Thermal processing

CASE HARDENING BASICS: NITROCARBURIZING vs. CARBONITRIDING

COMPANY PROFILE:
Lindberg/MPH

Technologies and Processes for the Advancement of Materials

JULY/AUGUST 2017
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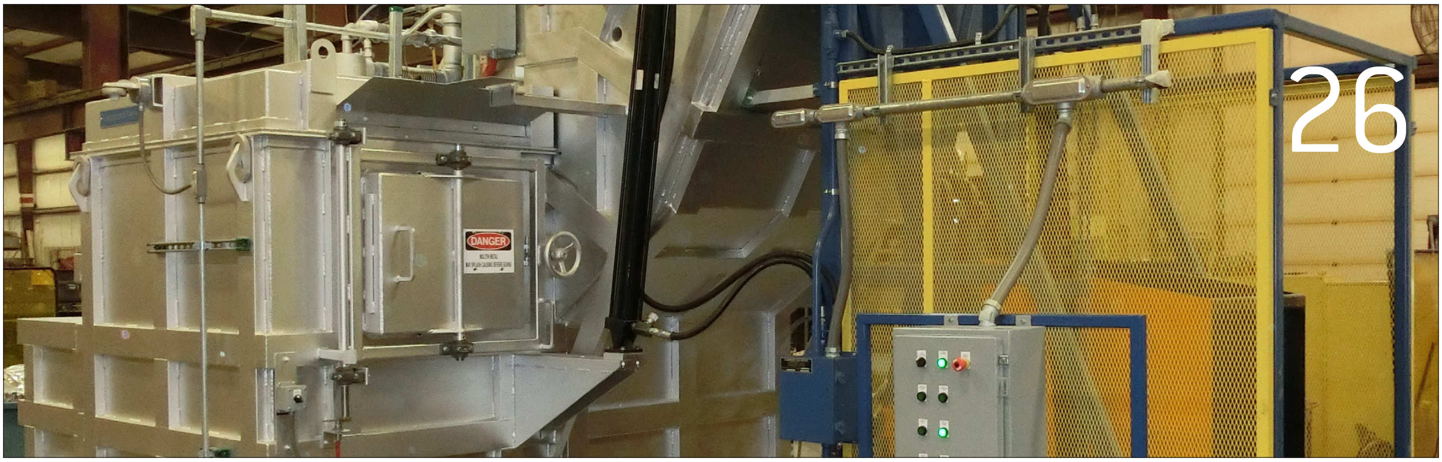
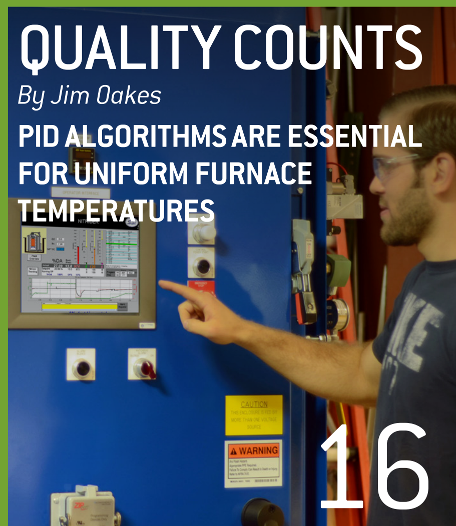


DEPARTMENTS

JULY/AUGUST 2017
Volume 6 / Number 4



RESOURCES

Cover photo: Lindberg/MPH

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LETTER FROM THE EDITOR

New issue focuses on process control/technology and heat-treating equipment

I want to give all the *Thermal Processing* readers a formal hello as I take the reigns as editor. I have been working with our sister publications, *Gear Solutions* and *Wind Systems*, for a while now, and I am excited about the prospect of bringing you more of the kinds of articles and information you have come to expect from *Thermal Processing* over the last five years.

It is my goal to continue that task, and with that in mind, I want to give you a heads up on what you'll find in the July/August issue as we focus on process control/technology and heat-treating equipment.

We have an article about how Conrad Kacsik and Modern Industries have partnered to complete a yearlong plant-wide upgrade of process controls for heat-treating equipment.

In our company profile, we talk with the president of Lindberg/MPH and how it has gone through a recent transformation to ensure it stays a leader in the heat-treating/non-ferrous melting industry.

In this month's Q&A, we chat with the director of technical sales at Abbott Furnace Co. In it, he discusses Abbott's mission to become a market leader in the design, production, and service of continuous process industrial furnaces, and how his company is looking to expand that role in the future.

And, of course, this issue of *Thermal Processing* gives you our featured columnists as they share that expert knowledge you've come to expect.

All-in-all, you'll find some interesting information that may help you decide on a crucial decision for your company or help you brainstorm some ideas for the future.

I hope everyone is having an awesome summer, and thanks for reading!

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TPS Ships Gruenberg Truck-In Oven to a Pet-Care Company

Thermal Product Solutions, a global manufacturer of thermal-processing equipment, recently shipped a truck-in oven to a pet-care company to heat-treat steel and glass.

The truck-in oven dimensions are 60" x 96" x 78" and the maximum temperature rating is 260°C. The oven is designed to maintain a temperature uniformity of ±5.5°C at a test temperature of 230°C. The Gruenberg oven is constructed in a panelized manner that allows for disassembly. Struts are internally vented, thus keeping the exterior as cool as possible.

"At TPS, we value the loyalty of our customers, said Sales Manager Scott Batchelder. "Due to the success of previous equipment, this customer trusted us to manufacture this truck-in oven to provide more efficiency and future growth for the company."

Features of this Gruenberg Truck-In oven include:

- Yokagawa UP35A programmable controller.
- Yokagawa UT150L high-limit thermostat.
- Honeywell DR4300 single pen chart recorder.
- Horizontal air circulation.
- Temperature Uniformity of ±5.5°C at 230°C

FOR MORE INFORMATION: www.thermalproductsolutions.com

Solar Atmospheres Adds a New Climate-Controlled Room

After surviving one of the hottest and most humid summer seasons on record, Solar Atmospheres of Western PA decided to construct a climate-controlled environment for the daily operation of its new all-metal hot-zoned vacuum furnace. The critical climate within this room is controlled using a high-quality HVAC system and is equipped with dehumidifiers and customizable thermostats. A heavy-duty insulation package was installed, which ultimately helps to manage and stabilize temperature and humidity around the clock. The space also was constructed to produce a slight positive pressure environment, which will help eliminate dust and debris from entering the set-up and fixturing areas.

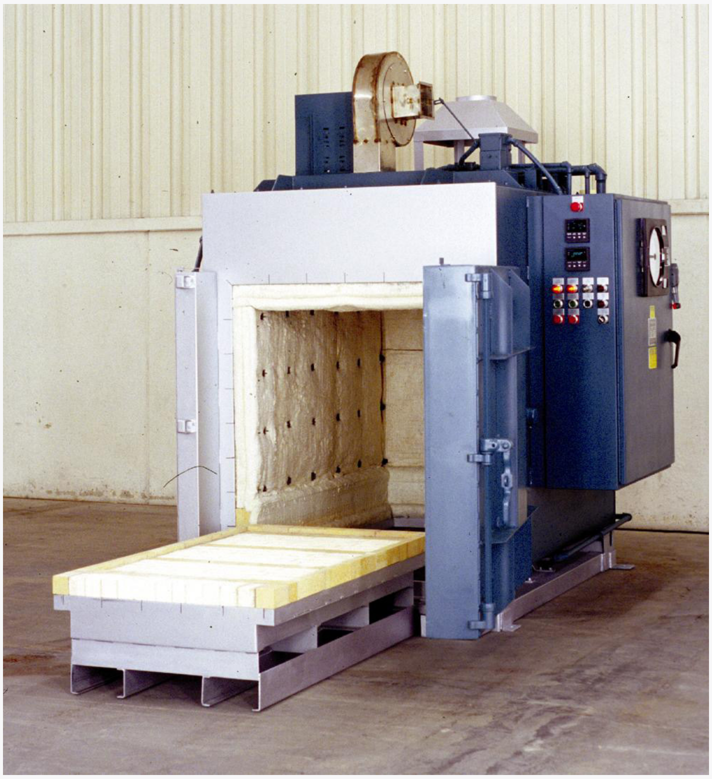
"With the new third party accreditation programs such as MedAccred gaining momentum, and knowing how detrimental high levels of humidity can be in the vacuum thermal processing of certain critical materials, we believe

this venture is well worth the investment," said Kevin Bekelja, vice president of operations.

Both medical and aerospace contractors are continuing to demand that environmental conditions be controlled, processes validated, and the risk of foreign object debris (FOD) be eliminated. This newly constructed environmentally controlled room will enable Solar Atmospheres of Western PA to pristinely thermally process critical components, which in turn will add even more value to the customer's operations.

FOR MORE INFORMATION: www.solaratm.com

Grieve Offers Gas-Fired Furnace and Walk-In Oven



No. 852 is an 850°F (454°C), high-temperature walk-in oven from Grieve, used for heat treating and baking varnish at the customer's facility. Workspace dimensions of this oven measure 60" x 96" x 72"; 120 KW are installed in Incoloy-sheathed tubular heating elements, while a 7,800 CFM, 5-HP recirculating blower provides combination airflow to the workload.

This Grieve oven has 8-inch insulated walls and a 4-inch insulated floor. Additional features include an aluminized steel interior and exterior and safety equipment for handling flammable solvents, including explosion-venting door hardware.

Controls on the No. 852 include a digital-indicating temperature controller and manual reset excess temperature controller with separate contactors.

No. 925 is a gas-heated, 2,000°F pallet furnace used for heat-treating. Workspace dimensions measure 30" x 48" x 36"; 700,000 BTU/HR are installed in two modulating natural gas burners with a floor-mounted combustion air blower. This unit also includes a 325 CFM intake-pressurizing blower with motorized dampers on the intake and exhaust for accelerated cooling.

This Grieve pallet furnace has 7-inch thick insulated walls, comprising 5 inches of 2,300°F ceramic fiber and 2 inches of 1,700°F ceramic fiber. The workload rests on a removable pallet with 7-inch thick insulation, comprising 4.5-inch thick 2,300°F firebrick and 2.5-inch thick 2,300°F firebrick.

Built to JIC/NEMA 12 electrical standards, No. 925 includes all safety equipment required by IRI, FM, and NFPA Standard 86 for gas-heated equipment. In addition, the furnace includes a 10-inch diameter circular chart recorder, digital programming temperature controller, and recirculating blower airflow safety switch.

FOR MORE INFORMATION: www.grievecorp.com

Premier/BeaverMatic Receives Order for IQF Furnace Line

Premier Furnace Specialists/BeaverMatic received an order for a complete (IQF) furnace line for a repeat BeaverMatic customer in the oil-field related industry. This order consists of a new internal quench furnace, temper furnace, spray/dunk washer, low-temperature industrial oven, 1,500 CFH endothermic generator, and manual load cart. All new equipment is designed to match existing equipment with 30" x 48"x 26" loads weighing 1,500 pounds while using standard "Beaver" baskets.

The control system is configured to allow for automated and manual sequencing, recipe management, and digital data collection. Current design meets AMS 2750 E, NEC, and current NFPA guidelines. This design allows for updates to existing equipment for installation of the future SCADA system. Construction will be complete in August 2017.

FOR MORE INFORMATION: www.premierfurnace.com • www.beavermatic.com

Tenney Space Simulation System Shipped to a Logistics Company

Thermal Product Solutions, a global manufacturer of environmental testing equipment, recently shipped a Tenney environmental vacuum/temperature space simulation system to a logistics company. The outer structural shell of the environmental simulator is designed to resist one atmosphere of external pressure while under vacuum.

The vessel has a 42-inch diameter and is 36.5 inches long. The temperature range of this space simulator is 60°C to 155° C. The temperature uniformity is ±5°C. A fluid conditioning system is employed to temperature condition the chamber using an electric immersion heater and an LN2 fluid cooling system to heat and cool a circulating heat-transfer fluid.

The system is designed for vacuum performance of 1×10^6 Torr within two hours based on a clean, dry, empty, and outgassed system with the ultimate performance being 1×10^7 Torr. This chamber features a two-stage vacuum system, which employs a vacuum roughing pump in the first stage and a turbo-molecular pump in the second stage.

"At Thermal Product Solutions, we want to provide the most advanced technologies for our customers," said Rick Powell, vacuum products manager. "For this project, we used a stainless-steel vacuum vessel and temperature-conditioned internal shroud to simulate outer space conditions."

Features of the Tenney environmental space simulator include:

- VersaTenn temperature control system with data acquisition.
- Conditioned thermal base plate on extension slides.
- Vacuum pumping system with roughing pump and turbo-molecular pump.

FOR MORE INFORMATION: www.thermalproductsolutions.com

Lindberg/MPH Ships Large Chamber Utility Box Furnace

Lindberg/MPH announced the shipment of an electrically heated, large chamber utility box furnace to an automotive supplier. The furnace will be used for batch testing aluminum castings on a daily basis at a temperature of 500°C.

