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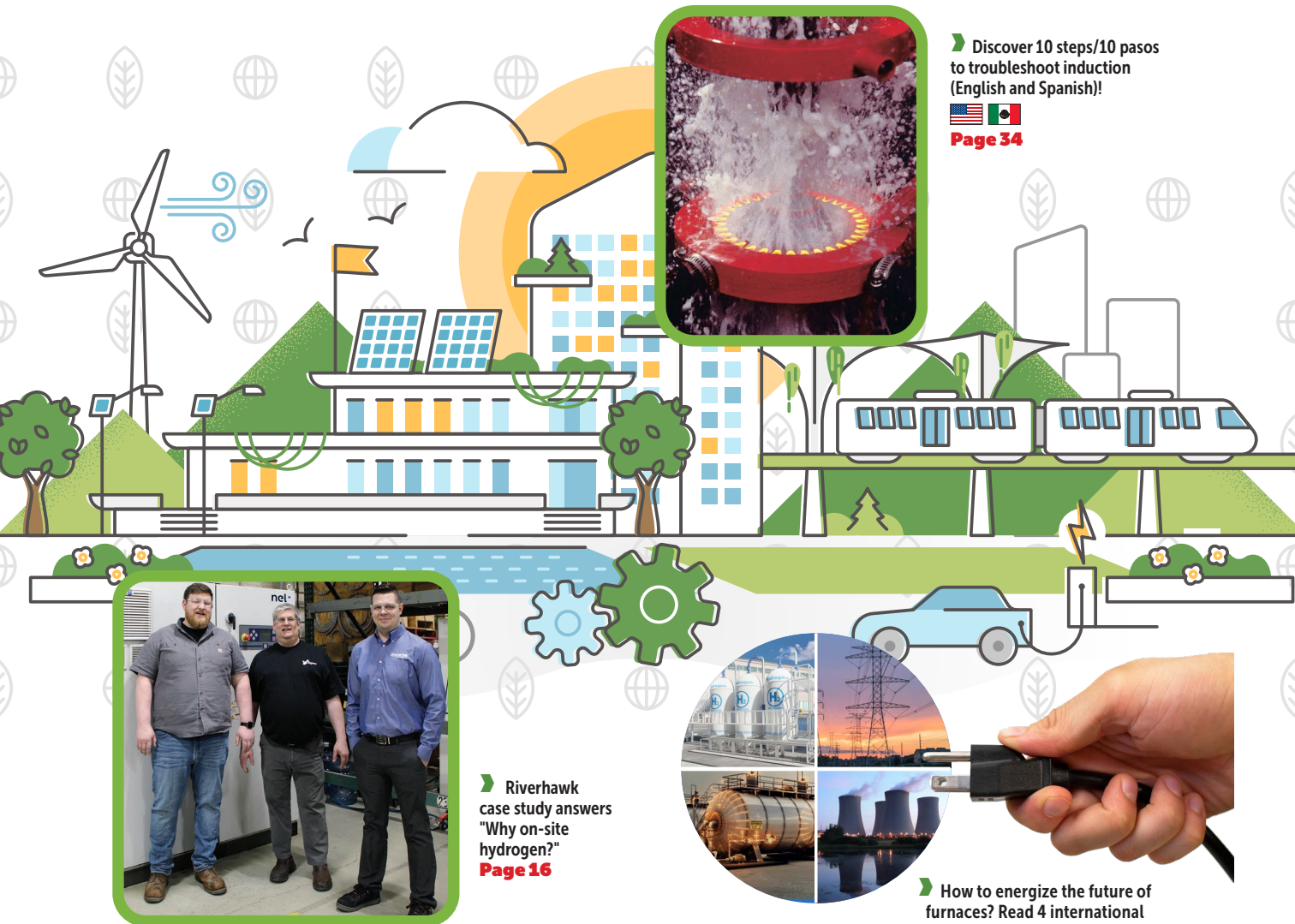
VOLUME 6 • NO. 3 **MAY 2023**

Heat Treat Today

Technology, Tips & News for Manufacturers with In-House Heat Treat

Focus on Sustainable Heat Treat Technologies



Discover 10 steps/10 pasos to troubleshoot induction (English and Spanish)!

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Riverhawk case study answers "Why on-site hydrogen?"

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How to energize the future of furnaces? Read 4 international expert perspectives.

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PURPOSE/VISION/MISSION

"We believe people are happier and make better decisions when they are well informed."

The Lord's loving kindnesses indeed never ceases,
For His compassions never fail.
They are new every morning;
Great is Your faithfulness.
Holy Bible, Lamentations 3:22-23

VOLUME 6 • NO. 3

May 2023

Columns

P8 COMBUSTION CORNER

Improving Your Use of Radiant Tubes, Part 4

This series has explored the geometry of a tube, why radiant tubes matter, what happens inside the tube, and radiant tube control systems. This month, we will continue our discussion of different modes of control for radiant tube burners.

By John Clarke, Technical Director, Helios Electric Corporation

P55 SUSTAINABILITY INSIGHTS

New Sustainability & Decarbonization Initiatives for Heat Treat

Searching for sustainability resources? In this first installment of the Sustainability Insights series of columns, learn from the Industrial Heating Equipment Association (IHEA) about resources available to in-house heat treaters across the industry.

By IHEA Editorial Team

P56 CYBERSECURITY DESK

What Should Heat Treaters Be Doing NOW?

Determine if CMMC applies to your business, learn about what changes were made to CMMC 1.0., know what you should be doing NOW to prepare for CMMC 2.0., and more.

By Joe Coleman, Cybersecurity Officer, Bluestreak Consulting™

P57 News from Abroad

In this issue, sample the new and the old: a brand new EAF furnace in Canada, a 50-year-old blast furnace in Germany, and new 3D tech. Also read about skyrocketing profits for one international company.

Departments

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P6 Editor's Page: Digitalization: An Ever-Expanding Frontier

P10 News Chatter The latest in equipment, personnel, company updates, and kudos from around the industry.

P58 Heat Treat Shop Manufacturers with in-house heat treat departments can buy or sell heat treat components, parts, services, and supplies.

P60 MTI Member Company Profile Get to know fellow heat treat manufacturers in MTI.

Features

P14 Upfront Planning: What To Expect with Induction Design and Fabrication

Induction heat treating: no harsh chemicals, gases, or even CO_2 emissions. Consider these five important factors before you dive into an induction design project.

By John Chesna, General Manager, Induction Tooling, Inc.

P16 On-Site Hydrogen Generation Essential for Riverhawk Company's Heat Treat Operations

Examine questions of hydrogen safety, price-point, and storage vs. delivery in this case-study with Riverhawk Company's in-house heat treat operations, and learn how they met stringent production requirements by leveraging on-site hydrogen and a hydrogen furnace.

By Marie Pompili, Freelance Writer

P19 Energizing the Future of Furnaces — 4 Perspectives

Heat Treat Today and media partner Furnaces International bring to you heat treat and energy insiders from around the world to review current technology investments and future energy opportunities that in-house heat treaters should consider when energizing the future of furnaces.

By Heat Treat Today Editorial Team and Furnaces International Editorial Team

P29 13 Induction and Sustainability Tips

Discover new tips, tricks, and resources for sustainable heat treating methods. And if you're looking for tips on combustion, controls systems, or induction in general, you'll find that, too!

By Heat Treat Today Editorial Team

P34 10 Steps To Troubleshoot Your Induction System

Nikola Tesla said, "If you want to find the secrets of the universe, think in terms of energy, frequency, and vibration." This 10 step guide will help in-house heat treat operators understand the secrets of induction and solve common problems that may arise.

By Alberto C. Ramirez, Power Supply and Automation Engineer, Contour Hardening, Inc.

10 pasos para solucionar las fallas en un equipo de inducción

Nikola Tesla afirmó <<Si quieres descubrir los secretos del universo, concéntrate en la energ'a, la frecuencia y la vibración.>>

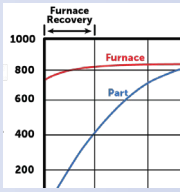
Los 10 pasos de esta guía servirán para apoyar a los operadores de departamentos internos de tratamiento térmico en entender los secretos de la inducción para así identificar posibles escollos en tales sistemas y dar solución a problemas comunes que se puedan presentar.

Por Alberto C. Ramirez, Power Supply and Automation Engineer, Contour Hardening, Inc.

P42 Induction Through Heating + Intensive Quenching: A "Green Ticket" for Steel Parts

Can an alternative heat treat approach that combines induction through heating and intensive quenching be the "green ticket" to avoid on-site carbon emissions?

By Edward Rylicki, Vice President, Technology, and Chris Pedder, Technical Manager Heat Treat Products and Services, at Ajax TOCCO Magnethermic Corp., and Michael Aronov, CEO, IQ Technologies, Inc.



P46 Sustainable Spotlights

"Heat Treat Today and the North American heat treating industry have had a long-term commitment to being environmentally responsible. Specifically, this publication is committed to caring for the earth — to exercise dominion and subdue it in the most stewardly way possible." — Heat Treat Today Publisher Doug Glenn. Find environmentally responsible, market-driven technologies in the following pages.

Doug Glenn, *Publisher*
Heat Treat Today

Letter from the Publisher

Is Sustainability Sustainable?

I have this gnawing question about the sustainability movement: Is sustainability sustainable? I realize it is heresy to question the "reality" of sustainability, but let's take a moment and do an honest (albeit, brief) assessment of how we got here, how the current crisis differs from previous crises, and what human nature tells us about the real driver behind this movement. While it is the responsibility of humans to be good stewards of the environment, there seem to be other motives driving current concerns for our Earth.

How We Got Here

The current sustainability movement is one in a class of catastrophic, world-ending theories that have reared their heads throughout history. Past examples include an impending ice age (1960's); a devastation of society due to the imminent loss of fossil fuels (early 1970's); Luddite predications of the fall of mankind due to the takeover of machinery, automation, or now, artificial intelligence; and persistent Malthusian predictions of the inevitable destruction of the world due to overpopulation.

The perceived oversupply of carbon dioxide is at the core of our current crisis — more precisely, carbon dioxide produced as a result of man's quest to "fill the earth and subdue it."

How the Carbon Crisis Differs from Other Crises

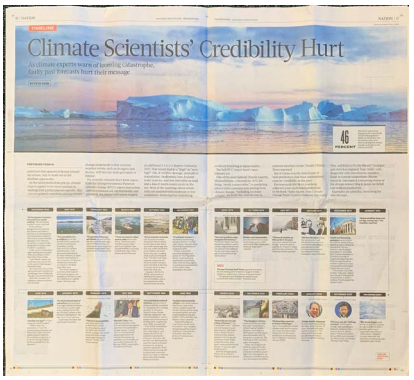
There are at least two specific ways that the carbon crisis differs from other crises.

The current crisis is perplexing because CO_2 — a naturally occurring substance that all humans and animals exhale — heretofore has been considered an inert, inconsequential environmental compound. Now, the entire civilized world is fixated on reducing carbon.

The second difference between this and previous crises is the unanimity that this crisis has produced. Thanks to the interconnectedness of the world by means of never before present communication channels like 24-hour cable news, social media, and international governmental and non-governmental cooperation, the idea of carbon as the world's nemesis has been more widely and more quickly accepted than any other crisis in the past.

The Real Driver

A solid understanding of human nature helps us understand the real driver behind the current crisis. Two quick stories to illustrate. . .



The negative perception of climate predictions was recently covered in an Epoch Times article released on Wednesday, March 29, 2023: "Experts Issue New Climate Warnings, But Past Forecasts Hurt Credibility."

RemTEC Summit

When I was employed by BNP Media and the publisher of *Pollution Engineering*, we started an environmental remediation event in cooperation with Georgia Tech called RemTEC Summit. At the very first event, we invited a high-level EPA official as a luncheon keynote speaker. The luncheon attendees were interested in what he had to say, but the room really came to life when he started talking about how much money the EPA planned to spend on remediation, on what they were going to spend it, and how best to get your cut! The money grab could not have been any more obvious.

A Recent "Nameless" Industry Meeting

In mid-March of this year, I attended a thermal processing industry meeting and saw much of the same thing. The vast majority of the meeting was spent talking about "sustainability" mostly in terms of CO_2 reduction and the replacement of hydrocarbon combustion with hydrogen combustion. At the end of the meeting, one of the participants gave an impromptu and impassioned talk about the inexorable march of sustainability and encouraged everyone to get on board because "it is coming." The person then commented that "trillions and trillions" of dollars would be thrown at this problem and concluded with this analogy (my paraphrase): I see the sustainability movement as a huge conveyor belt full of money, and all I want to do is be beside that belt grabbing my fair share.

This is the reality. People are lining up behind the sustainability movement regardless of whether they truly believe in the "science" that CO_2 is good or bad for the world. I wonder just how many people would be talking about sustainability if world governments were not throwing "trillions and trillions" of dollars at it. I'm looking forward to the day when the conveyor belt of taxpayer money dries up and we return to a more market-driven approach to environmental responsibility where trillions and trillions of consumers funnel money into sustainable technologies they believe most beneficial by purchasing products and services consistent with their sustainability beliefs. HTT

Chart a Better Course for your Induction Process!

