern.

The simulated patterns are very realistic and can be used to create a new pattern-indexing approach that is far-more robust against noise than commercially available techniques. Ongoing work considers machine-learning approaches to speed up the new technique and turn it into a near real-time indexing engine.

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Young Metallurgical Consulting may be a new company, but it's already making a difference in the heat-treating community with a "let me show you" approach to training.

John Young started the company in early 2016 soon after a friend had installed an integral-quench (IQ) furnace in a manufacturing facility. Once the furnace was in operation, the question became, "I own a heat treat furnace, now what am I supposed to do with it?" Enter Young, who was asked to work with the company and teach them the basics of operating a heat-treat line.

Young started at the beginning with austenite, martensite, critical temperatures, soak times and the theory of carbon potential and atmosphere control. He also covered safety, rack and fixture systems, and how to maximize productivity utilizing split loads. Effective and efficient scheduling was discussed as was how to prevent quality issues when changing between various process cycles. Young and the company also worked on proper sample preparation and hardness testing.

As you could expect, Young is no stranger to the heat-treat industry. He has held a variety of roles in a long, distinguished career, including blast furnace engineer, quality manager, general manager, sales representative and president.

As a quality manager, he was responsible for training furnace operators in basic metallurgy and inspection techniques. As a general manager, he directed a 50-person operation that processed fasteners for the auto industry. Young represented heat treaters in maintaining and increasing sales volume. And he was president of a company with a 25-member heat-treat department that provided services to the auto, heavy truck and railroad industries.

It goes without saying that Young's vast expertise is what makes his company successful. The focus of Young Metallurgical Consulting, which is based in West Bloomfield, Mich., is hands-on shop floor training. There are numerous video programs and printed materials available that are beneficial, but – as Young is quick to point out – "When we learned to walk, it was very helpful to have someone hold your hand and lead the way."

Young Metallurgical Consulting provides individualized training to personnel who are new to the heat-treating industry. Young is also an Adjunct Professor of Metallurgy at Macomb Community College, so he can provide more advanced training as the personnel gains proficiency. One of his main points of focus is customer service, which is a very significant part of being a successful heat treater. Customers want to send parts tomorrow and have them ready yesterday. Young has learned how to get customers involved so that they are part of the solution and not the problem.

Other services provided by Young Metallurgical Consulting include: production scheduling; sample preparation and hardness testing; and quality procedures, control plans, written plans and CQI-9 compliance.

Young Metallurgical Consulting is a one-man personalized training service and anticipates remaining that way moving forward. The company's mission is simple. "We will work with your staff to teach the day-to-day processes necessary to manage and improve your organization. Your employees will learn the aspects of heat treating that are not taught in a classroom and can only be gained through direct, hands-on experience."

Wisconsin Oven Corp.

Industrial Ovens for Thermal Processing

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

Wisconsin Oven Corp. is celebrating its 45th anniversary in 2018. The East Troy, Wis.-based company has been designing, engineering and manufacturing industrial ovens and other heating equipment since 1973.

The IHEA member's custom and standard industrial ovens (batch, conveyor and laboratory) are used for applications including heat treating, aluminum aging, powder coating, drying and composite curing. Wisconsin Oven also manufactures thermal incinerators for pollution control. This equipment is utilized by companies in a variety of industries, including aerospace, automotive, agriculture, construction, medical, military, mining and others.

Every oven manufactured is fully factory tested and adjusted prior to shipment from Wisconsin Oven's facility. All safety interlocks are checked for proper operation, and the equipment is operated at the normal and maximum operating temperatures. An extensive quality-assurance check list is completed to ensure all equipment meets quality standards.

In the thermal-processing industry, there are only a few ways to differentiate your company from the competition. Wisconsin Oven is quick to credit one thing for creating that difference: its people. Approximately 150 employees allow this oven manufacturer to outperform its competition and provide outstanding customer service. The company's experienced design team is able to meet even the most stringent standards for customers' equipment.

Wisconsin Oven has developed a culture that recognizes workers for a job well done. The Work of Champions program is an initiative to reward the performance of employees who go above and beyond the call of duty. Whether they're working overtime to take care of a customer, saving the company money by producing quality work in remarkable time or making beneficial suggestions, those efforts will be recognized.

The company is also serious about being a leader in the community. Wisconsin Oven was named the United Way of Walworth County's largest contributor in 2017, with employee donations reaching $20,000, and president and CEO Dave Strand was named Honorary Campaign Chair for 2018. A heartfelt letter sent by Strand to members encouraging them to pay it forward resulted in $18,000 in donations to the United Way of Walworth County.

Wisconsin Oven is owned by Thermal Product Solutions, a global leader in thermal-processing products with brands including Baker Furnace, Blue M, Gruenberg, Lunaire, Tenney and LindbergMPH.

Visit www.wisoven.com for more information.

Custom batch ovens

Horizontal quench system

EQUIPMENT NEWS

Vacuum Furnace

SECO/VACUUM Technologies will supply Rex Heat Treat with a 15-bar Vector vacuum furnace for its commercial heat-treating facility in Lansdale, Pa. The furnace will be used for through-hardening, tool and die steel processing, high-temperature solution nitriding, annealing and vacuum tempering. The system is scheduled for delivery by the end of the first quarter. The Vector will be equipped with patented PreNitLPC and FineCarb technologies for low-pressure carburizing for increased productivity via faster cycle times and higher processing temperatures. It will also be equipped with a 15-bar and 6-bar argon quench for greater versatility.
www.secovacusa.com

Austempering Furnace Line

AFC-Holcroft sold a complete batch carburizing and austempering line to Rotor Clip, a global manufacturer of retaining rings, wave springs and self-compensating hose clamps. The full line consists of a UBQA (universal batch quench austemper) furnace, washer with transfer pump, temper furnace, transfer car, scissor-lift table and stationary table. The UBQA furnace is designed for neutral hardening, austempering and other heat-treating processes where a controlled environment is required during the heating and quenching portions of the cycle.
www.afc-holcroft.com

Heat-Treatment Line

SMS group received an order from Ilsenburger Grobblech GmbH for the supply of a new heat-treatment line that will include two roller-hearth furnaces, shot blaster, plate leveler and water-treatment plant. The heat-treatment line will anneal and further process more than 200,000 tons of heavy plate per year. It will be designed to handle plate in thicknesses between 0.20-7.0 inches (5-175 mm), widths up to 138 inches (3,500

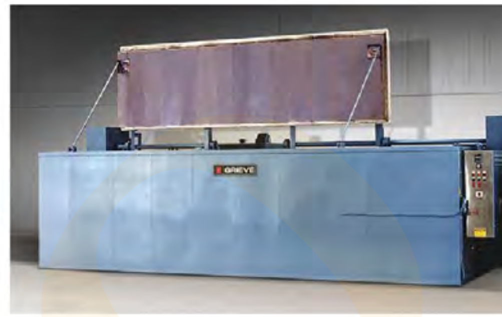
mm), lengths of 13-79 feet (4-24 meters) and weights up to 28 tons. The material grades to be processed will include high-strength carbon steels, highly wear-resistant steels and case-hardened and quenched/tempered steels.
www.sms-group.com

Vacuum Furnaces

Ipsen shipped 15 vacuum furnaces to eight states in the U.S., Asia and Europe to companies in the additive-manufacturing, aerospace, commercial heat-treating, medical and MIM industries. The shipments included nine TITAN vacuum furnaces, including three TITAN DS (debinding and sintering) units, two TITAN LT (low-temperature) units and several H2- and H6-sized furnaces, all equipped with PdMetrics predictive-maintenance software. Additional shipments included: three horizontal MetalMaster vacuum furnaces, each with a work zone of 36 x 30 x 48 inches and a load capacity of 2,000 pounds; two horizontal TurboTreater furnaces; and one vacuum aluminum brazing furnace.
www.ipsenusa.com

Top-Loading Oven

Grieve supplied a 1000˚F (538˚C) top-loading oven that will be used for curing composite materials in large molds at a manufacturer's facility. Workspace dimensions measure 168 inches wide x 48 inches deep x 48 inches high, and 120 kW are installed in Incoloy-sheathed tubular heating elements. A 12,500-CFM, 10-HP recirculating blower provides horizontal airflow. Oven controls include a digital-programming temperature controller, manual-reset excess-temperature controller with separate contactors and SCR power controller. www.grievecorp.com



BUSINESS NEWS

Bodycote Expands Nadcap HIP Capacity

Bodycote announced that its Sint-Niklaas, Belgium, hot isostatic pressing (HIP) location will take delivery of a new Mega-HIP unit, which will be operational by the end of 2018. The high-pressure, high-temperature unit is Nadcap-capable to meet the growing demand of the European aerospace market. This investment will significantly increase Bodycote's Nadcap HIP capacity globally. The company has over 50 HIP vessels of varying sizes in multiple locations. Processing capability can accommodate components up to 6.5 feet (2 meters) in diameter x 11.5 feet (3.5 meters) high and weighing over 66,000 pounds (30,000 kg).

Advanced Heat Treat Expands Capacity in Iowa

Advanced Heat Treat Corp. (AHT) purchased a gas nitriding unit to expand its capacity for UltraGlow gas nitriding and UltraOx surface-treatment solutions at its corporate office and service center in Waterloo, Iowa. The large, state-of-the-art, high-temperature gas nitriding unit will also allow for increased capacity of gas ferritic nitrocarburizing (FNC) and stress relief. AHT plans on hiring part-time and full-time laborers to deal with the added capacity.

Danieli to Supply Micromill Technology for Nucor Facility

Nucor Corp. selected Danieli's MI.DA micromill technology for its recently announced rebar mill in Sedalia, Mo. The plant will be designed to produce in excess of 350,000 short tons per year of straight rebar products in sizes, grades and custom lengths to fulfill the most demanding construction applications. The $250 million facility is scheduled to be in operation by the third quarter of 2019.

Solar Atmospheres of California Completes Expansion

Solar Atmospheres of California (SCA) completed its most recent facility expansion, which will allow the company to double its heat-treating capacity. The project began in July 2016 with groundbreaking for a new 25,000-square-foot building. Upon completion of construction in July 2017, SCA immediately began the design, fabrication and installation of all required support systems, including water and gas delivery. In preparation for the added capacity, SCA procured four new vacuum furnaces from sister company Solar Manufacturing. The equipment includes:

- A high-pressure vacuum gas carburizing furnace with an operating temperature range of 600-2200°F and a maximum loading capacity of 7,000 pounds.
- A high-pressure vacuum gas carburizing furnace with an operating temperature range of 600-2200°F and a maximum loading capacity of 15,000 pounds.
- An all-metal hot zone with isolated gas quench system with an operating temperature range of 600-2400°F and a maximum loading capacity of 15,000 pounds.
- A 120-inch-diameter x 288-inch-long horizontal car-bottom furnace with an operating temperature range of 600-2200°F and a maximum loading capacity of 150,000 pounds.

Equipment & Business News

INDUSTRY EVENTS

April 10-13
Ceramitec 2018; Munich, Germany
www.ceramitec.com

April 16-20
Wire & Tube 2018; Düsseldorf, Germany
www.wire-tradefair.com
www.tube-tradefair.com

April 23-25
IHEA Annual Meeting/ MTI Spring Meeting; Scottsdale, Ariz.
www.ihea.org / www.heattreat.net

April 23-26
Rapid 2018; Fort Worth, Texas
www.rapid3Devent.com

April 25-26
5th Central/Eastern European Heat Treatment Forum & Exhibition; Wroclaw, Poland
www.heat-treatment-forum.pl

May 1-3
Ceramics Expo; Cleveland, Ohio
www.ceramicsexpousa.com

May 7-10
AISTech 2018 – The Iron & Steel Technology Conference and Exposition; Philadelphia, Pa.
www.aist.org

June 5-7
Thermal Processing in Motion – Including the 4th International Conference on Heat Treatment and Surface Engineering in Automotive Applications; Spartanburg, S.C.
www.asminternational.org

June 6-8
19th China International Heat Treatment & Industrial Furnace Exhibition; Guangzhou, China
www.heattreatmentexpo.com

June 17-20
AMPM 2018 – Additive Manufacturing with Powder Metallurgy; San Antonio, Texas
www.ampm2018.org

June 17-20
Powdermet 2018 – International Conference on Powder Metallurgy & Particulate Materials; San Antonio, Texas
www.powdermet2018.org

July 30-Aug. 1
International Thermprocess Summit 2018; Atlanta, Ga.
www.ihea.org

Sept. 11-12
Forging Industry Technical Conference; Long Beach, Calif.
www.forging.org

Sept. 25-28
Heat Treat Mexico 2018 – Advanced Thermal Processing Technology Conference and Expo; Queretaro, Mexico
www.asminternational.org

FNA 2018

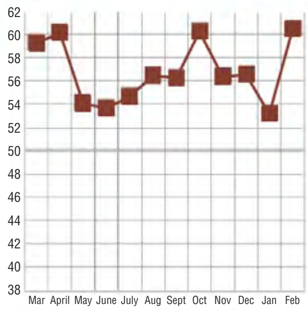
Oct. 8-10
Furnaces North America 2018; Indianapolis, Ind.
www.furnacesnorthamerica.com

Oct. 14-18
Euro PM 2018 Congress & Exhibition; Bilbao, Spain
www.europm2018.com

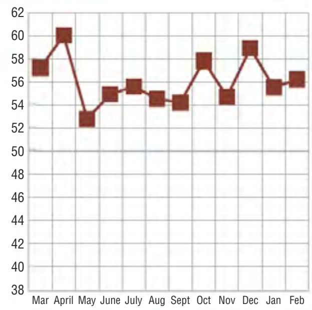
Oct. 15-17
2018 Die Casting Congress & Exposition; Indianapolis, Ind.
www.diecasting.org

ECOMOMIC INDICATORS

REQUEST FOR QUOTE

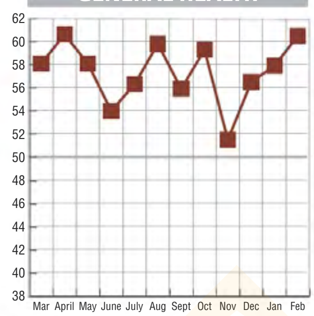


ORDERS



BACKLOG

GENERAL HEALTH



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

Process Thermal Imaging in the Modern Hot-Rolling Mill

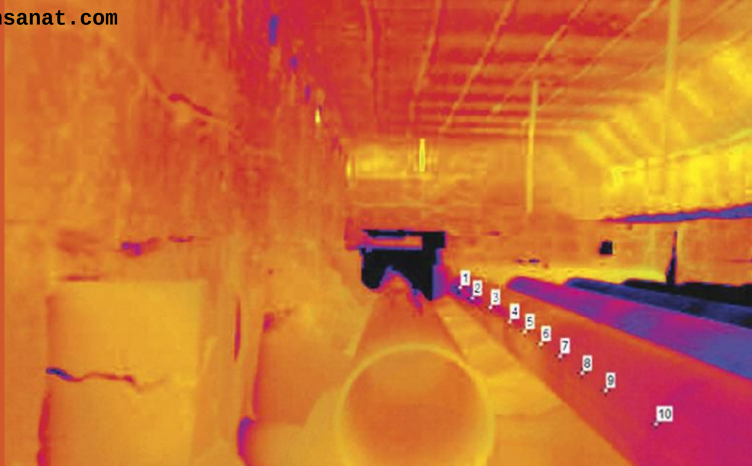


Fig. 3. Reheat furnace thermal image using a selected waveband detector

Richard Gagg – AMETEK Land; Dronfield, U.K.

Single-point radiation thermometers, also referred to as infrared pyrometers, have been widely used in steel hot-rolling mills for more than 60 years. They offer many advantages compared to contact sensors such as thermocouples.

Single-point radiation thermometers are installed at a distance, and they view the infrared radiation that is emitted by the target object. Their noncontact nature allows them to operate out of harm's way. Because they don't touch the surface, they can accurately measure moving objects, whereas thermocouples suffer from a frictional effect, generating heat and eroding the thermocouple. Pyrometers also feature extremely fast response speeds of a few milliseconds. This makes them very useful for measuring fast-moving strip or rod.

For furnace temperature-measurement applications, pyrometers measure the products in the furnace and not the furnace atmosphere. Noncontact pyrometers outlast contact sensors. They have very fast response speeds and are low maintenance. For some applications, a single-point pyrometer provides enough information for process control. In a hot-strip mill, a single-point pyrometer will measure a stripe (longitudinal profile) along the strip centerline.

With continuous, customer-driven requirements for higher-quality products, it is increasingly difficult to make premium-quality flat products with single-point temperature measurements.

Process Thermal Imaging

Two families of process thermal-imaging systems provide more complete temperature measurements in static and moving product environments.

2-D Thermal-Imaging Cameras

The first family of process thermal-imaging systems is based around 2-D thermal-imaging "cameras." Their radiation detector consists of a matrix of tens of thousands of pixels, each of which is a noncontact temperature sensor. Its focal-plane array then looks through a filter and lens at the thermal scene.

These process thermal imagers differ from portable thermal imagers in several important ways. Portable imagers use very low-power drain detectors. They sacrifice high-quality measurements to extend battery life in a portable imager. Process thermal imagers are built to operate in harsh industrial environments, providing years of continuous thermal imaging. Temperature-measurement accuracy across the entire scene is very important. Power use is not a design factor because they are powered by continuous power supplies. A process thermal imager is capable of viewing and measuring multiple targets in a scene simultaneously.

Figure 2 shows a process thermal imager measuring multiple strands at the exit of a caster. Fifteen areas of interest have been placed on the thermal image, and each is outputting a signal based on the peak temperature in each area.

Figure 3 shows the inside of a reheat furnace filled with pipes. By selecting the correct wavelength, the imager does not see the burners. At the top left of the roof, the image shows cold

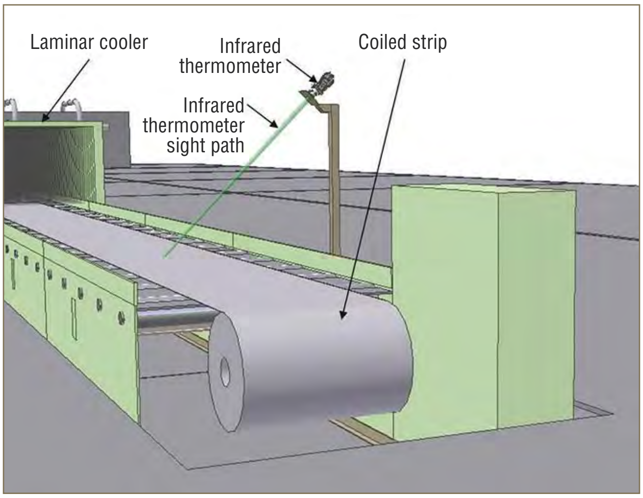


Fig. 1. A single-point pyrometer measuring the centerline temperature of a hot strip.