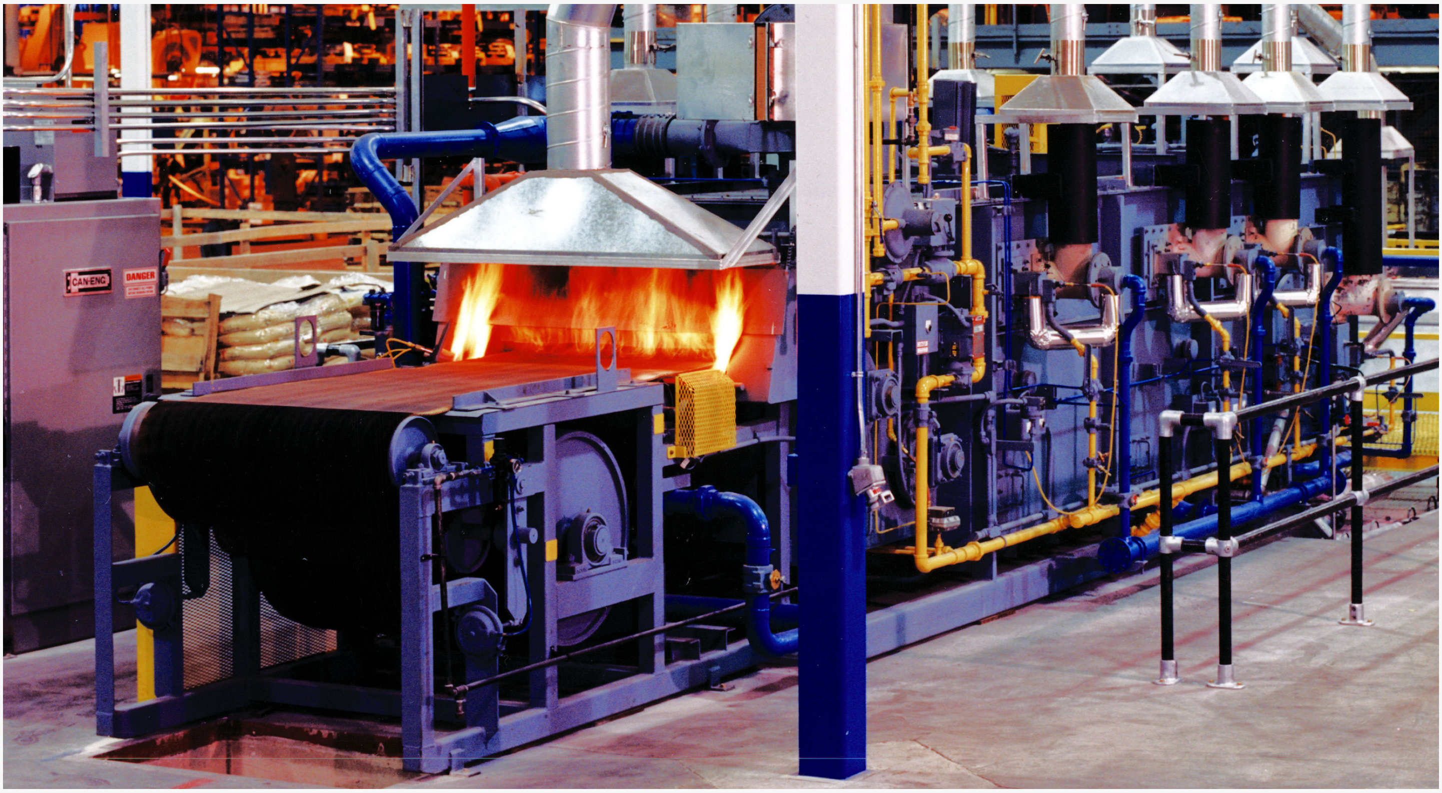
The work chamber dimensions of this heat treat furnace are 24" x 24" x 24", and it has a maximum temperature rating of 1,100°C. The large chamber utility box furnace is available in nine chamber sizes to meet demanding applications. The furnace uses vacuum formed ceramic fiber insulation with low heat loss for operating economy and minimum heat storage that results in rapid heat up and control response. To ensure even less heat loss, a double steel shell construction is used to create a low temperature outer surface. The insulation and heating elements maintain uniform heat distribution for an energy efficient design.

"At Lindberg/MPH we strive to find the best heat-treat solutions for our customers," said Sales Engineer Andrew Paul. "For this project, we designed a custom heating system to minimize heat loss and providing energy efficiency."

Features of the Lindberg/MPH box furnace include:

- Alloy hearth plate for supporting workload, 34-inch hearth height.
- Side-hinged, plug-type door, limit switch for power cutoff when door is open.
- Embedded elements in roof, rear, and side walls
- Prewired, side mounted, forced air cooled control console.
- Honeywell DC2500 Series primary temperature controller.
- Separate Honeywell DC2500 Series excess temperature control.
- LED element fault indication on control panel.
- SSR solid state power control module.
- Dual thermocouple assembly.
- Power circuit breaker

FOR MORE INFORMATION: www.lindbergmph.com



Automotive Supplier Expands Salt-Quenching Capabilities

Can-Eng Furnaces International Ltd. was recently awarded a contract to design and build a 1,500 lb/hr mesh-belt furnace system for the austenitizing and molten salt quenching of components used in the manufacture of the client's drivetrain systems. This contract was awarded by a repeat client who has favored Can-Eng for several multi-facility heat-treatment lines.

The new system incorporates several technological advancements for continuous atmosphere processing of products requiring carbon diffusion and quenching via a molten salt system — known as austempering. It includes automated bin-dumping loading, mesh belt atmosphere hardening furnace, salt quench, post quench wash and rinse system, mesh belt temper oven, and endothermic gas generator.

This new project is a result of Can-Eng's commitment to its customer's success, years of teamwork, and mutual cooperation, yielding a custom engineering project integrating the customer's focused needs with Can-Eng's robust continuous mesh belt heat treatment system technology. The project is scheduled to be commissioned in early 2018 in Mexico's centralized automotive manufacturing corridor. Can-Eng's mesh belt heat-treatment design team continues to focus globally on the design and development of mesh belt heat-treatment technology, servicing the increasingly stringent and demanding global automotive industry. Can-Eng's systems continue to lead the industry in up-time reliability, energy efficiency, and soft handling features delivering superior part cosmetics.

FOR MORE INFORMATION: www.can-eng.com

Fastener Company Orders Mesh Belt Heat-Treatment System

Can-Eng Furnaces International Ltd recently was awarded a contract to design and supply a mesh belt heat-treat system with a production capacity of 4,000 lb/hr of high-quality automotive fasteners for a European-based client. The new, high-volume fastener system includes an atmosphere controlled mesh belt hardening system, oil quench, post wash system, temper furnace, soluble oil system, bi-directional conveyor discharge, and Can-Eng's PET™ Level 2 SCADA system.

By integrating Can-Eng's Level 2 automation, the automotive supplier provides itself access to vital tracking of its products' status, detailed process data for continuous process improvements, comprehensive equipment diagnostics, cost analysis, and inventory management. The top-of-the-line system also uses Can-Eng's Energy Reduction System (ERS™), significantly reducing the energy requirements of the system. The system is scheduled to be commissioned in the last quarter of 2017.

FOR MORE INFORMATION: www.can-eng.com

GF Machining Solutions Launches New Apprenticeship Program

GF Machining Solutions in Lincolnshire launched its "learn and earn" apprenticeship program with the signing of its first official candidate during the company's Solutions Days manufacturing event. The two-day open house event was June 6-7 at its Lincolnshire, Illinois, headquarters and included live equipment demonstrations and technical presentations.

The program, scheduled to begin this fall, offers paths for application engineers and field-services engineers, and will accept up to five participants in its inaugural year. Under the guidance of experienced mentors, the application engineers will help analyze machine performance and provide technical support, while field-service engineers will assist in coordinating activities that relate to the installation and repair of machines and other manufacturing equipment.

During a presentation outlining the program, Jon Carlson, marketing specialist for GF Machining Solutions said the company plans to choose apprentices from local area high schools including Mundelein, Palatine, and others. He said the program is in partnership with Harper Community College and Chicago's Industrial Consortium for Advanced Technical Training.

Apprentices will alternate between class time and real-world, hands-on experience, while earning an associate's degree at Harper Community College, a DIHK certificate and a Department of Labor Certificate. GF Machining Solutions will pay apprentices' tuition, as well as provide them with an hourly wage plus benefits such as health insurance and paid time off.

"Student loans don't go away, so why start with one?" Carlson said.

The first apprentice chosen for the program is Corey Ocock.

"I am targeting the field-service engineer position after completing the advanced manufacturing program," Ocock said.

Ocock graduated from Palatine High School and gained experience operating a CNC 3-axis lathe and mill.

GF Machining Solutions plans to induct a minimum of four new apprentices to the program every year.

FOR MORE INFORMATION: www.gfms.com/us.

TPS ships Tenney vacuum drying ovens to medical device manufacturer

Thermal Product Solutions, a global manufacturer of thermal-processing equipment, announced the shipment of five Tenney Vacuum Drying Ovens to a medical device manufacturer. The chambers will be used for vacuum drying of suture material.

These vacuum ovens have temperature ratings of +15° C above ambient to +60° C and work chamber dimensions of 24.125" W x 24.5" D x 24.125" H. The pressure range is sire level to 200,000 feet (0.169 mm Hg).

The chambers utilize temperature limited heating cables that are evenly spaced on the exterior of the pressure vessel. These cables are covered with thermal mastic for optimal heat transfer. The heating of these vacuum drying ovens will be controlled via the main controller. There is no cooling on this system.

"At TPS, we apply our expertise, experience and resources to create the best products for our customers," said TPS' John Eldred. "These vacuum ovens utilize a combination of fiberglass and polyurethane insulation surrounds the chambers to maximize the insulating characteristics and maximize temperature uniformity."

Features of the Tenney vacuum ovens include:

- All main power circuits shall have overcurrent protection.
- Busch DP0080A dry screw style pump.
- Nitrogen back fill connection with a control solenoid valve.
- Stainless Steel removable shelves.
- Allen Bradley remote Flex I/O electrical control system.

FOR MORE INFORMATION: www.thermalprocessingsolutions.com

Carbolite Gero Furnaces can be used for graphitization

Carbolite Gero offers a range of furnaces up to 3,000 °C that are suitable for the various requirements of graphitization.

Heat treatment up to 3,000 °C under inert atmosphere induces the structural change from highly disordered or defective carbon atom structures into a perfectly three-dimensional crystal of pure graphite, an important material for a multitude of applications.

A graphite furnace of the LHTG range or the HTK range up to 3,000 °C is suitable for starting material that consists of pure carbon with minor impurities. Both heating elements and insulation of the cold wall vacuum furnaces consist of high-quality graphite materials. The top loader furnace, LHTG, is fitted with a circular mantle heater in a perfectly symmetrical orientation. The HTK GR is a front-loading chamber furnace incorporating symmetrical elements on four sides.

If organic matter of unknown composition or containing a large amount of impurities is used for graphitization, it is recommended to purify the sample by pre-carbonization under inert gas atmosphere before heat treatment in a more sensitive high temperature graphite furnace. This can be done in a low temperature hot wall furnace of the GLO range, up to 1,100 °C. The cold wall GLO is ideal for dirty processes with sequestered elements and a smooth nonporous interior for easy cleaning.

Samples that contain small amounts of impurities are ideal for specialized HTK graphite furnaces with dedicated debinding equipment, where carbonization and graphitization are carried out in one heat-treatment step. Those furnaces are equipped with a retort and an intelligent gas guidance system that assures the impurities are safely discharged from the furnace into the afterburner.

FOR MORE INFORMATION: www.carbolite-gero.com

Light-weighting automotive suspension component manufacturer expands production

Can-Eng Furnaces International Limited was recently awarded a contract from a leading North American manufacturer of forged aluminum suspension components. This project reflects a long list of recent projects involving automotive light weighting initiates where Can-Eng technologies have been favored in delivering the lowest cost of ownership per unit of production.

Automotive manufacturers continue to pressure supply partners in developing systems and components that deliver weight reduction benefits yielding reduced vehicle fuel consumption. The furnace system will be integrated into a completely automated forging cell expansion, with a sophisticated controls and part-tracking system, for heating aluminum billets prior to forging of automotive suspension components.

Can-Eng's patented rotary hearth furnace technology was utilized in this application as it provided optimal part handling and temperature profile parameter flexibility within the smallest manufacturing floor space. Can-Eng's Rotary Furnace Systems continues to replace conventional in-line continuous belt style heating systems as they offer superior footprint, energy consumption and maintenance requirement benefits.

FOR MORE INFORMATION: www.can-eng.com

Wisconsin Oven ships electrically heated batch core forming oven

Wisconsin Oven Corporation shipped an electrically heated batch core forming oven to a leader in the composites industry. This composite curing oven will be used for their patented process of forming honeycomb material for aircraft engines.

The work chamber is 10' x 6' x 5' and the maximum temperature rating is 800°F. The walls and ceiling feature a "CAN" style construction and includes 6 inches of 6-pound density. Based on a nine-point profile test, the temperature uniformity of this industrial oven is ±10°F at 550° and 685°.

"Based on the success of previous projects, this customer trusts Wisconsin Oven for their equipment needs, said Sales Representative Kelly LeBard of Hartley Corporation. "This oven will continue to provide efficient and consistent results for the customer."

Features of this composite curing oven include:

- 22,000 CFM @ 20 HP recirculation blower.
- 198 kW heat input.
- Meets CE requirements.
- Vertical lift door.
- Temperature Uniformity of ±10°F at 550° and 685°.
- CAN construction.

This batch core forming oven was fully factory tested and adjusted prior to shipment from the Wisconsin Oven facility. All safety interlocks were checked for proper operation, and the equipment was operated at the normal and maximum operating temperatures. An extensive quality assurance checklist was completed to ensure the equipment met all Wisconsin Oven quality standards. This equipment is backed by Wisconsin Oven's three-year warranty.

FOR MORE INFORMATION: www.wisoven.com

ThermTech expands existing Ipsen atmosphere furnace line to meet increased demand

ThermTech runs its equipment 24/6, 360 days a year. As the economy continues to pick up, it needed to expand its existing Ipsen atmosphere line to keep up with increased demand. Having received strong performance from the Atlas atmosphere furnace and ancillary equipment installed in 2015, ThermTech recently purchased another Atlas integral quench batch furnace from Ipsen. ThermTech will use the Atlas for carburizing, carbonitriding, and neutral hardening while supporting business from the oil & gas and heavy equipment industries.

"We have worked with several major providers of heat treatment equipment, but Ipsen is among the best for providing support after equipment is purchased," said Mary Springer, vice president of ThermTech. Supported by Ipsen's global ICS (Ipsen Customer Service) Team, ThermTech has received installation and startup assistance, as well as dedicated local support for any of its equipment, regardless of the manufacturer.

In a shop where every furnace matters and uptime is critical to its success, being able to receive the furnace in a short timeframe was also important. Ipsen is able to offer companies significant time savings with reduced lead time on the Atlas, one of their modular platforms. Overall, Ipsen's Atlas atmosphere line provides users with repeatable quality results. This includes achieving consistent, uniform case depth and uniform quench hardness due to the advanced quench system design.

FOR MORE INFORMATION: www.IpsenUSA.com/ATLAS

Linde and Praxair sign business combination agreement

Linde AG and Praxair, Inc. recently announced the companies have entered into a definitive business combination agreement (BCA) to come together under a new holding company through an all-stock merger of equals transaction. Linde and Praxair expect the transaction to close in the second half of 2018, subject to customary closing conditions, including regulatory approvals.

The proposed merger brings together two leading companies in the global industrial gas industry, leveraging the proven strengths of each. The transaction unites Linde's long-standing leadership in engineering and technology with Praxair's efficient operating model — creating a global leader.

The combined company will have a strong presence in all key geographies and end-markets, which will result in a more diverse and balanced global portfolio as well as increased exposure to long-term macro-economic growth trends. With a strong culture of innovation, sustainability and performance, the new company will enable the development and delivery of a broad range of products and solutions to customers and provide enhanced value for its employees, shareholders and communities.

"This combination is a compelling and transformative opportunity to create a world-class leader in the industrial gas industry," said Steve Angel, chairman and CEO of Praxair, Inc. "The combined company will give us the opportunity to leverage the individual strengths of both companies across a much larger global footprint and enhance our ability to drive innovation and growth."

Merger highlights:

- Combination leverages strengths of each company: Linde's long-standing leadership in engineering and technology with Praxair's operational excellence.
- Establishes strong, complementary positions in key geographies and end-markets, creates a more diverse and balanced end-market portfolio.
- Considerable value driven by approximately $1.2 billion (1.1 billion euros) in annual synergies and cost reductions.
- Combined pro forma revenues of approximately $29 billion (27 billion euros) in 2016 and combined current market value in excess of $70 billion (66 billion euros) as of May 31, 2017.
- All-stock transaction: Linde shareholders will receive 1.54 shares in the new holding company for each Linde share, and Praxair shareholders will receive one share in the new holding company for each Praxair share.
- Governed by a Board of Directors with equal representation from Linde and Praxair.
- The combined company will be named Linde, retaining the globally-recognized brand and will be listed on both the New York Stock Exchange and Frankfurt Stock Exchange.
- Closing expected in the second half of 2018.