Production Ready Inductor

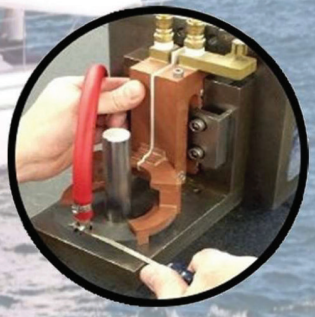
Metallurgical Report

Customer Specification

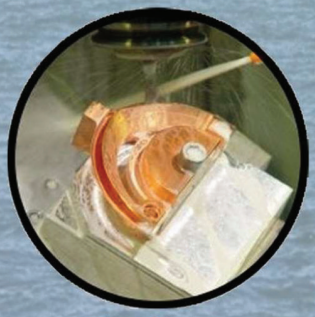
Metallurgical Evaluation

3D Design

Lab Development



Assembly



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SCAN ME!

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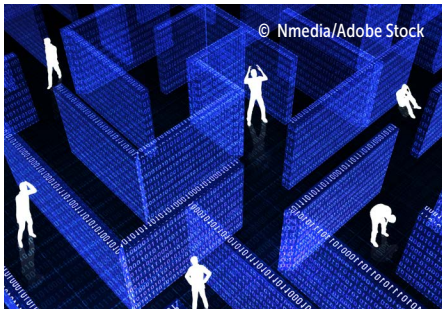
Message from the Editor

Digitalization: An Ever-Expanding Frontier

Bethany Leone, Managing Editor
Heat Treat Today

In order to create a more sustainable future for heat treaters, operators may be looking to "digitalization" as an immediate step for their heat treat systems. Digitalization is an amorphous term that can describe a few things.

One definition of digitalization curated for the heat treat industry is: the integration of advanced digital technologies (like cloud technologies, 3D visualization, simulation, analytics and collaboration tools, and even robotics) with heat treat equipment and all other aspects of production (order fulfillment, certifications, communication systems, etc.) to create a "digital twin" — that is, a holistic virtual representation of heat treat operations. By transitioning analog data and manual operations to a digital system, the end goal of creating a "digital twin" of all heat treat operations can be actualized, allowing heat treaters to monitor and analyze in real-time and create simulations and predictions about equipment performance.



This term tends to be broader than just "digitization" — the act of digitizing analog technologies to digital form — though the two terms are often used interchangeably.

An interest in digitalization makes a lot of sense. For one, updating manufacturing plants with digital practices is a huge draw for young people: "People want to work for a technologically advanced company that they can feel good about," according to Josh Hale, managing recruiter at International Search Partners, when he spoke on **Heat Treat Radio**. Additionally, Covid-19 labor constraints accelerated adoption of IIoT (industrial internet of things) technologies — digitalization being just one of many. But there are also several intrinsic promises that digitalization has to offer manufacturers, for example:

1. **Efficiency:** creating efficient operations that streamline business processes
2. **Accuracy:** increasing accuracy by achieving precise control over temperature, atmosphere, and other process parameters
3. **Data and Analytics:** real-time monitoring/data collection and rapid data analysis
4. **Safety:** reduced need for manual interventions, thus avoiding accidents and improving operator safety

From a sustainability perspective, digitalization means heat treaters can monitor, analyze, predict, test, and adapt *energy* efficiencies in their operations. This magazine features a conversation with experts in heat treat with an eye for energy, and they've commented on this specific topic. "With higher computational capacity on the controllers on a per furnace basis," John Clarke, technical director at Helios Electric Corporation notes, "we have the ability to start executing real-time analysis on the furnace and potentially implement a thermodynamic model of the furnace and how it's operating." Several representatives from Watlow illustrate this point: "Poor thermal uniformity can lead to scrap and rework of material, which both result in excess energy consumption." Read the ten-page conversation with six international expert contributors on page 19.

But there are drawbacks to adopting this new technology, and in the midst of all of this "good," I do wonder how difficult this transition has been — or can be — for some in-house heat treaters. Challenges when considering this technology include:

1. **Initial Investment.** The initial investment in new technology is always present, and so is the question of who will "dish out the dough." Will the furnace supplier try to absorb upgrading expenses? Or does it fall to the end-user buying the furnace or upgrade?
2. **Operational Complexity.** However easy to operate a technology is now, it was not always the case. I once thought typing at a computer was the most difficult thing in the world. Now, I'm so familiar with a keyboard that I can look over at my husband texting on his phone and *know* (to a degree) the message he is typing, just by watching his thumb position. What skills does your team have to learn a new system? How much time will it take to train 50%–75% of them? How long until you feel confident in the process?
3. **Overdependence on Technology.** We depend on digital technologies for many things (thank you, alarm clocks!), but is the level of dependence compromising something valuable? And to what degree? When it comes to cybersecurity threats, for example, what type of dependence on technology exposes you to more risk versus fortifying your internal systems?

The promises and challenges of digitalization will continue to face-off in offices and plant floors. While the boundary line of digital acceptance may shift, this new frontier towards creating "a holistic virtual representation of heat treat operations" means new technologies and processes that will be tested and adopted by heat treat pioneers, possibly you.

As with any frontier, there are known and unknown dangers. Let us know how your company is considering digitalization and what opportunities are golden nuggets or simply fool's gold: *editor@heattreattoday.com*.

Special thanks to Mike Löpke (head of software & digitalization at Nitrex Metal) and Jeffrey Halonen (CEO of Steelhead Technologies) for their insights. HTT

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COMBUSTION CORNER

Improving Your Use of Radiant Tubes, Part 4

John Clarke, Technical Director, Helios Electric Corporation

In previous months, this series has explored the geometry of a tube, why radiant tubes matter, what happens inside the tube, and radiant tube control systems. For the first three installments, check out Heat Treat Today's digital editions in November 2022, December 2022, and February 2023. This month, we will continue our discussion of different modes of control for radiant tube burners.

High/low and on/off controls require different control strategies from a proportional mode of control. In all cases, we assume the temperature control will be provided by a proportional-integral-derivative loop (PID loop). The function can be provided by a stand-alone instrument or a PID function in a programmable or process controller. The PID algorithm looks not only at the temperature of the process as indicated by the control element (thermocouple or RTD) and compares it to the setpoint — but it also considers the offset and rate of change as well. When properly tuned, a PID control loop can provide control accurate enough to match the process (actual) temperature to the setpoint within a degree or two.

For the lay person, another way of describing a PID loop is to consider how a driver regulates the speed of his automobile. Assume you are driving and want to catch up with and follow the car ahead of you — to do so, you need to match that car's speed and maintain a safe distance. What you don't do is floor the automobile until you get to the desired following distance and then hit the brakes. What you do is first accelerate to a speed faster than the target car to close the gap, then you instinctively take your foot off the accelerator when you get close, slowing gradually until your speed and position are as you desire. In this example, you have considered your speed, how close you are to the car you are attempting to follow, and the rate at which you are closing the gap. A PID loop is nothing more than a mathematical model of these actions.

The PID control loop provides an output — the format can vary, but it is in essence a percent output. It is a percent of the maximum firing rate the system needs to provide to achieve and maintain the desired furnace temperature. This percent output can be translated directly into a proportional output for proportional control — where the firing rate is proportional to the loop's output.

On/off or high/low controls require a different approach where a time proportioning output is provided in which the burner fires on and off on a fixed time cycle. In this mode of control, the PID loop's output is multiplied by the cycle time to determine the on or high fire period and the on or high fire time is subtracted from the cycle time to determine the off or low fire period. Cycle times can run from as little as 30 seconds to as much as a few minutes. Obviously, the shorter the cycle time, the more responsive the control, but also the more wear on the control components. The cycle time should be as long as possible but still meet the needs of the process control.

Don't confuse these pulses with other control methods that are marketed as pulse firing. When people speak of pulse firing, they often mean a pattern with alternate burners firing to provide greater temperature uniformity and heat transfer. This is a very interesting subject and the topic for another day. HTT

"You have considered your speed, how close you are to the car you are attempting to follow, and the rate at which you are closing the gap. A PID loop is nothing more than a mathematical model of [this] action."

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Heat Treat Today News Chatter

Business briefs from around the industry

A Few Dozen Quick Heat Treat News Items To Keep You Current

Heat Treat Today *is pleased to highlight the announcements of heat treat-related growth and achievement throughout the industry by sharing them in* ***News Chatter****, where we feature representatives, transactions, moves, and kudos from aerospace, automotive, medical, energy, and other sectors of manufacturing. Here are just a few of the news items that appeared in the* **Heat Treat Daily** *during the past few months as well as "new" news items.*

Subscribe to the **Heat Treat Daily** *e-newsletter at heattreattoday.com/subscribe and receive one to two news items from around the heat treat industry five days a week. Submit your news items to editor@heattreattoday.com.*

EQUIPMENT CHATTER

› A **FedDev Ontario** investment of over $9 million is helping **Cyclone Manufacturing Incorporated** (Cyclone) to add a heat treatment oven at its Milton, Ontario facility.

Cyclone with new heat treatment oven

› A leading manufacturer of shopping carts and display cases will be using an **L&L Special Furnace Co., Inc.** heat treating and tempering furnace.

L&L Special Furnace Co., Inc. furnace for shopping cart manufacturer

› **Solar Atmospheres**, using a furnace from **Solar Manufacturing**, provided two Ohio companies with two large vacuum heat treated H13 extrusion dies.

Extrusion dies for Ohio companies

› **thyssenkrupp Steel** is using modern regenerative burners from **WS Wärmeprozesstechnik GmbH** in its newest hot-dip galvanizing line 10.

Radiant tubes in galvanizing line

› **Nordic Traction Group**, a manufacturer of traction chains and tracks for forestry and agricultural machinery, installed an EndoFlex™ S gas generator system from **UPC-Marathon**, a **Nitrex** company.

System for carburizing traction chains

› Twin convection furnace systems for tempering were supplied to **Winston Heat Treating** from **DELTA H®**.

Twin convection furnaces for tempering

› **Solar Atmospheres Souderton, PA** installed a furnace for reclamation of titanium and tantalum materials with **Solar Manufacturing's** vacuum furnace technology.

Vacuum furnace for materials reclamation

› **L&L Special Furnace** delivered a highly uniform box furnace to a distributor of equipment to maintenance repair and overhaul (MRO) facilities located throughout the world.

Box furnace for equipment distributor

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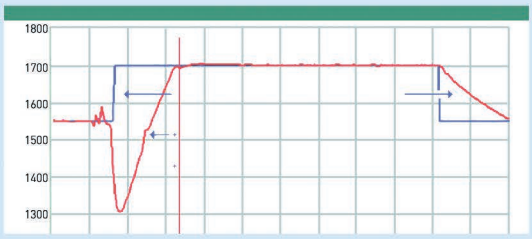

Temperature Control Chart

SSi's e-Trim technology is a sustainable solution for industrial combustion processes, which helps businesses reduce their carbon footprint while increasing efficiency and fuel savings.

The technology is designed to optimize combustion processes in real-time by using a precise monitoring system that checks and alarms on the air-to-fuel ratio. This results in more efficient combustion and reduced emissions.

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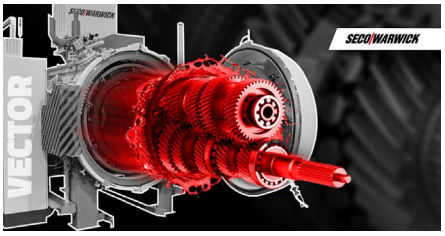
› **Solar Manufacturing** recently delivered a Mentor® vacuum furnace to a commercial heat treat facility in Eastern PA.

Furnace for vacuum heat treat and gas quench

› **voestalpine High Performance Metals del Perú** recently added a **NITREX** pit-type furnace for nitriding and nitrocarburizing a wide range of components made from high-performance steels.

New pit-type furnace for voestalpine High Performance Metals del Perú

› An international organization in the field of industrial automation has ordered a **SECO/WARWICK** heat treatment system (two Vector® vacuum furnaces, an atmosphere furnace, and a washer) with the goal of establishing a captive hardening plant within their machine park.



Heat treatment system for industrial automation

› **Lindberg/MPH**, a manufacturer of heat treat furnaces and nonferrous melting and holding equipment, shipped an electrically heated, steam atmosphere pit furnace for steam treating parts.

Steam atmosphere pit furnace

COMPANY/PERSONNEL CHATTER

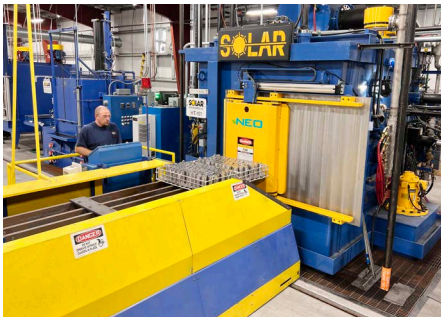
› **Víctor Zacarías** from **GTS Academy** hosted a webinar in Spanish in February on "CQI? Sección 3: Pirometría." He is one of **Heat Treat Today's 40 Under 40 Class of 2022** honorees.