Fig. 2. A five-strand caster exit area. Three temperature-measurement areas are located on each strand.

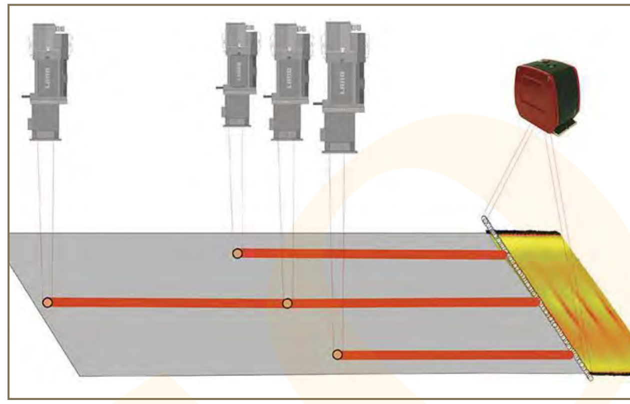


Fig. 4. Comparing a single pyrometer, three pyrometers and a scanner

holes, which are the burners with the cold fuel entering. It also shows the heating effect on the furnace roof (yellow stripes), but the flames themselves are invisible. Once the correct pipe temperature is reached, the pipe is pushed from the furnace. Not only can the imager measure the product temperature, it also shows the temperature balance within the furnace.

Line Scanners

A second family of process thermal imagers has evolved that is specifically designed to measure temperatures from edge to edge of moving products. These are commonly known as line scanners, or simply scanners.

Scanners consist of an extremely fast-response-speed radiation sensor that "looks" at the end of an inclined mirror. The mirror is attached to a high-speed motor that rotates. In this way, the pyrometer scans through a viewing angle, allowing it to "see" and measure objects along that scanned line. The scanner view is usually through a durable sapphire window that seals the enclosure. For flat products, edge-to-edge temperature variations can cause significant quality problems, and multiple pyrometers are required to provide more coverage.

Once multiple sensors are used, measurement costs increase and there are still unmeasured gaps. For example, pyrometers may have an accuracy specification of +/-0.3%, so one may be within specification and measuring 0.29% high and another may be similarly within specification and reading 0.29% low. In that example, there's almost a 0.6% difference between the two sensors, which have both passed the manufacturer's +/-0.3% accuracy testing. At 1200°C, that is over 7°C difference. Figure 4 shows the different measurement areas from single-point pyrometers versus a scanner.

In a fraction of a second, the scanner can scan a temperature profile through an 80- or 90-degree angle and sample 1,000 discrete temperature points. That is like having 1,000 radiation spot thermometers across the process with each one having the exact same matched calibration. Because a single sensor makes all those temperature measurements, there are no differential accuracy errors like there are with separate pyrometers. So, if the scanner indicates one edge of the strip is 3°C hotter than the other edge, it really is.

Compared with a process thermal-imaging camera, a scanner is superior for products with a linear movement. Conversely, a scanner isn't capable of producing a thermal image of a static scene, such as the inside of a furnace, and a process thermal-imaging camera is best suited to that environment.

Fig. 5. A scanner is mounted at a continuous caster exit, after the straightener, just before the slab is cut. The red water-cooled protective enclosure houses the scanner and is mounted above an angled heat-deflecting plate.

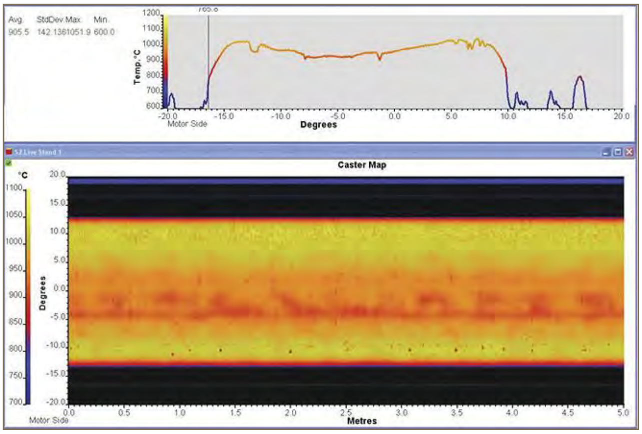


Fig. 6. Thermal image and cross profile of slab produced by scanner software

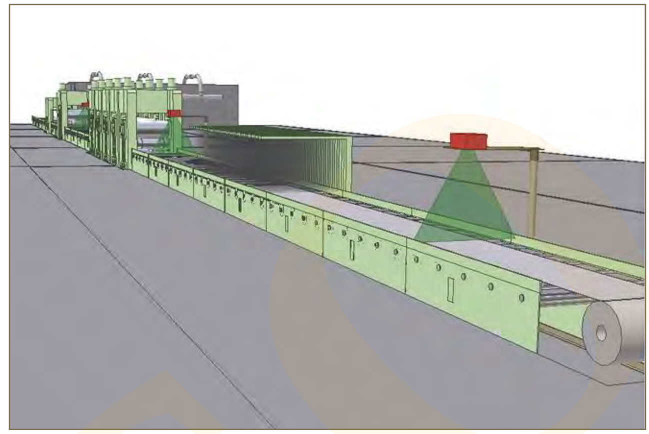


Fig. 7. Scanner rapidly measuring temperature profiles across the strip preceding the coiler

Scanners operate at frequencies up to 150 scans per second and measure 1,000 data points in each scan, producing a cross profile. They are ideal for fast linear-moving products in a rolling mill. These profiles are rapidly stacked together to provide a real-time thermal image of the product. This high-density thermal image is extremely useful in understanding the thermal properties of a product.

Figure 8 is the thermal image from a scanner in the same location. Notice the operator side of the strip is approximately 50°F colder than the centerline and drive side. The temperature profile produced by a scanner at the last finishing stand showed a flat temperature profile, so it was easy to determine that the problem was caused in the laminar cooling section. The red stripe marked on the image shows the area that would have been measured with a single-point pyrometer, which would not detect the temperature imbalance. Scanner zone outputs across the whole width of the strip provide signals to feed back to edge-masking controls in the cooling section.

Scanners typically communicate with PC software that provides displays of thermal profiles and images. The software also has comprehensive database and archive capabilities, which help analyze the thermal data more easily. Scanners also can communicate directly with PLCs and distributed control systems. Alternatively, scanners can provide analog or digital outputs for edge-to-edge temperature control.

In-Process Sensors

Many mills now frequently have multiple scanners along the length of a process line. These scanners can track product from the exit of a reheat furnace, past the descaler, into the roughing and finishing mills and then to the coiler. These systems provide a complete understanding of the process along with any areas in need of improvement. Single-point pyrometers are incapable of revealing edge-to-edge temperature variances. They only reveal a centerline temperature profile.

Another common measurement position for a scanner is inside a continuous-annealing line after the last control zone and before the strip enters the snout just before coating. At this location, a scanner provides detailed edge-to-edge thermal-profile data. Scanner zone outputs are fed to a control system to adjust the heaters necessary to achieve the correct temperature profile in the last control zone. Once a uniform temperature profile is achieved, the molten zinc will naturally coat the strip with an even thickness.

Figure 9 shows a thermal image from a scanner measuring coated strip. Notice the banding caused by an eccentric roll that

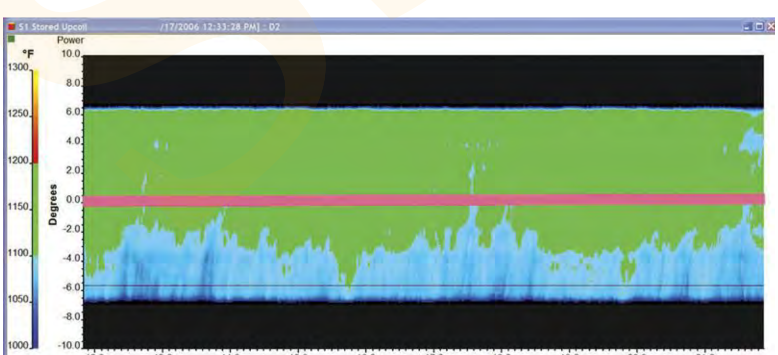


Fig. 8. Cold operator side caused by improper cooling. The red stripe shows how a single-point pyrometer would miss the problem.

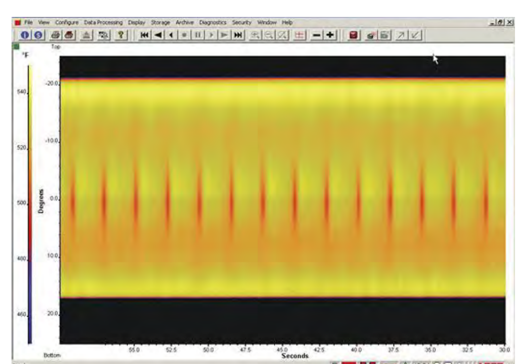


Fig. 9. Coated strip showing cold stripes caused by an eccentric roll.

was conducting heat away from the strip. By comparing the X-axis time scale and line speed, it was easy for the mill to identify which roll was causing the problem.

Flat-rolled products can suffer from uneven grain size caused by uneven temperature distribution. Camber problems can result from uneven temperature distribution. By producing steel with the required temperature characteristics from edge to edge, less scrap is produced, resulting in quality steel and higher yields. In addition, the addressable customer base for the steel is larger, and the producer can command higher prices.

Line scanners typically cost the equivalent of three pyrometers but have far-better features, capabilities and accuracy along with providing 1,000 measurements. Line scanners are simple to install and require just one cable that carries both power and Ethernet signals, so installation costs are minimized.

Conclusion

In today's world, markets require higher quality and companies expect improved profitability. Complete temperature measurement with line scanners and process thermal imagers provides a total picture of the product's temperature distribution. With this information, more-precise process control is possible, resulting in improved-quality products and satisfied customers.

For more information: Contact AMETEK Land, Stubley Lane, Dronfield, UK, S18 1DJ; tel: +44 (0)1246 417691; fax: +44 (0)1246 410585; e-mail: land.enquiry@ametek.com; web: www.landinst.com.

Innovative Heat Treatment for Weight Reduction of Heavy Components

James Lowrie and Gracious Ngaile – North Carolina State University; Raleigh, N.C.

Increasing scrutiny on the environmental impact of heavy-duty trucks and the desire for more fuel-efficient fleets has caused the manufacturers of class-7 and -8 trucks to investigate methods to reduce vehicle weight. This article focuses on another method to provide lightweight components, namely innovative heat-treatment schemes.

It was established that the weight of heavy-duty vehicles could be reduced by increasing the power density of the components in the powertrain. Geometric modification is a popular and self-explanatory method of accomplishing this,[1] but it is only one piece of the lightweighting puzzle.

Heat treatment is another important strategy to improve the power density of parts. When applied to steel parts, this process typically takes place as a heat-and-quench operation in which the phase of the steel is modified or a carburization process in which the carbon content on the surface of the part is increased. Both of these processes increase part hardness and strength, meaning that less material is required to carry the same load and thereby reduce weight. Both methods are widely used, but innovation could improve their effectiveness and allow for the production of even lighter and stronger parts.

Currently, traditional quenching is limited by the cooling rates that can be employed. In general, heat treaters employ the maximum-possible cooling rates because this results in the strongest-possible part. Extremely high cooling rates are not utilized, however, because increasing the cooling rates beyond a certain level results in distortion and cracking due to the large gradient in the temperature and phase distribution between the thin sections of the part and the thick sections. These gradients appear because the material in a thick section can be supplied with heat from the large amount of material in the core of the section, while material in thin sections rapidly loses any heat stored in its center.

Intensive Quenching

Intensive quenching is one option for innovating the heat-treatment process. It employs extremely rapid cooling rates to achieve improved hardness throughout the part and create beneficial compressive surface stresses on the part. These rapid cooling rates remove the ability for heat to conduct to the surface of the part by pulling heat from the surface much faster than the rate of conduction in the material. This eliminates the thermal gradients between thin and thick sections. Instead, the surface of the part develops a cold shell that rapidly transforms into martensite – the hardest and least dense phase of steel. This difference is illustrated in Figure 1, which shows how the steel phases develop based on the cooling rate applied during the quench.

The reduction in density at the part surface results in an expansion of the material, causing it to crowd together and create compressive stresses. These compressive stresses keep crack precursors closed so that cracks do not occur upon rapid quenching. Additionally, the increased strength of the martensite shell prevents distortion by resisting the high stresses created by the high thermal and phase gradients.

After the initial phase of rapid cooling to create the martensite shell, the cooling rate is greatly reduced so that the material in the core of the part has enough time to develop other steel phases, like bainite or pearlite, before reaching the martensite transformation temperature. This results in a mixed phase of steel in the core, which is denser than the outer shell, leaving permanent residual compressive stresses on the surface of the part. With proper adjusting of the intensive-quenching process, the part can achieve both beneficial residual surface compressive stresses and improved core hardness, which results in a component that is both stronger and more resistant to fatigue than one produced with traditional quenching methods.

The push to implement intensive quenching as a mainstream manufacturing process is largely being led by a company called IQ Technologies Inc.,[3] and a more detailed description of the intensive-quenching process than is given here can be found in their literature.[2] They have demonstrated the benefits of intensive quenching on a variety of parts, including metal-forming punches, output shafts, pinion gears and universal-joint crosses.[4] Their success in applying intensive quenching to these parts indicates that it may be an important element in reducing the weight of heavy-duty trucks. In order to investigate the potential benefits of applying this process to heavy-duty trucking components, the finite-element method was used to examine the potential mechanisms through which intensive quench can be used to reduce part weight.

Use of Simulations

The heat-treatment problem is difficult to solve because it consists of three mutually coupled problems that must be solved simultaneously, which makes a comprehensive simulation of the quenching process computationally expensive. For the purposes of determining how the intensive-quench process might be applied to heavy-duty trucking components, however, it is not necessary for this exacting model of the heat-treatment process to be used.

Instead, simulations were run by removing some of the system interactions, like the creation of heat due to plastic deformation and the release of latent heat during a phase change. This ensured that the mutual system coupling was removed while the major interactions remained (Fig. 2). Simulations of both oil quenching and intensive quenching were carried out so that the comparative benefits between the two processes could be identified. The two processes were differentiated by the cooling coefficients applied to the surface of the part. The temperature-dependent cooling coefficient used to describe the oil quench and the time-dependent cooling curve used to define the intensive quench are given in Table 1. ANSYS Workbench 17 was used to carry out the simulations with various subroutines added to allow for the calculation of phase change and its effects.

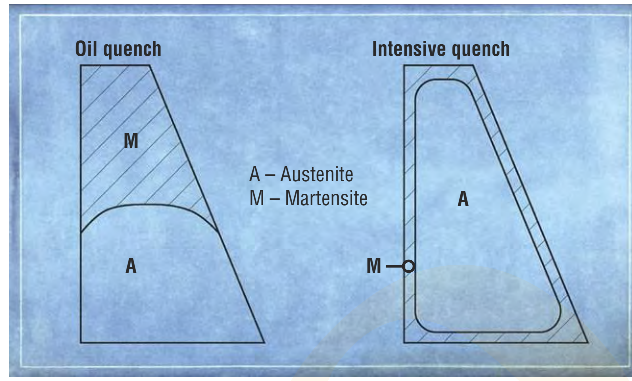


Fig. 1. Difference between the quenching characteristics of oil and intensive quenches[2]

Table 1. Cooling conditions used to describe the quenching conditions

Oil Quench[6]		Intensive Quench	
Temperature [°C]	Convection coefficient [w/m²k]	Time [s]	Convection coefficient [w/m²k]
0	250	0	6,000
350	300	6	6,000
500	3,000	6.5	0
550	4,000	30	0
700	500	30.5	200
800	500	300	200

Table 2. Material properties of the AISI 4140 material

Coefficient of thermal expansion $[\frac{1}{°C}]$	1.2×10^{-5}
Thermal conductivity $[\frac{W}{m°C}]$	60.5
Specific heat $[\frac{J}{kg°C}]$	434
Young's modulus [GPa]	200
Poisson ratio	0.3

Heavy-Duty Axle Shaft Example

The component simulated in this investigation was the heavy-duty axle shaft, which was examined under two loading conditions: full-floating and semi-floating. The material used to model the part is AISI 4140 steel, whose properties are described in Table 2. The dimensions of this part are given in Figure 3. In order to determine the phase distribution of the part, the

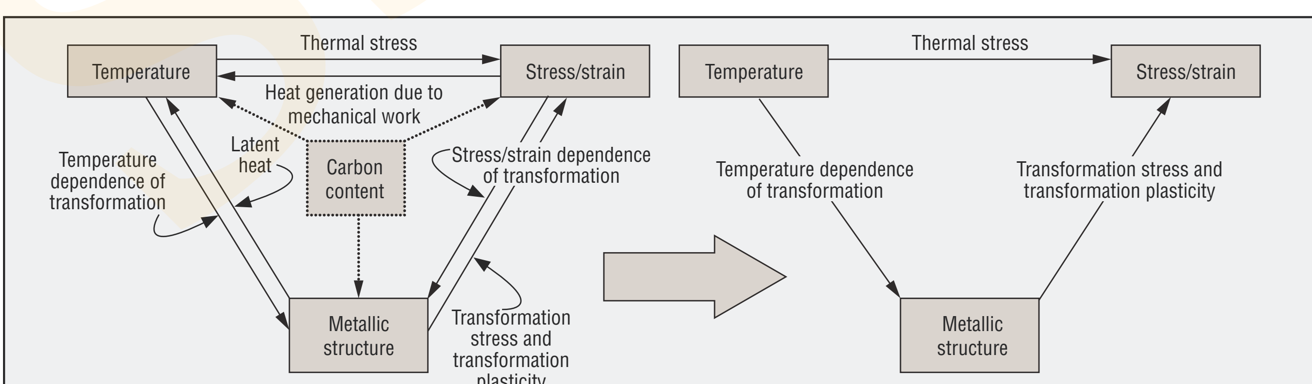


Fig. 2. Simplification of the heat-treatment paradigm for computationally efficient simulations[5]

continuous-cooling transformation curves provided by TimkenSteel for AISI 4140 steel were used.[7] The properties of each steel phase are given in Table 3.

The temperature distributions in the part during the oil quench and intensive quench are given in Figure 4. As expected, the thin sections of the part (i.e., the flange) cool down much more quickly than the thicker sections (i.e., the shaft) during the oil quench.