FOR MORE INFORMATION:
www.linde.com

Thermcraft's chamber furnaces can be used in almost all types of thermal processing

Thermcraft manufacturers box type chamber furnaces for use in nearly all types of thermal processing and heat-treating applications.

This pair of twin box furnaces will be used to process turbine parts for one of the world's leading manufacturers of power generation turbines. Each of these furnaces is equipped with multiple heavy-duty cast-plate heaters with heavy-gauge wire wound elements totaling 130 kW of power.

The vertical lift doors are opened and closed using dual synchronized pneumatic cylinders. Temperature controls include a single zone controller with integrated digital chart recorder/data acquisition and an independent over temperature controller, both reading Type K thermocouples.

Power is controlled by zero-cross SCR power controllers in a three-phase configuration and monitored by one ammeter per phase.

The furnace features include:

- Model Number: FBS-64-84-60-1F.
- Heated Chamber Dimensions: 64"x 84" x 60".
- External Dimensions (approx.): 165" x 150" x 130".

- Electrical: 480 Volts, 3 Phase, 60 Hz, 130 kW.
- Heating Zones: One.
- Maximum Temperature: 760°C (1,400°F)

FOR MORE INFORMATION: www.thermcraftinc.com

HarbisonWalker International announces CEO transition

HarbisonWalker International (HWI), the largest supplier of refractory products and services in the U.S., recently announced Stephen Delo will retire as chairman and chief executive officer, effective June 30, 2017. The HWI Board of Directors has elected Carol R. Jackson to be HWI's next chairwoman and chief executive officer, effective July 1, 2017. Jackson was serving as senior vice president and general manager at HWI.

Delo retires after serving in several manufacturing and management roles for more than 30 years. Most recently he has been chairman and chief executive officer at HWI for three and one-half years. Previously, he held several progressive roles at Honeywell International, including leadership positions in chemicals, operating systems, and integrated supply chain.

Under Delo's leadership at HWI, in less than four years, the company combined three of the top U.S. refractories companies together as one, and reorganized and rebranded as HarbisonWalker International. During that time, the organization restructured and built exceptional, high performing teams. Through the development of HarbisonWalker Business System (HBS), HWI began laying the groundwork for transformative changes in its approach to virtually every aspect of its business — from internal processes and structure to safety, quality, and performance.

In February 2017, HWI announced a $30 million investment to build a new, state-of-the-art monolithics plant in South Point, Ohio, that will be operational by early 2018.

"Steve has led us through monumental organizational changes, challenging market conditions, and numerous successes in less than four years," Jackson said. "He has grounded the organization for its future by instituting values, processes, systems, a focus on safety, and cultural beliefs that are the foundation for the next chapter of this company's 150-year legacy."

Jackson, with support from the leadership team, is committed to delivering on HWI's mission and achieving its vision. Guided by HWI's cultural beliefs and company values, Jackson and the senior leadership team will work closely together to continue to build on the solid foundation of the past three years and effectively position HWI for growth.

"I've been privileged to help evolve this company alongside our intensely committed employees across North America and globally," Delo said. "While I look forward to enjoying a long-awaited retirement, I'm extremely confident in the leadership of Carol Jackson as she assumes the role of chairman and CEO. Carol is a natural leader and manufacturing industry veteran and has played a key role in helping to run the company for the past three years. Her outstanding performance at HWI, along with a proven track record of success and prior significant leadership roles, all reinforced the Board's unanimous agreement in this transition plan. HWI is in talented, capable hands."

"I'm honored to be elected as the next chairman and CEO for HarbisonWalker International," Jackson said. "Each day, our teams are working hard to produce and innovate, and they are an amazing group of people. As we drive forward, HWI will continue to evolve for future growth by building on the strong foundation we've all been creating together."

FOR MORE INFORMATION: www.thinkhwi.com

State-of-the-Art Heat-Treating Systems Have Been Performing the Same Functions for Decades

By Jack Titus

NINETY-EIGHT 600-POUND TRAYS ARE IN continuous process, 13 are in the pre-process queue, nine preheating, 14 in the boost carb, eight in the diffusion chamber, eight in equalize, three trays in one of three quench options, slow-cool, dunk-oil quench, and in the holding chamber for multiple stations in press quench. The remaining 43 trays are in various stages of wash, temper, material handling, and load/unload stations.

Each of the 98 trays can have a different case depth and cooling and/or quench recipe. Sound like a sophisticated lights-out, just-in-time heat-treating system? Absolutely, it's a 21st century state-of-the-art hardening cell where the complexity of logic to control timing and tray tracking is nothing short of remarkable.

State-of-the-art certainly describes this heat-treating system, but even more significant is the cell that I will describe in the following column was sold 31 years ago, designed and commissioned in 1988.

At that time no one knew what a laptop was; iPhones, iPads, and android devices didn't exist. In fact, early cellphones, if you could afford one, were the size of a loaf of bread. The National Science Foundation Network (NSFNET), the beginning of the internet, was known only to scientists, the government, and hardcore techies. And the price of gasoline was 93 cents a gallon.

In 1986, a world-class off-road and mining equipment manufacturer approached Holcroft, Inc. about building a state-of-the art heat-treat system that would allow them to machine and heat-treat parts to meet its 24-hour ship-anywhere-in-the-world guarantee.

The resulting carburizing and hardening system was designed to process gears and shafts fixtured on 30-inch square (762 mm), 600-pound gross loaded trays every 15 minutes. Flexibility was paramount with a minimum ECD (effect case depth) of 0.026 inches at 0.40 percent carbon. Maximum case depth could be any metric one was willing to wait for.

The triple rotary trademarked "ROTO – CARB™" consisted of a pusher preheat — three oil-sealed rotary carburizing furnaces, one feeding the other in a straight line arrangement with a wash, temper, and associated handling conveyors (Figure 1). All equipment occupied a footprint of about 102 feet (31 meters) x 69 feet, 6 inches (21.2 meters).

Four pre-positioned queues were available for trays with one position dedicated for urgent processing on a moment's notice. Each tray was loaded with gears or shafts; the operator would queue in the ID and recipe, and they would be stored in the computer. Atmosphere control consisted of endo gas, but the custom oxygen probes were provided by the customer. Temperature set points were controlled by Baber Coleman 560 stand-alone instruments for all three rotary furnaces, preheat, temper, and holding chamber.

One of the control parameters critical to the operation was transferring trays between preheat, boost carb, diffuse, and equalize chambers. The rotaries continuously rotated and stopped only to transfer trays. However, before a tray could be transferred, an unoccupied space had to exist in the receiving location. This could only occur by continuously monitoring the location of each tray while knowing the time and case-depth requirement of every tray. Prior to loading a tray, an algorithm would test to determine if a space would be available in each of the furnace chambers to accommodate the boost carb, diffuse, and equalize recipe for the tray. If not, the next tray's recipe in the queue would be interrogated and continue through the queue until a suitable load recipe was found. This process was controlled by then state-of-the-art computers — IBM AT units running the DOS operating system. There were two computers, one managing tasks in real time while the second AT was the hot backup. If the primary system went down, the backup would immediately take over without skipping a beat. Each computer had 20-megabyte hard drives, trivial capacity by today's standards. In addition to the hard drives, each AT had dual 3.5-inch, 1.2 megabyte high-density floppy disk drives. Again, high end memory for the time. Discrete

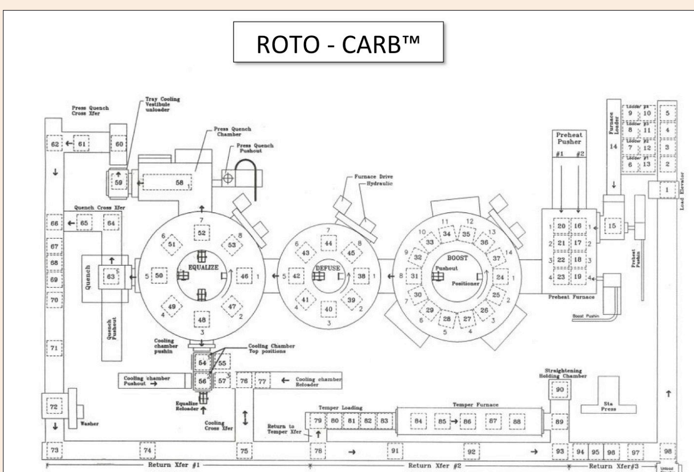


Figure 1

I/O, recipe management, and tray-handling motion was controlled via the same primary/backup philosophy as the computers but with Allen Bradley 2/30 PLCs. If the primary PLC failed, the backup would seamlessly take over.

(An interesting side note: the icon you click on in Windows to save a file is a replica of the 3.5-inch floppy disk.)

Trays would move from preheat into the boost carb rotary where the surface carbon would be increased to and maintained at approximately 1.10 percent to 1.30 percent, depending on the material and application. Likewise, the duration in the boost chamber would be monitored and, when the target case depth was achieved, moved to the diffuse chamber for the final near net-case depth while reducing the carbon potential to approximately 1.00 percent. The equalize rotary would receive a tray from the diffuse chamber and reduce the surface carbon to 0.85 percent to 0.90 percent while reducing the temperature to 1,550°F prior to quenching. Figure 2 is a display model of the ROTO – CARB™ cell.

Each rotary furnace had a maximum rotation speed of 1 rpm (revolution per minute). The minimum ECD mentioned above is based on the 15 minute Takt time and one-half revolution of the furnace. If the load mass was the appropriate value, less than 600 pounds, the recipe could produce shallower case depths by decreasing the time between trays entering the system.

When the recipe called for a press quenching stacked or side-by-side gears, the tray would be diverted from the equalize rotary to the press quench holding chamber. In the chamber, two positions are available, one for removing stacked gears and the second for removing gears resting side-by-side. When stacked, the process logic would alert an operator of what was to come. If stacked, the operator would enable the slot door to open, and the tech would manually remove the top gear, then the spacer if used. The sliding wall would move lower to align the slot door with the next gear for removal. This sequence would continue until all stacked gears were press quenched. The empty tray, when instructed, would be moved to the tray cooling

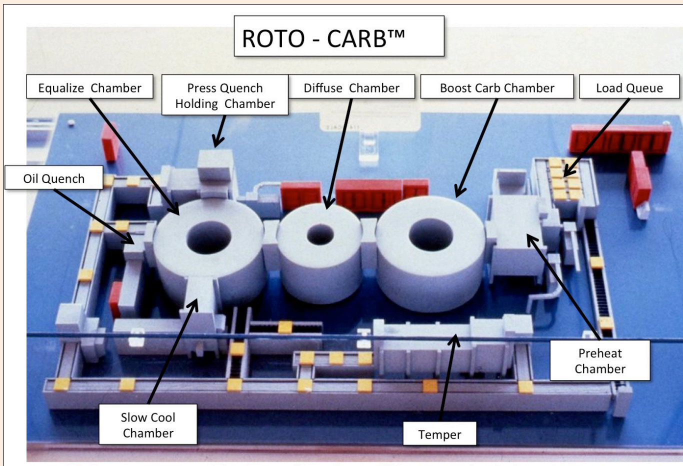


Figure 2, Display model

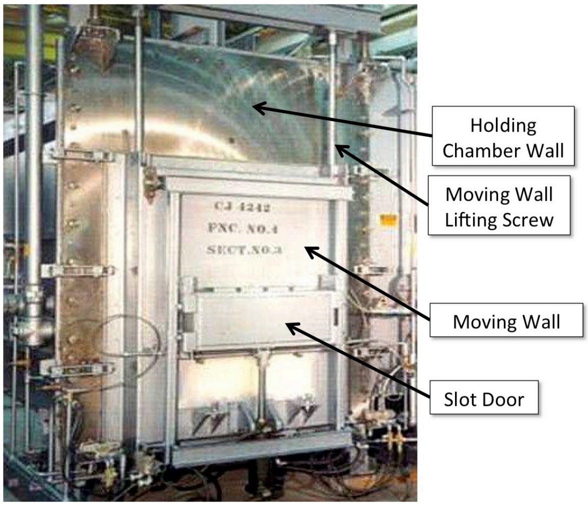


Figure 3, Press Quench Holding Chamber

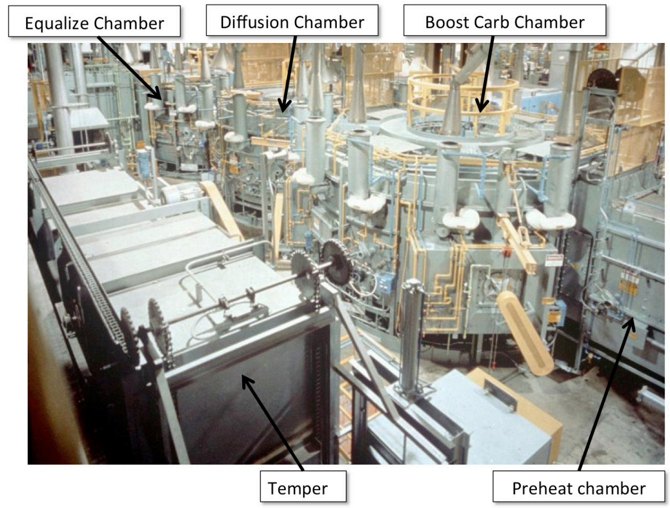


Figure 4, ROTO-CARB™

station where the quenched gears would be restacked on the cooled tray. When gears lie side-by-side, the tray would be positioned to the next holding chamber location where the wider slot door would allow the tech to remove both gears individually. To facilitate gear handling, a compressed air assisted manipulator helped the tech to move heavy gears to the press. Figure 3 is an example of the moving wall.

The second discharged position from the equalize chamber is the dunk-oil quench. This function operated much like a batch IQ furnace where the equalize push out would move a tray into the quench vestibule. The third cooling option consisted of one or two functions: The tray could be pushed out to the slow cooling chamber for complete cooling, or the tray could be cooled to <1,000°F (538°C) then recharged back into the equalize chamber for either dunk or press quenching. Figure 4 is a birds-eye view of the ROTO - CARB™ cell.

For those interested in PLC logic, the following is a partial explanation of the tray tracking logic used in the ROTO – CARB™ system, referencing Figure 1: When a tray was loaded at position 1, the information for the part/tray was moved to 1 of the 98 integer tracking files N1 to N98. All of the recipe data was loaded into that file. As the trays moved to a new position, the "pointer" (independent address in today's PLC logic) for that position was modified to point at the storage integer file the previous position pointed at. For example, if data was loaded initially in N1, the data exists all the way through the system in N1, the position pointer was the only thing that changed. So for example, in position 9, whatever integer file the information for that part/tray was loaded into at position 1, that is the file position 9 pointer pointed at. When the tray moved to position 10, the pointer for position 10 would be updated with the file number that was in position 9, and then position 9 would be set to an empty file until a new tray was moved into it. Most of the time the entire data file just moved a pointer number that pointed to a fixed file. When a part/tray left the system, that integer file was freed up and put back in the open files to be used. After a while, files were not sequential because trays loaded later may be out before trays loaded first [1].