Víctor Zacarías with a webinar in Spanish

› **AMETEK — Newage Testing Instruments**, an established manufacturer and worldwide supplier of hardness testers and accessories, announced the launch of its improved Brinell Optical Scanning System, B.O.S.S.

Brinell Optical Scanning System

› **Solar Atmospheres of Western PA** announced the approval of a critical Boeing specification for the oil quenching of alloy steels in accordance with Boeing's specification BAC 5617.



Boeing specification for Solar Atmospheres of Western PA

› **Advanced Heat Treat Corp.**, a provider of heat treat services and metallurgical solutions, announced the promotion of **John Ludeman** to vice president of Operations.

John Ludeman, new VP of Operations for Advanced Heat Treat Corp.

› **Wisconsin Oven Corporation**, a manufacturer of industrial ovens, has appointed **Jeff Kent** to the position of general manager.

General manager at Wisconsin Oven Corporation, Jeff Kent

› **Centorr Vacuum Industries** announced that it has promoted **Randy Fellbaum** to the position of chief operating officer.

› **Edgewater Capital Partners**, a private equity firm, has acquired **NeoGraf Solutions, LLC**. NeoGraf is a designer, formulator, and manufacturer of specialty natural graphite products for a diverse set of end markets, headquartered in Lakewood, Ohio.

› **Ipsen USA** announced the return of **Pete Kerbel** in the role of sales representative/Midwest regional sales owner.

Sales Representative/Midwest Regional Sales Owner, Pete Kerbel

› **NUTEC Group** has announced effective February 1, 2023, **Genaro F. Cueva** will step down from the position of CEO, remaining in his position as Chairman of the Board. He will be replaced as CEO by **Daniel Llaguno**, currently president of Nutec Fibers Division.

Daniel Llaguno, CEO of NUTEC Group

› **Bastian Barthel** has joined the **AMPOWER** team as the new lead consultant of sinter-based additive manufacturing technologies.

› **Aalberts surface technologies - specialized heat treatment US** and **Aalberts surface technologies - accurate brazing** announced they have merged into a single business unit. The combined companies now operate as **Aalberts surface technologies - HIP | braze | heat treatment**.

› **Hubbard-Hall** welcomes **David Keller** as senior chemist.

David Keller, senior chemist at Hubbard-Hall

› The **Plibrico Company** has launched an industry first: a field enabling QR code platform. These field enabling QR codes provide information that extends well beyond what might be printed on the refractory packaging or labels.

› **Pfeiffer Vacuum** celebrated the groundbreaking of a new state-of-the-art industrial complex at Berliner Strasse in Asslar in Germany.

Groundbreaking of new industrial complex

KUDOS CHATTER

› **Fluke** celebrates 75 years of continuous innovation, putting its customers first, and supporting its communities. The company honors **John Fluke's** legacy.

"Always give the customer a little bit more than they paid for." – John Fluke

› **Gasbarre Products, Inc.** recently marked its fiftieth anniversary. The company was founded in 1973 by **George Gasbarre Sr.**, in Falls Creek, PA, USA.

50 years for Gasbarre Products, Inc.

› Congratulations to five additive manufacturing scholarship recipients as part of the Women in 3D Printing TIPE Conference! **Andrew Duffield**, **Shivani A**, **Raveeshankar Sambathkumar, Liza Allison**, and **Shayla Anthony**.

Scholarship winners at Women in 3D Printing TIPE Conference

› The **Plibrico Company's** employees came together from Ohio to Washington (including New York, Indiana, and Florida) to volunteer their time and creativity to make handmade cards for **Cards for Hospitalized Kids**.

Plibrico Company with Cards for Hospitalized Kids

Upfront Planning: What To Expect with Induction Design and Fabrication

By John Chesna, General Manager, Induction Tooling, Inc.

Induction heat treating: no harsh chemicals, gases, or even CO_2 emissions. But to get there, heat treaters should first understand how to plan for an induction design and fabrication project upfront. Consider these five important factors before you dive into induction.

Introduction

There are many less than obvious factors to consider when preparing and planning for induction. So where to start? There are five important factors that manufacturers with in-house heat treat operations should understand in order to successfully prepare an induction heating project and design.

But first, what is induction heating? Induction heat treating is the process in which a high frequency conductor (induction tool) induces currents (eddy currents) into an electrically conductive workpiece. Without ever touching the workpiece, the current generated and the resistance causes heating. Ever since its proven usefulness around the time of World War II, induction has been chosen as the go-to heat treatment for a variety of applications across many industries including agricultural, medical, and transportation. Now, it seems that most industries have taken advantage of induction heat treating, and its popularity will likely only continue to increase with the push for the use of "clean" and "green" energy.

#1 Plan for Inductor Wear

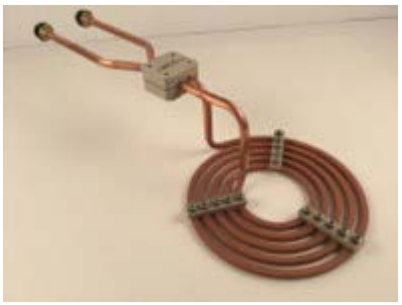
One of the most important factors to an induction project is realizing the inductor/coil is a wear item. It can be highly engineered, hand fabricated, machined, or even 3D printed. Yet, in the overall process, it is still a wear item: an item that will eventually require replacement or repair. The inductor is exposed to the worst of the elements during the induction process and can fail from standard use, accidents, or unforeseen circumstances. Inductor designers are constantly being challenged to create tools that will last longer, require less maintenance, or run more cycles. All of those can be achieved, but the inductor will eventually require replacing and *that is not a bad thing*!

A properly serviced and maintained inductor will ensure quality parts are being produced. As the inductor wears, the efficacy degrades, leading to undesirable results. Repair of the inductor will correct this issue and ensure the parameters required for the desired heat treat pattern are restored. Depending on production needs, a good principle is to have more than one inductor on hand so that while one is being repaired the spare inductor can remain on the machine to keep up with manufacturing demand. Planning for this is important for the project's timing and budget.

#2 Types of Inductor Designs

Determining a specific inductor design will be necessary to properly heat parts. The inductor creates the magnetic field in the workpiece, and typically the inductor is shaped to couple closely where heat treatment of the part is desired. Additionally, if quenching is required for the heating application, this function will be considered in the inductor's design. The inductor's design must deliver the electrical energy and quench medium to the workpiece while allowing accessibility for material handling purposes. For this reason, inductors take on many different designs. Common inductor designs include:

- Pancake: used for heating flat surfaces
- Single turn or multi-turn: commonly shown as copper tubing wrapped cylindrically around the workpiece
- Hairpin: typically, a simple back and forth loop used to heat long lengths internally or externally on the workpiece
- Split return: used to focus the energy in particular areas of the workpiece
- MIQ (machined integral quench) paddle: the most commonly used design for scanning applications



Pancake inductor with strap supports

Six turn multi-turn inductor

MIQ (Machined Integral Quench) scanning inductor with removable quench plate

#3 Power and Frequency

Know the power supply and/or work-head power and frequency. Depending on the composition of the part that requires processing, the power and frequency of the equipment will help estimate the depth of the pattern that *can* be achieved, as well as help determine how successful the part will be for induction heating. Irregularly shaped geometries with points, holes, or sharp edges sometimes cause difficulty establishing eddy currents where the induction pattern is desired. Some parts, after review, are good candidates for induction heat treatment but cannot be processed with the existing power supply and/or work-head setup.

If an inductor is being built to mount to existing induction equipment, it is important to know the scope of parts that are currently being processed or expected to be processed on the machine. The electrical circuit of the power supply, work-head, and inductor must load match to the part. If a variety of parts are being run then multiple styles of inductors may exist or will be required to be used. Different designs of inductors, e.g., single-turn, multi-turn, or split return used on the machine will change the transformer effect and capacitor requirements of the system. Availability to tune the system capacitance and inductance becomes vitally important for operation. Please note that adjusting capacitance can be dangerous and should only be done by a trained technician. Newer power supplies function differently than older models, yet load tuning needs to be considered.

#4 Part Details

A detailed pre-induction print is needed. The print should list the material as well as the desired heat treatment pattern to determine the inductor design. As the print specifies the pattern, it should also provide limits. Inductors are then typically designed to the shape of the part. The inductor may require an integrated quench, electrically insulating protective coating, locators, or additional assembly fixturing depending on the part's size. An inductor built for one part may be used or tried on a similar part. However, the same results cannot be expected to render on the part for which it was not designed. If the manufacturer knows that a family of parts will be run, the full scope should be presented to inductor designers for consideration before the build.

#5 Material Handler

Ideally an inductor supplier would be contacted to develop the induction heating process for a part; then, that information should be shared with the material handling designer. That would be the ideal, but that's not the way it usually happens. Sometimes, a machine is built to process a part that no longer is in use, so the machine is now being retrofitted to process different parts. The design of a new inductor is needed to accommodate this existing machine which may create size constraints to the inductor's design.

The contact style, how the inductor mounts to the work-head, will need to be determined. There are a variety of commonly used power supplies and work-heads available from OEMs in the market. As each OEM keeps their contacts standard to their equipment, there is no singular standard footprint in the market. Once the contact style has been determined, the inductor can be designed for maximum power delivery efficiency.

How the part and inductor are presented to each other is important. The centerline distance, a measurement from where the inductor mounts to where the part will be processed, needs to be known. The centerline determines the required length of the inductor and indirectly how much room is available for the inductor's design.

Conclusion

Due to the variety of factors, no two projects are ever the same. Induction heating is an exciting technology, and I encourage everyone to learn more about it. HTT

(Photo Source: Induction Tooling, Inc.)

About the Author:

John Chesna is the general manager of Induction Tooling, Inc. and has been involved with the induction heat treating industry for over 8 years. He is a graduate of the University of Akron with a Bachelor of Science in Mechanical Engineering Technology. His responsibilities include overseeing day-to-day operations including the design, manufacturing, and testing of induction heat treating inductors. Additionally, John was a recipient of **Heat Treat Today's *40 Under 40*** *award in 2022.*

For More Information:
Contact John at ***jchesna@inductiontooling.com****.*

On-Site Hydrogen Generation Essential for Riverhawk Company's Heat Treat Operations

By Marie Pompili, Freelance Writer

For heat treat operations, use of hydrogen comes with questions about price-point, safety, and storage or delivery. Read this case study to learn how a manufacturer with in-house heat treat, Riverhawk Company, contended with these questions and decided to meet stringent production requirements for pivot bearings by leveraging on-site hydrogen and a hydrogen furnace.

Cantilevered-double ended thick spring. Riverhawk purchased the Free-Flex® pivot bearing line from Goodrich. Many of the company's clients, in a wide range of critical industries, have been purchasing flex pivots for long-running applications.

For companies using hydrogen furnaces for heat treating operations, questions always surface surrounding the provision of the necessary hydrogen. Should we have it delivered in cylinders? Do we have the room outdoors for a large storage tank? Can we generate it ourselves? For Randy Gorman, maintenance supervisor at Riverhawk Company, the overriding question is always, "How do we handle hydrogen safely?" The ultimate solution the company chose was the installation of an on-site hydrogen generator. How and why the in-house heat treater came to that conclusion is an interesting story.

Making a History

Located in New Hartford, NY, Riverhawk Company was established in 1993 as a value-added provider of hydraulic tooling. The company quickly grew from a "buy and assemble" operation to a manufacturer with 14 CNC machine tools, 21 conventional machines, and all the necessary peripheral devices, tools, and software. Through a period of smart acquisitions and the development of new product lines, Riverhawk became one of the leading manufacturers of tensioners, powertrain couplings, and accessories for the turbomachinery industry; the instrumentation product line of legacy torque and vibrations measuring instruments; and the Free-Flex® pivot bearings, which are very well known in high performance industry sectors.

Riverhawk staff (L to R): Spencer Roose, Flex Pivots Manager; Randy Gorman, Maintenance Supervisor; and Josh Suppa, Pivot Department Engineer

Pivot Bearing Line Requires Improved Heat Treat Abilities

The Free-Flex® pivot bearing line is the focus in this heat treat/hydrogen story. Riverhawk purchased this line from Goodrich in 2004. It is the same product that was developed by Bendix more than 60 years ago. In fact, many of the original part numbers are the same, and the manufacturer strives to maintain the quality and performance characteristics that Bendix established more than six decades ago. Many of the manufacturer's clients have been purchasing flex pivots for long-running applications, some of which are 25 to 50 years old.

If a product line could talk, the flex pivots could share some tales and compelling accounts about all it has seen and done in the world's most critical and sophisticated applications — many in the military, commercial aerospace, outer space, industrial robotics, medical, clean rooms, information technology, semiconductors, and many more. In all of these challenging sectors, clients are well-known and demand exacting results.