The intensive quench, on the other hand, creates a nearly uniform shell of cold material all around the part in the initial stages of cooling followed by a much more even cooling in the later stages of the process. Another interesting result is that the intensive quench cools the part much quicker than the oil quench in the initial stages of the cooling but achieves a temperature similar to that of the oil quench after 150 seconds.

These differences obviously have a major effect on the phase distribution in the final part. The final distribution of martensite in the axle shaft is given in Figure 5. The increase in the cooling rate in the first stages of the intensive-quenching process resulted in the intensively quenched part having a higher volume fraction of martensite than the oil-quenched parts for all areas. At the same time, the intensive quench caused a shell of pure martensite to be formed on the outside of the part while a mixture of bainite and martensite was established in the center of the shaft.

Phase Distribution

The phase distribution created by these two quenching schemes plays a key role in the formation of residual stresses in the part. There were areas of high tensile residual stresses created by the oil quench on the surface of the axle shaft that were not present in the intensively quenched part.

Additionally, very large compressive residual stresses (~130 MPa) were created by the intensive quench. These compressive stresses were about an order of magnitude above the compressive residual stresses created by the oil quench. However, the intensive-quenching process created a corresponding area of tensile stress on the inside of the axle shaft. This is a result of the difference in the densities of the surface and core of the part. Essentially, the surface material is stretching the core of the part while the core of the part is restricting the expansion of the surface.

In addition to the effects on the residual stresses in the part, its phase distribution has an effect on the total strength of the part. Specifically, the increased volume fraction of martensite in the intensively quenched part will result in increased hardness and strength. The result of this increase in strength is an increased safety factor when the part is in service.

To demonstrate this, the FEA models

containing the residual stresses from the two quenching schemes were combined with simulations of the axle shaft under the full-float and semi-float loading conditions. The results of these simulations were then compared to the estimated ultimate tensile stress of the part to determine what the minimum safety factor, SF, was for each case, as shown in the equation.

The minimum safety factors for the full-float case were 4.00 and 4.34 for the oil- and intensive-quenched parts, respectively. For the semi-float case, they were 3.78 and 4.08, respectively. Clearly, this increase in the safety factor means that some material can be removed without negatively affecting the strength of the part by switching the oil quench to an intensive quench.

In this particular case, a weight savings of 3% was achieved by applying the intensive quench to an axle shaft with a smaller

Table 3. AISI 4140 steel phase properties

Steel Phase	Specific Volume[8] [cm³/g]	Hardness[9] [HRC]	Approximate Strength[9] [MPa]
Austenite	0.1225	N/A	N/A
Pearlite	0.1271	26	870
Bainite	0.1271	33	1,050
Martensite	0.1281	59	2,140

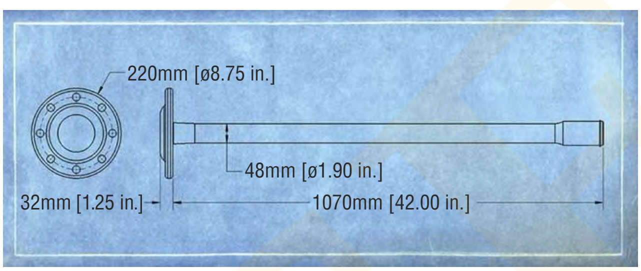


Fig. 3. Geometry used to simulate the heavy-duty axle shaft

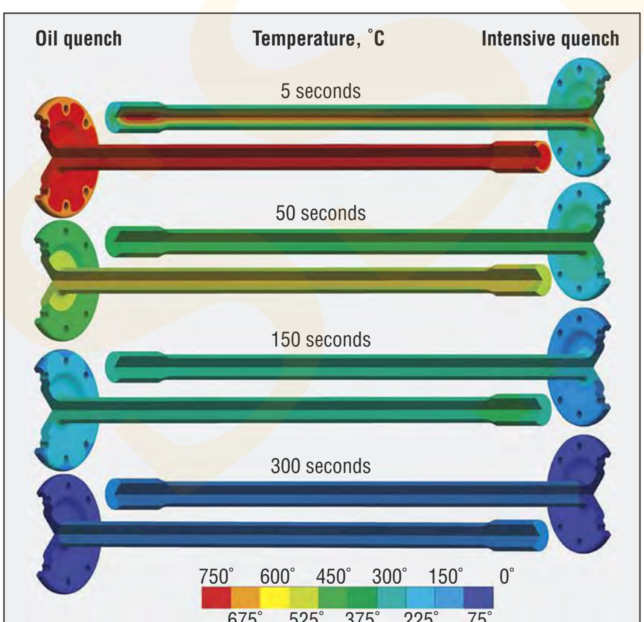


Fig. 4. Temperature distribution in the oil-quenched and intensively quenched axle shaft for various times

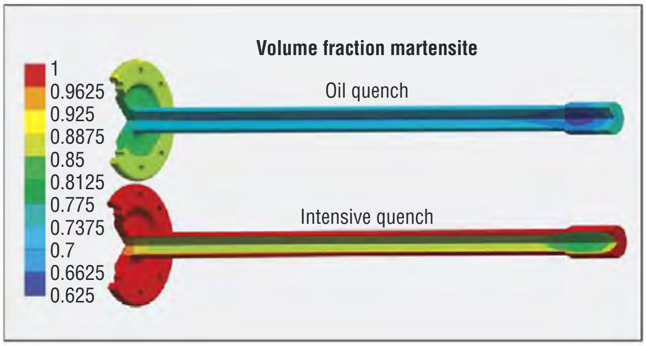


Fig. 5. Volume fraction of martensite after the oil and intensive quench

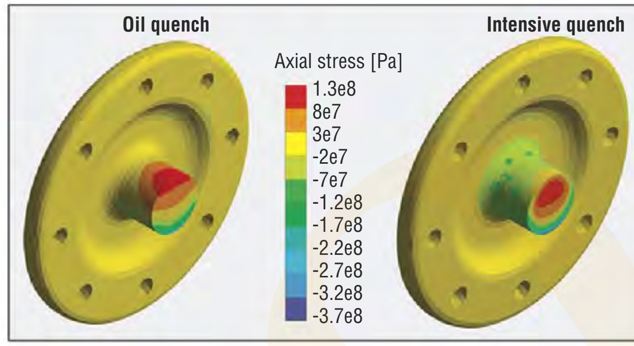


Fig. 6. Axial stress in the semi-float axle shaft for the oil- and intensive-quenched conditions

diameter, but it is important to note that greater reductions could probably be achieved by optimizing the intensive-quenching process.

$$SF = \frac{\text{Strength}}{\text{Residual stress + torsional stress + bending stress}}$$

Another interesting benefit of the intensive-quenching process is that the compressive residual stresses on the part reduce the severity of the alternating stresses on the surface of the part. This is best illustrated by looking at the axial stress in the shaft under the simultaneous bending and torsion loads of the semi-float load case.

Figure 6 gives a contour map of these stresses with a cross section at the point of maximum stress due to bending for both the oil- and intensive-quenched part. The stress pattern in the oil-quenched shaft is nearly exactly what one would expect of a beam under bending (i.e., large tensile stresses on one side of the shaft and large compressive stresses on the other side).

The stress pattern in the intensively quenched part, on the other hand, is much different. In this case, the compressive residual stresses on the surface of the part have reduced the total axial stress on the outside of the shaft to a level that is much lower than the stresses on the outside of the oil-quenched part. This reduction in the tensile surface stresses on the axle have the result of reducing the severity of the alternating stresses on the shaft and will likely lead to a greater service life.

Another change in the stress pattern in the intensively quenched part is the development of tensile stresses in the core of the part. Because fatigue cracks are likely to start on the surface of the part, however, the development of these stresses is less important than the reduction of alternating surface stresses. Overall, the increased fatigue life of parts that have undergone intensive quenching over the traditional oil quench should allow them to be lightened while still achieving improved mechanical properties and performance.

Conclusion

Clearly, the development of innovative heat-treatment schemes can play a key role in the weight reduction of heavy-duty trucking components by creating high-power-density parts. In the case of intensive quenching, the process allows for the use of extreme cooling rates that make it possible to achieve harder and stronger components than their oil-quenched counterparts.

Additionally, the unique phase distribution created by the process creates compressive residual surface stresses that help to improve the fatigue life of the part by reducing the severity of alternating stresses that may appear when the part is in service. The increased strength and fatigue life of the part allow a high-quality part to be created using less material, which has the dual benefit of reducing component size and weight.

Furthermore, there is the potential for even greater weight reductions by combining this innovative heat-treatment scheme with other weight-reduction strategies, such as hollow geometries. This would allow for the creation of compressive residual surface stresses on both the inside and outside of the part. A synergistic effect like this could greatly reduce part weight and increase component performance.

Acknowledgement

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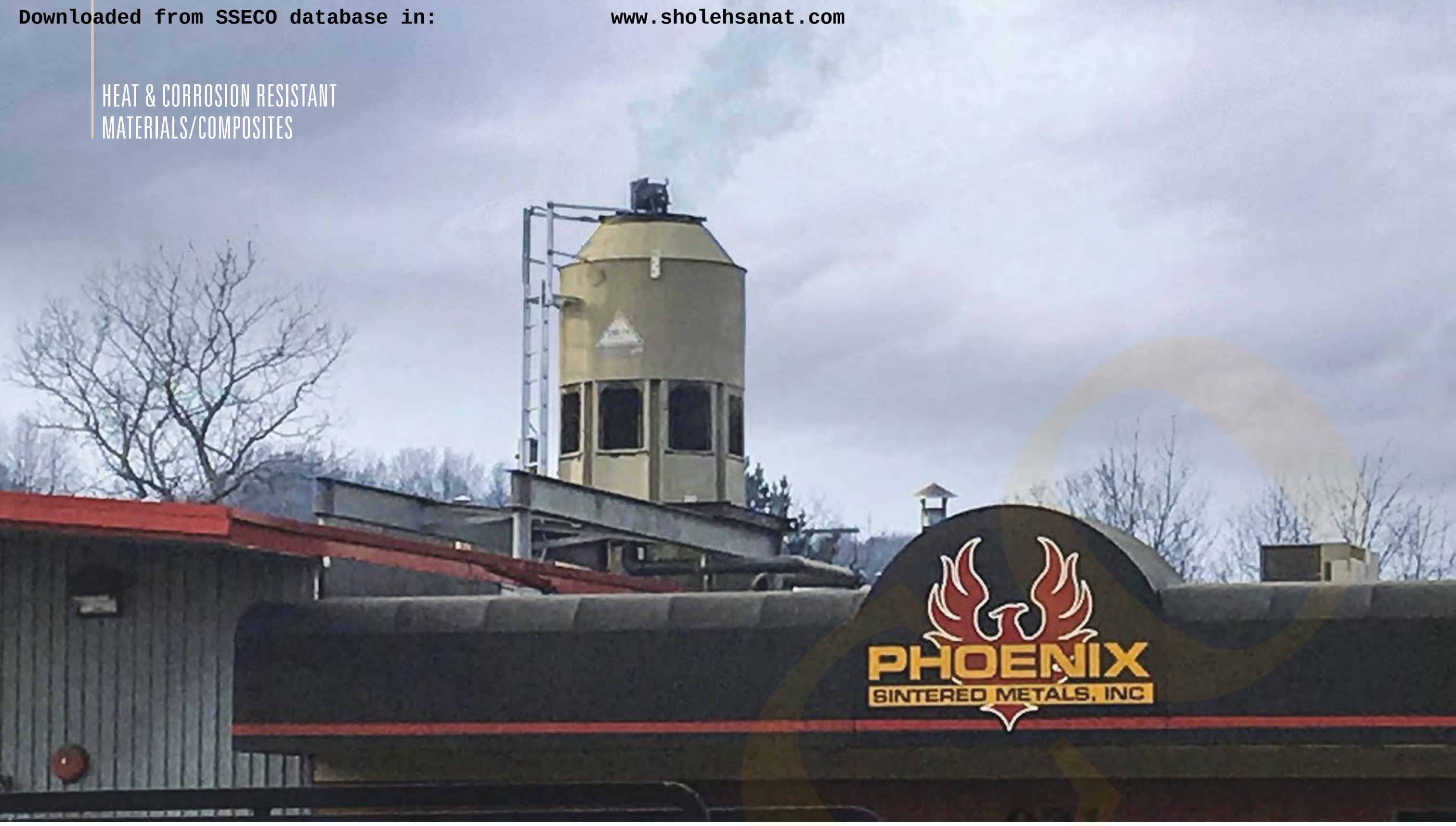

Corrosion-Resistant Plastic Cooling Towers Cut Costs

Faced with an aging cooling tower, a powdered-metal parts maker installed an HDPE plastic cooling tower. The low-maintenance tower has a seamless shell design without joints, seams, panels, gaskets, bolts, fasteners or caulking.

John Flaherty – Delta Cooling Towers Inc.; Roxbury Township, N.J.

For operations using extreme heat, engineered plastic cooling towers provide cooling and can outlast traditional alternatives.

When it comes to process cooling, few industries rely on the application of heat as much as the sintering process in powder-metal manufacturing. With temperatures in the high-heat section of a sintering furnace reaching several thousand degrees Fahrenheit, the parts must be cooled dramatically before being handled by operators.

Sintering is a process by which metal particles are chemically bonded and formed by heat and pressure without reaching the point of total liquefaction. To accomplish this, powdered-metal and alloy mixtures are compacted into near-net shapes, typically using a high-pressure press. The compacted material then must be placed in a sintering furnace to improve the bonds and harden the material to the desired final specifications.

To expedite the temperature-reduction process, cooling towers commonly are used to circulate water through a jacket that cools the air surrounding the part. The most common type of cooling towers are constructed of galvanized steel. For sintering, metalworking and other industrial processes, these galvanized towers unfortunately are susceptible to corrosion and rust problems that can require ongoing maintenance. This can lead to expensive process downtime along with repair costs.

Structure Maintenance Solutions, Drawbacks

Phoenix Sintered Metals LLC, a powdered-metal part manufacturer, inherited a galvanized cooling tower when the company purchased its facility in Brockway, Pa. The tower was so corroded it was losing water – and expensive water-treatment chemicals – at an alarming rate. Patching was slowing but not preventing the losses.

"We were losing a lot of water out of the bottom of the cooling tower on a daily basis because of the leaks," explained Josh Crawford, maintenance supervisor at Phoenix Sintered Metals.

For aging galvanized cooling towers, this scenario is not unique. Metal cooling towers are under constant attack by salt air or the caustic atmosphere of many industrial sites. Minerals in hard water as well as its pH level also can contribute to corrosion.

To combat the slow deterioration, plant personnel often are tasked with patching panels and holes. Eventually, the cooling tower is replaced. Even with diligent maintenance practices and cooling-water chemistries, galvanized cooling towers typically must be replaced every 7 to 12 years.

"We were spending a lot of time trying to patch cracks in the floors. We were able to contain it a little bit but never able to completely stop it. As time went on, the cooling tower continued to rust, and the problem became worse," Crawford said.

The cooling tower, having been relocated from a shuttered, second location prior to Phoenix Sintered Metals LLC's acquisition of the facility, was oversized for the current operation by about 60%. While this did not impact the unit's cooling capability, an oversized unit adds to operating costs in terms of electricity to operate fans and pumps. The costs of water replacement and specialized water chemistries are also higher.

Eager for a more permanent solution, Crawford contacted ProChemTech International Inc. to inspect and evaluate the system. Also based in Brockway, Pa., ProChemTech provides cooling-water chemistry, systems design and engineering solutions.

"The previous ownership used that tower for quite a few years," said Bill Foringer, plant manager at ProChemTech. "Initially, Phoenix Sintered considered refurbishing it, but that isn't cost effective when you need new fan, motor, base and pan – it can get quite expensive. So, at that point we started looking at new cooling towers."

Metal cooling towers are under constant attack by salt air or the caustic atmosphere of many industrial sites. Minerals in hard water as well as its pH level also can contribute to corrosion.

Engineered Plastic Cooling Towers

When asked to make a recommendation, ProChemTech suggested a high-density polyethylene (HDPE) plastic cooling tower. Phoenix Sintered opted to purchase an HDPE tower from a manufacturer with a line of factory-assembled and modular plastic cooling towers in capacities up to 2,500 tons. Made from corrosion-proof engineered plastic, the seamless-shell design does not have joints, seams, panels, gaskets, bolts, fasteners or caulking like conventional towers.

"What drew our attention right away is that we wouldn't have to worry about the rusting of the shell," Crawford said. "Granted, had we purchased a new, galvanized tower, it wouldn't require much upkeep at first, but eventually it would get to that point where we would have those same issues."

Phoenix Sintered selected an induced-draft tower. Crawford said he is impressed by the cost and length of warranty associated with plastic cooling towers. Because HDPE towers are unaffected by corrosives, they require little maintenance and provide a longer service life.

According to Crawford, the unit was installed in July 2016 by a local contractor recommended by ProChemTech and has been working well since.

For more information: Contact John Flaherty, president of Delta Cooling Towers Inc., 185 US Hwy 206, Roxbury Township, N.J. 07836; tel: 800-289-3358; fax: 973-586-2243; e-mail: info@deltacooling.com; web: www.deltacooling.com.

Why Nitriding Steel is Growing in Popularity

Gas nitriding – hard, wear-resistant case with good lubricity

Rob Simons – Paulo; St. Louis, Mo.

Nitriding has continued to evolve from its roots of accidental discovery in early 20th-century metallurgy. The nitriding process is favored for a broadening variety of parts and applications across industries due to its relatively low temperature and precision.

A case-hardening technique in use since the early 20th century, nitriding has been an effective lower-temperature heat treatment for steel workpieces since even before engineers and metallurgists fully understood it.

Its appeal lies in the ability to harden a part by dissolving nitrogen into its surface without austenitizing, thus all but eliminating the risk of distortion. That opened the door for improving an ever-widening variety of parts. Its popularity grows as the industry realizes the technique is effective across a broad variety of parts and applications.

Origin of Nitriding Steel

Metallurgist Adolph Machlet developed nitriding by accident in 1906. That year, he applied for a patent that called for replacing atmosphere air in a furnace with ammonia to avoid oxidation of steel parts. Shortly after he submitted the patent application, he noticed that treating parts in an ammonia atmosphere at elevated temperatures caused a "skin, casing, shell or coating" to develop around a piece that was extremely difficult to corrode or tarnish.

Also in 1906, German metallurgist Adolph Fry led a research program during which he made the same discoveries Machlet made. He also noticed that adding alloying elements to iron heavily influenced the results of nitriding.

Machlet's patents for nitriding in the U.S. were approved in 1913 and 1914, and Fry received patents in Germany for his process in 1924.