Ever since the term "lean manufacturing" entered our lexicon, reducing inventory in the manufacturing chain has been a primary goal. To manufacture an item meant parts required in making a product must arrive at the assembly station "just-in-time." Heat treating, and carburizing in particular, where many parts are processed simultaneously could frustrate that effort. However, Holcroft Inc. had a solution to that conundrum: it's called the rotary hearth carburizing furnace. In essence, flexibility is the key word here, flexibility to overcome the first-in-first-out obstacle many manufacturing processes endure.

Rotary furnaces can operate in two ways: They can function like a pusher turned into a circle where the trays follow the first-in-first-out scenario, one revolution and out, or like ROTO - CARB™ where they can dwell as long as desired to achieve the desired case depth or one-half revolution.

In my view, the rotary furnace has not been applied as often as it should for its just-in-time functionality and flexibility. In addition, rotary furnaces, regardless of type, are self-emptying, meaning that unlike pushers that require empty trays to push out full ones to change recipes, they satisfy the lean manufacturing philosophy. Rotary furnaces can be made in almost any size with as few as four trays of almost any size and integrated into a variety of cell and quench configurations.

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PID Algorithms Are Essential for Uniform Furnace Temperatures

By Jim Oakes

IT DOES NOT MATTER WHAT THERMAL TREATMENT a work piece requires, proper control is the foundation for repeatability and quality processing. For heat-treating processes, there are typically different types of control parameters that are continuously or discontinuously monitored to deliver the proper part metallurgy. Field devices are used to monitor the "process variable" that is tied into a controller, and the controller uses an algorithm to provide an action based on the deviation from the desired set point. The core control component for thermal processing is, of course, temperature, measured using a thermocouple.

Algorithms used for control are broad, but most thermal treatments use PID loop control. A PID controller is a control loop feedback mechanism. It is expected to control a process using only a process variable. Every application is different and requires specific settings and approaches. For example, parameters for heating a furnace electrically are vastly different than those for heating a furnace using gas burners. PID stands for proportional-integral-derivative, and the response of the control loop is entirely dependent on three terms:

Proportional: The proportional term looks at current error (difference between set point and process variable) of the system. Depending on the controller, the proportional term is expressed as either proportional band (PB) or gain. PB and gain are simply the inverse of one another (1/X). For example, a 20 percent proportional band equates to a gain of five. Knowing what term a controller is using is critical to correct tuning.

Integral: This term is related to the accumulated past error of the system. Integral is typically expressed in repeats per minute or minutes per repeat. The "repeat" is the current (proportional) error. The integral is the sum of error over a period of time.

Derivative: The derivative term looks at the expected future error of the system. The derivative is applied based on the rate of change of the process variable. While most heating applications can function quite well with just the PI terms being used, the derivative term can help with a process that has a quick and sudden change (for example, opening an oven door and closing it). Derivative works in the opposite direction of the proportional term and acts as a dampener.

TEMPERATURE CONTROL

Heating systems can use two types of PID control: time proportioning or full proportional control. A system with on/off control (for example, a heating contactor applying full power when engaged or a gas valve fully opening when called for) is typically controlled by time-proportioning. With a time-proportioning signal, a cycle time is applied to the control loop, which will multiply the control variable output by the cycle time to calculate the control signal's total on time.

If the system has a 4-20 mA control valve or a silicon-controlled rectifier (SCR), then it is a full proportional control system. With full proportional control, the control valve/elements will be adjusted to a level that corresponds to the control output. Full proportional control will provide for the tightest tolerances and the least amount of process variable changeability at setpoint.

ATMOSPHERE CONTROL

PID control is also used for heat-treating processes that use atmosphere (or in some cases, lack of atmosphere). Sensors provide a reading that

the controller will interpret as the atmosphere process variable, and then react based on the proportional control setup and PID values for that control loop. It is always ideal for the sensor to be reading the direct atmosphere that the work pieces are exposed to in order to provide optimal response to the changing environment. Oxygen sensors (a k a carbon probes), hydrogen analyzers, non-dispersive infrared analyzers, vacuum gauges, and flow meters all play a role in the different types of atmospheres control available for heat treatment.

Each heat-treating process as it relates to gas atmospheres typically has the ability to measure the composition of the gas using a sensor exposed to the work pieces in-situ or through a sampling of the atmosphere. The control parameter for the atmosphere is an attribute of the process. For example, for ferritic nitrocarburizing (FNC), the industry specification AMS 2759/12 calls for the control of the nitriding potential (Kn). The output of the control loop setup for FNC would typically control the addition of ammonia and/or dissociated ammonia to meet the Kn set point. Kn is commonly calculated using an analyzer that calculates the percentage of hydrogen in the atmosphere, but it will also require information about the flow of additional gases influencing the total hydrogen measured (not just hydrogen from the breakdown of ammonia). Although the PID algorithm is still evaluating just one data point and providing an output to control the gases, the controller requires the logic to calculate multiple data points for that specific process variable.

QUALITY, PRODUCTIVITY, AND REPEATABILITY

Proper control delivers attributes necessary to produce correct metallurgical results in a productive and predictable environment. PIDs define a properly "tuned" furnace, which is necessary to meet uniformity requirements for CQI-9 or Nadcap. The PID parameters are a significant part of making the temperature uniform without exceeding top end temperature tolerances and also ensuring that the atmosphere stays in the necessary boundaries for control. In past articles, out-of-control furnaces were discussed both from an atmosphere and temperature standpoint where a negative impact was highlighted when operating outside control parameters. The PID algorithms are the first step to ensure control to the setpoint and managing variation from setpoint.

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Several techniques are available, but there are pros and cons to each

By Lee M. Rothleutner

GRAIN SIZE IS A CRITICAL METALLURGICAL characteristic, significantly influencing design parameters such as strength and toughness. Austenite grain size (often referenced to as prior-austenite grain size) is of particular interest to users of heat-treated plain-carbon and low-alloy steel components — so much so that industry standards such as ASTM E-112 [1] and ISO:643 [2] outline a variety of procedures for determining austenite grain size.

Techniques include delineation of austenite grains with pro-eutectoid phases (ferrite and cementite), selective oxidation or etching of austenite grain boundaries, and analysis of electron backscatter diffraction (EBSD) data of finely polished metallurgical specimens [3]. Each method has its benefits and limitations, but some techniques may characterize your heat-treatment process better than others. For example, the Kohn oxidation method [2] and the McQuaid-Ehn carburization method [1, 2] require atmospheres and heat treatments that may not be representative of the process requiring characterization. As a result, selective etching techniques are considerably more appealing.

Figures 1-4 show examples of some of the more widely used techniques. Figure 1 shows a specimen of modified 15V41 that was forced-air cooled from forging temperature, held for 30 minutes at 700°C, then quenched to room temperature and etched using 2 percent nital. Figures 2-4 represent examples of specimens that underwent no special heat treatment but use an etchant similar to Brownrigg *et al.* [7] to reveal the austenite grain size. Figure 2 shows the case region of an induction hardened 10V45 shaft. Figure 3 shows the core of a furnace-austenitized and quenched-modified 8620 specimen. Figure 4 shows an isothermally transformed bainitic modified 52100 specimen.

SELECTIVE ETCHING TECHNIQUES

Selective etching techniques such as the Bechet-Beaujard method [2] and its variants [7, 8] as well as a variety of other etchants [9-11] have distinct benefits over all other techniques. These etchants allow through hardened (both martensitic or bainitic) specimens to be examined with no additional heat-treatment steps that can bias the true austenite grain size of the process. However, achieving results that can be easily interpreted is far from a trivial task. Often each alloy and heat treatment requires a slightly modified methodology.

EXAMPLE ETCHANT AND GUIDELINES

The simplest austenite grain size etchant is water-based saturated picric acid solution but slight variations in the etchant, sample preparation, and methodology can dramatically improve results. It is believed that this etchant attacks trace elements such as phosphorus (P) that segregate to austenite grain boundaries at austenitizing temperatures. Therefore, special temper embrittlement heat treatments have been shown to improve etching results in alloys with low P content [8]. One instance in which this step is necessary is laboratory heats of steel that have very low P content. Another factor that is often overlooked is the specimen polish. A freshly polished metallographic specimen (1 μm or finer) provides the best results. Below are an etchant and general procedure as well as a list of considerations developed from a review of the literature [7-11] that will provide a starting point for developing a procedure that will work for your process.

ETCHANT:

1. 13 g/L picric acid in deionized (DI) water
   - This is slightly above the solubility limit to ensure the solution is saturated.
2. 3% Teepol
   - Wetting agent. Substitutions can be made depending on availability of Teepol.
   - Increasing the concentration for lower carbon levels (i.e. 0.2 wt.% C) has been shown to improve results.
3. 1% hydrochloric acid
   - Exact concentration depends on alloy. Sometimes this addition is not needed.

PROCEDURE:

1. Heat etchant to 65°C while stirring with magnetic stirrer. Keep etchant covered while not in use to prolong life.
   - Each batch of etchant typically only lasts 2-3 specimens.
   - Temperature can be reduced if etchant is observed to be too aggressive.
2. Immerse specimen in etchant for 5-10 seconds. Specimen will tarnish significantly.
   - Preheating the specimen on the hot plate or with a heat gun improves results.
3. Rinse with DI water followed by ethanol.
4. Lightly polish specimen by hand on a stationary medium- to high-nap polishing cloth with 1 μm or finer diamond compound.
   - Counting the number of revolutions around the pad helps repeatability. Less than 10 revolutions are typically all that is necessary.
5. Clean with ethanol and dry with clean compressed gas.
6. Inspect with light microscope.
   - Try dark-field illumination to reveal the grain boundaries if bright-field produces marginal results.
7. Repeat steps 2-6 until acceptable results are achieved.

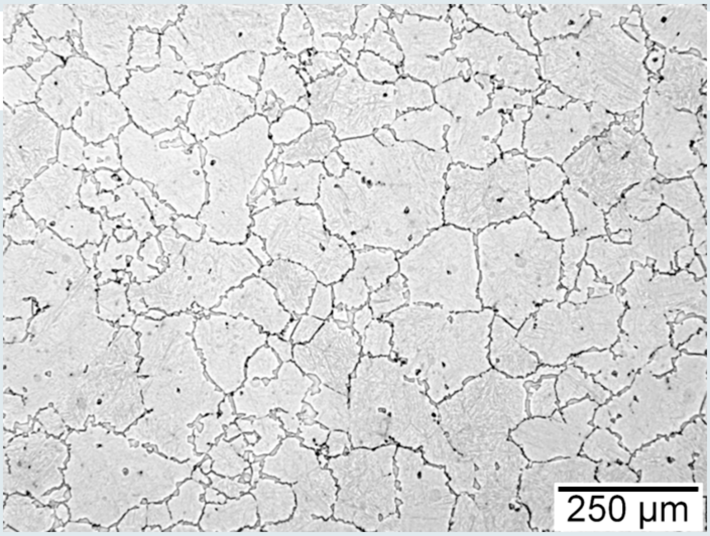

Figure 1. Optical micrograph showing austenite grain boundary delineation using isothermally transformed ferrite in a modified 15V41 [4]

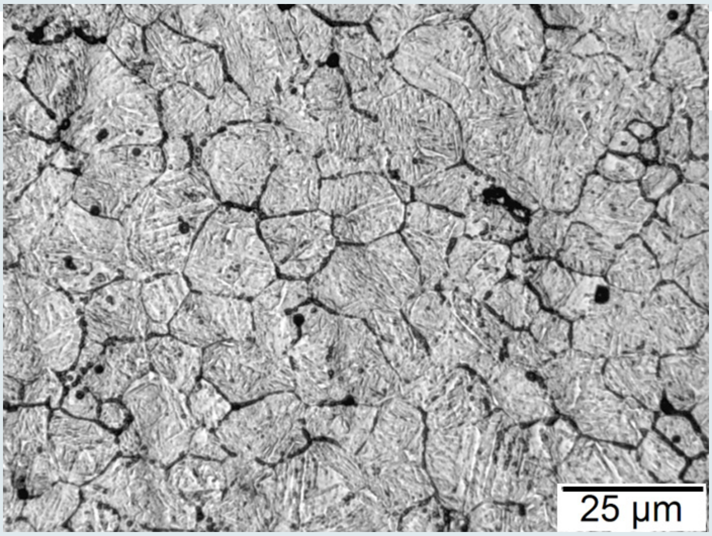

Figure 2. Optical micrograph showing selective etching of austenite grain boundaries in an 10V45 induction hardened case [5]

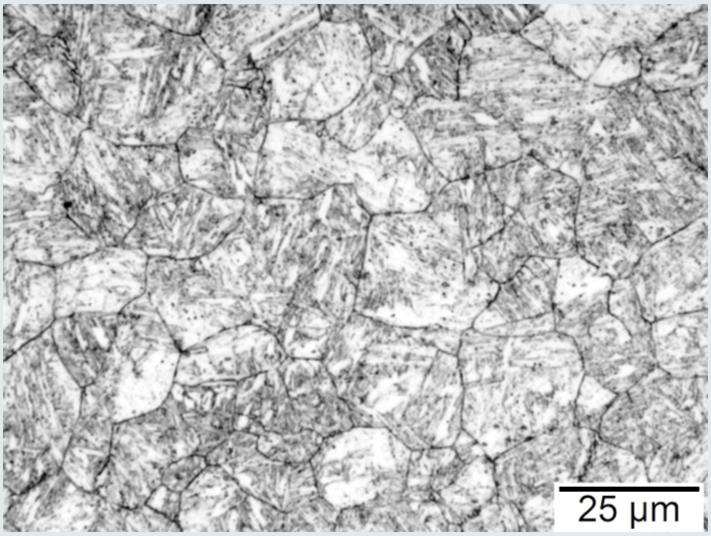

Figure 3. Optical micrograph showing selective etching of austenite grain boundaries in a quenched and tempered modified 8620.

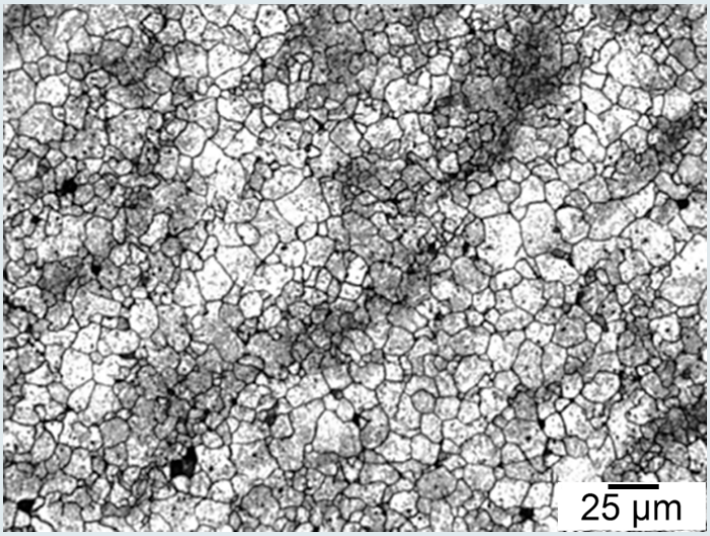

Figure 4. Optical micrograph showing selective etching of austenite grain boundaries in a bainitic modified 52100 [6].