Shortly after integrating the pivot line into its existing production processes, it became clear that the company needed to improve its heat treat function. After researching several options, Riverhawk purchased a new Camco batch hydrogen furnace.

The pivot line consists of flat springs crossed at 90° and supporting cylindrical counter-rotating sleeves. Standard Free-Flex® pivots are made from 410 and 420 stainless steel; however, certain special material compositions include 455 stainless, Inconel 718, titanium, and maraging steel. During the manufacturing process for the flexure bearings, Riverhawk uses the batch atmosphere heat treat furnace to braze the springs to the body halves

using a braze alloy, and to simultaneously heat treat certain components in the assembly. The atmosphere used for the heat treating and brazing is a 100% hydrogen atmosphere — chosen because it is universally applicable to all the different metallurgy used for the flex pivots.

The Tension: Delivered vs. On-site Hydrogen?

The use of a batch atmosphere heat treat furnace requires that the hydrogen atmosphere be flushed from the furnace with inert nitrogen when a finished batch is unloaded and a new load is added. Likewise, the furnace must return to inert atmosphere again with nitrogen after the new load is added, and before hydrogen is again injected; hence, hydrogen is used in a batch-wise fashion. The function of the hydrogen atmosphere is to prevent oxidation of the metal surfaces, and to promote fluxing of the braze alloy during the thermal cycle.

Until 2009, Riverhawk used hydrogen-filled cylinders to provide hydrogen to their batch heat treat furnace. Each run of the furnace would use several cylinders of hydrogen. Increases in production rates required careful management of hydrogen gas supply to the furnace. Running out of hydrogen mid-run could sacrifice a whole batch of nearly completed parts.

In 2009, the company elected to move away from hydrogen cylinders and transition to a hydrogen supply approach less disruptive to their production process. The choices were either bulk stored hydrogen or on-site hydrogen generation. After extensive consideration, they chose a model H2 hydrogen generator from Nel Hydrogen because the zero-inventory hydrogen generation saved the company money as compared to the cost of permitting, construction, and compliance for bulk stored hydrogen approaches.

The approach that was not chosen — delivered, stored bulk hydrogen — was unappealing for several reasons. Chief among these were the capital cost of the hydrogen storage infrastructure, the requirement for permitting for the necessary hydrogen storage, the accompanying project schedule risk for permitting, the continuous compliance issues with stored hydrogen, and the price volatility of delivered hydrogen that would have made cost accounting more difficult.

"The state and local regulations were likely necessary; however, there was a lot to wade through to become compliant," said Gorman.

Finding the Best Way

Fast forward 14 years to today and Riverhawk is once again analyzing its approach to handling its hydrogen requirement.

"The H2 model generator that we have has served us well for 14 years, several years beyond the typical life of a cell stack," said Gorman. "But we need more capacity and redundancy due to the increased demand for our Free-Flex® products and to cost-effectively mitigate the risk of a hydrogen generator issue, leaving us without the use of our furnace."

The company decided to go with a model H4 hydrogen generator from Nel Hydrogen, which doubles their capacity with two cell stacks and the capacity for three if and when needed. The new system features the same footprint as the former H2 model, which is important to them, and they are even gaining floor space as they will eliminate the number of cylinders formerly stored nearby. The additional free space to move about also appeals to Gorman's top mandate for safety.

Josh Suppa — engineer of the Pivot Department at Riverhawk — has had hands-on experience with this particular generator series (pictured on page 16). "The maintenance of it is easy, and if there ever is a rare issue, Nel is quick to respond either in person or if it's something that they can walk us through, they take all the time we need to resolve the matter and get us back online quickly. From a product line and customer satisfaction perspective, we cannot take the risk of our heat treat operation to go down for long. It's that integral to our success. It's essential, really, and one of our core competencies."

Riverhawk will soon use a model H4 hydrogen generator from Nel Hydrogen, which doubles their capacity with two cell stacks and the capacity for three if and when needed. The new system features the same footprint as the former H2 (pictured here).

Choosing On-Site Hydrogen Generation

Looking back on the initial decision to generate on site, one of the important issues that Riverhawk and Nel personnel had to determine was the most cost-effective configuration of the hydrogen generator and ancillaries to supply the hydrogen required for thermal processing. Had the manufactuer used a continuous furnace such as a belt furnace, then the calculations would have been easy, as the flow rate required would have been level and continuous. Instead, the batch furnace required more complex calculation because the hydrogen flow rate varies depending on the stage of the furnace cycle: fast hydrogen flow to fill the furnace, then slow to maintain the atmosphere, then no flow during parts removal and during loading. Additionally, there were many factors that affected the precise furnace cycles employed, including the size of the pivots in each batch, the number of parts loaded, and the specific metallurgy of the flex pivots in the batch. Overall, the cycle times can vary between 6 and 12 hours per batch.

It is important to seek out a knowledgeable hydrogen partner in this endeavor to specify exactly what's needed, no more and no less. For heat treat applications, users generally would want compact equipment, extreme hydrogen purity, load following, near-instant on and instant off, and considerable hydrogen pressure that make it flexibly suited for a variety of thermal processes

By combining on-site hydrogen generation with a small amount of in-process hydrogen surge storage if needed, on-site hydrogen generation can be used to meet the needs of batch processes, such as batch furnaces. By carefully choosing generation rate and pressure, and surge storage vessel volume, the process can provide maximum process flexibility while minimizing the amount of hydrogen actually stored.

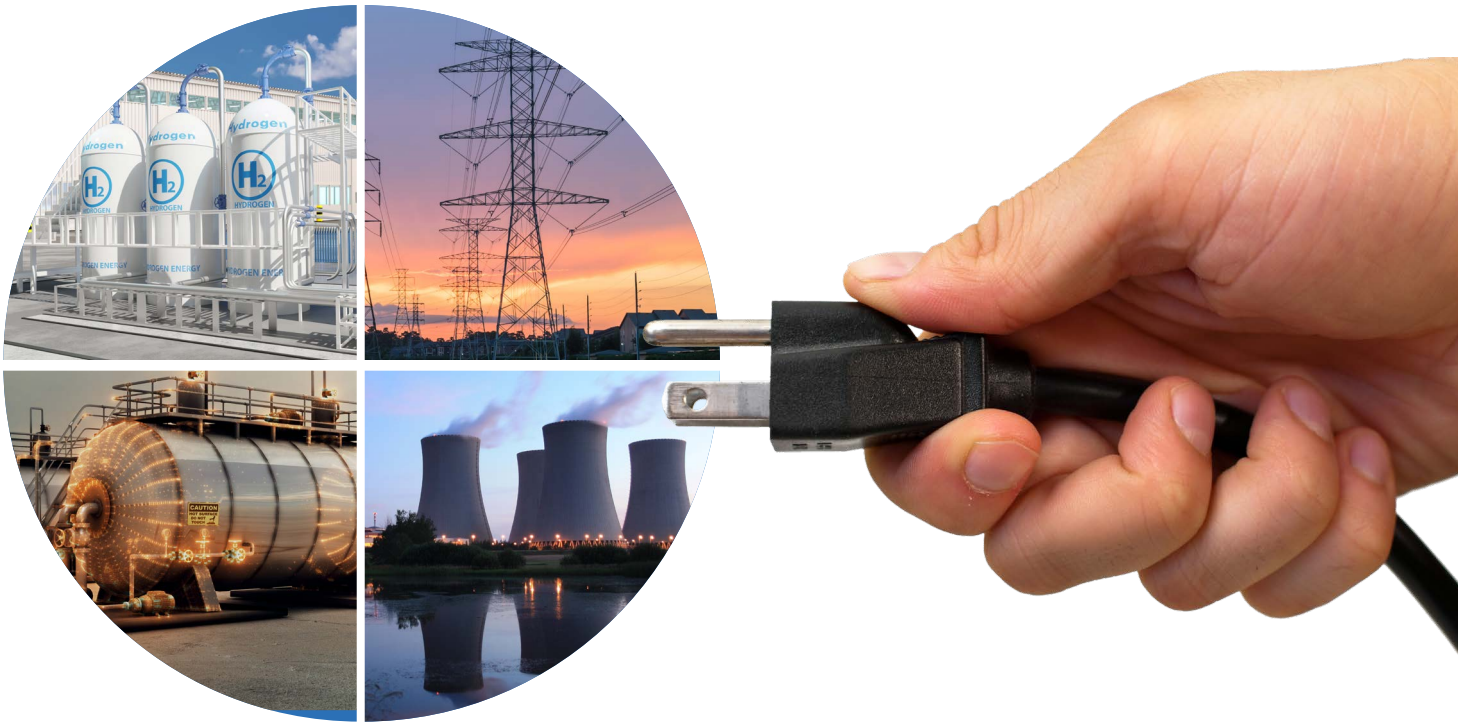
In practice, client priorities such as minimum hydrogen storage, or lowest system capital cost, or highest degree of expandability, or least amount of space occupied can be met by choosing the specific hydrogen generator capacity and surge storage system employed for any particular production challenge.

In this case study, the optimum solution chosen was based on lowest capital cost and operating cost (including maintenance) while preserving the maximum possible expandability for production increases, and safety. These sound like common reasons and may be yours as well. Success continues at Riverhawk with the arrival of the new H4 generator in the coming weeks. HTT

(Photo Source: Nel Hydrogen)

For more information:

Visit nelhydrogen.com and www.riverhawk.com.



Energizing the Future of Furnaces — 4 Perspectives

By **Heat Treat Today** *Editorial Team, in collaboration with* **Furnaces International**

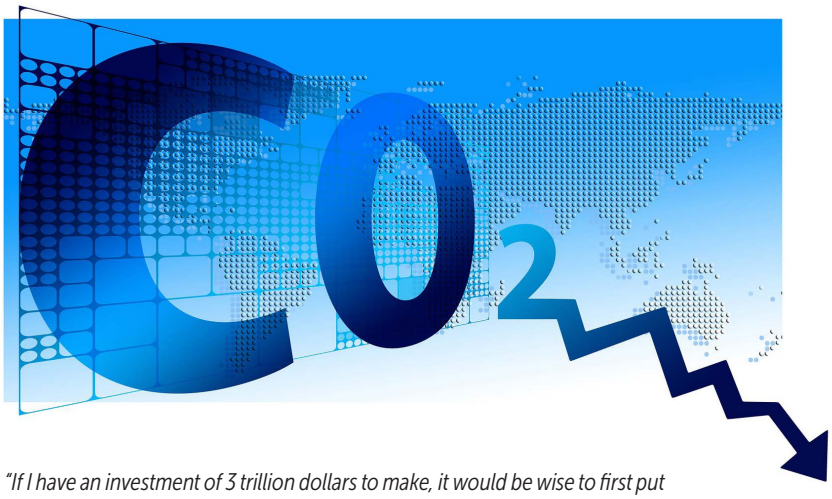
What will the future run on? With growing discontent around current energy sources like natural gas and other fossil fuels, power sources for furnace equipment are due for a makeover. In this article written by **Heat Treat Today** *and media partner* **Furnaces International**, *learn from heat treat and energy insiders around the world as they consider current technology investments and future energy opportunities that in-house heat treaters should consider when energizing the future of furnaces.*

The four perspectives were written in response to the following questions: 1. What are the short-term and long-term investments for sustainable energy for heat treat furnaces? 2. What role does data and digitalization have in efforts to decarbonize heat treat furnace operations? 3. What other steps can be taken now in heat treat operations to decarbonize heat treat furnaces? 4. What challenges need to be overcome for (North American/European) heat treaters to leverage sustainable technology in furnaces?

1. Heat Treat Today — Wise Heat Treat Decisions for Sustainable Solutions

"Don't let the perfect be the enemy of the good," is an excellent principle to follow when heat treaters look at making their operations more sustainable. Particularly when it comes to investments, the first step to reducing carbon output from heat treat equipment should always be to put in place a proper combustion maintenance system. I've never seen an investment that did not generate a savings that eclipsed the cost, well within one year. And this not only saves money, it also prolongs equipment life. It's an all-around good thing to do from *any* angle.

John Clarke, Technical Director, Helios Electric Corporation



"If I have an investment of 3 trillion dollars to make, it would be wise to first put it towards improving the efficiency of the existing equipment. That one change means fewer tons of CO_2 emitted by the end of the year."
— John Clarke (Source: Geralt via Pixabay)

Another area that heat treaters can improve is efficiently scheduling furnace up-time. All too often, I visit facilities where equipment that is not doing any work remains at operating temperature for a long time, because operators do not know precisely when to introduce more work into the furnace. If possible, idling the furnace at a much lower temperature would save a lot of money.

Programs and scheduling are the low-hanging fruit. Not taking care of them first would be like putting new carpet in the basement before you fix the leak. It's always best to take care of the fundamentals and make sure you're doing the best you can with what you've got before you go ahead and make those *other* investments.