How it Works

The process of nitriding steel begins by heating parts in a furnace to a relatively low temperature (950-1100°F, depending on a part's intended use) compared to other heat-treatment methods. At these low temperatures the steel remains ferritic, which means that the phase changes that alter the structure do not occur.

But the temperature is high enough for ammonia molecules injected into the furnace to break apart once they contact the workpiece. That breakup releases nitrogen atoms, which dissolve in the steel and form the desired diffusion zone. A minimal intermetallic compound layer also forms.

One benefit of nitriding as opposed to using other heat treatments is that modern nitriding equipment allows for computer-controlled injection of ammonia to achieve varying case depths. Another is that parts are slow cooled rather than cooled rapidly via quenching, a process that further limits the risk of distortion.

The precision of the process is such that parts' intended qualities are achieved in a single step. Therefore, they do not need to be softened down to specifications via tempering.

Increasing Popularity

Because nitriding steel workpieces offers superior surface qualities with minimal risk of distortion, the process has become a mainstay treatment of parts across a variety of industries.

- Manufacturers of automotive parts choose to nitride gears,

crankshafts and valve parts because the process imparts hard diffusion layers to the part surface. The increased fatigue strength resists the formation of surface and subsurface cracks.
- Nitriding has become an attractive heat-treatment option for makers of tool steels and forging dies because it imparts added surface hardness without the risk of distortion and resists tempering on forging dies and soldering on aluminum casting dies.
- Makers of firearms nitride components such as gun barrels and slides because the process decreases friction coefficients, increases wear resistance and fatigue strength, and imparts moderate corrosion control.

Expect to see the popularity of nitriding continue to increase. The techniques and technologies in play will only get better because the process will only become more precise. If engineers haven't considered new material and design possibilities that can arise from specifying nitriding, now is a good time to start.

For more information: Contact Rob Simons, metallurgical engineering manager, Paulo, 5711 West Park Ave., St. Louis, MO 63110; tel: 314-450-4356; fax: 314-450-4556; e-mail: rsimons@paulo.com; web: www.paulo.com

Nitrocarburizing

Nitrocarburizing entails the dissolution of carbon and nitrogen into a workpiece, but more nitrogen is used in nitrocarburizing compared to carbonitriding. There are two forms of nitrocarburizing: austenitic and ferritic.

Austenitic nitrocarburizing refers to the temperature of the nitrogen-enriched zone at the surface of a part. A phase change occurs in that zone, allowing the nitrogen to diffuse. Ferritic nitrocarburizing is conducted at a lower temperature where no phase change occurs. Ferritic nitrocarburizing is unique in that it offers case hardening without the need to heat metal parts into a phase change (it is done at 975-1125°F). Nitrogen atoms are soluble in iron within that temperature range, but the risk of distortion is decreased. Due to their shape and size, carbon atoms cannot diffuse into the part in this low-temperature process.

Case depths as a result of nitrocarburizing are typically shallower compared to carbonitriding.

Workpieces improved by nitrocarburizing include drivetrain components in automobiles and heavy equipment, firearm components like barrels and slides, and dies for manufacturing processes.

Nitrocarburizing decreases the potential for corrosion in parts and enhances their appearance. The process generally takes only a few hours.

Fig. 4. Ferritic nitrocarburized gray iron (1000x)

Fig. 1. Gas nitrided 1006 steel (500x)

Fig. 2. Gas nitrided H13 (500x)

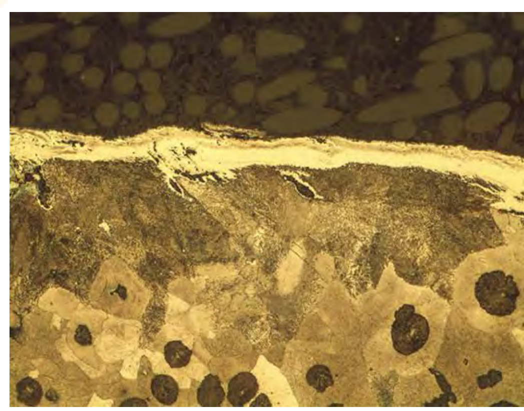

Fig. 3. Ferritic nitrocarburized ductile iron (500x)

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www.metexht.com
Rajiv Rishi, Plant Mgr.

Metlab*
Wyndmoor, PA (215) 233-2600
www.metlabheattreat.com
Mark Podob, V.P.-Mktg./Sales

MFCO Aluminum Heat Treat*
Wichita, KS (316) 267-7289
www.metalfinishingco.com

MFCO Chihauhua Heat Treat*
Chihuahua City, Mexico (614) 483-1559
www.metalfinishingco.com

Mid South Metallurgical*
Murfreesboro, TN (615) 896-6212
www.midsouthmetallurgical.com
Steve Jefsen

✪ Midwest Thermal-Vac Inc.*
5727 95th Ave., Kenosha, WI 53144
(262) 605-4848; (877) MTV-2003
Fax: (262) 605-4806; info@mtvac.com
www.mtvac.com; Nicole Otto, Gen. Mgr.

Missouri Heat Treat, a Div. of Unitherm Furnace LLC*
Wentzville, MO (636) 327-5234
www.unithermfurnace.com/mht
Brian Alls, Dept. Supv.

Modern Industries Inc., Heat Treating*
Erie, PA (814) 455-8061
www.modernind.com
Bryan Jageman, Gen. Mgr.

Modern Industries Inc.*
Kersey, PA (814) 885-8514
www.modernind.com
Pam Gerarge, Plant Mgr.

Modern Metal Processing Inc.*
Williamston, MI (517) 655-4402
www.modernmetalprocessing.com
Ed Wesolek, Pres.

Morgan Ohare Inc.*
Addison, IL (630) 543-6780
www.morganohare.com
Joan Sosinski

MPT America Corp.*
Valencia, CA (661) 257-1933
www.plasma-nitride.com
Andrew Velasco, Oper. Mgr.

MT Heat Treating Inc.*
Mentor, OH (440) 255-3211
www.mtheat-treat.com
Weldon Lawson, Mgr.

National Metal Processing Inc.*
Richmond, KY (859) 623-9291
www.nmpheattreat.com
Norman S. Graves, Pres.

Nevada Heat Treating Inc.*
Carson City, NV (775) 246-1040
www.nevadaheattreating.com
Harvey Hornung, Gen. Mgr.

Newton Heat Treating
City of Industry, CA (626) 964-6528
www.newtonheattreating.com
Greg Newton, Pres.

Nitrex Inc., Chicago Operations*
Aurora, IL (630) 851-5880
www.nitrexheattreat.com
Tom Cooper, Gen. Mgr.

Nitrex Inc., Indiana Operations*
Franklin, IN (317) 346-7700
www.nitrexheattreat.com
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Nitrex Inc., Michigan Operations*
Mason, MI (517) 676-6370
www.nitrexheattreat.com; Raja Gumber

Nitrex Inc., Nevada Operations*
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www.nitrexheattreat.com
Joe Beal, Cust. Serv. Mgr.

Nitrex Inc., West Coast Operations*
San Jose, CA (408) 275-0330
www.nitrexheattreat.com; Jim Johansen

✪ View Product spec sheets for these companies at www.industrialheating.com/commercialheattreat

Nitrex Metal Inc.
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www.nitrexheattreat.com
Jack Kalucki, Sales-Heat Treating

Nitrex Thermal Technology Co. Ltd.
Anzhen, Wuxi, Jiangsu, China
86-0510-8878-8627; www.nitrex-ntt.cn
Jimmy Liu

Nitro-Vac Heat Treat Inc.*
Warren, MI (586) 754-4350
www.nitrovac.com; William Stomber

NitroSteel - A Premier Thermal Solutions Co.*
Pleasant Prairie, WI (262) 947-0441
Chinmay Godbole, Plant Gen. Mgr.

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Rowley, MA (978) 948-2633

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www.northernheattreatltd.com
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www.ohiomet.com
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www.ohioverticalheattreat.com
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Oregon Induction Corp.*
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Waterport, NY (716) 845-6398
www.pkerengineering.com
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Pacific Heat Treating Co.*
Sunnyvale, CA (408) 736-8500
www.pacificheattreating.com
Douglas Holt, Mgr.

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Kent, WA (253) 854-4241
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www.parkertrutec.com

Parker Trutec - MMI Inc.*
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www.parkertrutec.com

Parker Trutec Inc.*
Springfield, OH (937) 323-8833
www.parkertrutec.com
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Parker Trutec Mexicana S.A. de C.V.*
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www.pennaflame.com
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www.pvht.com
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P & L Heat Treating & Grinding Inc.*
Youngstown, OH (330) 746-1339
www.plheattreatinggrinding.com
William H. Pociask, Pres.

Plymouth Brazing Inc.
Westland, MI (734) 453-6274
www.plymouthbrazing.net

Power Parts Intl.
West Bend, WI (262) 335-2777
www.powerpartsinc.com
Michael Shaw

Precision Heat Treating Co.
Kalamazoo, MI (269) 382-4660
www.precisionheat.net
Donald Juzwiak, V.P.

Precision Heat Treating Corp.*
Ft. Wayne, IN (260) 749-5125
www.phtc.net; Ken Vandre, Pres.

Precision Heat Treating Corp.
Jackson, MS (601) 355-4208
www.precisionheattreating.biz
precision-heat-treating-corporation.business.site
Alfred T. Bogen, III, Owner/Pres.

Precision Heat Treating Inc.*
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Tom Neal, Pres.

Precision Thermal Processing*
Clintonville, WI (715) 823-8650
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Premier Thermal Solutions LLC*
Lansing, MI (517) 485-5090
www.premierthermal.com
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Progressive Steel Treating Inc.
Loves Park, IL (815) 877-2571
www.progressivesteeltreating.com

Q-Tech Heat Treat LLC*
Dallas, TX (214) 630-8262
www.qtechht.com
Sean Fussell, Pres.

Quality Heat Treating Inc.*
Burbank, CA (323) 849-6604
www.qualityht.com
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Indianapolis, IN (317) 357-8691
www.qualitysteeltreating.com
Bill Slade, Prod. Mgr.

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Cincinnati, OH (513) 541-6300
www.qcst.com
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R & R Heat Treating Inc.
E. Stroudsburg, PA (570) 424-8750
David P. Daniels, V.P.

Radyne Corp.
Milwaukee, WI (800) 236-8360
www.radyne.com
Cory, Zahringer

Refrac Systems
Chandler, AZ (800) 473-3722
www.refrac.com
www.die-bond.com
Norman Hubele, Pres. & Founder

Republic Heat Treat*
Houston, TX (713) 692-3410
www.republicht.com

Rex Heat Treat*
Anniston, AL (256) 835-3370
www.rexht.com
Jon Montgomery, Regl. Sales Mgr.

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www.rexht.com
Douglas Gerber, Plant Mgr.

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Lansdale, PA (215) 855-1131
www.rexht.com
Chris Constable, Sales Mgr.

Robert Wooler Co.*
Dresher, PA (215) 542-7600
www.robertwooler.com
Biff Keidel, Pres./Gen. Mgr.

Rochester Steel Treating Works Inc.*
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www.rstwinc.com
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www.rockfordheattreaters.net
Tom Deutsch, V.P.

Rogers Metal Services Inc.
Skokie, IL (847) 679-4642
www.rogersmetal.com
Jon Zimmerman, Pres.

Scarrott Metallurgical Co.*
Los Angeles, CA (310) 645-7300
www.scarrott.com
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Schmolz + Bickenbach Int., Heat Treatment
Carol Stream, IL (630) 682-3900 x8
www.schmolz-bickenbach.us
Eric Nordin, Sales Mgr.

Scientific Metal Treating*
Roselle, IL (630) 582-0071
www.scientificmetaltreating.com
Kevin Haraldson, Pres.

Seattle Heat Treaters, dba Stober & Chiaro
Seattle, WA (206) 763-2744
Jeff Stober, V.P.

SEI Heat Treat*
Houston, TX (713) 699-3892
www.seiheat.com
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Milwaukee, WI (414) 355-1020
www.serviceht.com
Paul Armitage, Pres.

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Fax: (724) 982-0593
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www.solaratm.com
Mike Harper, Sales Mgr.

The Sousa Corp.*
Newington, CT (860) 523-9090
www.sousacorp.com
Andrew Sousa, V.P.-Quality

Southwest Metal Treating Corp.*
Ft. Worth, TX (817) 551-1295
www.swmt.net
Garrett Bodkin, Gen. Sales Mgr.

Southwest Specialty Heat Treat*
Wytheville, VA (276) 228-7739
www.swhtva.com
David Carpenter, Pres.

S&P Heat-Treating Inc.
Warwick, RI (401) 737-9272
www.spheattreating.com
Michael Rapoza, Gen. Mgr.

Specialty Alloy Processing Co. Inc.
Murrysville, PA (724) 339-0464
Ed Moses, Pres.

Specialty Heat Treat Inc.*
Houston, TX (713) 937-3101
www.specialtyheattreat.com
Sam Moore, Gen. Mgr.

Specialty Steel Treating Inc.*
East Granby, CT (860) 653-0061
www.sst.net

Specialty Steel Treating Inc.*
Farmington Hills, MI (248) 478-5900
www.sst.net; Scott Verhelle, Exec. V.P.

Specialty Steel Treating Inc.*
Fraser, MI (586) 293-5355
www.sst.net
Mark Sosnowski, V.P.

Specialty Steel Treating Inc. (Malyn)*
Fraser, MI (586) 415-8346
www.sst.net; Mark Sosnowski, V.P.

Spectrum Heat Treat*
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Ron Lockwood

Spectrum Thermal Processing LLC*
Cranston, RI (401) 808-6249
www.spectrumthermalprocessing.com
Stephen Egan, Gen. Mgr.

Stack Metallurgical Services Inc.*
Portland, OR (503) 285-7703
www.stackmet.com
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Steel Treaters Inc.*
Oriskany, NY (315) 736-3081
www.steeltreaters.com
Dave Stopera, Site Mgr.

Stokes Steel Treating Co.*
Flint, MI (810) 235-3573
Robb Stokes, Pres.

STT Nitrex Querétaro, S. De R.L. De C.V.
La Noria, El Marqués, Querétaro, Mexico
52-442-221-5243
www.nitrexheattreat.com
Carlos Llerena

Sturm Steel Treating Inc.*
Indianapolis, IN (317) 357-2368
Gerry Fitzwater, Heat Treat Mgr.

Sun Steel Treating Inc.*
South Lyon, MI (877) 471-0840
www.sunsteeltreating.com
Yolanda Brown, Admin. Asst.

✪ View Product spec sheets for these companies at www.industrialheating.com/commercialheattreat

Superior Metal Treating & Equipment Inc.*
Kansas City, MO (816) 924-1966
www.smteinc.com; Glen R. True, Pres.

Tamayakin Co. Ltd.*
Musashimurayama, Tokyo, Japan
81-42-560-4331
Tsuyoshi Yamada, Pres.

Taylor-Winfield Technologies Inc.
Youngstown, OH
(330) 259-8500
www.taylor-winfield.com
http://inductionheating-tw.com
Ryan Neiss, Induction Heating Product Mgr.

TC Industries Inc.*
Crystal Lake, IL (815) 459-2400
www.tcindustries.com
Jim Farnstrom

Techniques Surfaces do Brasil Ltda
Diadema - SP, Brazil
55-11-4056-4433
www.tsbrasil.srv.br
Eros de Araujo Neto, Commercial Mgr.

Temperature Processing Co. Inc.*
Longmont, CO (303) 772-0250
www.tpcolorado.com
Eric Engelhard, V.P.

Temperature Processing Co. Inc.*
North Arlington, NJ
(201) 991-8000
Veronica Morales, Contract Spec.

Texas Heat Treating Inc.*
Round Rock, TX (800) 580-5884
www.texasheattreating.com
Buster Crossley, Pres.

Texas Steel Conversion
Houston, TX (713) 733-6013
Alfred Cox, V.P.-Quality

Thermal Braze Inc.
Jupiter, FL (561) 746-6640
www.thermalbraze.com
David Wise, V.P.

Thermal Metal Treating Inc.*
Aberdeen, NC (910) 944-3636
www.thermalmetal.com
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Thermal Modification Technologies*
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www.thermalmodtech.com

Thermal Specialties*
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www.thermalspecialties.com
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www.thermetco.com

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Edmonton, AB (780) 440-4373
www.thermexmetal.com
Norm Hanson, Pres.

Thermo-Fusion Inc.*
Hayward, CA (510) 782-7755
www.thermo-fusion.com; Nils Kjell, Dir.

ThermTech*
Waukesha, WI (800) 752-6917
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Tohken Thermo Mexicana SA de CV*
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Tooling and General Heat Treatment*
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www.nitrogas.com.ar
Oscar Ricardo Granero, Pres.

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Milwaukee, WI (414) 395-4137
www.regalptspts.com
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Tri-State Metal Inc.*
East Chicago, IN (219) 397-0470
www.tri-statemetal.com

Tri-City Heat Treat Co.*
Rock Island, IL (309) 786-2689
www.tcht.com; Cindy Ellis, CFO

Tri-J Metal Heat Treating Co.
Pomona, CA (909) 622-9999
www.trijonline.com; Yusheng Shew, Pres.

Trojan Heat Treat Inc., Plant 4 Heat Treat Services Corporation of America*
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Ron DiSalvio, Pres.

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Valley Metal Treating Inc.*
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Vira-Tech Inc.*
Santa Fe Springs, CA (562) 693-3277
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Michael Schmidt, Sales Mgr.

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www.tecvac.com
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Weiss Industries Inc., Heat Treating Div.*
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John L. Reger, CEO

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Lou Ghinga, Business Dev.

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Zion Industries Inc.*
Valley City, OH (330) 483-4650
www.zioninduction.com
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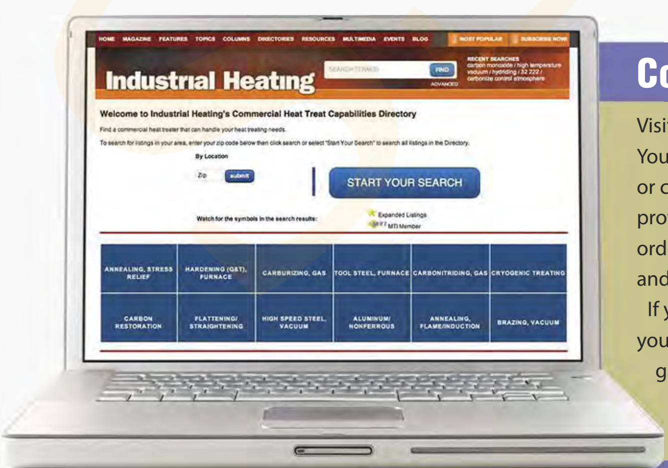

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Visit http://industrialheating.com/commercialheattreat to view this directory online. You can search for a heat treater by location, MTI membership, certifications and/or category (e.g., annealing, brazing, carburizing, etc.). A heat treater's online listing provides you with contact information and a list of services provided. You can also order a print copy of the Commercial Heat Treat Capabilities Directory from this URL and/or provide us with feedback.