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Facing the Everyday Enemy of Your Vacuum Furnace

By Jim Grann

WATER VAPOR (E.G., EXCESSIVE RETAINED humidity) is the most commonplace enemy of vacuum furnaces. In fact, it is the No. 1 threat to everyday heat treatment processes. If water vapor does permeate the hot zone, possible outcomes include reduced hot zone life, discolored work, poor brazing, longer cycle times, and excessive outgassing.

A furnace atmosphere full of water vapor can also cause excessive outgassing. This, in turn, can extend the cycle time due to waiting for the vacuum to recover. As a result, you have maintenance personnel checking the furnace for no specific reason, which takes it out of production and wastes more time.

One should remember, though, that the hot zone is not the only thing affected by water vapor. Water vapor retention can also affect the pipes, pumping system, heat exchanger, and vacuum sensors. In addition, if you place parts/fixtures that have been sitting out in a humid or damp shop in a furnace, water vapor can leap off the parts and affect the furnace.

HOW WATER VAPOR AFFECTS DIFFERENT HOT ZONE TYPES

Water vapor affects molybdenum the same way it affects graphite. Yet, graphite hot zones consume themselves faster due to water vapor retention. Regardless of your hot zone type, the negative effects that occur during the process remain the same.

However, you can add, on average, at least two years to your capital investment's life span if you follow vacuum best practices. This includes performing scheduled cleanup cycles, verifying the door is closed between cycles, and keeping water vapor out and leak rates down.

CORRECTING WATER VAPOR RETENTION

Correcting water vapor retention is one way to increase the longevity of your hot zone. To handle the threat of water vapor, you should follow the best practices listed above. This also means keeping the vacuum furnace door closed between loads (especially if it's wet or humid outside) and pumping the furnace down between cycles to at least 30 in Hg.

Some may argue that if you pump the furnace down between cycles to remove excessive water vapor, then you have to backfill to get the door open again, which wastes gas. Yet you have to weigh the cost of the gas vs. the effect of water vapor on the furnace and hot zone. If you pump the furnace down and backfill it, the wasted argon or nitrogen gas can cost about $20 every time. In comparison, though, all the negative outcomes that can result from excessive water-vapor retention outweigh the cost of additional gas usage.

If you do leave the door open for an extended amount of time, you have a few options:

The most common (and recommended) practice is to put the parts in the furnace and pump down without starting the heat cycle right away. Instead, adjust the cycle and extend the time it spends pumping prior to heating. This lets you boil off additional water while the furnace is under vacuum.

Close the furnace door without the parts and run a mini drying cycle. This option is often performed during worst-case scenarios, such as prolonged door open times.

In the end, removing water vapor from the furnace takes time, heat, and vacuum. If you are preparing for an extended shutdown, we recommend that you pump down the furnace and backfill it to negative-5 in Hg. Doing so reduces the leak-up rate during long periods of inactivity. As a result, you are able to come back from shutdown to a clean, dry, empty furnace that can resume normal operations.

DISCOLORATION AND WATER VAPOR

If a cycle did start without following the proper steps or taking enough time to remove the water vapor, parts may emerge with discoloration. The color itself depends on the material. Discoloration tends to start at a sky blue and become darker based on how much water vapor and/or air was in the furnace.

Most controls platforms should be able to prevent discoloration from occurring, including Ipsen's CompuVac® and VacuProf® controls systems. By using the Outgas Hold feature in the software, you can control at what pressure the furnace heat turns on. As a result, the heat will not turn on if the furnace is excessively outgassing. If there is also excessive outgassing during a heating cycle, the controls will place the cycle into hold.

ROUGHING PUMP AND WATER VAPOR

Since water vapor can also affect the pumping system, it is important to keep your roughing pump oil at the right temperature. Doing so turns the water into steam and prevents any water vapor from mixing with the oil in your roughing pump. This is important as your whole process pumping ability declines if the roughing pump becomes water-bound.

As such, we recommend the use of a roughing pump water miser. Based on the actual oil temperature, the water miser regulates the water flow to the mechanical pump. You can also set it to the desired temperature, so any water vapor coming in can't mix or emulsify with the oil. This prevents the water vapor from having a negative impact on the process.

If you have a water miser installed and note excessive water, one solution is to open the gas ballast. This allows the roughing pump to increase its temperature temporarily, so it can remove any excessive water.

Not everyone has a water miser on the pumping system, though. As a result, they pump water in and out of the roughing pump at all times. Yet doing so is not conducive to good vacuum practices. Instead, one should regulate the temperature of the roughing pump oil to ensure it stays within 140 to 160°F (60 to 71°C).

MONITORING FOR RELATIVE HUMIDITY

The PdMetrics® predictive maintenance software platform monitors the relative humidity and ambient temperature. The platform then indicates any prolonged exposure of the furnace to water vapor. It does this by considering how long the furnace takes to pump down compared to the ambient temperature and humidity, how long the door is open, and previous leak-up rates.

If there is an issue, the system will set off a vacuum integrity alert that states it's taking too long to pump down. It will then determine if it is humid outside. If it is, the software will provide a set of steps that you should first follow. If it is not, it will provide a different set of steps for you to take. As such, it prioritizes corrective actions based on sensor readings and running algorithms.

Water vapor can significantly affect the furnace's performance, as well as the parts being heat-treated. If the ultimate goal is to protect your vacuum furnace and extend your hot zone's life span, then following good vacuum practices is essential.

Discover additional best practices and tips for vacuum furnace maintenance at www.IpsenHarold.com.

ABOUT THE AUTHOR: Jim Grann, Ipsen's senior technical manager, started with Ipsen in 1978, and since then, he has held roles in quality control, technical support, and Ipsen U instruction, among others. He is a technical expert who works with support services, furnace orders, inspections, and special processes. His 38 years of experience and interactions with customers around the world allow Grann to provide excellent solutions and support when troubleshooting furnace- and process-related issues.

Lindberg/MPH

Despite being in business for more than a century, Lindberg/MPH has undergone a recent transformation to make sure it stays a leader in the heat-treating/non-ferrous melting industry.

By Kenneth Carter

LINDBERG/MPH HAS BEEN AROUND FOR OVER 100 YEARS. During that century, it has changed hands and names, but since it became part of Thermal Product Solutions (TPS), the company has been making great strides to alter its entire culture.

And with that cultural change, Lindberg/MPH has become one of the more profitable and fastest-growing brands under the TPS umbrella, according to Steve Kempowski, who has been Lindberg/MPH's president for the last two years.

"What we have done over the past two years has been to really revitalize and get the brand out there again — the Lindberg/MPH brand," Kempowski said. "It has a lot of history. But over the years — with the changes in ownership, changes in location — people knew Lindberg was still there, but really didn't count on them when they wanted new equipment. Basically they thought we were just doing parts and really not into original equipment any longer."

And because of that misconception, a lot of business went elsewhere, he said.

"Over the past two years, we did a lot of marketing, getting the brand out there again, letting people know that Lindberg is alive and well, and that they are doing original equipment and never stopped," Kempowski said. "And with that has come growth for the past couple of years. So we are definitely in a growth mode. Our goal is to continue to grow year after year and get back into a lot of the markets where we were the dominant player."

Lindberg/MPH is poised to offer its products to a variety of those markets, including integral quench furnaces for carburizing, conveyer-type equipment for the electronics industry, pit furnaces for nitriding applications, pit furnaces for steam-treating applications, as well as standard box furnaces used for a variety of different applications.

Lindberg/MPH customers also cover a wide range of industries including aerospace/military, automotive, commercial heat treating, energy/oil, electronics, and the forging markets.

"We've also invested heavily in the past few years in new equipment," Kempowski said. "Brakes, shears, punches, structural saws, paint booths, and people. We've really been adding people."

Lindberg/MPH expects its line of Pacemaker integral quench furnaces — which Kempowski said Lindberg already has received several orders for — to make the industry take notice.

"That's one of the areas Lindberg was dominant in the '90s and early 2000s," he said. "So we have recently landed several orders for that style of furnace."

The Pacemaker furnaces are used for carburizing steel.

"There are a lot of different things you carburize, but carburizing is a hardening application." Kempowski said. "Once a part is made, you need to harden it to make it last longer, so it doesn't wear out as fast. And that's what the Pacemaker is typically used for."

In addition to the Pacemaker integral quench furnace, Lindberg/MPH also offers pit nitriders.

"You also have another hardening application called nitriding," Kempowski said. "Nitriding is a heat-treating process that diffuses nitrogen into the surface of a metal to create a case-hardened surface. That's what the pit nitriders are commonly used for."

The other side of the Lindberg coin is the MPH side, which is involved with melting equipment.

"That has been going very strong and growing, also," Kempowski said. "That's for the non-ferrous melting industry, die casters. They melt aluminum and die cast parts for automotive and aerospace. That's what that product line is used for most of the time."

Lindberg/MPH also has done some projects for the hot-stamp industry, according to Kempowski.

"Typically what they do is they will heat up a blank of metal, and then put it in a stamping machine that will stamp it into a shape," he said. "For instance, it could be the side impact beams on a car, body pillars for a car, framing, bumpers, the roof panels. Or it could be as simple as a garden shovel. Those are all hot stamped applications. And that's an emerging market. There's always been cold stamping, but they're finding that hot stamping is actually working better. It doesn't work-harden the material as bad."

Lindberg/MPH won't be content with its current line of industry products. It is about to embark on a project in the near future involving atmosphere generators, according to Kempowski.

"It's kind of an older technology; not a lot has changed over the years with it," he said. "But we're thinking there's got to be something better, a more cost effective, easier way to crack gasses. And we'll be embarking on an R&D project very soon to start looking at those innovative approaches to older technologies."

The products Lindberg/MPH offers is certainly integral to its success, but the company also depends on its people, first and foremost, according to Kempowski.

"We've really changed (the company atmosphere) around and made more of a family fun atmosphere, which just gets people more excited about the work they do," he said.

And there has been quite a bit of transformation since Lindberg/MPH was founded in 1912 as the "Replaceable Heating Elements" company in New York. The name came from the owners' patented, replaceable heating elements for research heating applications.

The company has gone through many mergers and changes that include the MPH merger in 2005 and its current affiliation with TPS.

"Basically, they started by doing replacement heating elements, and then it grew into making furnaces," Kempowski said. "Part of the story I heard was, at one point, Lindberg was a heat treater and decided they couldn't get quality equipment from anybody, so they decided to start building their own."

To date, Lindberg/MPH has installed more than 75,000 industrial furnaces all over the world covering a variety of applications.

"Over the years, things have been added to (the company)," Kempowski said. "We started by adding heavy duty to it, the Leeds and Northrup brands. Blue M brands were brought into it, which are still part of the family. And it just has grown from there."

But in the end, that continued growth boils down to the employees and keeping them around, which means keeping them engaged and excited to work for Lindberg/MPH, according to Kempowski.

"We do a lot to celebrate victories, engage people, and make sure that they're happy and want to come to work," he said.

FOR MORE INFORMATION, go to www.lindbergmph.com.

Case Hardening Basics: Nitrocarburizing vs. Carbonitriding

The terms sound alike and often cause confusion, but nitrocarburizing and carbonitriding are distinct heat-treating processes that have their advantages depending on the material used and the intended finished quality of a part.

By Rob Simons

Confusion surrounding the case-hardening techniques of nitrocarburizing and carbonitriding prove the point that it's easy to get lost in the nomenclature behind heat-treating processes.

That comes with the territory. Metallurgy is complicated.

But there's value to explaining the differences between these techniques[1] and the benefits that result from their uses, including cutting down on the confusion to help manufacturers better understand what goes on in the heat treater's furnaces.

CASE HARDENING

Case hardening[2] refers to the "case" that develops around a part subjected to a hardening treatment. Nitrocarburizing and carbonitriding both make a workpiece surface harder by imparting carbon, or carbon and nitrogen, to its surface.

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 sent the patent application off, 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.

Material, part specs, and intended uses dictate whether nitrocarburizing or carbonitriding is the best case-hardening method.

CARBONITRIDING

During carbonitriding, parts are heated in a sealed chamber well into the austenitic range — about 1,600 degrees Fahrenheit — before nitrogen and carbon are added. Because the part is heated into the austenitic range, a phase change in the steel's crystal structure occurs that allows carbon and nitrogen atoms to diffuse into the part.

Nitrogen is added to low-carbon, low-alloy steels because they don't harden well without the boost the nitrogen provides. The nitrogen comes in the form of ammonia gas molecules that crack apart on the surface of the part to provide nitrogen that diffuses into the steel. Adding nitrogen also helps a part maintain hardness during use in high-temperature operational conditions.

Carbonitriding typically achieves greater case depths compared to nitrocarburizing. There's no theoretical limit to how deep a case can be achieved in either process, but a practical limit is the time and resources one is willing to spend to achieve certain case depths.

The carbonitriding process takes from a few hours up to a day or more to achieve the desired results: a part with high surface hardness but with a relatively ductile core. The process concludes with a quench.

Carbonitriding is used to harden surfaces of parts made of relatively less expensive and easily-machined steels, like stamped automotive parts or wood screws. The process makes parts more resistant to wear and increases fatigue strength.

NITROCARBURIZING

Nitrocarburizing also entails the dissolution of carbon and nitrogen into a workpiece, but, compared to carbonitriding, more nitrogen is used in nitrocarburizing. 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.

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

Ferritic nitrocarburizing is unique in that it offers case hardening without the need to heat metal parts into a phase change. (It's done between 975 and 1,125 degrees Fahrenheit.) Within that temperature range, nitrogen atoms are soluble in iron, 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.

Workpieces improved by nitrocarburizing include drive-train components in automobiles and heavy equipment, firearm components such as barrels and slides, and dies for manufacturing processes.

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

INCREASING POPULARITY

Because case hardening offers superior surface qualities with less risk of distortion, it's 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 critical surface hardness without the risk of distortion that accompanies higher-temperature treatments.

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.

KNOWLEDGE IS POWER

The nitrocarburizing and carbonitriding processes can be complicated, but they're also critical to ensuring parts can stand up to the environments in which they'll be used. By learning more about these and other heat-treating processes[3], a big step can be taken toward more productive future discussions and a stronger relationship with heat-treatment partners.

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ABOUT THE AUTHOR: Rob Simons is a metallurgical engineer specializing in ferrous heat treatments with 35 years of experience in the industry. He earned a degree in metallurgical engineering from the University of Missouri — Rolla in 1982 and will be a featured presenter at the ASM Heat Treat 2017 conference. He has been at Paulo for 30 years. Founded in 1943, Paulo is one of the largest providers of heat-treating, brazing, and metal-finishing solutions in North America. Headquartered in St. Louis, Missouri, Paulo operates five divisions servicing the Mid-West, Great Lakes, and Southeast regions of the United States.