In the near term, capital investments are a bit more tricky. There are certainly technologies that will improve efficiency with greater capital investment. These include recuperation or other methods of enhancing heat transfer. For radiant tubes, it could be inserts. The other elements could be pulse firing, particularly in instances where we're trying to induce an increased rate of heat transfer by creating more mixing within the furnace chamber. These are "on-the-shelf" methods, though they have much longer payback periods, on average.

Switching equipment from gas to electric — or something drastic like that — may not be the answer. We have to focus on the incremental improvement. If I have an investment of 3 trillion dollars to make, it would be wise to first put it towards improving the efficiency of the existing equipment. That one change means fewer tons of CO_2 emitted by the end of the year.

Speaking generally, evolutionary technologies must be developed. We have to pursue R&D aggressively, but let's target the ultimate goal: reduce tonnage of CO_2 emitted. *That's* the goal. Let's not confuse the technology or the tool with the ultimate goal.

Digitalization Empowers Investments

Digitalization, especially the improvement in data acquisition and analysis, is huge. With higher computational capacity on the controllers on a per furnace basis, we have the ability to start executing real-time analysis on the furnace and potentially implement a thermodynamic model of the furnace and how it's operating. If I track measurements of total fuel flow, exhaust temperature, and time using the computational powers of a modern PLCs, for example, I can know the core temperature of the piece and *exactly* when I should pull the piece. That's digitalization.

The other thing we need to keep in mind is the ability to upload data for analysis. In a sense, this is "the internet of things" (IoT). Let's say I'm producing 100 tons of steel through a furnace per day. If I monitor the amount of natural gas that system consumes, I know that I have an energy intensity of X cubic feet of natural gas per ton of steel produced. If there's a deviation, for *whatever* reason, I know to investigate. It could be the burners are out of tune, it could be something changed in the process, it could be a thermocouple is bad. So, there are a myriad of potential problems that could arise and, if I'm pulling that data, I can know that *before* I otherwise would.

This modern tendency of collecting and analyzing data is an incredibly powerful tool that should be encouraged and pushed forward. This is an example of the good and not the perfect; we're trying to take the existing systems and make them more functional and effective.

Digitalization should also be considered holistically — energy is just one part of it, granted a large and expensive part. But it is worth noting that digitalization helps efforts to create safer operations by making systems more consistent.

Next Steps Require a Step Back

As a consultant, I often disrupt facilities, force people to stop thinking about day-to-day activities, and challenge them to think anew about some of these systems. Never underestimate the importance of thinking — and thinking slowly. And thinking requires quiet, but it also requires collaboration, and it requires the plant manager to actually engage with the line operators. Often, we have silos of knowledge — we have maintenance, we have operations, we have management — and they don't communicate.

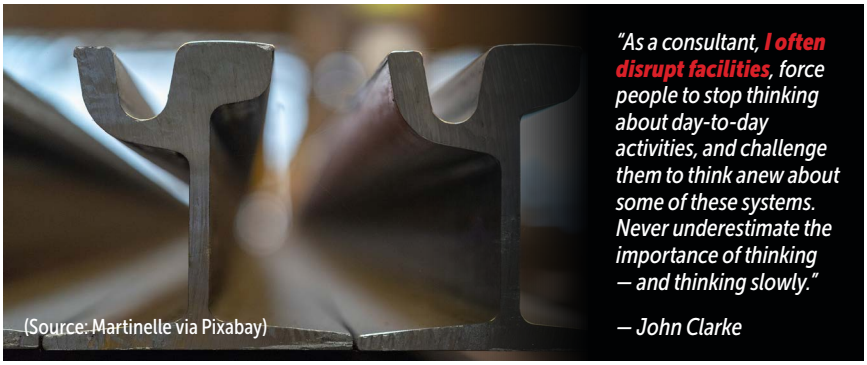
Second, in stepping back, make a plan. Prepare the planning process for facility transitions.

Finally, we may always take a step back and ask if a material change to eliminate a heat processing step can be made. In some cases, eliminating the heat processing step entirely will have a big financial impact. Perhaps there are performance specifications that can be met with microalloyed steels that *don't* require heat treating! In these cases, be aware that incoming steel costs do not chew up savings.

From a decarbonization point of view, you would need to look at the overall supply chain carbonization and intensity of the mining of these more exotic materials. Depending on the supply chain carbon output of the new material, eliminating heat treating could be a plus on CO_2 emissions, though perhaps not a total cost savings.

Challenges Are from Within: Interest Rates and Internal Investment

In North America, rising interest rates mean that we are somewhat in a catch-22. When interest rates are low, investments into changing equity or the treasury level of the companies typically occur versus investing in the core business. Now that interest rates are higher, companies actually may start looking at optimizing the actual performance of their individual company. But too many people are too aggressively pursuing figures, caring more about the return on equity versus focusing on the core performance of the operations. Enterprise is often given a capital budget of X when, in reality, the capital budget really should be based on a two-year hurdle rate. Management wants to invest in the enterprise on all projects that will return 30% on internal investments because they see large corporations making major investments and other businesses are lucky to earn half that kind of return.



One of the impediments is simply convincing management and decisionmakers on the validity of internal investment. Your enterprise represents an internal investment opportunity that exceeds the return you're likely to receive from an acquisition of a new enterprise. I know that runs counter to some of the thinking prevalent in the market today, but it is important to point out. I am an "internal return on investment" kind of guy, so I speak with a bias. But time and time again, I see opportunities go unexecuted because they don't meet a preconceived budget. If your objective is to make money, invest it to maximize the return.

Our national laboratories and our universities throw out a lot of great technology. Some of it is ready for primetime, some is in the nascent of condition and needs more investment and time to mature. I'm not sure we have enough enterprises to partner with these design and research groups and commercialize the ideas. It's in this "valley of death" — where the basic technology has been developed and proven to be viable, but the commercialization and the manufacturing is lacking — that we need to overcome and increase enterprise. Particularly in the heat treating industry, there is a problem of fewer "catchers" who will partner with and develop new technologies that could aid in decarbonization. This is because there have been a lot of acquisitions. If you look at the membership of IHEA, it's the same people and the same businesses but there are fewer people. Everyone is buying everybody else. Larger corporations tend to be less likely to take the risk on a piece of technology that won't *immediately* pay back. They also have a lot of "not-invented-here" issues as well.

One solution is for the Department of Energy to invest. Though they already do this, even greater investments into brokers and advocates are necessary to pick up this technology and pass it through instead of simply trying to contact people. During U.S. President G.W. Bush's time, the Department of Energy had a "Save Energy Now" program during a natural gas spike. The program sent people, like myself, around to plants to run analyses for free. The program was extremely valuable because it gave enterprises motivation. I did speeches at many different automotive plants and participated in collaborative events as part of that program. I think refunding that program and refocusing on *something* like that would be beneficial.

My idea of the way forward is half technical and half promotional, demonstrating to people that there *is* another way. That is an effective role for government. I would like to see them redo that. It would be a different emphasis. HTT

About the Author

John Clarke is the technical director and owner of Helios Electric Corporation, a company based in Fort Wayne, Indiana, that specializes in energy and combustion technologies. The depths of his knowledge on energy and combustion topics can be seen in the technical articles and columns that John has contributed to **Heat Treat Today's** *Combustion Corner.*

For more information:

Contact John at jclarke@helios-corp.com.

2. Furnaces International

Energizing Our Evolving Industry: Past, Present, Future

Yesterday's Attempts at Energy Efficiency

For the industrial context where the improvement of productivity, energy efficiency, and environmental performance is increasingly essential — especially for temperature furnaces — the coupling between the hybridization of furnaces integrating different technologies becomes a solution to be seriously taken into account.

Philippe Kerbois, Global Industry Manager for Glass, AMETEK Land

During the last century, with the appearance of energy and emission constraints, the steel and glass industries used for the most part the same energy saving techniques with heat recovery on flue gases for preheating combustion air, thus reducing energy consumption by 20%–30%. In the 1980s, regenerative burners arrived. Based on the same principle of preheating air — though at higher levels — regenerative burners improved the energy efficiency of the installation, but also increased NO_x emissions. This is clear for many large industrial companies in steel, glass, and cement, for whom the industrial electric furnaces reduce emissions and risks, and require little maintenance. But the electrification of existing furnaces, which often run on gas, is far from obvious as fired furnaces are still numerous all over the world.

Today's Solutions: Which Is the Way Forward, Gas or Electric?

Today, what can be done to improve energy efficiency? Improving energy efficiency in glass or steel reheat furnaces can be achieved by implementing various strategies. The approach for short term investments needs to be pragmatic. It is possible to implement better practices and technologies on any furnace.

We can point to some general short-term steps that can help improve energy efficiency:

- Conduct an energy audit
- Insulate the furnace
- Upgrade insulation
- Install energy-efficient motors and drives
- Implement energy management systems
- Optimize combustion
- Use waste heat recovery systems
- Upgrade to more efficient equipment

- Use advanced process control systems

By implementing these strategies, it is possible to significantly reduce energy consumption and improve the energy efficiency and emission of a fired glass furnace. However, it is important to note that the specific strategies used will depend on the furnace's operating conditions.

When heat treaters step back from burner-focused solutions and short-term plans, the next question is often: Do we need to change or upgrade our equipment? And is electric the only wise way to go when seeking energy efficiency?

The choice between gas and electric furnaces depends on a variety of factors, and there is no one-size-fits-all solution. It is important to consider the specific needs of the application and weigh the costs, energy efficiency, and environmental impact when making a decision. One might consider the following:

- Gas furnaces are generally less expensive to purchase and install than electric furnaces. However, the cost of operating a gas furnace can be higher due to the fluctuating price of natural gas. Electric furnaces, generally more expensive to purchase and install, typically have more stable operating costs.
- All the relevant references of use of electrical furnaces in the past were related to lack of flexibility especially in glass when changing the quality and types of glass or colors. This could cause some issues where flexibility is needed for production operations.
- Considering the environmental impact, gas furnaces produce carbon dioxide (CO_2), and other greenhouse gases that contribute to climate change. Electric furnaces do not produce direct emissions, but their indirect emissions depend on the source of the electricity used to power them. If the electricity is generated from renewable sources such as wind or solar power, then electric furnaces can be more environmentally friendly.

Tomorrow's Possibilities: Looking Beyond the Short-Term

In order to move into the future, education about the present is key. Focusing on environmental impact looks different regionally, and the lack of awareness and education of local teams needs to be considered as well. Regulations and standards related to emissions and energy efficiency could be regulatory barriers: What is true in China or India is not necessarily fit for Continental Europe, the U.K., or U.S.

From region to region, the compliance with these regulations can be a significant challenge for heat treaters. Meeting these requirements may require significant investments in new technology or modifications to existing systems where electric furnaces are direct impact on the direct emissions.

Many heat treaters or glass manufacturers may not be aware of the benefits of sustainable technologies or may not fully understand how to implement them. Providing education and training sessions on sustainable technologies can help overcome this challenge. Data and digitalization play a critical role in efforts to decarbonize heat treat furnace operations. Here are some ways in which data and digitalization can contribute to decarbonization:

"Investing in renewable energy sources such as solar or wind power can provide long-term energy savings and reduce greenhouse gases, but for most heat treaters, these are monumental decisions. The approach to long terms investments needs to be pragmatic focusing on renewable energy sources when available near the plants where a power grid is available."
— Philippe Kerbois (Source: Manny Becerra)

- Resistance to change
- Real-time monitoring
- Predictive maintenance
- Optimization of energy consumption
- Supply chain optimization
- Carbon accounting

Investing in renewable energy sources such as solar or wind power can provide long-term energy savings and reduce greenhouse gases, but for most heat treaters, these are monumental decisions. The approach to long terms investments needs to be pragmatic focusing on renewable energy sources when available near the plants where a power grid is available.

Any end-users can work with experts in sustainable technology to identify opportunities and develop strategies for implementation of Industry 4.0 technology using SCADA systems and predictive tools. It may also be helpful to collaborate with other companies or industry groups to share best practices and insights. Government incentives or funding programs may be available to help offset the costs of implementing sustainable technologies

In conclusion, data and digitalization are critical tools in efforts to decarbonize heat treat furnace operations. By providing real-time monitoring, predictive maintenance, energy optimization, supply chain optimization, and carbon accounting, data and digitalization can help heat treaters to reduce their carbon footprint and transition towards more sustainable operations, including electric furnaces. HTT

About the Author
Philippe Kerbois, previously Regional Sales Manager EMEA – Glass for AMETEK Land, has over 20 years' experience in high value, complex technical solution sales with specialties in glass, renewable energies, automotive, water filtration, energy production, gas turbines, automation, building automation and oil and gas. He holds a degree in mechanical engineering (Diploma of Higher education) associated to ESTACA degree (Aeronautics and Automotive Engineering school).