If you're a heat treater, you can log in and update your directory information. If you're not currently listed, you can create an account and set up your company to gain year-round exposure in print and on our website.

Contact Stacey Hurley at hurleys@bnpmedia.com or 248-786-1662 for more information.

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INDUSTRIAL HEATING

2018 Commercial Heat-Treating Capabilities Directory

Company	State/Province	MTI Member	Annealing											Brazing					Carbo-nitriding				Carburizing				
			Bright	Full	Homogenize	Isothermal	Local	Flame/Induction	Normalize	Recrystallize	Spheroidize	Solution (Quench)	Stress Relief	Dip	Furnace	Induction	Torch	Vacuum	Fluid Bed	Gas	Salt	Vacuum	Fluid Bed	Gas	Pack	Salt	Vacuum
Advanced Heat Treat Corp., Cullman	AL												●														
Ajax TOCCO Magnethermic Corp., Albertville	AL		●	●			●	●	●			●	●			●		●									
Bodycote, Athens	AL		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
CMC Impact Metals, Pell City	AL								●				●														
Pinson Valley Heat Treating, Pinson	AL	★		●		●			●	●	●	●	●					●		●				●			
Rex Heat Treat, Anniston	AL	★																									
Bodycote, Hot Springs	AR		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Coleman Heat Treating, Jacksonville	AR	★	●	●				●	●		●	●	●		●			●		●				●			
Parker Trutec - MMI Inc., Paragould	AR	★																									
Controlled Thermal Technology, Phoenix	AZ	★	●	●	●	●			●	●	●	●	●							●	●			●			
DIE-BOND LLC, Chandler	AZ		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●									●
Phoenix Heat Treating Inc., Phoenix	AZ	★	●	●	●	●			●	●	●	●	●						●	●				●			
Refrac Systems, Chandler	AZ		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●									●
Accurate Steel Treating, South Gate	CA	★		●	●				●			●	●							●				●			
Aremac Heat Treating LLC, City of Industry	CA	★	●	●	●	●			●	●	●	●	●							●				●			
Bodycote, Fremont	CA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Huntington Park	CA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Rancho Domiguez	CA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Santa Fe Springs	CA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Vernon	CA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Westminster	CA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Byington Steel Treating Inc., Santa Clara	CA	★	●	●	●		●		●		●	●	●							●				●			
California Brazing, Newark	CA	★	●	●									●		●		●	●									
Certified Metal Craft Inc., El Cajon	CA	★	●	●	●	●			●			●	●		●		●	●		●				●			
City Steel Heat Treating Inc., Santa Fe Springs	CA			●	●	●	●	●	●	●	●	●	●							●				●	●		
Coast Heat Treating Co., Los Angeles	CA	★																									
Continental Heat Treating Inc., Santa Fe Springs	CA	★	●	●	●				●		●	●	●							●				●			
Cook Induction Heating Co., Maywood	CA	★	●	●			●	●							●	●	●										
Galaxy Brazing Co. Inc., Santa Fe Springs	CA	★	●	●			●	●	●			●	●		●	●	●	●									
Garner Heat Treat Inc., Oakland	CA	★	●	●		●	●		●		●	●	●			●	●	●		●				●			
MPT America Corp., Valencia	CA	★																									
Newton Heat Treating, City of Industry	CA											●	●														
Nitrex Inc., West Coast Operations, San Jose	CA	★	●	●			●	●	●		●	●	●		●	●	●	●		●				●			●
Pacific Heat Treating Co., Sunnyvale	CA	★	●	●		●	●	●	●	●	●	●	●											●			
Palmdale Heat Treating Inc., Palmdale	CA		●	●		●			●			●	●							●				●		●	
Quality Heat Treating Inc., Burbank	CA	★	●	●	●				●		●	●	●											●			
Scarrott Metallurgical Co., Los Angeles	CA	★	●	●	●	●			●	●		●	●		●			●									
Solar Atmospheres, Fontana	CA	★	●	●	●	●			●	●	●	●	●		●			●									●
Spectrum Heat Treat, Benicia	CA	★							●			●	●														
Thermal Technologies, Chatsworth	CA	★																									
Thermal-Vac Technology Inc., Orange	CA	★	●	●	●		●	●	●	●		●	●	●	●	●	●	●									
Thermo-Fusion Inc., Hayward	CA	★	●	●	●			●	●			●	●		●		●	●		●				●			
Tri-J Metal Heat Treating Co., Pomona	CA			●			●		●		●		●							●				●			
Valley Metal Treating Inc., Pomona	CA	★	●	●	●				●		●	●	●							●				●			
Vira-Tech Inc., Santa Fe Springs	CA	★	●	●	●				●			●	●		●		●	●									
Temperature Processing Co. Inc., Longmont	CO	★	●	●	●	●		●	●	●	●	●	●			●	●	●		●				●			
American Heat Treating Inc., Monroe	CT	★	●	●	●	●	●	●	●	●	●	●	●					●		●				●			
Anderson Specialty Co., West Hartford	CT												●													●	
BeeHive Heat Treating Service Inc., South Norwalk	CT		●	●	●		●	●	●			●	●		●	●	●	●		●	●			●	●	●	
Bodycote, Berlin	CT		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●

Hardening (Q&T)									High-Speed Steel				Ferritic Nitrocarburizing				Nitriding					Tool Steel															
Flame	Fluid Bed	Furnace	Induction	Intensive Quenching	Neutral Salts	Precipitation	Press Quenching	Vacuum	Fluid Bed	Furnace	Salt	Vacuum	Fluid Bed	Gas	Ion	Salt	Fluid Bed	Gas	Ion	Salt	Vacuum	Fluid Bed	Furnace	Salt	Vacuum	Aluminum/Nonferrous	Austempering	Boronizing	Carbon Restoration	Cryogenic Treating	Flattening/Straightening	Hot Isostatic Pressing (HIP)	Laser HT	Marquenching	On-Site (field) HT	Sintering	Steam Treating
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INDUSTRIAL HEATING
2018 Commercial Heat-Treating Capabilities Directory

	State/Province	MTI Member	Annealing											Brazing					Carbo-nitriding				Carburizing				
			Bright	Full	Homogenize	Isothermal	Local	Flame/Induction	Normalize	Recrystallize	Spheroidize	Solution (Quench)	Stress Relief	Dip	Furnace	Induction	Torch	Vacuum	Fluid Bed	Gas	Salt	Vacuum	Fluid Bed	Gas	Pack	Salt	Vacuum
Bodycote, South Windsor	CT		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Eastern Metal Treating Inc., Enfield	CT												●														
Metallurgical Processing Inc., New Britain	CT	★	●	●	●				●			●	●		●			●		●				●			
The Sousa Corp., Newington	CT	★	●	●	●	●	●		●	●		●	●							●				●			●
Specialty Steel Treating Inc., East Granby	CT	★	●	●	●	●			●		●	●	●		●			●		●				●			
Atlantic Heat Treat, Wilmington	DE	★	●	●	●	●	●	●	●	●	●	●	●		●					●				●			
Braddock Metallurgical, Daytona Beach	FL	★		●					●				●							●				●			
Braddock Metallurgical, Jacksonville	FL	★	●	●	●	●	●	●	●	●	●	●	●							●				●	●		
Braddock Metallurgical - Tampa, Riverview	FL	★	●	●	●	●		●	●	●	●	●	●							●				●	●		
Braddock Metallurgical Aerospace Services, Boynton Beach	FL	★	●	●					●			●	●		●			●		●				●			
Thermal Braze Inc., Jupiter	FL		●	●	●		●	●				●	●		●	●		●									
Aremac Heat Treating East LLC, Eastman	GA	★	●	●	●				●			●	●							●				●			
Bodycote, Covington	GA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Braddock Metallurgical, Atlanta	GA	★	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●				●	●		
Advanced Heat Treat Corp., Waterloo (Burton)	IA			●	●	●	●	●	●	●	●		●							●				●			
Advanced Heat Treat Corp., Waterloo (Midport)	IA			●	●	●		●	●	●	●		●							●				●			
Donohoo Steel Treating, Bettendorf	IA	★		●			●	●	●				●							●				●			
Z-Machine Inc., Ocheyedan	IA												●														
Beechner Heat Treating Co. Inc., Rockford	IL			●					●				●														
Bluewater Thermal Solutions, Chicago Plant 3, Melrose Park	IL												●											●			
Bluewater Thermal Solutions, Chicago Plant 1, Northlake	IL			●				●	●				●														
Bluewater Thermal Solutions Chicago Plant 2, Northlake	IL		●	●		●			●	●			●		●												
Bluewater Thermal Solutions, Rockford	IL		●	●	●	●			●	●	●	●						●		●				●			
Bodycote, Melrose Park	IL		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Certified Heat Treating, Peoria	IL	★		●	●				●		●	●	●							●				●			
Chem-Plate Industries, Elk Grove Village (Devon Ave.)	IL	★																									
Chem-Plate Industries, Elk Grove Village (Morse Ave.)	IL	★																									
Chem-Plate Industries, Elk Grove Village (Touhy Ave.)	IL	★																									
Diamond Heat Treat, Rockford	IL	★							●				●			●				●							
FPM HEAT TREATING, Cherry Valley	IL	★											●							●				●			
FPM HEAT TREATING, Elk Grove Village	IL	★	●	●	●	●	●	●	●	●	●	●	●					●		●				●			
General Surface Hardening Inc., Chicago	IL	★		●		●	●	●	●			●	●							●				●			
GFI Metal Treating, Rockford	IL	★																									
Hudapack Metal Treating of Illinois Inc., Glendale Heights	IL	★							●			●	●														
Induction Heat Treating Corp., Crystal Lake	IL	★						●								●											
Metals Technology Corp., Carol Stream	IL		●	●	●	●	●		●	●	●	●	●					●		●				●			
Morgan Ohare Inc., Addison	IL	★																		●							
Nitrex Inc., Chicago Operations, Aurora	IL	★	●	●			●	●	●		●	●	●			●		●		●				●			●
Progressive Steel Treating Inc., Loves Park	IL		●						●			●						●	●								
Rockford Heat Treaters Inc., Rockford	IL		●	●	●		●	●	●		●	●	●		●		●	●		●				●			
Rogers Metal Services Inc., Skokie	IL		●	●											●	●	●										
Schmolz + Bickenbach Int., Carol Stream	IL			●	●	●			●	●	●	●	●														
Scientific Metal Treating, Roselle	IL	★	●	●	●	●	●	●	●		●	●	●							●				●			●
TC Industries Inc., Crystal Lake	IL	★		●					●				●														
Tri-City Heat Treat Co., Rock Island	IL	★		●	●	●		●	●			●	●							●				●			
Advanced Nitriding Solutions, Batesville	IN	★																		●							
Applied Thermal Technologies Inc., Warsaw	IN	★	●		●								●					●									
Atmosphere Annealing LLC, North Vernon	IN			●	●	●			●	●																	
Bluewater Thermal Solutions, South Bend	IN		●	●	●	●			●			●	●							●				●			
Bodycote, Elkhart	IN		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Ft. Wayne	IN		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Greensburg	IN		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Indianapolis	IN		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Calumet Surface Hardening Co. Inc., Hammond	IN	★		●				●																	●		
Chicago Flame Hardening Co., East Chicago	IN	★						●					●														
Circle City Heat Treating Inc., Indianapolis	IN	★		●					●		●	●	●							●				●			
Contour Hardening, Indianapolis	IN							●																			
Dependable Metal Treating Inc., Kendalville	IN	★		●									●							●				●			
Exotic Metal Treating Inc., Indianapolis	IN		●	●	●				●			●	●		●			●									
H.T.I., Logansport	IN	★																									
Lake City Heat Treating, Warsaw	IN	★	●	●	●				●			●	●														
Master Induction Heat Treat LLC, Laporte	IN	★																									
Nitrex Inc., Indiana Operations, Franklin	IN	★	●	●			●	●	●		●	●	●			●		●		●				●			●
Precision Heat Treating Corp., Ft. Wayne	IN	★	●	●				●	●				●		●					●				●			
Quality Steel Treating LLC, Indianapolis	IN	★	●	●					●				●					●									

Hardening (Q&T)									High-Speed Steel				Ferritic Nitrocarburizing				Nitriding					Tool Steel															
Flame	Fluid Bed	Furnace	Induction	Intensive Quenching	Neutral Salts	Precipitation	Press Quenching	Vacuum	Fluid Bed	Furnace	Salt	Vacuum	Fluid Bed	Gas	Ion	Salt	Fluid Bed	Gas	Ion	Salt	Vacuum	Fluid Bed	Furnace	Salt	Vacuum	Aluminum/Nonferrous	Austempering	Boronizing	Carbon Restoration	Cryogenic Treating	Flattening/Straightening	Hot Isostatic Pressing (HIP)	Laser HT	Marquenching	On-Site (field) HT	Sintering	Steam Treating
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INDUSTRIAL HEATING

2018 Commercial Heat-Treating Capabilities Directory

	State/Province	MTI Member	Annealing											Brazing					Carbo-nitriding				Carburizing				
			Bright	Full	Homogenize	Isothermal	Local	Flame/Induction	Normalize	Recrystallize	Spheroidize	Solution (Quench)	Stress Relief	Dip	Furnace	Induction	Torch	Vacuum	Fluid Bed	Gas	Salt	Vacuum	Fluid Bed	Gas	Pack	Salt	Vacuum
Sturm Steel Treating Inc., Indianapolis	IN	★	●	●					●				●							●				●			
Tri-State Metal Inc., East Chicago	IN	★																									
Bodycote, Wichita (McLean)	KS		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Wichita (West)	KS		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Metal Finishing Co., Wichita	KS	★	●	●	●	●			●		●	●	●											●			
MFCO Aluminum Heat Treat, Wichita	KS	★																									
Bodycote, Princeton	KY		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Kentucky Heat Treating Co., Winchester	KY	★	●	●	●	●			●	●	●		●							●				●			
National Metal Processing Inc., Richmond	KY	★	●	●			●		●				●			●				●				●			
Acadiana Testing & Heating, Amelia	LA	★											●														
Bodycote, Lafayette	LA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Andover	MA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Ipswich	MA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Worcester	MA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
County Heat Treat, Millbury	MA	★	●	●	●	●	●	●	●		●	●	●					●		●				●			
Hardline Heat Treating Inc., Southbridge	MA	★	●	●	●	●	●	●	●		●	●	●		●			●	●	●		●	●	●	●		●
Northeast Metals Technologies, Rowley	MA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●									
A & S Brazing Co., Warren	MI						●	●					●			●	●										
Advanced Heat Treat Corp., Monroe	MI												●														
Ajax TOCCO Magnethermic Corp., Madison Heights	MI		●	●			●	●	●			●	●			●		●									
ALD Thermal Treatment Inc., Port Huron	MI	★	●						●		●	●	●														●
Alloy Steel Treating Co. Inc., Gobles	MI		●	●				●	●				●							●				●			
American Metal Processing Co., Warren	MI	★																		●				●			
Applied Process Inc., Livonia	MI	★																						●			
Atmosphere Annealing LLC, Lansing (Bassett)	MI	★		●		●			●	●	●		●														
Atmosphere Annealing LLC, Lansing (Mt. Hope)	MI		●	●		●			●	●			●														
Atmosphere Heat Treating / Austemper Inc., Wixom	MI	★																									
Bluewater Thermal Solutions, Benton Harbor	MI			●		●			●				●							●				●			
Bluewater Thermal Solutions, Coldwater	MI		●	●									●		●	●	●										
Bluewater Thermal Solutions, Saginaw	MI																										
Bodycote, Canton (Haggerty)	MI		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Canton (Ronda)	MI		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Grand Rapids	MI		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Holland	MI		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Livonia	MI		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Romulus	MI		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Century Sun Metal Treating, Traverse City	MI	★	●	●	●	●		●	●		●	●	●							●				●			
Commercial Steel Treating Corp., Madison Heights	MI	★							●				●							●				●			
Custom Heat Treat Inc., Kingsford	MI								●																		
Detroit Steel Treating Co., Pontiac	MI			●	●		●	●	●	●	●	●	●							●				●			
Dynamic Surface Technologies, Canton	MI	★																●	●				●				
East-Lind Heat Treat Inc., Madison Heights	MI	★	●	●	●	●	●	●	●			●	●							●	●			●	●	●	
EFD Induction Inc., Madison Heights - see our ad on page 23	**MI**							●								●											
Engineered Heat Treat Inc., Madison Heights	MI	★	●	●	●				●			●	●							●				●			
Fire Kote Steel Treating, Wyoming	MI		●	●			●	●	●				●														
Hansen-Balk Steel Treating Co., Grand Rapids	MI	★	●	●	●	●		●	●		●	●	●					●						●			
Heat Treating Services, Pontiac	MI	★		●	●	●			●		●		●														
Hi-Tech Steel Treating Inc., Saginaw	MI	★		●	●	●		●	●		●	●	●							●				●			
Hy-Vac Technologies Inc., Detroit	MI	★	●	●	●	●			●	●	●	●	●		●			●									
Induction Services Inc., Warren	MI							●																			
Inductoheat Inc., Madison Heights	MI		●					●					●			●											
Industrial Steel Treating Co., Jackson	MI	★	●	●			●	●	●				●							●				●			
Magnum Induction, New Baltimore	MI	★						●																			
Metallurgical Processing Co., Warren	MI	★																		●				●			●
Modern Metal Processing Inc., Williamston	MI	★	●						●			●	●		●		●	●									
Nitrex Inc., Michigan Operations, Mason	MI	★	●	●			●	●	●		●	●	●			●		●		●				●			●
Nitro-Vac Heat Treat Inc., Warren	MI	★	●	●	●	●			●		●	●	●		●		●	●						●	●		
Pillar Induction, Sterling Heights	MI							●								●											
Plymouth Brazing Inc., Westland	MI		●	●					●				●		●	●	●										
Precision Heat Treating Co., Kalamazoo	MI							●					●			●				●				●			
Premier Thermal Solutions LLC, Lansing	MI	★																									
Specialty Steel Treating Inc., Farmington Hills	MI	★							●				●							●				●			
Specialty Steel Treating Inc., Fraser	MI	★	●	●	●				●		●		●					●		●				●			●
Specialty Steel Treating Inc., Fraser (Malyn)	MI	★	●						●				●					●				●		●			●
Stokes Steel Treating Co., Flint	MI	★		●					●											●				●			