Case Study: Conrad Kacsik and Modern Industries

Two companies partner together to complete a yearlong plant-wide upgrade of process controls for heat-treating equipment.

By Molly J. Rogers

Modern Industries, one of the largest heat-treating facilities in Pennsylvania, has seen its share of equipment come and go since its beginning 71 years ago. According to Bryan Jageman at Modern Industries, it's not the furnaces themselves that have changed that much, but the technology of the controllers that control the furnaces — the ability to control them better, faster, and remotely.

"In the aerospace, defense, and medical industries, more and more of the requirements for documentation becomes more stringent every day," Jageman said. "Every three to five years, there are upgrades that we take a look at."

Since all of Modern Industries' furnaces had the original controllers on them, the company set out to replace the legacy controllers on more than 30 furnaces and pieces of equipment in its facility. While interviewing different companies that sell or make new systems to upgrade original controllers and spending hundreds of hours reviewing specifications, Modern Industries saw one company — Conrad Kacsik — that stood out from the rest, offering a customized package that fit its needs.

"We purchased the Honeywell HC900 controllers with accompanying SpecView software and hired them to do the full installation, a turnkey operation," Jageman said. "They are very knowledgeable because they are constantly working and designing controllers all over the country. Not only did they install the controllers, but they also allowed us to add a little more technology that we possibly wouldn't have thought of. So they brought a lot of experience to the table, and that helped personalize the controllers and software to fit what Modern does every day. Now that helps us provide the best documentation for our customers."

Before the installation, Modern had obsolete Surface Combustion operator terminals with monochrome monitors that were hard to view, and according to Kevin Helsley, one of the engineers at Conrad Kacsik who worked with Modern Industries on the project, the technology had already surpassed them.

Helsley and Conrad Kacsik's engineering team showed them demonstrations, capabilities, and solutions that they could offer.

"Based on our quotations, our abilities, and competitive pricing, we were awarded the job," Helsley said.

THE INSTALLATION

Modern Industries has a wide range of heat-treat equipment including vacuum furnaces, IQ furnaces, tempers, cast belts, and nitriders. Conrad Kacsik integrated all of the equipment into one data collection system.

"We replaced the controllers, the operator interface, and the PLC racks with the Honeywell HC900 PLC hybrid controller with touchscreen HMI," Helsley said.

Terry Newton, another Conrad Kacsik engineer for the project, said the team selected the Honeywell HC900 because it suited Modern Industries' customization and expansion requirements.

"HC900 is a PLC-based controller made specifically for process control," Newton said. "We've used it from its inception and have always achieved good results out of it. It is a Honeywell product, not a Conrad Kacsik product, so customers are not married to us afterwards like they would be with other companies that sell proprietary systems. If they want more local support after the project is done, they don't necessarily have to come back to us for everything. It's a standard off-the-shelf product that we've assembled into an engineering package."

However, Modern Industries continues to call on Conrad Kacsik for additional support to add more furnaces, integrate more features into the system, and troubleshoot any issues. The SpecView software installed by the engineers gives them the ability to remotely log in to the HC900 Supervisory Control System at Modern's plant.

"For example, by logging in remotely, we can see that the controller is functioning properly, but they might have a bad device on their furnace, and we can pinpoint it for them," Newton said. "Another feature of SpecView is that it does its own data collection, so they have redundancy built into their system. If the computer collecting all of their data crashed or there was a power outage, the information is stored locally on each machine. They will never lose data. It's always there."

Conrad Kacsik worked closely with Modern Industries to develop scenarios for the control systems for carbon potential.

"From furnace to furnace, you will always have differences depending on the condition of the furnace, leaks, age, etc., and by utilizing our control schemes, we were able to match it up per furnace," Newton said. "Every one had a different logarithm built into it."

"They would put a sample in the furnace, and then we would take the sample and break it down," Helsley said. "It would give us an actual reading of the percent of carbon in it, and we kept modifying our control scheme for our system to match their results from their testing, because their testing equipment was very good."

While multiple furnaces are connected on one control in the HC900, Modern Industries has the ability to look at the data individually for each furnace with the HMI touchscreen or the Specview SCADA package. Using Specview, a profile manager was developed for each furnace type within the plant. For example, this feature allows Modern Industries to develop a single profile for a furnace type and send it to 13 of their tempers at once, while they are in process.

CHALLENGES

With both Modern Industries and Conrad Kacsik acknowledging that it would be a difficult task to undertake a plant-wide system upgrade that would take a year to complete, the companies implemented necessary steps to handle the project in the most efficient manner and minimize the impact on Modern's operation.

"We had to integrate our system while Modern maintained production, working with their production schedule," said Pat Dunn, another engineer on the Conrad Kacsik team. "We had to have the furnaces available to us and get them offline and done in an efficient manner that didn't disrupt their production."

The installation was broken into four segments, shutting down one furnace line at a time.

"If we didn't have the furnace line shut down and prepared, they would not have been able to start, and that would have put us behind," Jageman said. "But that never happened. We were ready for them."

Jageman said the preplanning and coordination from both companies alleviated any scheduling issues and delays that might normally happen in a project this large.

"It was pretty seamless," Jageman said. "This was a yearlong project, and we met every week to review the progress. We discussed potential problems and solutions, and then put together the next weeks scheduling goals. We had to make sure we could dream up any problem that could arise and have a reaction plan in place. It might take two to three days for preplanning, but avoiding setxbacks is invaluable."

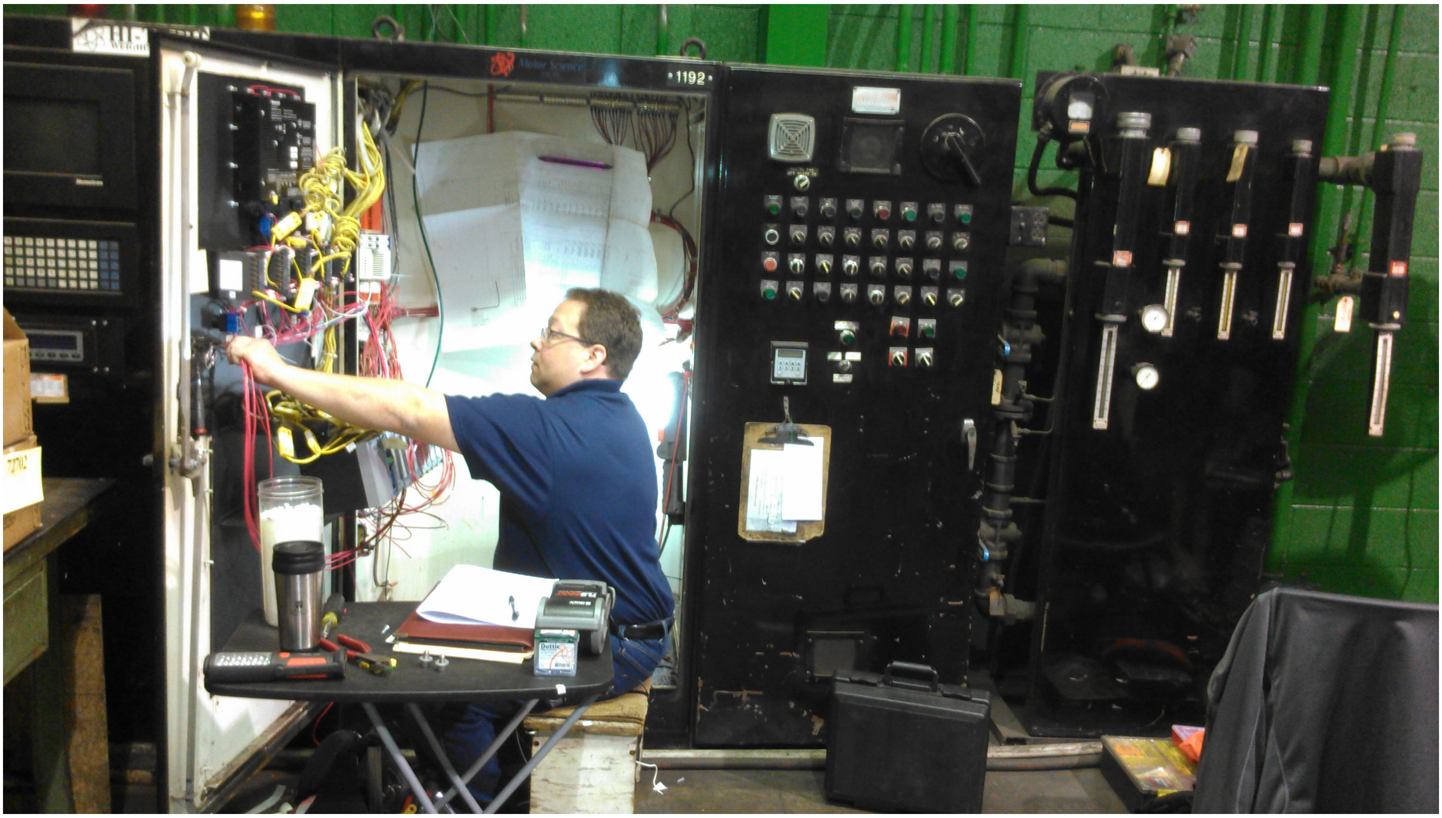
There are always challenges with training employees with a new system, but dividing it into three-month installation periods helped the team at Modern get up to speed.

"By the time we finished one line that took three months, our crew was adept with it, and by the time it was all done, the crew was proficient with it," Jageman said. "The training that goes along with the installation is invaluable."

THE RESULTS

Modern's previous furnace-control systems consisted of standalone, menu-driven controls with monochrome displays. The operators now have a graphics-driven system, touch-screen HMIs, and an easier menu system that they enjoy working with versus the multiple menu levels. Before, they could only look at data points and try to reconstruct what happened, but now it's visual. They can see where they stay within tolerances and that their processes ran correctly.

With the new SpecView system, authorized personnel at Modern can view what's happening in the system while sitting at their



desks. They can also access the sytem remotely through the internet. SpecView was programmed into each computer to mirror all of the individual HC900 control station screens and to provide furnace operators with recipe-management capability. Customized screens were also developed to enable customer names, part numbers, part quantities, and additional information to be combined with individual furnace data.

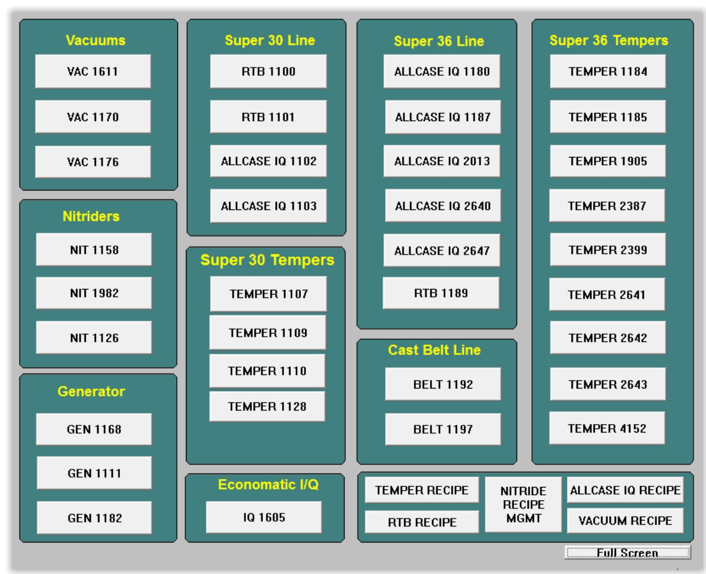
There are benefits from a maintenance aspect as well. If Modern had a circuit board problem with the old system, they would need to send it out to have someone rebuild it — a costly and inefficient procedure. Conrad Kacsik stocked the parts at Modern's facility that are integrated in the system, so if they have a breakdown, they can call them and it's an easy turnaround.

Also, with the HC900 as a PLC-type control, individual cards can be hot-swapped. For example, the legacy control running six tempers would normally have to be shut down, affecting all of the tempers, in order to repair or replace that control. With the new system, individual cards can be pulled out while everything else is still running. The card is replaced, and the system can be back up quickly, eliminating downtime and associated costs.

According to Jageman, the results from the upgrade are benefiting Modern Industries' customers as well, through reduced cycle times, more capabilities, and more accurate documentation.

"Since all of our furnaces were included in the upgrade, it has added to our ability to service our customers and opened up more capacity for customers that we didn't have before," Jageman said. "Now that we are able to more accurately track and document the processes and functions of our furnaces, Modern can provide state-of-the-art service to all of their customers.

Jageman said system accuracy tests (SATs) and furnace uniformity surveys are now easier because the documentation is more readily available and can be transferred to its quarterly surveys and SAT record files.



"It's all dropped into a file, and each furnace has a file," Jageman said. "Whenever we have an audit, it's right there and easy to open. For record-keeping purposes and the transfer of data and documentation, we save time and money."

It's also helped Modern improve accuracy of documentation.

"In a previous Nadcap audit, we had some nonconformances for pyrometry, but since we've had this system installed, our last audit was so successful that we achieved Nadcap merit status," Jageman said. "I believe the software and the technology that Conrad Kacsik brought helped us obtain that. And that alone speaks volumes."

Conrad Kacsik has expertise in pyrometry that helped ensure that Modern Industries uses the new software and the new accuracies to improve audits and the way they track product as it goes through the shop.

"They installed software to get the most benefits out of our equipment," Jageman said.

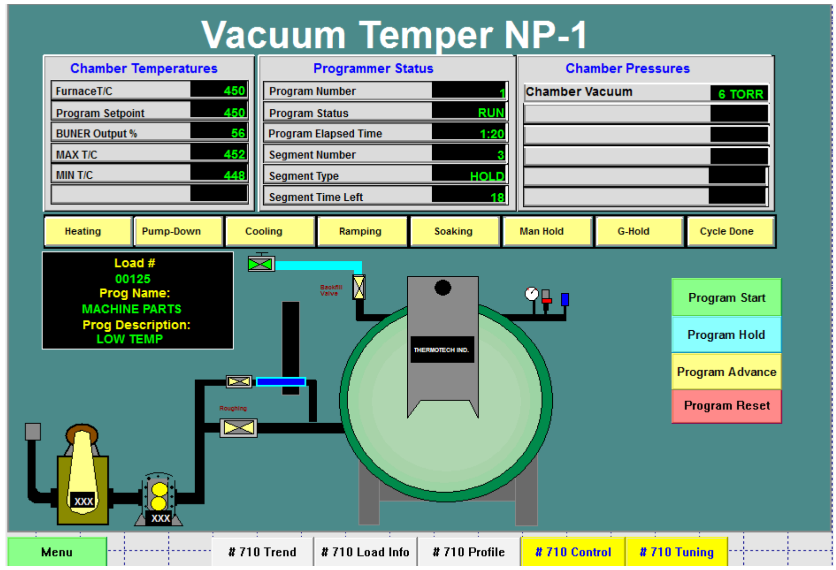
CONCLUSION

Overall, the new system has made processes more efficient and less manual, so Modern can track data more easily, and, in turn, produce better parts and help its customers.