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3. Heat Treat Today

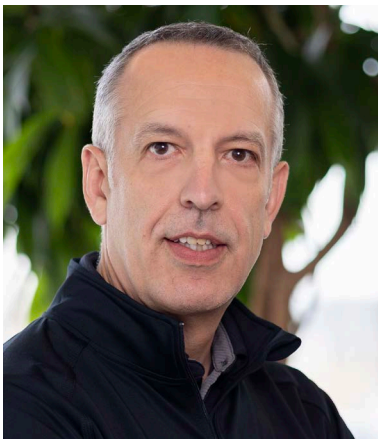
Investing in Efficiency

A Low Carbon Future Could Be One Investment Cycle Away

It is helpful to put some numbers around sustainability. Recent reports from the IEA (International Energy Agency) indicate we need to improve energy intensity by around 4% between now and 2030 and about 3% from 2030 to 2050 to be close to achieving net zero goals. The 4% level is double what was achieved over the last decade.

Sustainable investments in heavy industry (steel, cement, chemical) have already started. Blast furnaces and cement kilns last for around 40 years, and 2050 as a net zero target is now less than one investment cycle away. North America is leading the way by investing in electrifying the industry via electric-arc furnaces which aid in cleaning up an industry that has had a high dependency on coal. Newer technologies, including the electrolysis of steel, promise alternative ways of low-carbon manufacturing, but this technology will only likely provide significant production quantities after 2030.

At the lighter end of the industry, industrial furnaces for heat treatment may generally have a slightly shorter lifecycle. Still, investment decisions in new capital equipment today will directly impact the industry's emission profile over the next 30 years. Therefore, this long-term investment needs to consider the potentially changing energy landscape.



Peter Sherwin, Global Business Development Manager, Watlow

Miranda Pizzella, Engineering Manager, Watlow

Andy Selvy, Chief System Designer, Watlow

At face value, in many places in the U.S. and Europe, the ratio between gas and electric pricing would steer investment towards gas-fired furnaces if the only criteria were running costs (ignoring heat treat equipment that is only electric-fired, e.g., vacuum furnaces). This cost advantage is starting to change with increasing carbon taxes, potential disruption of fuel supply (currently in Europe), further stringent NO_x emission requirements and continued supply challenges for complex gas trains.

Combustion burner design can significantly impact the energy efficiency of a furnace. Straight-through tubes are on the scrap heap, and recuperative and even regenerative burner systems now aid efficient energy use. In addition, dual-fuel burners that can work on hydrogen or natural gas are becoming available. Although the economics of carbon-free hydrogen remains a constraint to its heavy use, this is expected to change over time, with innovations to improve the hydrogen landscape post-2030.

There is a significant amount of research in next-generation elements for electric furnaces. The element material composition, desired life, and manufacturability are all areas currently being explored. In addition, the controllability of an electrical element is significantly better than its combustion alternative, and unique algorithms are in development to take advantage of this to aid efficient processing.

More Digitalization, Greater Efficiency

Today, heat treat operations lack visibility and access to critical process data, leaving operators reactive when mitigating performance factors such as utilization time, quality, yield, and energy consumption. Data and digitalization provide many opportunities to improve efficiency and reduce overall energy consumption within furnace operations. Poor thermal uniformity can lead to scrap and rework of material, which both result in excess energy consumption.

Process drift can also cause more energy to be consumed over time to achieve the same operational results. Examples of process drift include drift from target program set points, processing times, nominal values such as desired heater power output and thermal uniformity values. Lack of visibility to process drift can create rework when specifications are missed the first time or potentially result in a scrapped batch.

"Through proper data collection and analytics combined with thermal systems expertise, problems can be overcome, which not only reduce carbon emissions but also improve productivity and profitability for heat treaters."
(Source: panuwat at Adobe Stock)




It is important to recognize that data can be a powerful input for decision making to improve process efficiency. However, data alone is not enough to act to create significant improvement. To utilize data for process improvements, it must be delivered in a way that is easily consumed and creates clear action to be taken. Thus, it is important that we combine data with subject matter expertise to contextualize and transform data into actionable insights. For example, Watlow and Eurotherm have combined their expertise to enable value creation in collecting, interpreting, and transforming data into actionable insights that can be put in the hands of the operators when they need it, where they need it.

Through proper data collection and analytics combined with thermal systems expertise, problems can be overcome, which not only reduce carbon emissions but also improve productivity and profitability for heat treaters.

Steps Towards Digitalization

A heat treater's first step towards digitalization should be to work with suppliers to understand what digital solutions are being offered. Watlow and Eurotherm have pooled their skills to find ways to offer better solutions. Driving towards data-driven decisions impacting process performance and energy consumption is relatively simple and gives operators an opportunity to take proactive measures, and it also lays the foundation for future investment through data-driven performance trade-offs and insights.

At a thermal-loop level, find suppliers that are focused on improving the performance of electric-fired furnaces from the transformer to the element to the power controller and process controller/recorder.

Consult your supplier about recording strategies and leveraging power data. First, record data in a format that doesn't create data islands but protects the integrity of the raw data. And second, leveraging power data in real-time allows you to share information between furnace zones or different furnace equipment, which can help lower peak-power demands by scheduling when the individual SCR power controllers fire.

Recently, we launched a new I4.0 pilot service program which provides data insights to enable peak performance. Tracking process performance through insightful data, correlations related to process inefficiencies can be established. Energy consumption improvements to the process can be made such as identifying and mitigating inefficient combustions.

Consider the Cost

Top of the list of challenges to adopting sustainable technologies is the ongoing cost conversation — the cost of gas versus electricity. The gas and electric prices do differ significantly across all regions. However, this equation is changing in even the most attractive gas districts. Once you add on rising compliance costs to emissions plus the ramp of renewables, this will ultimately favor an electric future.

In the U.S. and most parts of Europe, energy has been plentiful and reliable for a long time. The U.S. has also enjoyed decades of relatively low costs of all forms of energy. Contrast this with some regions of Asia where weekly and sometimes daily power interruptions still occur. As a result, there is a different mentality and behavior around resource use and abuse.

The higher price of energy in Europe, and the current spike in the Ukraine conflict, have started to impact behaviors. For example, we now see customers with a mid-cycle refurbishment of a furnace looking to evaluate a move from gas to electric. HTT

About the Authors

Peter Sherwin is a global business development manager who is passionate about offering best-in-class solutions to the heat treatment industry. He is a chartered engineer and a recognized expert in heat treatment control and data solutions. He has lived and worked in the U.K., India and the U.S.

Miranda Pizzella holds a Ph.D. in aerospace engineering with a concentration in thermal-fluid science from Parks College, Saint Louis University. Miranda is leading the company's Industry 4.0 strategy and has accelerated the adoption of related technologies to transform the business through leveraging data to create more value. Miranda currently leads the computational engineering team and the Industry 4.0 development team.

Andy Selvy holds a B.S. in ceramic engineering from Missouri University of Science and Technology and an MBA from Maryville University. In his current role as a chief system designer, he leverages 20 years of solving complex thermal system problems to help grow new technology into scalable products and services.

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Contact Peter Sherwin at peter.sherwin@watlow.com or visit these helpful links:

https://www.iea.org/reports/net-zero-by-2050

https://www.energy.gov/eere/analysis/energy-efficiency-vs-energy-intensity

www.watlow.com

4. A Hybrid Future

Furnaces International

A Middle Way: Hydrogen in Combination with Fossil Fuels

Stuart Hakes, Chief Executive, F.I.C (UK) Limited

There are a number of things to be taken into consideration for "energizing the future of glass furnaces."

In the short-term, it is possible to add electric boost to an operating furnace on-the-run, to reduce the amount of fossil fuel being used. However, the proportion of electrical energy that can be installed, relative to the amount of gas currently being used, makes a very small difference to the CO_2 emissions. The reason being that approximately 30% of the total energy is used for "holding heat," i.e. to keep the structure warm. A fair part of this holding heat is required in the regenerators which pre-heat the air and although 1 kW of electricity should save 2 kW of fossil fuel, in reality with regenerative furnaces it is difficult to get close to this figure. Anything from 1.3-1.8kW is the norm.

The next stage, which is a small incremental investment, is to go to superboost. Superboost, again, is not very effective unless the amount of air and gas going through the regenerators can be reduced, which is nigh on impossible on end-port furnaces and difficult on cross-fired furnaces. Therefore, the other option is to add hydrogen to the natural gas stream and this can only be done by Government edict. But it is relatively easy to do with the existing burner set up, however, this is only feasible up to a maximum of 30% with current technology, before major technical issues are encountered. There are particular capital requirements needed for handling large amounts of hydrogen.

Less Fossil Fuels, More Hydrogen and Electrification

The proper progress for glass furnaces is to convert from fossil fuel, air/gas, regenerative furnaces to oxy-fired. This will give an improvement in thermal efficiency which will have a small impact on CO_2 emissions but not significantly. The only way long term to have a major impact is either hydrogen firing or all-electric. In both cases a considerable amount of investment is required. However, the opinion of the author is that hydrogen will be a premium fuel and the only fuel in many industries and therefore if alternatives are available for the glass industry these will more likely to be adopted.

The issues regarding the safety of using hydrogen presents huge difficulties in terms of mitigating risk. We must also consider that burning hydrogen increases the level of foam in a glass furnace, which is detrimental to melting efficiency and the refining of glass. Whilst these two factors may be overcome, there is the final issue that currently, no refractories exist that can withstand the product of combustion of a hydrogen flame, which is superheated water, possibly at 2400°C (4352°F). This is a major problem for the industry to overcome.

For this reason the author believes that a hybrid furnace with 80% of the melting energy from

electric and 20% from some kind of top heat, could be electric heating, or could be hydrogen flame or some other alternative fuel, is the answer. The issue with going all-electric is that a massive investment is needed in the grid reticulation system as well as finding sources to generate green electricity to cover the requirements. This is a major issue for the Government to address as many other industries will need to electrify as well.

The major challenges for hydrogen are as enunciated above. In particular, the safety issue of hydrogen is a huge change, the other issue is that 3 times the volume of hydrogen is required than that of natural gas meaning reticulation systems will have to be changed. And finally, in container forehearths where air/gas mixtures are used for conditioning the glass, this is not possible with hydrogen and so the only way to decarbonize this process is to go all-electric. This technology is currently available and already shows anything between 80-90% both energy reduction and cost reduction. As I stated before, the only other major challenge is the amount of electricity available for industry and the public at large, in order to make these changes. HTT

Short-Term Digitalization Efforts, Investments, and Impact

Big data and digitalization can assist decarbonization efforts, but this requires no more than what is currently available for fossil fuel fired furnaces. Capital investment is low, and the technology is available now.

About the Author
Stuart Hakes has 58 years in the glass industry. He studied Glass Technology in England and worked in the United Kingdom with container plants affiliated to the O-I Group. Stuart joined F.I.C. (UK) Limited as CEO in 1999 and has been there ever since.

For more information:
Visit *www.fic-uk.com.*

13 Induction and Sustainability Tips

By **Heat Treat Today** *Editorial Team*

Looking for industry expertise on saving energy or planning ahead for making in-house heat treating green? Discover new tips, tricks, and resources for sustainable heat treating methods. With many of these tips, heat treating with sustainability in mind can be easy. And if you're looking for tips on combustion, controls systems, or induction in general, you'll find that, too! If you'd like to submit a tip, email Bethany Leone, managing editor, at **bethany@heattreattoday.com.**

#1 Maintenance of Induction Coils Used in Hardening Applications

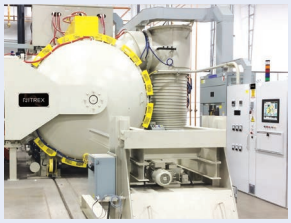
How should you maintain induction coils used in hardening applications? Elbow grease — a little goes a long way. After each use, a simple solution of soap and hot water will remove sticky quench and debris. Scrub hardened dirt with a Scotch-Brite pad. Check for pitting, arcing, and insulator damage. If all is good, use a hot water rinse, and it's ready for use. If the inductor is to remain on the machine for an extended period, it is advised to wash it and the associated bus daily. Check for damage. Following this simple procedure will reduce business waste.

Soap and hot water will remove sticky quench and debris. (Source: Induction Tooling, Inc.)

Source: William Stuehr, President/CEO, Induction Tooling, Inc.

#partscleaning #inductorcoil #hardening

#2 Insulation = Key for Energy Savings in Vacuum Furnaces



Look for insulation quality in your next vacuum furnace. (Source: NITREX)

Improvements in insulation materials are also contributing to greater energy efficiency of vacuum furnaces. Most furnaces on the market today have a 1" (25.4 mm) graphite board with bonded Grafoil and two layers of graphite felt. However, the insulation performance of a 1" (25.4 mm) graphite board is about 25% less efficient than a 1" (25.4 mm) graphite felt. For processes that require high operating temperatures, typically over 2,200°F (1,204°C), an all graphite felt that is 2" or 2.5" thick (50.8 mm or 63.5 mm) minimizes heat loss inside the hot zone. Efficiency gains of up to 25% are possible over the standard 1" (25.4 mm) board and 1" (25.4 mm) graphite felt insulation and an even greater gains at higher operating temperatures. To safeguard the graphite felt from mechanical harm and localized compression, these thicker all-graphite felt insulation configurations are usually covered with a carbon fiber composite (CFC) sheet about 0.050" (1.27 mm) thick.