Hardening (Q&T)									High-Speed Steel				Ferritic Nitrocarburizing				Nitriding					Tool Steel															
Flame	Fluid Bed	Furnace	Induction	Intensive Quenching	Neutral Salts	Precipitation	Press Quenching	Vacuum	Fluid Bed	Furnace	Salt	Vacuum	Fluid Bed	Gas	Ion	Salt	Fluid Bed	Gas	Ion	Salt	Vacuum	Fluid Bed	Furnace	Salt	Vacuum	Aluminum/Nonferrous	Austempering	Boronizing	Carbon Restoration	Cryogenic Treating	Flattening/Straightening	Hot Isostatic Pressing (HIP)	Laser HT	Marquenching	On-Site (field) HT	Sintering	Steam Treating
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INDUSTRIAL HEATING

2018 Commercial Heat-Treating Capabilities Directory

	State/Province	MTI Member	Annealing											Brazing					Carbo-nitriding				Carburizing				
			Bright	Full	Homogenize	Isothermal	Local	Flame/Induction	Normalize	Recrystallize	Spheroidize	Solution (Quench)	Stress Relief	Dip	Furnace	Induction	Torch	Vacuum	Fluid Bed	Gas	Salt	Vacuum	Fluid Bed	Gas	Pack	Salt	Vacuum
Sun Steel Treating Inc., South Lyon	MI	★	●	●	●	●			●	●	●	●	●														
Trojan Heat Treat Inc., Homer	MI	★	●	●		●			●		●		●														
Vac-Met Inc., Warren	MI	★	●	●	●	●			●	●	●	●	●		●			●									
Wyatt Services Inc., Sterling Heights	MI	★		●	●		●	●	●		●		●											●			
Zion Industries Inc., Grand Ledge	MI	★						●								●											
Arrow Tank & Engineering Co., Cambridge	MN	★											●														
Bodycote, Eden Prairie	MN		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Flame Metals Processing Corp., Rogers	MN		●	●	●	●	●		●	●	●	●	●		●			●		●				●			
Med-Tek Inc., Minneapolis	MN	★	●	●	●	●	●	●	●	●	●	●	●					●		●				●			
Metal Treaters Inc., St. Paul	MN	★	●	●	●	●	●	●	●	●	●	●	●							●				●			
Krankka Metallurgical LLC, New London	MO		●	●	●		●	●	●	●		●	●		●		●	●							●		
Missouri Heat Treat, Wentzville	MO	★		●	●	●	●	●	●		●	●	●							●				●			
Paulo, Kansas City	MO	★	●	●	●	●	●	●	●	●	●	●	●							●				●			
Paulo, St. Louis	MO	★	●	●	●	●	●		●	●	●	●	●							●				●			
Superior Metal Treating & Equipment Inc., Kansas City	MO	★	●	●		●	●	●	●		●	●	●		●	●	●	●		●				●			
Valley Heat Treat Co., Valley Park (St. Louis)	MO			●			●		●			●	●														
Precision Heat Treating Corp., Jackson	MS			●					●			●	●							●				●			
American Metal Treating Inc., High Point	NC	★	●	●	●	●	●	●	●	●	●	●	●							●				●			
Braddock Metallurgical, Charlotte	NC	★	●									●	●		●			●		●				●			
East Carolina Metal Treating Inc., Raleigh	NC	★	●	●	●	●		●	●	●	●	●	●					●		●				●			
Flame Treating Systems Inc., Durham	NC							●																			
JF Heat Treating Inc., Gastonia	NC	★		●				●	●				●							●				●			
Thermal Metal Treating Inc., Aberdeen	NC	★							●				●							●				●			
Zion Industries Inc., Hildebran	NC	★						●								●											
Lawrence Industries Inc., Hastings	NE							●	●			●	●							●				●			
Bodycote, Laconia	NH		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bennett Heat Treating & Brazing Co., Newark	NJ	★	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●				●			
Bodycote, Roselle	NJ		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Braddock Metallurgical, Bridgewater	NJ	★	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●				●	●		
Temperature Processing Co. Inc., North Arlington	NJ	★	●	●					●		●	●	●		●												
Nevada Heat Treating Inc., Carson City	NV	★	●	●	●	●	●		●	●	●	●	●		●		●	●		●				●			
Nitrex Inc., Nevada Operations, North Las Vegas	NV	★	●	●			●	●	●		●	●	●			●		●		●				●			●
B & W Heat Treating Co. Inc., Tonawanda	NY								●				●														
Bodycote, Rochester	NY		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Syracuse	NY		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Brazetek Heat Exchangers, Brooklyn	NY														●			●									
Elmira Heat Treating Inc., Elmira	NY	★	●	●				●	●			●	●		●	●		●		●				●			
Great Lakes Metal Treating Inc., Tonawanda	NY	★							●				●											●			
Hercules Heat Treating, Brooklyn	NY	★	●	●	●	●			●	●	●	●	●														
Jasco Heat Treating Inc., Fairport	NY	★	●	●	●	●	●	●	●		●	●	●							●				●			
P-Ker Engineering, Waterport	NY														●			●									
Rochester Steel Treating Works Inc., Rochester	NY	★	●	●	●		●	●	●		●	●	●							●				●			
Steel Treaters Inc., Oriskany	NY	★	●	●	●	●	●	●	●		●	●	●		●			●		●				●			
Advanced Flame Hardening Inc., Hinckley	OH																										
Aerobraze Engineered Technologies, Cincinnati	OH		●	●	●	●	●		●	●			●		●		●	●									
Ajax TOCCO Magnethermic Corp., Warren - see our ad on page 24	**OH**		●	●			●	●				●	●			●		●									
Ajax TOCCO Magnethermic Corp., Wickliffe	OH		●	●			●	●				●	●			●		●									
Akron Steel Treating Co., Akron	OH	★	●	●	●	●	●	●	●	●	●	●	●							●				●			
Al-Fe Heat Treating Inc., Wadsworth	OH			●								●	●														
American Heat Treating, Dayton	OH	★	●									●	●														
American Metal Treating Co., Cleveland	OH	★						●																			
American Steel Treating, Perrysburg	OH	★	●	●	●	●			●		●	●	●							●				●			
Atmosphere Annealing LLC, Canton	OH	★		●	●	●			●	●	●		●														
Bodycote, Cincinnati	OH		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Highland Heights, Cleveland	OH		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Columbus	OH		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, London	OH		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
B O S Services Co., Willoughby	OH	★											●														
Bowdil Co., Canton	OH	★							●				●														
Byron Products Inc., Fairfield	OH	★	●	●	●		●	●	●			●	●		●	●	●	●									
Certified Heat Treating Inc., Miamisburg	OH	★																									
Certified Heat Treating Inc., Springfield	OH	★	●	●	●	●	●	●	●	●	●		●		●	●				●				●			
Cincinnati Flame Hardening Co., Fairfield	OH			●								●	●														
Cincinnati Steel Treating Co., Cincinnati	OH	★		●	●	●		●	●		●	●	●							●				●			
CryoPlus Inc., Wooster	OH																										

Hardening (Q&T)									High-Speed Steel				Ferritic Nitrocarburizing				Nitriding					Tool Steel															
Flame	Fluid Bed	Furnace	Induction	Intensive Quenching	Neutral Salts	Precipitation	Press Quenching	Vacuum	Fluid Bed	Furnace	Salt	Vacuum	Fluid Bed	Gas	Ion	Salt	Fluid Bed	Gas	Ion	Salt	Vacuum	Fluid Bed	Furnace	Salt	Vacuum	Aluminum/Nonferrous	Austempering	Boronizing	Carbon Restoration	Cryogenic Treating	Flattening/Straightening	Hot Isostatic Pressing (HIP)	Laser HT	Marquenching	On-Site (field) HT	Sintering	Steam Treating
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INDUSTRIAL HEATING

2018 Commercial Heat-Treating Capabilities Directory

	State/Province	MTI Member	Annealing											Brazing					Carbo-nitriding				Carburizing				
			Bright	Full	Homogenize	Isothermal	Local	Flame/Induction	Normalize	Recrystallize	Spheroidize	Solution (Quench)	Stress Relief	Dip	Furnace	Induction	Torch	Vacuum	Fluid Bed	Gas	Salt	Vacuum	Fluid Bed	Gas	Pack	Salt	Vacuum
Dayton Forging & Heat Treating, Dayton	OH	★	●	●	●				●		●	●	●							●				●			
Derrick Co. Inc., Cincinnati - see our ads on pages 42-43, 46-47, 50-51, 60-61	**OH**	★		●	●	●			●		●	●	●	●													
Erie Steel Ltd., Toledo	OH	★	●	●	●				●			●	●							●				●			
Euclid Heat Treating Co., Euclid	OH	★	●	●	●	●	●	●	●	●	●	●	●							●				●			
Franklin Brazing & Metal Treating Inc., Lebanon	OH	★	●	●					●				●		●												
General Metal Heat Treating Inc., Cleveland	OH	★			●				●			●	●							●	●			●			
H & M Metal Processing Co., Akron	OH	★																									
Heat Treating Technologies Inc., Lima	OH	★		●					●				●							●				●			
HI TecMetal Group, Brazing & Metal Treating (BMT), Cleveland	OH	★	●	●									●		●												
HI TecMetal Group, Brite Brazing, Cleveland	OH	★													●		●										
HI TecMetal Group, HI Tech Aero, Eastlake	OH	★	●	●	●				●		●	●	●		●			●									
HI TecMetal Group, Nettleton Steel Treating (NST), Wickliffe	OH	★		●	●				●		●	●	●							●				●			
HI TecMetal Group, Walker, Cleveland	OH	★																									
Kowalski Heat Treating, Cleveland	OH	★	●	●	●	●	●	●	●	●	●	●	●					●									
MT Heat Treating Inc., Mentor	OH	★	●	●					●											●				●			
Ohio Metallurgical Service, Elyria	OH	★	●	●	●	●	●	●	●			●	●							●				●			
Ohio Vertical Heat Treat, Cleveland	OH	★		●					●				●											●			
Parker Trutec Inc., Springfield	OH	★																						●			
Paulo, Willoughby	OH	★	●	●	●	●			●	●	●	●	●		●			●									
P & L Heat Treating & Grinding Inc., Youngstown	OH	★	●	●		●			●			●	●														
Queen City Steel Treating, Cincinnati	OH	★		●					●		●		●							●				●			
Taylor-Winfield Technologies Inc., Youngstown	OH							●				●	●			●		●									
Weiss Industries Inc., Mansfield	OH	★		●		●	●		●				●							●				●			
Winston Heat Treating Inc., Dayton	OH	★	●	●				●	●				●							●				●			
Zion Industries Inc., Valley City	OH	★						●								●											
Bodycote, Oklahoma City	OK		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Tulsa (74th)	OK		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Tulsa (Pine)	OK		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Cargill Heat Treat, Oklahoma City	OK	★																						●			
Precision Heat Treating Inc., Tulsa	OK	★		●					●				●											●			
Thermal Specialties, Sapulpa	OK	★		●					●		●	●	●							●				●			
Oregon Induction Corp., Troutdale	OR	★																									
Stack Metallurgical Services Inc., Portland	OR	★	●	●	●	●			●	●	●	●	●							●				●			●
Thermal Modification Technologies, Tualatin	OR	★							●			●	●														
Advanced Heat Treating Inc., St. Marys	PA	★							●			●	●							●				●			
Bennett Heat Treating & Brazing Co., Ivyland	PA	★	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●				●			
Bluewater Thermal Solutions, St. Marys	PA												●							●				●			
Bodycote, York	PA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Evans Heat Treating, Huntingdon Valley	PA	★	●	●				●	●						●					●				●			
Fredericks Company/Televac, Huntingdon Valley	PA																					●					●
Keystone Metallurgy, Nazareth	PA	★																									
Metlab, Wyndmoor	PA	★	●	●	●	●	●	●	●	●	●	●	●		●		●	●		●				●		●	
Modern Industries Inc., Erie	PA	★	●	●	●	●	●	●	●	●	●	●	●		●		●	●		●				●			
Modern Industries Inc., Kersey	PA	★							●				●							●				●			
Penna Flame Industries, Zelienople	PA	★						●					●			●											
Peters' Heat Treating Inc. - West, Meadville	PA	★	●	●				●	●			●	●						●				●	●	●		
Peters' Heat Treating Inc., McKean	PA	★	●	●	●	●	●	●	●			●	●		●				●				●	●	●		
Peters' Heat Treating Inc., Meadville	PA	★	●	●			●	●	●			●	●						●				●	●	●		
R & R Heat Treating Inc., E. Stroudsburg	PA			●			●	●			●	●	●			●	●			●				●	●		
Rex Heat Treat, Bedford	PA	★	●	●					●				●							●				●			
Rex Heat Treat, Lansdale	PA	★	●	●					●											●				●			
Robert Wooler Co., Dresher	PA	★	●	●	●	●	●	●	●	●	●	●	●		●			●		●				●			
Solar Atmospheres Inc., Souderton - see our ad on page 27	**PA**	★	●	●	●	●			●	●	●	●	●		●			●						●			●
Solar Atmospheres, Hermitage	PA	★	●	●	●	●			●	●	●	●	●		●			●						●			●
Specialty Alloy Processing Co. Inc., Murrysville	PA			●	●	●		●	●		●	●	●							●							
Vacu-Braze Inc., Perkasie	PA	★	●	●	●	●	●	●	●		●	●	●		●	●	●	●		●				●			●
Metallurgical Solutions Inc., Providence	RI			●	●	●	●	●	●	●	●	●	●			●	●							●			
S&P Heat-Treating Inc., Warwick	RI																										
Spectrum Thermal Processing LLC, Cranston	RI	★	●	●	●				●		●	●	●					●									●
Bluewater Thermal Solutions, Corporate, Greenville	SC		●	●	●	●		●	●	●	●	●	●		●	●		●		●				●			
Bodycote, Fountain Inn	SC		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Greenville	SC		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
IMT Duncan LLC, Duncan	SC	★										●	●														
IMT York LLC, York	SC	★		●		●	●	●	●		●	●				●				●				●			
Ionic Technologies Inc., Greenville	SC	★																									

Hardening (Q&T)									High-Speed Steel				Ferritic Nitrocarburizing				Nitriding					Tool Steel				Aluminum/Nonferrous	Austempering	Boronizing	Carbon Restoration	Cryogenic Treating	Flattening/Straightening	Hot Isostatic Pressing (HIP)	Laser HT	Marquenching	On-Site (field) HT	Sintering	Steam Treating
Flame	Fluid Bed	Furnace	Induction	Intensive Quenching	Neutral Salts	Precipitation	Press Quenching	Vacuum	Fluid Bed	Furnace	Salt	Vacuum	Fluid Bed	Gas	Ion	Salt	Fluid Bed	Gas	Ion	Salt	Vacuum	Fluid Bed	Furnace	Salt	Vacuum												
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INDUSTRIAL HEATING

2018 Commercial Heat-Treating Capabilities Directory

	State/Province	MTI Member	Annealing											Brazing					Carbo-nitriding				Carburizing				
			Bright	Full	Homogenize	Isothermal	Local	Flame/Induction	Normalize	Recrystallize	Spheroidize	Solution (Quench)	Stress Relief	Dip	Furnace	Induction	Torch	Vacuum	Fluid Bed	Gas	Salt	Vacuum	Fluid Bed	Gas	Pack	Salt	Vacuum
Solar Atmospheres, Greenville	SC	★	●	●	●						●	●	●					●									●
Bodycote, Morristown	TN		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Coleman Commercial Heat Treating Inc., Memphis	TN			●			●	●	●				●														
Mid South Metallurgical, Murfreesboro	TN	★	●	●	●				●		●	●	●							●				●			
Parker Trutec - MMI Inc., Sevierville	TN	★																									
Paulo, Murfreesboro	TN	★	●	●	●	●	●		●	●	●	●	●							●				●			
Paulo, Nashville	TN	★	●	●	●	●		●	●	●	●	●	●							●				●			●
Bodycote, Arlington	TX		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Haltom City	TX		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Houston	TX		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Houston-Hayes	TX		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Commercial Metal Treating, Ft. Worth	TX	★	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●				●			●
Houston Heat Treat, Houston	TX	★	●	●	●	●			●			●	●							●				●			
K & D Heat Treat Inc., Houston	TX			●	●				●		●	●	●														
Katy Heat Treat LLC, Katy	TX	★	●	●	●				●			●	●														
Lark Heat Treating Inc., Houston	TX	★	●	●	●	●		●	●	●	●	●	●		●			●		●				●			
Lone Star Heat Treating Corp., Houston	TX			●	●	●	●	●	●		●	●	●		●	●	●			●				●			
LST Heat Treating LLC, Longview	TX	★		●					●		●	●	●							●				●			
Magnum Metal Treating, Conroe	TX	★	●	●	●				●			●	●							●				●			
Permian Heat Treaters, Odessa	TX	★		●					●		●	●	●														
Q-Tech Heat Treat LLC, Dallas	TX	★		●	●	●		●	●		●	●	●							●				●			
Republic Heat Treat, Houston	TX	★							●			●	●														
SEI Heat Treat, Houston	TX	★							●			●	●														
Southwest Metal Treating Corp., Ft. Worth	TX	★		●					●		●	●	●														
Specialty Heat Treat Inc., Houston	TX	★		●	●	●			●	●	●	●	●							●				●			
Texas Heat Treating Inc., Round Rock	TX	★	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●				●			●
Texas Steel Conversion, Houston	TX								●				●														
Thermal Specialties of Texas LLC, Ft. Worth	TX	★		●					●		●	●	●							●				●			
Blanchard Metal Processing, Salt Lake City	UT	★	●	●	●	●	●	●	●	●	●	●	●							●				●			
Southwest Specialty Heat Treat, Wytheville	VA	★		●	●				●		●	●	●		●		●							●			
Virginia Metal Treating, Lynchburg	VA	★											●														
Bodycote, Camas	WA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Cascade Metallurgical Inc., Kent	WA	★		●	●	●	●	●	●			●	●							●				●			
Inland NW Metallurgical Services Inc., Spokane Valley	WA	★	●	●	●				●		●	●	●					●		●				●			
Pacific Metallurgical, Kent	WA	★	●	●	●	●			●	●	●	●	●											●			
Seattle Heat Treaters, Seattle	WA			●				●	●		●	●	●							●				●			
AP Westshore Inc., Oshkosh	WI	★																						●			
AP Westshore Monster Parts Div., Oshkosh	WI																							●			
Bodycote, New Berlin	WI		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Sturtevant	WI		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Commercial Heat Treating Inc., Milwaukee	WI	★		●					●				●								●				●		
Complete Heat Treating, Milwaukee	WI	★																									
Fox Valley Heat Treat Inc., Oshkosh	WI	★		●	●	●	●	●	●	●	●		●							●				●			
FPM HEAT TREATING, Milwaukee	WI	★							●				●							●				●			
Gallos Metal Solutions Inc., Milwaukee	WI	★																									
Heat Treating Engineers Inc., Milwaukee	WI	★		●	●				●			●	●														
Hudapack Metal Treating Inc., Elkhorn	WI	★		●			●	●	●		●	●	●							●				●			
Hudapack Metal Treating Inc., Franklin	WI	★		●				●	●			●	●							●				●			
International Thermal Systems, Milwaukee	WI		●	●				●				●	●	●	●	●											
Lucas-Milhaupt Inc., Cudahy	WI														●		●	●									