"One of the things we pride ourselves on, when we sit down with a customer, is that we work to understand their processes so that we can find a solution to their problems," Dunn said. "Our goal is to develop a solution in a cost-effective manner. Not every customer may need the sophistication of the PLC system that we installed at Modern. We use controllers from multiple manufacturers: Watlow, Honeywell, Eurotherm, Future Design Controls, Yokogawa — to provide a solution to each specific customer's needs. A smaller customer might need another solution, so we offer a lot of options, depending on what the situation requires."

Once the installation was complete, Jageman said members of his crew were like kids at Christmas.

"They were excited about the upgrade and the changes — all of the new toys they have to play with and all the things that they wished they could do in the past, they are now able to do," Jageman said. "They couldn't wait for it to be complete. Everyone was very pleased to see the upgrade, and our customers are impressed. Every one that comes through here says it's state-of-the-art."



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Email: sales@premierfurnace.com

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Email: sales@whkay.com
Website: www.whkay.com

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257 Elmwood Ave #300, Buffalo, NY 14222
Phone: 905-877-5254 • Fax: 905-877-6205
Email: jmistry@parkthermal.com
Website: www.parkthermal.com

BATCH OVENS & BOX TEMPERING FURNACES

54" wide x 72" long x 84" high, Despatch Walk-In Oven Gas, 500 F. **REF #102**
8" 18" 8" Lucifer Elec. 1250 F. **REF #103**
12" 16" 18" Lindberg Elec. 1200 F. **REF #103**
12" 16" 18" Lindberg (3) Elec. 1250 F. **REF #103**
30" 48" 22" Dow Elec. 1250 F. **REF #103**
34" 19" 33" Poll.Ctrls Burnoff Gas 900 F. **REF #103**
36" 36" 35" Despatch Elec. 400 F. **REF #103**
36" 36" 120" Steelman Elec. 450 F. **REF #103**
36" 48" 36" Grieve Elec. 350 F. **REF #103**
36" 60" 36" CEC (2) Elec. 650 F. **REF #103**
37" 19" 25" Despatch Elec. 500 F. **REF #103**
37" 25" 37" Despatch Elec. 850 F. **REF #103**
37" 25" 50" Despatch Elec. 500 F. **REF #103**
38" 20" 24" Blue-M Elec. 1200 F. **REF #103**
38" 26" 38" Grieve Elec. 1000 F. **REF #103**
48" 24" 48" Blue-M Elec. 600 F. **REF #103**
48" 30" 42" Despatch Gas 850 F. **REF #103**
48" 48" 48" CEC (N2) Elec. 1000 F. **REF #103**
48" 48" 60" Gasmac Burnoff (2) Gas 850 F. **REF #103**
48" 48" 72" Despatch (2) Elec. 500 F. **REF #103**
48" 48" 72" Lydon Elec. 500 F. **REF #103**
54" 108" 72" Despatch Elec. 500 F. **REF #103**
56" 30" 60" Gruenberg Elec. 450 F. **REF #103**

BOX FURNACES

J.L. Becker Slot Forge Furnace, 1986, Brand New, Never Used **REF #101**
L & L Special Furnace Electrically Heated Box Furnace, 1991 **REF #101**
J.L. Becker Box Temper Furnace, 1989 **REF #101**
Sunbeam Electric Box Furnace, good running condition **REF #101**
Surface 30-48-30 Electric Temper Furnace, good/ very good condition **REF #101**
Atmosphere Furnace Co. 36-48-30 Electric Temper Furnace, good/ very good condition **REF #101**
Atmosphere Furnace Co. 36-48-30 Electric Temper Furnace, good/ very good condition **REF #101**
Atmosphere Furnace Co. 36-48-30 Electric Temper Furnace, good/ very good condition **REF #101**
Surface Combustion 30-48-30 Gas Fired Temper Furnace, good/ very good condition **REF #101**
Surface 30-48-30 Gas Fired Temper Furnace, good/ very good condition **REF #101**
24" wide x 48" long x 18" high, Lindberg batch temper, Gas, 1400 F. **REF #102**
30" wide x 48" long x 26" high, BeaverMatic batch temper, Gas, 1400 F. **REF #102**
8" 18" 8" Blue-M Elec. 2000 F. **REF #103**
12" 24" 8" Lucifer-Up/Down (Retort) Elec. 2150/1400 F. **REF #103**
12" 24" 8" C.I. Hayes (Atmos) Elec. 1800 F. **REF #103**
12" 24" 12" Hevi-Duty (2) Elec. 1950 F. **REF #103**
12" 24" 12" Lucifer-Up/Down Elec. 2400/1400 F. **REF #103**
3" 24" 12" Electra-Up/Down Elec. 2000/1200 F. **REF #103**
15" 30" 12" Lindberg (Atmos) - Retort Elec. 2000 F. **REF #103**
17" 14.5" 12" L & L (New) Elec. 2350 F. **REF #103**
22" 36" 17.5" Lindberg (Atmos) Elec. 2050 F. **REF #103**
24" 36" 18" Thermnlyne (2) - Unused Elec. 1800 F. **REF #103**
36" 48" 24" Sunbeam (N2) Elec. 1950 F. **REF #103**
36" 72" 42" Eisenmann Kiln (Car) Gas 3100 F. **REF #103**
60" 48" 48" Recco (1998) Gas 2000 F. **REF #103**
60" 96" 60" Park Thermal Elec. 1850/2200 F. **REF #103**
126" 420" 72" Drever "Lift Off"-Atmos (2 Avail) Gas 1450 F. **REF #103**
13" 14" 12" ELECTRIC 1300ºF **REF #104**
10" 10" 18" ELECTRIC 2000ºF **REF #104**
22" 36" 22" ELECTRIC 1600ºF **REF #104**
12" 6" 8" ELECTRIC 2000ºF **REF #104**
12" 8" 18" ELECTRIC 2800ºF **REF #104**
20" 13" 36" ELECTRIC 1850ºF **REF #104**
12" 18" 18" ELECTRIC 1250ºF **REF #104**
4" 10" 4" ELECTRIC 2000ºF **REF #104**
22" 10" 8" ELECTRIC - C/W STAND 1250-2000ºF **REF #104**
15" 8" 30" ELECTRIC - ATMOSPHERE 1950ºF **REF #104**
11" 11" 17" ELECTRIC - CABINET 2000ºF **REF #104**
33" 40" 48" ELECTRIC 500ºF **REF #104**
18" 18" 30" ELECTRIC - GLO BAR 2900ºF **REF #104**
30" 30" 54" ELECTRIC - AGING 500ºF **REF #104**
30" 30" 54" R ELECTRIC - AGING 500ºF **REF #104**
30" 30" 54" ELECTRIC 500ºF **REF #104**
24" 18" 24" NATURAL GAS - BATCH FURNACE **REF #104**
24" 18" 24" NATURAL GAS - BATCH FURNACE **REF #104**
36" 30" 84" ELECTRIC 1200ºF **REF #104**
24" 24" 24" ELECTRIC 2000ºF **REF #104**
29" 22" 36" NATURAL GAS 1250ºF **REF #104**
12" 11" 24" ELECTRIC - BOX 2000ºF **REF #104**
24" 24" 24" ELECTRIC - GAS MAC 850ºF **REF #104**
18" 12" 12" ELECTRIC 2100ºF **REF #104**
48" 30" 36" ELECTRIC - ATMOSPHERE TEMPERING **REF #104**
50" 24" 29" NATURAL GAS 1250ºF **REF #104**
36" 18" 24" ELECTRIC 1250ºF **REF #104**
17" 17" 36" NATURAL GAS 1250ºF **REF #104**
15" 6" 10" ELECTRIC 1850ºF **REF #104**
6" DIA 48" ELECTRIC - TUBE FURNACE 1200ºC **REF #104**
7" 4" 14" GAS **REF #104**
10" DIA 18" GAS - FORGE FURNACE **REF #104**
9" 6" 15" GAS - FORGE FURNACE **REF #104**
6" 6" 15" GAS - FORGE FURNACE **REF #104**
12" 10" 20" ELECTRIC - SPEEDY MELT FURNACE 2000ºF **REF #104**
12" 9" 18" ELECTRIC **REF #104**
12" 12" 18" NATURAL GAS 1250ºF **REF #104**
14" 14" 18" ELECTRIC - GLOBAR 2500ºF **REF #104**
17" 17" 17" ELECTRIC - HITEMP KILN 2200ºF **REF #104**
35" 24" 60" ELECTRIC 1430ºF **REF #104**
10" 9" 14" ELECTRIC - FRONT DOOR LOADING 2000ºF **REF #104**
12" 12" 24" ELECTRIC - 13KW 2300ºF **REF #104**
12" 12" 24" ELECTRIC - 20KW 2000ºF **REF #104**
18" 12" 24" ELECTRIC 2000ºF **REF #104**
36" 24" 56" ELECTRIC 800ºF **REF #104**
24" 24" 36" ELECTRIC - CYCLONE 1250ºF **REF #104**
24" 36" 30" ELECTRIC RE-CIRC. BOX FURNACE 2000ºF **REF #104**
18" 20" 45" ELECT. RE-CIRC. W/ FLAME CURTAIN & BASKET 2000ºF **REF #104**
12" 12" 18" ELECT. RE-CIRC. BATCH (MATCH PAIR WITH I3958) 1250ºF **REF #104**
12" 12" 18" ELECT. RE-CIRC. BATCH (MATCH PAIR WITH I3957.) 1250ºF **REF #104**

CAR BOTTOM FURNACES

Holcroft 48-144-48 Car Bottom Furnace **REF #101**
Sauder 48-144-48 Car Bottom Furnace **REF #101**
48" 48" 72" GAS FIRED CAR BOTTOM 2000ºF **REF #104**
130" 72" 216" GAS FIRED CAR BOTTOM 2000ºF **REF #104**
130" 72" 215" GAS FIRED CAR BOTTOM 2400ºF **REF #104**
108" 36" 192" GAS FIRED CAR BOTTOM 2400ºF **REF #104**
72" 48" 216" GAS FIRED CAR BOTTOM 2000ºF **REF #104**

CHARGE CARS

Surface Combustion 30-48 Charge Car (Double Ended), fairly good condition **REF #101**
Atmosphere Furnace Company 36-48 Charge Car (Double Ended) **REF #101**
Surface Combustion 30-48 Charge Car (Double Ended) **REF #101**

CONTINUOUS ANNEALING FURNACES

Wellman Continuous Mesh Belt Annealing Furnace **REF #101**
Aichelin-Stahl Continuous Roller Hearth Furnace & Conveying System, 1996 **REF #101**
Park Thermal Continuous Mesh Belt Furnace, 2005, Excellent Condition – New – Never been used **REF #101**

CONTINUOUS HQT FURNACES

Tokyo Gasden Ro Continuous Mesh Belt HQWT Furnace Line, 1989 **REF #101**

CONTINUOUS TEMPERING FURNACES

Surface Combustion Mesh Belt Temper Furnace **REF #101**
J.L. Becker Conveyor-Type Temper Furnace with Ambient Air Cool Continuous Belt, 1997 IQ Furnaces **REF #101**
Surface Combustion 30-48-30 Pro-Electric IQ Furnace **REF #101**
AFC 36-48-30 IQ Furnace with Top Cool **REF #101**
AFC 36-48-30 IQ Furnace **REF #101**
Surface Combustion 30-48-30 IQ with Top Cool, Excellent Condition, 2000 **REF #101**
Surface Combustion 30-48-30 IQ Furnace, Excellent Condition **REF #101**

DRAW TEMPER FURNACES

24" wide x 48" long x 18" high, Lindberg batch temper, Gas, 1400 F **REF #102**
30" wide x 48" long x 26" high, BeaverMatic batch temper, Gas, 1400 F (NEW) **REF #102**
18" 12" 30" ELECTRIC 1250ºF **REF #104**
16" 15" 12" ELECTRIC - BOX DRAW 1250ºF **REF #104**
36" 16" 24" ELECTRIC - BOX DRAW 1250ºF **REF #104**
12" 18" 16" ELECTRIC - BOX DRAW 1400ºF **REF #104**
30" 20" 48" ELECTRIC - BOX DRAW 1250ºF **REF #104**
24" 18" 36" NATURAL GAS ROLLER DRAW 1400ºF **REF #104**
30" 30" 48" NATURAL GAS 1200ºF **REF #104**
60" 40" 60" NATURAL GAS - DRAW FURNACE 800ºF **REF #104**
29" 16" 36" ELECTRIC - DRAW/TEMPER 1400ºF **REF #104**
54" 54" 150" ELECTRIC 900ºF **REF #104**
24" 18" 10 FEET ELECTRIC 500ºF **REF #104**
30" 24" 72" GAS - GRAVITY FEED DRAW 1350ºF **REF #104**
12" 14" 12" ELECTRIC - WATER COOLED FAN 1200ºF **REF #104**

ENDOTHERMIC GAS GENERATORS

Lindberg 1500 CFH Endothermic Gas Generator, 1992, good condition **REF #101**
Lindberg 1500 CFH Endothermic Gas Generator, 1996, excellent condition **REF #101**
Surface Combustion 5600 CFH Endo. Gas Generator **REF #101**
Surface Combustion 5600 CFH Endo. Gas Generator **REF #101**
Surface Combustion 5600 CFH Endo. Gas Generator **REF #101**
Surface Combustion 5600 CFH Endo. Gas Generator **REF #101**
Rolock Inc. 2000 CFH Endothermic Gas Generator **REF #102**

EXOTHERMIC GAS GENERATORS

J.L. Becker 12,000 CFH Exothermic Gas Generator w/ Dryer, w **REF #101**
Thermal Transfer 30,000 CFH Exothermic Gas Generator, 1994, excellent condition **REF #101**
Seco Warwick 2000 CFH Exothermic Gas Generator **REF #102**
Sunbeam 2000 CFH Exothermic Gas Generator **REF #102**
Alhern 6000 CFH Exothermic Gas generator **REF #102**
J L Becker 6000 CFH Exothermic Gas Generator **REF #102**
JL Becker 6000 CFH Exothermic Gas Generator **REF #102**

FLUIDIZING BED FURNACE

14” 30 DIA 5” ELECTRIC 1600°F **REF #104**

FREEZERS

Webber 36-48-36 Chamber Freezer, 1980 **REF #101**
Cincinnati Sub Zero 36-48-36 Chamber Freezer, 1995 **REF #101**

MESH BELT FURNACES

17” 8” 10’ ELECTRIC 600°F **REF #104**
23” 4” 10’ NATURAL GAS 1250°F **REF #104**
24” 12” 96” ELECTRIC 500°F **REF #104**