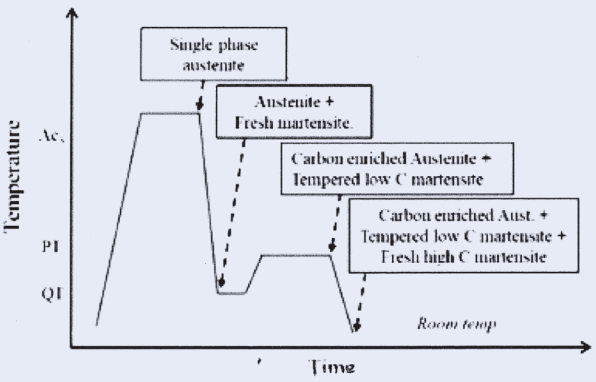
Source: NITREX *#insulation #energysavings #graphite*

#3 Thinner Steel, Lighter Car

Fuel efficiency (and the stringent requirement for passenger safety) has raised the bar for the automotive industry to procure steel with high strength, hardness, and ability to fabricate. Reduction of weight requires lighter cars with thinner body material which can absorb impact. These dual contradictory properties of high hardness material which can be easily shaped can normally be achieved either by heat treat or through addition of alloys. These two processes are described below.

Normal heat treatment to produce small grains in the material will increase the hardness in steel but also create a propensity to fracture. Thus, a process known as quench and partition — where carbon diffusion from martensite to retained austenite to stabilize the latter — has been introduced. Further verification and prediction of the phases has been conducted using thermodynamics modeling for phase characteristics by Behera & Olsen at Northwestern University, Materials Science and Engineering.

The process starts with full automatization (or in some cases intercritical annealing) followed by fast quench to a defined quench temperature (QT) between the martensite start, Ms, and martensite finish, Mf, temperature. The steel is then reheated to the partition temperature (PT) and held there for a certain partition time followed by a quenching step again to room temperature, as shown in the image.



Quench and partition process (Source: Speer et al. The Minerals, Metals & Materials Society 2003)

The quenching step establishes the largely martensite matrix while the partition step helps stabilize the retained austenite by carbon partitioning. During the holding step, carbon diffuses from martensite to retained austenite and thus improves its stability against subsequent cooling or mechanical deformation. The final microstructure consists predominantly of tempered martensite and stabilized retained austenite with possibly a small amount of bainite formation and carbide precipitation during the partition step and fresh martensite formation during final quenching.

The other process to achieve high hardness and high ductility is by alloy addition in carbon steel. Over, 2,000 different types of steel exist. A new type of steel that is extremely strong, but simultaneously ductile is used in the automotive industry. Small quantities of elements like vanadium or chrome in steel promotes ductility. They are not brittle; however, up until now they have not been strong enough to enable the construction of car bodies with thinner sheets.

In the crystals of steels, the atoms are more or less regularly arranged. Steels become particularly ductile though if they can switch from one structure to another. This is because this process allows energy absorption, which can then no longer initiate any damage in the material. In a car body or other steel components, tiny areas then alternate with the two different atom arrangements.

Ductile steels have two coexisting crystal structures. The search produced an alloy made from 50% iron, 30% manganese and 10% respectively of cobalt and chrome (Max Planck Institutes).

Source: Madhu Chatterjee, President, AAT Metallurgical Services LLC

#quenchandpartition #quenchtemp

#4 Maintaining Tooling Fixtures for Induction Hardening

Tooling fixtures are usually maintained simply by storing them inside a mandrel and a box. This system will prevent coils from getting distorted.

Most tooling should be rinsed in hot water to wash off the polymer and then dried and stored away for future use.

It is a good practice to use deionized water for cooling the power supplies.

Source: Madhu Chatterjee, President, AAT Metallurgical Services LLC

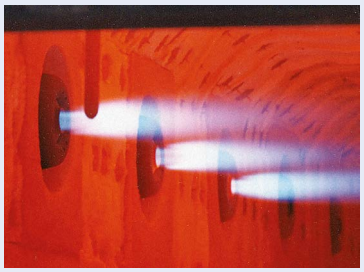
#partscleaning #toolingfixtures

#5 Maximizing Energy Efficiency of Vacuum Furnaces

The use of AC to DC transformers is an energy-efficient innovation that can significantly lower energy consumption of the heating system. Typically, a system uses alternating current as the primary source, which fluctuates output during each half cycle. Using AC to DC transformers limits these fluctuations, reducing the amount of energy used. Furthermore, transformers operate at optimal efficiency when under a reduced load – i.e., less than 70% output in steady-state heating – rather than ramping up to the full operating temperature. Another advantage of the DC-type transformer is that its operating power factor is very close to 1.0, which lowers the utility company's calculation of peak demand surcharges.

Source: NITREX *#ACDCtransformers #inductiondesign*

#6 Burner Tuning & Calibration — It's Not Your BBQ Grill!



Burner tuning and calibration (Source: WS Thermal)

Burner adjustment to nominal gas and air ratios is a typical component of your combustion equipment maintenance. However, this process cannot be minimized in importance as any adjustment can affect operation, efficiency, exhaust emissions, and equipment life. Factors to consider and address during any burner adjustment include:

- Burner adjustment should always be done (when possible) at normal furnace operating temperature under typical production to maintain best conditions for final calibration
- Provide clean combustion air: maintain blower filter and consider source of any plant air
- An increase of gas may not increase power to system due to heat transfer or throughput issues
- A decrease in combustion air will not create a hotter flame or add power to the system as this may only create a gas-rich operation resulting in reduced power and CO in exhaust
- Verify gas and combustion supply pressures and consider creating a monthly log of incoming pressures
- While a visual inspection of flame can help to verify operation or proper combustion, burner gas/air adjustment cannot accurately be performed by simply looking at color or size of flame
- A working understanding of the burner system is important to determine and verify values to gas/air and excess O_2 to specific application

Source: WS Thermal *#burnertuning #cleancombustion*

#7 Want a More Consistent Heat Control?

Try power feedback for your electric heating elements. Power feedback is ideal for variable resistance heating elements. Kilowatts are used as the unit of control, rather than just current or voltage.

Source: Tony Busch, Sales Application Engineer, Control Concepts, Inc.

#heatelements #powerfeedback

#8 Combustion Efficiency: Do You THINK or Do You KNOW?

Installing retrofittable monitoring equipment provides real time and historical combustion data.

Combustion is a chemical reaction. With the right mix of fuel and air, emissions are minimized while heat output is maximized.

Minimize emissions with data (Source: PSNERGY)

The question is: "Do you think it is right or do you know it is right?" With today's technology, knowing combustion is running efficiently by maintaining proper ratios at each burner is not only possible, it is necessary.

Minimize emissions, improve quality, and maximize heat output per BTU with data!

Source: Taylor Smith, Specialist of Technical Sales and Marketing, PSNERGY

#combustion #emissions #energy #efficiency

#10 Switch to Aqueous

As industry tries to become more "green," a number of companies are switching from lubricants that are petroleum or mineral oil-based to water-based ("aqueous") lubricants instead. However, some of these companies then make the mistake of not changing their degreasing fluids that they use to remove these lubricants prior to their next processing operations, and stay with their standard degreasing fluids, such as acetone or alcohol, which are not effective at fully removing water-based lubricants. Instead, they need to run tests to find an appropriate alkaline-based degreasing fluid for such water-based lubricants, since alkaline-based degreasers will be effective at removing such lubricants. Commonly available dish-detergents (alkaline-based) have been shown to be highly effective for such use.

Source: Dan Kay, Owner, Kay & Associates

#aqueouscleaner #gogreen #lubricants

#9 Tips for Induction Hardening

What are the benefits of induction hardening? Here are a few:

- Saves space: Induction hardening requires minimum space required in comparison with furnaces
- Saves energy: Induction heating equipment does not need to be kept running when not in use
- Clean: Induction heating equipment requires no combustion gases
- Energy-efficient: Only a small proportion of the material needs to be heated
- Minimize deformation: Induction hardening requires no applied force
- Save maintenance costs: Inductor coils have a long life, reducing the need for maintenance

Source: Humberto Torres Sánchez, Chief Metallurgist, ZF Group

#induction hardening #deformation #zerocombustiongas

#11 Give Sustainability the Green Light

Conserving energy is not only good for the environment, but it can mean more money in your pocket and less downtime. Here are three tips to improve furnace efficiency with diagnostic technology:

1. Do you have tight and secure terminal connections? Poorly connected power cables waste electricity and can cause fires. An SCR power controller monitors terminal temperature changes and will alert you before failures happen. It also monitors heat sink temperatures and ensures the control's cooling fan is working properly.

GPC Controller (Source: GEFRAN, Inc.)

2. Do you have a heater-break alarm? Heating zones typically have multiple heating elements, wired in parallel. A broken element is difficult to detect and will impact the heater's circuit, reducing the power of the process. This can waste energy and affect product quality. A heater-break alarm will alert you to a failing heater circuit.
3. Do you pay high electricity bills? You could benefit from a factory load management system. It's now possible to limit peak current loads and power usage across your factory and multiple furnaces. These systems communicate by sharing important power-demand information and providing more effective power distribution.

A connected and automated factory network saves electricity and improves operational efficiency by establishing powerful furnace management systems.

Source: John Thoma, Sales Manager, GEFRAN, Inc.

#automation #sustainabililty #efficiency

#12 Tips for Selecting Induction Heating Equipment

"The following factors typically influence equipment design:

- Material
- Prior microstructure
- Part geometry
- Austenitizing temperature
- Production rate
- Power requirements, kW (typically selected by vendor based on information provided)
- Frequency selection, kHz (typically selected by vendor based on information provided)
- Pattern/profile (i.e., shape of heating area)
- Coil design (typically selected by vendor based on information provided)
- Process-development requirements
- Application-specific criteria (e.g., water vs. polymer quenching)
- Method of loading and unloading the workpiece (e.g., manual or robotic)
- Stock removal after heat treatment
- Type of tempering (i.e., furnace/oven vs. induction)"

Source: Dan Herring, The Heat Treat Doctor®, Atmosphere Heat Treatment, vol. 1, 2014, pp. 656.

#inductionequipment #inductiondesign

#13 NO_x and High Efficiency Burners

Nitrogen oxides, or NO_x emissions, are generated in high temperature combustion systems. Nitrogen and oxygen are present in combustion air and react in the high-temperature region of the flame to produce various oxides of nitrogen. NO_x is a generic term combining NO (nitric oxide) and NO_2 (nitrogen dioxide).

Modern high-efficiency burners with a high pre-heat of combustion air through known means of recuperative or regenerative systems increase the temperature of the oxygen and nitrogen within the combustion air and the potential for high NO_x levels. Therefore, NO_x reduction methods become even more important with high pre-heat burners.

Typical reduction methods of NO_x in high efficiency burner systems include:

- Recirculation of combustion products or flue gases is very effective to reduce temperature peaks and therefore reduce nitric oxide formation.
- Lowering the temperature of the flame by air staging at the point of combustion.
- Flameless oxidation (Flox) reduces NO_x using the previously mentioned principles by lowering the peak flame temperature. Flameless oxidation works by injecting gas and preheated air directly into the system, and above the autoignition temperature.
- Oxygen combustion can theoretically reduce NO_x formation by taking away nitrogen in the combustion process. In this case, pure oxygen is introduced instead of combustion air, but this application is typically limited by process and costs associated in producing pure oxygen.

Source: WS Thermal *#NOx #combustion #Flox*

10 Steps To Troubleshoot Your Induction System

By Alberto C. Ramirez, Power Supply and Automation Engineer, Contour Hardening, Inc.

Nikola Tesla said, "If you want to find the secrets of the universe, think in terms of energy, frequency, and vibration." These three components are evident in getting to know the inner workings of an induction system. When it comes to troubleshooting such a system at in-house heat treat departments, this 10 step guide will help heat treat operators understand the secrets of induction and solve common problems that may arise.

Metals can be heated by the process of electromagnetic induction, whereby an alternative magnetic field near the surface of a metallic (or electrically conductive) workpiece induces eddy current (and thus heat) within the workpiece.

Induction systems can be complex systems that aim to heat treat specific parts or sections of a mechanical component; depending on the degree of complexity of the part to be treated, it will be the challenge of a professional to detect any problem.

1. Familiarize Yourself with the Process

The induction process involves many characteristics such as: position of the piece within the induction coil, load positions, cooling positions, cycle times, applied electric power, and others. It is important that the professional can identify the failure and the particular situation at the moment in which it is occurring.

On some occasions, the failures are not evident and therefore it is essential to analyze the part that has been treated. This analysis can be key to understanding situations such as poor depth due to electrical power or decrease in output frequency, among other possible scenarios.