Hardening (Q&T)									High-Speed Steel				Ferritic Nitrocarburizing				Nitriding					Tool Steel															
Flame	Fluid Bed	Furnace	Induction	Intensive Quenching	Neutral Salts	Precipitation	Press Quenching	Vacuum	Fluid Bed	Furnace	Salt	Vacuum	Fluid Bed	Gas	Ion	Salt	Fluid Bed	Gas	Ion	Salt	Vacuum	Fluid Bed	Furnace	Salt	Vacuum	Aluminum/Nonferrous	Austempering	Boronizing	Carbon Restoration	Cryogenic Treating	Flattening/Straightening	Hot Isostatic Pressing (HIP)	Laser HT	Marquenching	On-Site (field) HT	Sintering	Steam Treating
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INDUSTRIAL HEATING
2018 Commercial Heat-Treating Capabilities Directory

			Annealing											Brazing					Carbo-nitriding				Carburizing				
	State/Province	MTI Member	Bright	Full	Homogenize	Isothermal	Local	Flame/Induction	Normalize	Recrystallize	Spheroidize	Solution (Quench)	Stress Relief	Dip	Furnace	Induction	Torch	Vacuum	Fluid Bed	Gas	Salt	Vacuum	Fluid Bed	Gas	Pack	Salt	Vacuum
Metals Engineering, Depere	WI	★		●			●	●	●		●		●			●	●			●				●			
Metals Engineering Inc., Green Bay	WI	★		●					●		●		●							●				●			
Midwest Thermal-Vac Inc., Kenosha	WI	★	●	●	●	●		●	●	●	●	●	●		●			●				●					●
NitroSteel - A Premier Thermal Solutions Co., Pleasant Prairie	WI	★																									
Power Parts Intl., West Bend	WI							●	●				●			●											
Precision Thermal Processing, Clintonville	WI	★	●	●	●	●			●	●	●	●	●											●			
Radyne Corp., Milwaukee	WI		●	●			●	●	●	●		●	●			●		●									●
Service Heat Treating Inc., Milwaukee	WI	★	●	●	●	●			●		●	●	●							●				●			●
Thermet Inc., Waukesha	WI	★						●								●											
ThermTech, Waukesha	WI	★		●	●			●	●		●	●	●							●				●			●
Treat All Metals, A Regal Beloit Affiliation, Milwaukee	WI	★		●	●	●			●		●	●	●							●				●			
High Performance Heat Treating Inc., Huntington	WV			●					●		●	●	●			●								●			
Hi Tech Heat Treating Ltd., Edmonton	CANADA			●					●			●	●											●			
Thermex Metal Treating Ltd., Edmonton	CANADA	★		●	●				●		●	●	●							●				●			
A & M Heat Treating Ltd., Mississauga	CANADA	★	●	●	●	●	●		●	●	●	●	●							●				●		●	
A & M SurfTech Ltd., Mississauga	CANADA																							●			
Aberfoyle Metal Treaters Ltd., Puslinch	CANADA	★		●	●				●		●	●	●														
Advanced Heat Treating Solutions, Mississauga	CANADA	★	●	●	●	●	●	●	●	●	●	●	●							●				●			
Ajax TOCCO Magnethermic Corp., Ajax	CANADA		●	●			●	●				●	●			●		●									
Allied Heat Treat Ltd., Mississauga	CANADA		●	●	●	●	●	●	●	●	●	●	●		●			●		●				●			
All-Source Heat Treating Inc., St. Catharines	CANADA	★		●	●	●	●	●	●		●	●	●											●	●		
Bluewater Thermal Solutions, Kitchener	CANADA			●					●		●		●							●				●			
Bodycote, Burlington NMT, Burlington	CANADA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Kitchener	CANADA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Bodycote, Newmarket	CANADA		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●		●		●			●
Cambridge Heat Treating, Cambridge	CANADA	★	●	●					●			●	●							●				●			
Exactatherm Ltd., Mississauga	CANADA	★		●	●	●			●			●	●														
H & S Heat Treating, Port Robinson	CANADA	★	●	●	●	●			●	●	●	●	●							●				●			
Industrial Heat Treating Ltd., Beamsville	CANADA	★							●				●		●												
L&M Heat Treating, Burlington	CANADA	★		●								●	●														
Metex Heat Treating Ltd., Brampton	CANADA	★	●	●	●	●	●	●	●				●		●	●				●				●			
Northern Heat Treat Ltd., Coniston	CANADA							●	●				●							●				●			
Vac Aero International Inc., Oakville	CANADA	★	●	●	●				●		●	●	●		●			●									
voestalpine High Performance Metals Ltd., Mississauga	CANADA		●	●	●				●			●	●							●		●					
Metcor Inc., St. Eustache	CANADA		●	●	●		●	●	●	●	●	●	●		●	●		●		●	●			●			
Nitrex Metal Inc., Montreal	CANADA		●	●			●	●	●		●	●	●			●		●		●				●			●
THERMETCO Inc., Montreal	CANADA	★		●	●	●			●	●	●	●	●							●				●			
Vac Aero International Inc., St. Laurent	CANADA	★	●	●					●			●	●		●			●									
Tratamientos Termicos Nitrogas S.A., Buenos Aires	ARGENTINA		●									●	●					●									
Heat Treatment Australia, Queensland	AUSTRALIA	★		●		●			●			●	●					●								●	
Tooling and General Heat Treatment, St. Marys	AUSTRALIA	★											●						●				●				
Brasimet Processamento Termico Ltda, Jundai SP	BRAZIL	★																									
Techniques Surfaces do Brasil Ltda, Diadema - SP	BRAZIL																										●
Jiangsu Fengdong Thermal Technology Co. Ltd., Jiangsu Province	CHINA		●						●			●								●				●			
Nitrex Thermal Technology Co. Ltd., Anzhen, Wuxi, Jiangsu	CHINA		●	●			●	●	●		●	●	●		●	●	●	●		●				●			●
ALD Vacuheat GmbH, Limbach-Oberfrohna	GERMANY								●		●		●					●				●		●			●
Austenit S.A., Mixco (Zona 8)	GUATEMALA			●									●								●					●	
Tamayakin Co. Ltd., Musashimurayama, Tokyo	JAPAN	★	●	●					●				●							●				●			
Ajax TOCCO Magnethermic Corp., Quintana, El Marquez, Queretaro CP	MEXICO		●	●			●	●				●	●			●		●									
CRIO SA de CV, Queretaro	MEXICO	★							●				●							●							
MFCO Chihauhua Heat Treat, Chihuahua City	MEXICO	★																									
Parker Trutec Mexicana S.A. de C.V., Aguascalientes, AGS.	MEXICO	★																									
STT Nitrex Querétaro, S. De R.L. De C.V., La Noria, El Marqués, Querétaro	MEXICO		●	●			●	●	●		●	●	●		●	●	●	●		●				●			●
Tohken Thermo Mexicana SA de CV, Aquascalientes	MEXICO	★																									
Heat Treatments Ltd., Mt. Roskill, AUK	NEW ZEALAND	★											●							●				●			
Braddock Metallurgical, Bayamon	PUERTO RICO	★	●	●	●	●	●	●	●	●	●	●	●		●	●		●		●				●	●		
Hitech Heat Treatment Services Pte. Ltd.	SINGAPORE	★	●	●	●	●	●	●	●	●	●	●	●		●		●	●		●				●	●		●
University of Ljubljana, Ljubljana	SLOVENIA															●									●		
Harchris Heat Treatment (Pty.) Ltd., Springs, Gauteng	SOUTH AFRICA			●	●				●		●	●	●														
Ajax TOCCO International Ltd., Birmingham, Saltley, West Midlands	UNITED KINGDOM		●	●			●	●								●		●									
Beta Heat Treatment Ltd., Oldbury, West Midlands	UNITED KINGDOM	★										●															
Hauck Heat Treatment Ltd., Birmingham, West Midlands	UNITED KINGDOM					●			●		●	●	●					●		●	●			●			●
Wallwork Cambridge Ltd., Cambridge	UNITED KINGDOM		●	●				●	●				●				●	●		●				●			●

Hardening (Q&T)									High-Speed Steel				Ferritic Nitrocarburizing				Nitriding					Tool Steel															
Flame	Fluid Bed	Furnace	Induction	Intensive Quenching	Neutral Salts	Precipitation	Press Quenching	Vacuum	Fluid Bed	Furnace	Salt	Vacuum	Fluid Bed	Gas	Ion	Salt	Fluid Bed	Gas	Ion	Salt	Vacuum	Fluid Bed	Furnace	Salt	Vacuum	Aluminum/Nonferrous	Austempering	Boronizing	Carbon Restoration	Cryogenic Treating	Flattening/Straightening	Hot Isostatic Pressing (HIP)	Laser HT	Marquenching	On-Site (field) HT	Sintering	Steam Treating
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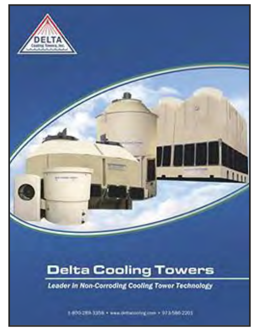
If your company was not included in this directory or if any information has been presented inaccurately, contact Breanne Rozek, directories mgr. at rozekb@bnpmedia.com.

Induction Heaters

Across International

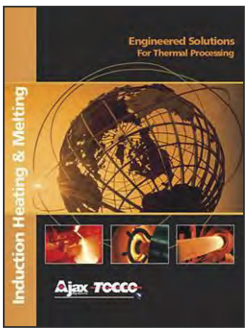
Founded and based in New Jersey, Across International supplies laboratory equipment in the areas of heat treatment and material processing for universities, research facilities and labs. We have more than 20 years of industrial manufacturing experience with induction heaters, drying ovens, ball mills, lab furnaces and pellet presses.
www.acrossinternational.com



Cooling Towers

Delta Cooling Towers

Delta Cooling Towers manufactures a complete line of corrosion-proof engineered-plastic cooling towers. The towers carry a 15-year warranty on the casing, which is molded into a unitary leak-proof structure of engineered plastic. All models are factory assembled and simple to install.
www.deltacooling.com



Induction Heating Systems

Ajax TOCCO Magnethermic Corporation

Ajax TOCCO Magnethermic Corporation is a world leader in the induction heating, melting and forging industries. Our proven applications include brazing, annealing, hardening, tempering, seam annealing, shrink fitting, curing, forging and melting.
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Solutions for Heat Treaters

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Materials Testing Equipment

Applied Test Systems

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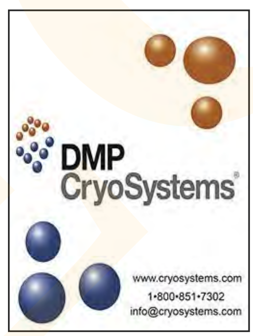
www.atspa.com



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Furnaces

Can-Eng Furnaces

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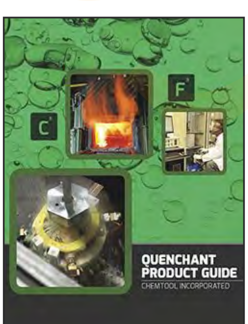
www.can-eng.com

Induction Brazing

EFD Induction

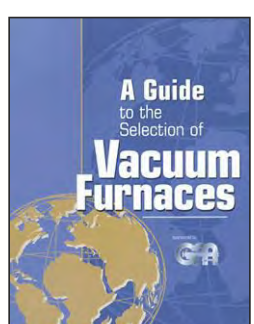
EFD Induction is pleased to announce the release of its brochure, "Induction Brazing: A Guide to Key Features and Benefits." This 36-page, full-color brochure presents a sampling of signature brazing projects, best-practice brazing methods and an overview of EFD Induction's full range of brazing equipment.
www.efd-induction.com



Quenchant Product Guide

Chemtool Incorporated

Tenaxol™ is a brand of quenchants sold by Chemtool Incorporated. Tenaxol quenchants have been in the heat-treating industry for more than 50 years. Dow Chemical UCON® quenchants are sold and serviced exclusively by Chemtool Incorporated in North America. Contact sales@chemtool.com or call 815-957-4140.
www.chemtool.com



Vacuum Furnace Selection Guide

G-M Enterprises

An (8) eight-page, full-color handout for prospective furnace buyers. The handout is a checklist of considerations when purchasing a new vacuum furnace. Please call for our "Guide to the Selection of Vacuum Furnaces."
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www.gmenterprises.com

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www.IpsenUSA.com/Customer-Stories

Vacuum Furnaces

Solar Manufacturing

Solar Manufacturing designs and fabricates a full range of vacuum furnaces for heat treating, brazing, carburizing, nitriding and sintering. Energy-efficient hot-zone designs, advanced SolarVac controls and improved quench technologies provide maximum performance.
www.solarmfg.com

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JPW Industrial Ovens & Furnaces

JPW is a U.S. manufacturer of industrial batch and continuous process ovens as well as furnaces. We offer a wide range of temperature options and solution-based products designed to meet the most demanding process requirements.
www.jpwdesign.com

Hardness Testing

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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

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Nel Hydrogen

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www.ProtonOnSite.com

Thermal-Processing Systems

Surface Combustion

This brochure introduces Surface Combustion and its overall capabilities as a provider of diverse products for the thermal-processing industry. Surface's capabilities also include a wide array of aftermarket services and support activities. Whatever your heat-processing needs, Surface can put its over 85 years of experience to work for you.
www.surfacecombustion.com

Vacuum Furnaces

SECO/Vacuum Technologies

A new brochure from SECO/Vacuum Technologies (SVT) describes the company's mission to serve the North American vacuum heat-treatment, brazing, sintering and metallurgy markets with vacuum furnace technologies and support close to home. Innovative technologies, advanced engineering and a unique Value Incentive Program distinguish SECO/Vacuum as an industry leader. www.SecoVacUSA.com

Vacuum Furnaces

TAV Vacuum Furnaces

Specializing exclusively in the manufacture of high-temperature vacuum and high-vacuum furnaces, TAV Vacuum Furnaces has developed an accurate knowledge of these technologies and their performance. This allows us to provide special solutions and bespoke systems to process innovative materials and sensitive products. We have the know-how that's needed to increase your productivity and efficiency.
www.tav-vacuumfurnaces.com

Vacuum Heat Treating

Solar Atmospheres Inc.

Specialists in vacuum heat treating with over 40 furnaces ranging from lab-size to more than 40 feet long. In addition, 10- and 20-bar quenching is available. Other services include vacuum brazing, carburizing, nitriding, and process research and development. ISO 9001/AS 9100, Nadcap, ITAR.
www.solaratm.com

Furnaces/Ovens/Heating Systems

Thermcraft Inc.

Thermcraft Incorporated offers a wide range of standard products that includes: ceramic refractory or vacuum formed ceramic fiber heaters, control systems, as well as industrial oven and furnace systems including mechanical handling equipment. Thermcraft Incorporated is also a recognized leader in custom heat-treating, industrial systems.
www.thermcraftinc.com

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- HOT AQUEOUS RINSE
- GLASS BEAD BLAST
- SOLVENT/DETERGENT RINSE

5. MACHINED/GROUND BEARING SURFACES.

6. FAST FOURIER TRANSFORM (FFT) ALGORITHM BALANCING

7. DYNAMIC PERFORMANCE TEST AND NORMAL OPERATING TEMPERATURE BREAK IN.

8. ONE YEAR WARRANTY ON MATERIALS AND WORKMANSHIP.

9. COMPREHENSIVE REVERSE ENGINEERING CAPABILITY ON EARLY MODEL EQUIPMENT AND COMPONENTS.

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In addition to a competitive salary, we offer one of the best health care plans in the area that includes medical, dental and vision insurance. We offer long term disability, life insurance, 401(k) with company match, 11 paid holidays, paid vacation, tuition reimbursement and more.

ESSENTIAL DUTIES:

1. Lead process development projects and new product introduction projects to on-time completion.
2. Resolve product quality issues with customers in a timely manner.
3. Insure accuracy and completeness of furnace system accuracy tests and furnace temperature uniformity surveys.
4. Act as the divisional Quality Systems assessor and lead auditor in our IATF 16949 and NADCAP accredited division.
5. Accompany customer and third party audits, and follow-up to ensure all required corrective actions are implemented and communicated to the auditing party.
6. Perform other duties as assigned.

MINIMUM QUALIFICATIONS (Knowledge, Skills, Abilities):
Must have a Bachelor's degree in a technical discipline, with material science or engineering strongly preferred. Two years job related experience as a quality professional or project manager strongly preferred. Must be proficient with current computer software.

REQUIREMENTS:

- Must be able to work within a professional and office environment.
- Must be able to sit for extended periods of time.
- Must be able to climb stairs frequently.
- Must be able to move about on foot, particularly from one work site to another approximately 70% of the working day.
- Must be able to lift 30lbs. occasionally.
- Must be able to operate office equipment, computer, printers, copiers, etc., which includes all physical abilities required for data input.
- Must be able to understand and reliably carry out extensive and detailed process instructions.
- Must be able to communicate effectively by both written and oral means.
- Must maintain a very high level of accuracy at all times, despite interruptions.
- Must be able to comprehend complex systems information to effectively troubleshoot problems and implement improvements.

Hours: 7:00 a.m. - 5:00 p.m. with 1 hour lunch, extra hours as needed
Travel: Limited travel to customers and misc.
EOE Statement: We are an equal employment opportunity employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, gender, national origin, disability status, protected veteran status or any other characteristic protected by law.

Now is a great time to join Modern Industries! For over 71 years, Modern Industries, Inc. headquartered in Erie, PA has been a successful employer offering full-service contract CNC machining, a variety of Heat Treating processes, and Materials Research to aerospace, automotive and related industries.