MESH BELT BRAZING FURNACES

Lindberg Continuous Mesh Belt Brazing Furnace **REF #101**
J.L. Becker 26” Mesh Belt Brazing Annealing Furnace, 2007 **REF #101**
10” J.L. Becker Mesh Belt Furnace with Muffle, 1988 **REF #101**
24” J.L. Becker Mesh Belt Furnace **REF #101**
Premier Furnace 14” wide mesh belt Aluminum Brazing Furnace 1400 F. **REF #102**
Alhern 20” wide mesh belt Copper Brazing, Annealing Furnace 2100 F **REF #102**
J L Becker 20” wide mesh belt Copper Brazing, Annealing Furnace 2100 F. **REF #102**
JL Becker 20” wide mesh belt Copper Brazing, Annealing Furnace 2100 F. **REF #102**
Alhern 28” wide mesh belt Copper Brazing, Annealing Furnace 2100F. **REF #102**

MISC. EQUIPMENT

Atmosphere Furnace Co. 36-48 Stationary Holding Stations, 1987, 36”W x 48”L work area **REF #101**
Atmosphere Furnace Co. 36-48 Stationary Holding Stations, 1987, 36”W x 48”L work area **REF #101**
Atmosphere Furnace Co. 36-48 Stationary Holding Stations, 1987, 36”W x 48”L work area **REF #101**
Atmosphere Furnace Co. 36-48 Scissors Lift Holding Stations, 1987, 36”W x 48”L work area **REF #101**
Atmosphere Furnace Co. 36-48 Scissors Lift Holding Stations, 1987, 36”W x 48”L work area **REF #101**
Surface Combustion 30-96 Stationary Load Tables, 96-inch rail length, 15-inch rail centers **REF #101**
Surface Combustion 30-96 Stationary Load Tables, 96-inch rail length, 15-inch rail centers **REF #101**
Surface Combustion 30-96 Stationary Load Tables, 96-inch rail length, 15-inch rail centers **REF #101**
Surface Combustion 30-48 Scissors Lift Table, 48-inch rail length **REF #101**
Airco Flo meter panel# 1 **REF #102**
Airco Flo meter panel# 2 **REF #102**
Smart Skim unit **REF #102**
8xxx 2.400 CFH 12 oz (2) North American 1/3HP **REF #103**
8xxx 3.000 CFH 12 oz (3) North American 1/2HP **REF #103**
8xxx 5.400 CFH 4 oz North American 1/3HP **REF #103**
8236 12.000 CFH 12oz (3) North American 1/2HP **REF #103**
8712 15.600 CFH 37 oz, North American 5HP **REF #103**
8193 19.500 CFH 32 oz, Spencer 5HP **REF #103**
8245 23.400 CFH 8 oz. North American 1,5HP **REF #103**
8185 24.000 CFH 24 oz. Buffalo Forge 7.5HP **REF #103**
8251 45.600 CFH 16 oz. Spencer 5HP **REF #103**
8252 66.000 CFH 24 oz . Snencer(New) 10HP **REF #103**
8253 66.000 CFH 24 oz. Spencer 10HP **REF #103**
8250 150.000 CFH 16 oz. Hauck 15HP **REF #103**

OVER - UNDER FURNACES

12” 11” 48” GLO BAR ELECTRIC 3000°F **REF #104**
9.5” 9.5” 18” COILED ELEMENTS ELECTRIC 2300°F **REF #104**
22” 11” 14” COILED ELEMENTS ELECTRIC 2200°F **REF #104**
12” 7” 30” ELECTRIC - CRESS **REF #104**
18” 12” 24” ELECTRIC 2100/1250°F **REF #104**
12” 12” 36” ELECTRIC 2300/1250°F **REF #104**

PARTS WASHERS

J.L.Becker Gas-Fired Tub Washer **REF #101**
48-72-48 Gas Fired Spray Washer **REF #101**
Dow Furnace Co. 30-48-30 Electrically Heated Spray, Dunk & Agitate Washer **REF #101**
Atmosphere Furnace Co. 36-48-30 Spray/Dunk Washer **REF #101**
Atmosphere Furnace Co. 36-48-30 Spray/Dunk Washer **REF #101**
Surface Combustion 30-48-30 Electrically Heated Spray Dunk/ Dunk Washer **REF #101**
Surface Combustion 30-48-30 Electrically Heated Washer **REF #101**

PIT FURNACES

Lindberg 28” x 28” Pit-Type Temper Furnace **REF #101**
14” 60” Procedyne - Fluidised Bed Elec. 1850 F. **REF #103**
16” 20” Lindberg Elec. 1250 F. **REF #103**
22” 26” L & N Elec. 1200 F. **REF #103**
28” 48” Lindberg Elec. 1400 F. **REF #103**
38” 48” Lindberg Elec. 1400 F. **REF #103**
40” 60” L & N -Steam/N2 Elec. 1400 F. **REF #103**
40” 60” Wellman-Steam/N2 Elec. 1400 F. **REF #103**
48” 48” Lindberg (Atmos) - Fan Elec. 1850 F. **REF #103**
20” 48” ELECTRIC 1200°F **REF #104**
30” 36” NATURAL GAS 1250°F **REF #104**
24” 30” ELECTRIC 1400°F **REF #104**
16” 18” GAS - CYCLONE 1300°F **REF #104**
28” 96” NATURAL GAS 1400°F **REF #104**
24” 28” ELECTRIC - HOMO CARBURIZING 1400°F **REF #104**
16” 30” ELECTRIC SALT POT 1650°F **REF #104**
22” 36” 22” ELECTRIC SQUARE PIT 1600°F **REF #104**
6” 4” 16” ELECTRIC VACUUM PIT 2400°F **REF #104**
24” 24” ELECTRIC 1400°F **REF #104**
12” dia 18” ELECTRIC - HOMO PIT 1200°F **REF #104**
30” 30” 30” ELECTRIC 800°F **REF #104**
30” DIA 30” ELECTRIC - PIT CYCLONE 1250°F **REF #104**
12” 20” ELECTRIC - KEYHOLE 1250°F **REF #104**
4.5” 24” 4” ELECTRIC - SQUARE PIT **REF #104**
24” 48” 24” ELECTRIC - SQUARE PIT 1200°F **REF #104**
18” 18” 18” ELECTRIC - TOP LOAD 2000°F **REF #104**
16” Dia. 20” ELECTRIC - CYCLONE 1250°F **REF #104**
22” Dia 26” ELECTRIC - CYCLONE 1250°F **REF #104**
22”Dia 26” ELECTRIC 1250°F **REF #104**
8”dia 9”deep ELECTRIC - TEMPERING 1250°F **REF #104**
35” 60” GAS **REF #104**
28”DIA 28” ELECTRIC - CYCLONE PIT 1250°F **REF #104**

VACUUM FURNACES

Brew/Thermal Technology Vacuum Furnace **REF #101**
Abar Ipsen 2-Bar Vacuum Furnace, 1986, good condition **REF #101**
24”W x 36”D x 18”H Hayes (Oil Quench) Elec. 2400 F. **REF #103**
48” Dia 60” High Ipsen (Bottom Load) Elec. 2400 F. **REF #103**

ATMOSPHERE GENERATORS

750 CFH Endothermic Dow Elec. **REF #103**
750 CFH Endothermic Insen Gas **REF #103**
1000 CFH Exothermic Gas Atmosphere **REF #103**
1000 CFH Ammonia Dissociator Lindberg Elec. **REF #103**
1000 CFH Ammonia Dissociator Drever Elec. **REF #103**
1500 CFH Endothermic (Air Cooled) Ipsen Elec. **REF #103**
1500 CFH Endothermic Ipsen Gas **REF #103**
3000 CFH Endothermic air Cooled) Lindberg Gas **REF #103**
3000 CFH Endothermic (Air Cooled) Lindberg (2) Gas **REF #103**
3000 CFH Endothermic (Air Cooled) Lindhera Gas **REF #103**
3600 CFH Fnclothermic (Air Cooled) Surface (2) Gas **REF #103**
3600 CFH Endothermic Surface Gas **REF #103**
5600 CFH Endothermic Surface (3) Gas **REF #103**
6000 CFH Nitrogen Generator (2000) Gas Atmospheres Gas **REF #103**
10 000 CFH Exothermic Seco-Warwick Gas **REF #103**

INTERNAL QUENCH FURNACES

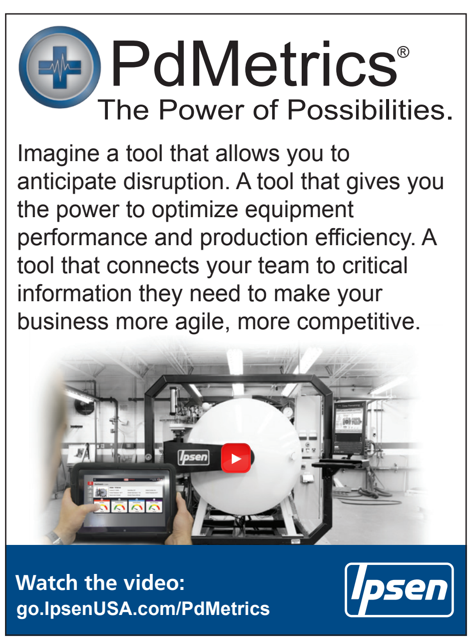
24 inch wide, 48 inch long, 18 inch high, Lindberg, Gas, 1850 F. **REF #102**
24”W 36”D 18”H Dow (Slow Cool) Line Elec. 2000 F. **REF #103**
24”W 36”D 1 8”H Ispen T-4 - Air Cooled Gas 1850 F. **REF #103**
24”W 36”D 18”H Ispen T-4 - Air Cooled Gas 1850 F. **REF #103**
24”W 36”D 18”H Isoen T-4 - Air Cooled Gas 1850 F. **REF #103**
24”W 36”D 18”H Ispen T-4 - Air Cooled Gas 1850 F **REF #103**
30”W 48”D 30”H Surface Allcase Elec. 1750 F. **REF #103**
30” 30” 48” NATURAL GAS 1750°F **REF #104**
12” 10” 24” ELECTRIC - BABY PACEMAKER 1850°F **REF #104**
45” 40” 72” ELECTRIC - ALUMINUM QUENCH 1250°F **REF #104**
12” 9” 18” IPSEN 2000°F **REF #104**
87” 36” 87” SURFACE COMBUSTION W/ 12,500G. QUENCH 1850°F **REF #104**
62” 36” 62” SURFACE COMBUSTION W/ 9,500G. QUENCH 1850°F **REF #104**
62” 36” 62” SURFACE COMBUSTION W/ 9,500G. QUENCH 1850°F **REF #104**
15” 12” 30” Electric c/w load carts 1850°F **REF #104**

CONTINUOUS/BELT FURNACES + OVENS

5”W 36”D 2”H BTU Systems (Inert Gas) Rec. 1922°F **REF #103**
12”W 48”D 2”H Lindberg (Inert Gas) Elec. 1022°F. **REF #103**
12”W 15’D 4”H Sargent&Wilbur’94(Mufflel) Gas 2100°F. **REF #103**
16”W 24’D 4”H Abbott-Retort (1996) Elec 2400°F. **REF #103**
24”W 12’D 6”H Heat Industries Elec. 750°F. **REF #103**
24”W 40’D 18”H Despatch Elec. 500°F. **REF #103**
60”W 45’D 12”H Roller Hearth Annealer (Atmos) Gas 1700°F **REF #103**

MARKETPLACE

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



AD INDEX

> "We believe we offer world-class engineering. Our products are superior, very robust. We have excellent service after the sale"

WHAT IS ABBOTT FURNACE'S MISSION?

Our mission is to be the market leader in the design, production, and service of continuous process industrial furnaces. And we do that by focusing our resources on the development of new technology to meet our customers' specifications.

CAN YOU TOUCH ON HOW ABBOTT FURNACE BEGAN?

We began in 1982 as Abbott Controls and Fabricating. And primarily what they did back then was build control panels and did calibrations and service work for other furnace manufacturers. Our owner at that time realized that there wasn't much being done in furnace development and improvements, so in 1986, we manufactured our first furnace. As of today, we have over 800 furnaces installed and working in the field. We were and still are privately owned and operated. In 2014, ownership changed from Tom Jesberger and Jeff Marzella to our current owner, Ed Gaffney.

The next big thing that happened to us was that in 2016 we bought the intellectual property of Drever Furnace Company, and we have fully integrated that into Abbott now, so we can offer all of their products as well as our own products. And then, earlier this year, we started Abbott De Mexico, which is our Mexican division. Our goal is not to manufacture there, but it's strictly to provide service and technical sales support in the Mexican market.

WHAT PRODUCTS AND SERVICES DOES ABBOTT FURNACE OFFER?

As far as services go, we provide atmosphere and furnace troubleshooting field service work and calibrations. We're also set up to provide off-site training on our equipment for thermal processes that may be required. We can help people understand everything they need to do as far as what's going on in a furnace, whether it's a powdered metal sintering operation, we're very familiar with all the processes. So we can help educate customers on that.

As far as equipment goes, primarily we produce continuous process furnaces. We produce sintering furnaces for the powdered metal world, brazing furnaces for all types of brazing applications from aluminum to copper to carbon steel right up to stainless steel. We also build pusher furnaces that go up to 2,900 degrees Fahrenheit. With the addition of Drever product lines, we also have roller hearth furnaces, strip annealing furnaces, and applications like that. We do heat-treat furnaces. We also do lab furnaces. We're able to manufacture atmosphere generators. And we do some specialized equipment like batch, box, and car-bottom furnaces that are a little bit outside the normal market. Normally, they have some special requirement, but we do build those as well. And we do a lot of ancillary equipment, just about any kind of custom fab you may need, anything furnace related, parts accumulators, parts washers, things like that.

WHAT ARE SOME OF ABBOTT FURNACE'S PROUDEST ACHIEVEMENTS?

We designed and produced two munitions neutralization ovens for a Department of Defense contractor. That was a complete design certification install. It was quite a big task. We also are ISO 17025 accredited as a calibration lab. And we've had that certification now for 15-plus years.

One of the other things we're pretty proud of is we've designed and developed several furnaces to manufacture solid-oxide fuel cells. We're a market leader in the powdered metals industry, and we're a leader in the stainless steel brazing technology as well on continuous furnaces. We have a very robust cost-effective product for that market.

We did acquire Drever Furnace Company intellectual property, and we have fully integrated that into the Abbott product line.

WHAT SETS ABBOTT FURNACE APART WHEN IT COMES TO WHAT YOU CAN OFFER A CUSTOMER?

We believe we offer world-class engineering. Our products are superior, very robust. We have excellent service after the sale, and we design our furnaces to help our customers achieve the lowest cost of ownership possible.

HOW IS ABBOTT FURNACE PREPARING FOR THE FUTURE OF FURNACE MANUFACTURING DURING THE NEXT 10 YEARS?

We try to recruit, train, and develop new engineers and technicians with the latest technology. We focus on continuous improvement of our people, our processes, and our products to meet the ever-changing thermal processing market.

We also try to integrate the best technology into our equipment to make it energy efficient and to reduce atmospheric costs. And we're constantly striving to stay current on all the latest technologies to allow us to adapt to our products. And by technologies, I mean what's going on in the world, what markets are changing, and what our customers are doing to try and advance. So we have to try and stay up to date on everything they're doing as well and all the fields that we play in.

FOR MORE INFORMATION, go to www.abbottfurnace.com

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