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Modern Industries, Inc.
Dave Jacquel, PHR, SHRM-CP
Human Resources Manager
Ph: (814) 455-8061 ext. 277

MODERN INDUSTRIES, INC.

EMPLOYMENT OPPORTUNITIES

WANTED: FULL-TIME HEAT TREAT MACHINE MAINTENANCE - A

Modern Industries Corporate Headquarters Erie, PA

LEAD A MAINTENANCE TEAM IN OUR HEAT TREAT DIVISION! Are you a confident, independent decision maker that has a sense of urgency in getting tasks completed? Do you have initiative, the ability to make decisions and take responsibility for them? ***THEN COME LEAD OUR TEAM!***

GENERAL:
Responsible for all machinery maintenance duties as assigned in heat treat, mechanical, electrical, hydraulic and pneumatic systems in complex equipment.

MINIMUM QUALIFICATIONS (Knowledge, Skills, Abilities):
Must have high school diploma or equivalent. Must have extensive formal technical education and training. Must demonstrate proficient performance of all Class B and C Heat Treat Machine Maintenance essential duties.

ESSENTIAL DUTIES:

1. Maintain all heat treat machinery and furnaces, and keep equipment in good operating condition with minimal supervision.
2. Assist in all phases of the installation of new equipment.
3. Effectively troubleshoot heat treat machinery and furnace performance problems, plan repair methods and time required, and order replacement parts and material.
4. Schedule heat treat servicing, and maintain system records.
5. Wear personal protective equipment and follow safety instructions as required.
6. Perform other duties as assigned.

REQUIREMENTS:

- Must be able to stand for 75% of the working day.
- Must be able to manually move, lift, carry, pull, or push objects weighing approximately 50lbs on a regular basis.
- Must be able to stoop, kneel, crawl, bend, and reach several times a day.
- Must be able to climb stairs and ladders frequently.
- Must be able to work in and around dust, fumes, and odors.
- Must be able to work in high places.
- Must be able to tolerate a hot work environment, even at times when summer outdoor temperatures combine with residual heat from furnaces.
- Must be able to communicate effectively by both written and oral means.
- Must be able to work independently with minimal daily supervision.
- Must be able to understand and reliably carry out extensive and detailed process instructions.
- Must be able to retain instructions sufficient to perform repeat tasks successfully and with minimal supervision.

Hours: First Shift. 7:00 a.m. - 3:00 p.m. with overtime as needed
Travel: Occasional day travel to satellite location, occasional training
EOE Statement: We are an equal employment opportunity employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, gender, national origin, disability status, protected veteran status or any other characteristic protected by law.

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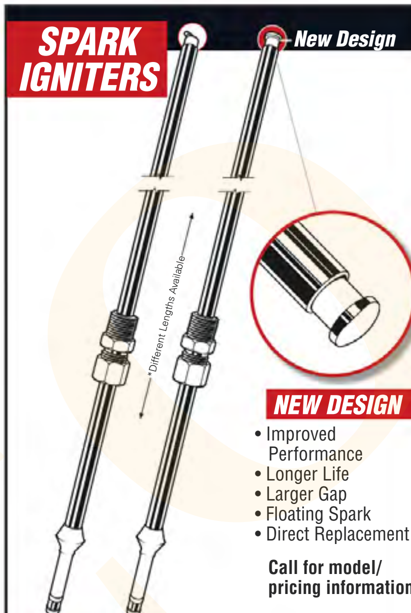

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Batch Temper Furnaces
C0049 Can-Eng Batch Temper Furnace (30"W x 48"L x 30"H, 1400°F, gas-fired)
C0052 Surface Combustion Batch Temper Furnace (30"W x 48"L x 30"H, 1200°F, gas-fired)
C0068 Despatch Box Furnace (60'W x 72'D x 66"H, 395ºF, electric)
C0113 Lindberg Batch Temper Furnace (48'W x 48'L x 48"H, 1400°F, electric)
U3644 BeaverMatic Batch Temper Furnace (36'W x 48'D x 36"H, 1500ºF, gas-fired)
V1010 Dow Batch Temper Furnace (30"W x 48"L x 20"H, 1250ºF, gas-fired)
V1024 PIFCO Batch Temper Furnace, Skid Hearth (36"W x 48"L x 30"H, 1200ºF, electric)
V1049 Surface Combustion Temper Furnace (87'W x 87'L x 36"H, 1350ºF, gas-fired)
V1068 Surface Combustion Oil Quench Furnace (30'W x 30'D x 48"H, 1950ºF, gas-fired)
V1081 Lindberg Batch Temper Furnace (20'W x 24'D x 18"H, 1250ºF, electric)
V1090 Lindberg Nitrogen Temper Furnace (24'W x 36'D x 18"H, 1350ºF, gas-fired)
V1095 Surface Combustion Temper Furnace (30"W x 48"D x 30"H, 1250ºF, gas-fired)
V1096 Surface Combustion Temper Furnace (30'W x 48'D x 30'H, 1400ºF, gas-fired)
V1106 Dow Batch Normalizer Furnace (45'W x 84'D x 32'H, 1800ºF, gas-fired)

Batch High-Temp Furnaces
C0007 JL Becker Batch High-Temp Furnace with atmosphere (72"W x 72"H x 72"L, 1650ºF, gas-fired)
U3556 Pacific Industrial Batch High-Temp Furnace (24"W x 36"L x 18"H, 2800ºF, electric)
U3637 Pacific Scientific Batch Temper (30'W x 48'D x 24'H, 1600ºF, gas-fired)
U3643 Surface Combustion Temper Furnace (30'W x 48'D x 42'H, 1400ºF, electric, 81kw)
U3645 Surface Combustion Hi-Temp Furnace (42'W x 60'D x 24"H,1850ºF, gas-fired)
V1013 Thermolyne High-Temp Batch Furnace (10'W x 14'L x 9'H, 2000ºF, electric)
V1067 Seco Warwick Batch High-Temp Furnace (24"W x 24"H x 36"D, 1800ºF, electric)
V1130 Onspec Slot Forge Furnace (72'W x 96'D x 48"H, 2000ºF, gas-fired)

Batch Oil Quench Furnaces
C0086 Huber Car Bottom Furnace (10'4"W x 12'9"D x 8'H, 1800ºF, gas-fired)

Drop Bottom Furnaces
C0069 Enviro-Pak Drop Bottom Furnace (48'W x 48'D x 48"H, 1200ºF, electric)
U3543 Despatch Drop Bottom Furnace (4'W x 6'L x 4'H, 1200ºF, electric)

Internal Quench Furnaces
C0064 Lucifer IQ Furnace (18"W x 24"D x 18"H, 1900ºF, electric)
U3569 Surface Combustion IQ Furnace (24"W x 18"H x 36"D, 1750ºF, gas-fired)
U3570 Surface Combustion IQ Furnace (24"W x 36"D x 18"H, 1750ºF, gas-fired)
U3606 Dow/AFC IQ Furnace (30"W x 48"L x 24"H, 1850ºF, gas-fired)
V1046 Surface Combustion IQ Furnace (87'W x 87'L x 36"H, 1850ºF, gas-fired)
V1047 Surface Combustion IQ Furnace (62'W x 62'L x 36"H, 1850ºF, gas-fired)
V1048 Surface Combustion IQ Furnace (62"W x 62"L x 36"H, 1850ºF, gas-fired)
V1062 Surface Combustion Super IQ Furnace (36"W x 72"D x 36"H, 1950ºF, gas-fired)
V1082 Holcroft IQ Furnace with Top Cool (36"W x 48"D x 30"H, 1850ºF, gas-fired)
V1083 Holcroft IQ Furnace with Top Cool (36"W x 48"D x 30"H, 1850ºF, gas-fired)
V1092 Surface Combustion Allcase IQ Furnace (30'W x 48'L x 30'H, 1850ºF, gas-fired)
V1093 Surface Combustion Allcase IQ Furnace (30"W x 48"L x 30"H, 1850ºF, gas-fired)
V1111 Surface Combustion IQ Furnace (30"W x 48"D x 30"H, 1850ºF, gas-fired)

Mesh Belt Brazing Furnaces
C0102 JL Becker Mesh Belt Brazing Furnace (30"W x 24'5" heated L x 10"H, 2050ºF, electric)
C0103 JL Becker MB Brazing Furnace w/Exo & Dryer (30'W x 24'5" heated L x 10"H, 2050ºF, electric)
U3529 CI Hayes Mesh Belt Brazing Furnace (18"W x 6"H x 8' heating, 2100ºF, electric)
U3592 JL Becker Mesh Belt Brazing Furnace (12"W x 6"H, 2100ºF, electric)
V1035 Seco Warwick Mesh Belt Brazing Furnace (18"W x 12"H, 2100ºF, electric)

Mesh Belt Tempering Furnaces
C0044 CGS Moore Mesh Belt Curing Oven (22'W x 20'L x 10"H, 500ºF, gas-fired)
C0073 Heat Machine Mesh Belt Tempering Furnace (24'W x 10'L x 12"H, 1250ºF, gas-fired, PT2501)
C0074 Holcroft Mesh Belt Tempering Furnace (24'W x 176'L x 12"H, 750ºF, gas-fired, PT3136)
C0075 Industrial Heating Mesh Belt Tempering Furnace (24'W x 22'L x 12"H, 950ºF, gas-fired, PT3630)
C0079 Internat'l Thermal Flat Wire Continuous Furnace (9'W x 10"H, 24' heating, 17' cooling, 650ºF, gas-fired)
C0080 Surface Combustion Mesh Belt Temper Furnace (18'W x 11"H, 13' long, 1000ºF, gas-fired)
C0081 Park Thermal Mesh Belt Temper Furnace (17.5'W x 7'H, 15'8" long, 900ºF, gas-fired)
C0083 Eltropuls Plasma Furnace System (56'Dia x 80'D, 1022ºF, electric)
C0090 Hengli Mesh Belt Sealing Furnace - Atmosphere (5.9'W x 3.5"H, 2100ºF, electric)
U3638 American Gas Furnace MB Temper Furnace (31'W x 5"H, 17' heated length, 1100ºF, gas-fired)
V1022 Surface Combustion Mesh Belt Tempering Furnace (42"W x 36'D x 12"H, 1350ºF, gas-fired)

Pit Furnaces
V1088 Leeds & Northrup Pit Furnace (24" ID x 30" deep, 750ºF, electric)

Roller Hearth & Rotary Furnaces
U3550 PIFCO Powered Roller Hearth Temper Furnace (21'W x 12'L x 18"H, 1000ºF, electric)
V1009 Ipsen Continuous Temper Roller Hearth Furnace (24"W x 10'L x 18"H, 1350ºF, electric)
V1091 Finn & Dreffein Rotary Hearth Furnace (13'3"ID x 5'3"ID x 4'W x 2'8"H, 2275ºF, electric)

Steam Tempering Furnace
U3616 Degussa Durferrit Steam Tempering Furnace (24'Dia x 48'D, 1200ºF, electric)

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

Vacuum Furnaces
C0013 CI Hayes Oil Quench Vacuum Furnace (24'W x 36'D x 18"H, electric)
C0027 Pacific Scientific Vacuum Temper Furnace (24"W x 36"D x 24"H, 1450ºF, electric)
C0111 Lindberg Vacuum Furnace (15'W x 24'L x 12"H, 2400ºF, electric)
U3612 AVS Vacuum Annealing Furnace 2-Bar (18'W x 24'D x 12"H, 2400ºF, electric)
U3635 Lindberg Hydryzing Gas Generator (6000 CFH Endo, gas)
V1004 CI Hayes Vacuum Furnace, Oil Quench (18"W x 30"L x 12"H, 2400ºF, electric)
V1128 Ipsen Vacuum Furnace (18"W x 32"D x 12"H, 2400ºF, electric)
V1131 Abar Vacuum Furnace (34'W x 60'D, 2250ºF, electric)
V1135 Abar Vacuum Furnace 2 Bar (72'Dia x72'Deep, 2400ºF, electric)
V1136 Surface Combustion Vacuum Furnace, 2-Bar (26'W x 36'L x 22"H, 2400ºF, electric)
V1138 Ipsen Vacuum Furnace, 5-Bar (24'W x 36'L x 14"H, 2400ºF, electric)

Endothermic Gas Generators
C0093 JL Becker Modular Endo Gas Generator (3-4000/6-8000/9-12000 CFH)
U3594 AFC-Holcroft Gas Generator (3,000 CFH Endo, gas)
V1075 Lindberg Gas Generator (3000 CFH Endo)
V1105 Surface Combustion Gas Generator (5,600 CFH Endo, 1950ºF, gas)
V3512 Surface Combustion Gas Generator - 5,600 CFH Endo

Exothermic Gas Generators
V1036 Seco Warwick Gas Generator (3,000 CFH Exo, gas)

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

Ovens - Cabinet
C0037 Grieve Cabinet Oven (36"W x 36"L x 36"H, 650°F, electric)
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, 850ºF, electric)
U3629 Cabinet Oven (30'W x 30'D x 36'H, 750ºF, electric)
U3642 Blue-M Cabinet Oven (36"W x 36"D x 36"H, 650ºF, electric)

Ovens - Walk-In
C0035 Park Thermal Walk-In Oven (48"W x 48"D x 60"H, 500°F, electric)
C0038 Despatch Walk-In Oven (54"W x 108"L x 72"H, 500°F, electric)
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, 850ºF, gas-fired)

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)
V1051 Surface Combustion Charge Car (DEDPER, 87"W x 87"L)
V1085 Holcroft Charge Car (DE/DP, 36"W x 48"D)
V1112 Surface Combustion Charge Car, SE, 30"W x48"D

Compressors
U023 Spencer Turbo Compressor

Scissors Lifts & Holding Stations
V1086 Holcroft Scissors Lift & (2) Holding Tables

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

Holding & Cooling Stations
V1113 Forced Cool Station (30"W x 48"D x 30"H)
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U3404 JL Becker Cooling Tower with Tank (Tower: 51"W x 36"L x 64"H, Tank: 72"W x 84"L x 66"H)
U3595 JL Becker 2-Tank Water Cooling System (tank: 72"L x 36"W x 37"H, 2 Dayton 1HP Motors)
U3646 HydroThrift, Duplex Pump Base, Water Cooling System
V1038 Bell & Gossett Shell & Tube Heat Exchanger with Tank

Washers
V1052 Surface Combustion BIQ Washer (87"W x 87"L x 36"H, 180°F, gas-fired)
V1084 Holcroft Spray/Dunk Washer (36"W x 48"D x 30"H, 190ºF, gas-fired)
V1101 Surface Combustion Spray Washer (36"W x 48"D x 30"H, 180ºF, electric, 58kw)

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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.

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Holcroft Gas Fired Mesh Belt Furnace, 24"W x 9"H x 14' 8"L, 400,000 BTUH, 750°F c/w controls.

HUBER

Huber Gas Fired Car Bottom Furnace, 10'-4"W x 8'H x 12'-8"L, 1,800°F, 5,200,000 BTUH and controls.

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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 Gas Fired Box Furnace, 3' W x 3' H x 4' L, 1,200°F, 500,000 BTUH, pneumatic vertical rising door, powered rollers and controls.

PARK THERMAL

Park Thermal Gas Fired Car Bottom Furnace, 36" W x 36" H x 96" L, 1,200°F, vertical lift door at both ends, powered car with cast hearth, re-circ. fan and 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.

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WPI Main Aluminum Scott T Dry Type Transformer, 250 KVA, 460 VAC 3 PH Primary, 60 HZ, 25/28/31/34/37/40 VAC 2 PH Secondary

WPI Teaser Aluminum Scott T Dry Type Transformer, 250 KVA, 460 VAC 3 PH Primary, 60 HZ, 25/28/31/34/37/40 VAC 2 PH Secondary

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High Temperature Electric Furnace, 24" W x 24"H x 36" L, Max. Temp. 1,800°F, Powered Rollers, Load/Unload Table & Controls.

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, 5000 lb. Payload Each, 36"W x 36"H x 72"L, Recuperated Rear Handler And Controls.

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.

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.

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HaoShi Carbon Fiber Co., Ltd. GanSu	66	0086-931-8893573	www.chinahaoshi.net.cn
I Squared R Element Co. Inc.	26	716-542-5511	www.isquaredrelement.com
Industrial Gas Engineering Co., Inc.	IFC	630-968-4440	www.igefans.com
Ipsen Inc.	3	800-727-7625	www.ipsenusa.com
JPW Industrial Ovens & Furnaces	22	570-995-5025	www.jpwdesign.com
Metal Treating Institute (FNA 2018)	IBC	904-249-0448	www.furnacesnorthamerica.com
Nel Hydrogen	21, 37	203-949-8697	www.protononsite.com
Rolled Alloys	34	800-521-0332	www.rolledalloys.com
SAFE Cronite Inc.	36	440-353-6594	www.safe-cronite.us
SECO/WARWICK Corporation	17	814-332-8400	www.secowarwick.com
Solar Atmospheres Inc.	27	800-347-3236	www.solaratm.com
Solar Manufacturing	10	267-384-5040	www.solarmfg.com
Sun-Tec Corp.	48	248-669-3100	www.sunteccorp.com
Surface Combustion Inc.	4	800-537-8980	www.surfacecombustion.com
TAV Vacuum Furnaces	13	39 0363 3557 11	www.tav-vacuumfurnaces.com
Thermcraft Inc.	39	336-734-4800	www.thermcraftinc.com
Vacuum Pump Services Corp.	35	215-660-3020	www.vacpumpservices.com

Energy Smart Cooling

Start Counting Your Savings

RULE #1.
Optimize your heat rejection technology

When choosing a cooling system consider your climate and the maximum operating temperature of your equipment for optimum efficiency. Lower fluid temperatures increase energy usage and operating costs. Consider using hybrid cooling systems to optimize operation - such as an air cooled exchanger to offload chillers in the winter.

TYPE	OPERATING COST	TEMPERATURE
Air Cooled	$	105°F
Evaporative	$$	85°F
Chiller	$$$$	65°F

Air cooled heat exchanger

Evaporative cooling tower with outdoor mechanical room

Chiller (mechanical refrigeration)

RULE #2.
Specify Safe, Reliable, and Low Maintenance equipment

The Solanus Cooler shown at right is perfect for cooling quench tanks. By using free air for cooling it completely eliminates the need for precious water resources.

NO WATER USAGE for safety and economical operation — self-cleaning tubes for low maintenance

SOLANUS

Quench oil coolers use no water

RULE #3.
Get some expert advice — make it pay to go green!

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