In addition to the analysis of the piece, it is vital to inspect the "crime scene," since many of the induction systems — given the nature of the process and the danger involved in handling high electrical potentials — are usually highly automated and the work stations are difficult for staff to access. A good work strategy consists of carefully observing the general conditions of the equipment to determine where the problem will begin to be solved.

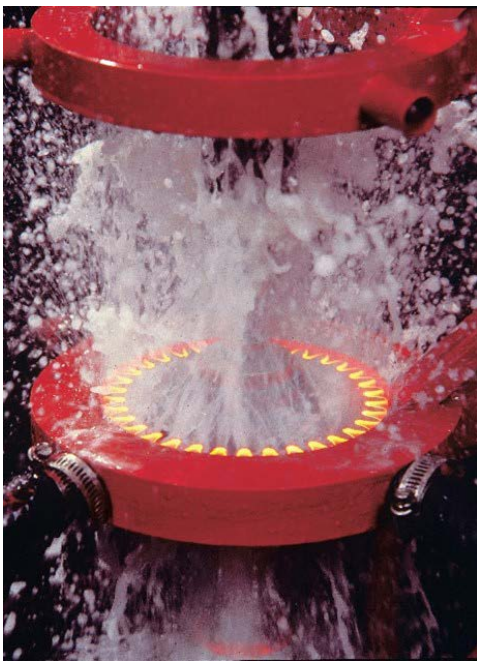


Figure 1. Induction hardening process

Figura 1. Proceso de endurecimiento por inducción

10 pasos para solucionar las fallas en un equipo de inducción

Nikola Tesla afirmó: <<Si quieres descubrir los secretos del universo, concéntrate en la energía, la frecuencia y la vibración.>>

Al revisar los mecanismos internos de un sistema de inducción es posible evidenciar cada uno de estos tres elementos. Los 10 pasos de esta guía servirán para apoyar a los operadores de departamentos internos de tratamiento térmico en entender los secretos de la inducción para así identificar posibles escollos en tales sistemas y dar solución a problemas comunes que se puedan presentar.

Los metales pueden calentarse mediante el proceso de inducción electromagnética, mediante el cual un campo magnético alternativo cerca de la superficie de una pieza de trabajo metálica (o conductora de electricidad) induce corrientes de Eddy (y, por lo tanto, calentamiento) dentro de la pieza de trabajo.

Los sistemas de inducción pueden llegar a ser sistemas complejos que tienen como objetivo endurecer piezas o secciones específicas de un componente mecánico, dependiendo del grado de complejidad de la pieza a tratar; para el profesional, el desafío será el diagnóstico de los problemas que se lleguen a presentar.

1. Familiarízate con el proceso

El proceso de inducción envuelve muchas características tales como: posición de la pieza dentro de la bobina de inducción, posiciones de carga, posiciones de enfriamiento, tiempos de ciclo, potencia eléctrica aplicada, entre otras. Es importante que el profesional sea capaz de identificar la falla y la situación particular en el momento en el que se está presentando.

En algunas ocasiones las fallas no son evidentes y, por ende, es indispensable analizar la pieza que ha sido tratada; este análisis puede ser clave para entender situaciones tales como: falta de profundidad de capa por potencia eléctrica o disminución en la frecuencia de salida, entre otros posibles escenarios.

Adicional al análisis de la pieza, es vital inspeccionar la "escena del crimen" ya que muchos de los sistemas de inducción, dada la naturaleza del proceso y el peligro que implica manejar altos potenciales eléctricos, suelen ser en extremo automatizados y las estaciones de trabajo de difícil acceso para el personal, así que una buena estrategia de trabajo consiste en observar detenidamente las condiciones generales del equipo para determinar el punto de inicio para la resolución del problema.

2. Identify Main Components and Certain Security Mechanisms of Your Induction System

Understanding the interrelationship of the system is important to comprehend which element performs a certain action, as well as the communication channels between them. Once this knowledge is generated, a failure can be associated with a particular component. Induction systems are usually made up of the elements in Figure 2.

As we mentioned before, the process involves high electrical potentials, and for this reason, the nature of the power supplies involves power electronic devices such as electrical capacitors, which store energy. Therefore, it is important to electrically discharge the system before beginning to inspect a piece of equipment.

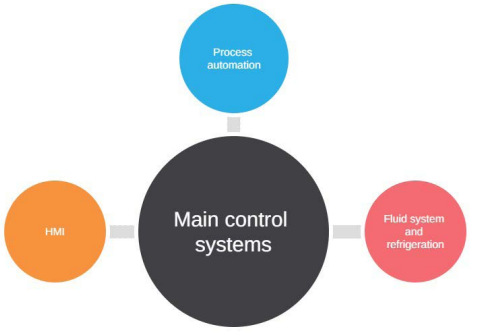


Figure 2. Induction system components

Figura 2. Componentes de un sistema de inducción

2. Identifica los componentes principales de tu sistema de inducción, así como los mecanismos de seguridad para ciertas zonas en particular

Entender la interrelación del sistema es importante para comprender qué elemento realiza cierta acción, así como los canales de comunicación entre ellos. Una vez que se genere este conocimiento, se puede asociar una falla a un componente en particular. Usualmente los sistemas de inducción se componen de los siguientes elementos:

Como mencionamos con anterioridad el proceso implica altos potenciales eléctricos, y para eso la naturaleza de las fuentes de alimentación involucra dispositivos electrónicos de potencia, como capacitores eléctricos, los cuales almacenan energía y, por ende, es importante descargar eléctricamente el sistema antes de comenzar a inspeccionar un equipo.

3. Have the Necessary Tools Ready To Carry Out a Good Analysis of the Problem

Like any technical problem, the use of a mechanical tool is essential when carrying out some type of project, but for the diagnosis of failure in induction equipment it is important to have:

- Oscilloscope
- Function generator
- Ammeter
- Digital and analog multimeter
- High voltage probes

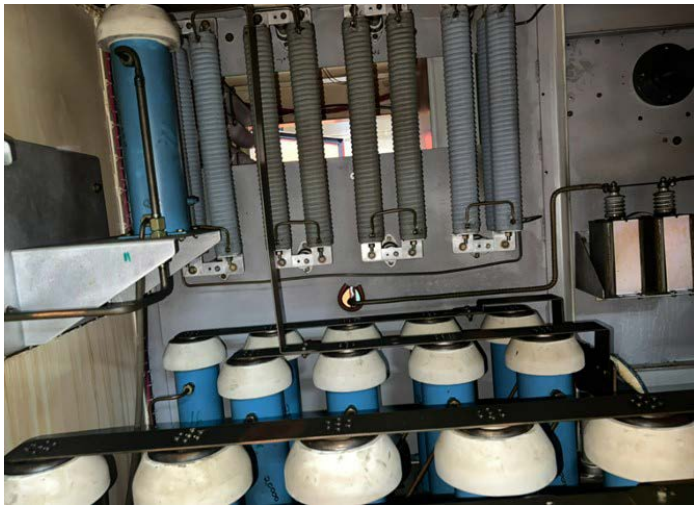


Figure 3. Capacitors
Figura 3. Capacitores

Without these elements it is exceedingly difficult to reach a reliable diagnosis, and the possibility of finding the fault is minimal. Therefore, having these meters in good condition and above all, calibrated, gives a clearer perspective of the problem.

4. Verify that the Process Sensors, Power Monitors, and Induction Coils Are Working Properly

There are different meters that collect information about the process. This information can mostly be viewed through the HMI (human machine interface). On many occasions, a good way to begin to understand the problem is by collecting the information on the process. If these meters do not work correctly, they can lead you to wrong conclusions.

Verify the energy meters are working correctly, as well as your input and output signals.

Induction coils are a key element in the induction process since, according to their geometry, they generate the appropriate magnetic fields to achieve the expected metallurgical results. If there are water leaks or the electrical transmission elements are loose or dirty, it could be the root cause of the problem. It is important to start troubleshooting once this circuit is ruled out.

3. Ten preparadas las herramientas necesarias para realizar un buen análisis del problema

Al igual que cualquier problema técnico, el uso de la herramienta mecánica es indispensable al realizar algún tipo de proyecto, pero para el diagnóstico de una falla en un equipo de inducción es importante contar con:

- Osciloscopio
- Generador de funciones
- Amperímetro
- Multímetro digital y analógico.
- Sondas de alto voltaje

Sin estos elementos es muy difícil llegar a un diagnóstico fiable, y la posibilidad de encontrar la falla es mínima. Por ende, tener estos medidores en buen estado y, sobre todo, calibrados nos da una perspectiva más clara del problema.

4. Verifica que los sensores del proceso, los monitores de energía y las bobinas de inducción funcionen correctamente

Existen distintos medidores que recogen información acerca del proceso; esta información en su mayoría puede ser visualizada a través del *HMI (Human Machine Interface*), y, en muchas ocasiones, una buena manera de comenzar a entender el problema es recopilar la información del proceso. Si los medidores no funcionan correctamente, te pueden llevar a conclusiones erróneas.

Verifica que los medidores de energía estén funcionando correctamente, así como tus señales de entrada y de salida.

Las bobinas de inducción son un elemento clave en el proceso de inducción ya que acorde a su geometría generan los campos magnéticos adecuados para lograr los resultados metalúrgicos esperados. Si existen fugas de agua o los elementos de transmisión eléctrica se encuentran sueltos o sucios, seguramente podrán ser la raíz del problema. Es importante comenzar a realizar el diagnóstico de la falla una vez se haya descartado este circuito en particular.

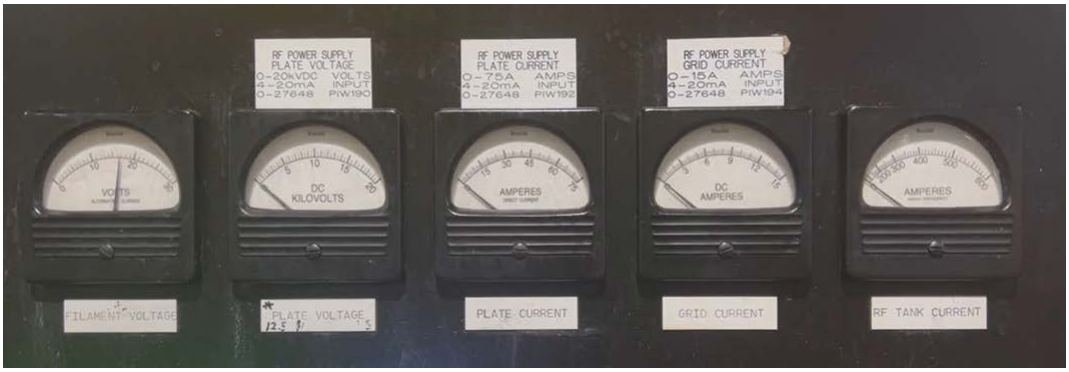


Figure 4. Energy parameters example
Figura 4. Ejemplo de parámetros de energía

5. Carry Out Studies of Constant Energy in Your Substation To Identify Possible Problems in Your Energy Supply, Including Critical Times

Electrical energy is the main source in an induction process, power supplies transform and potentiate this resource to create electronic fields strong enough to generate heat in the piece.

Therefore, it is important to find evidence that rules out failures of the electrical system that the induction system is a part of. In the same way, understanding how our electrical system behaves can help us generate behavior patterns that can determine the solution at specific times when it may arise.

6. Document Your Work Methodically and Take One Step at a Time

Induction systems can be very intimidating if you have not had previous experience, and, like any element or situation, it is important to logically approach the problem by analyzing the failure mode, identifying the main parts that interact at that specific moment. From there, document and take small steps, one at a time. If you don't, it is very likely you will lose all the work you have done, and the situation will get worse.

If the moves are unsuccessful, you can always return to your starting point and try another approach. The idea is that the failure mode remains the same no matter what moves you make until the problem is resolved. In this way you will have the failure contained, otherwise you could be damaging other elements without realizing it.

5. Realiza estudios de energía constante en tu subestación para identificar posibles problemas en tu suministro de energía, así como tiempos críticos

La energía eléctrica es la fuente principal en un proceso de inducción; las fuentes de alimentación transforman y potencializan este recurso para crear campos electrónicos lo suficientemente fuertes para generar el calor en la pieza.

Por ende, es importante descartar con evidencia que el problema en cual nos encontramos no se debe a una falla del sistema eléctrico del cual nuestro sistema de inducción forma parte. De igual manera entender cómo se comporta nuestro sistema eléctrico nos puede ayudar a generar patrones de comportamiento que puedan determinar la solución en momentos específicos en los que se lleguen a presentar.

6. Trabaja de forma metódica documentando tus movimientos y realiza un paso a la vez

Los sistemas de inducción pueden ser muy intimidantes si no has tenido experiencia previa, y, al igual que con cualquier elemento o situación, es importante abordar de manera lógica el problema analizando el modo de la falla, identificando las partes principales que interactúan en ese preciso momento, y, a partir de este análisis, documentar y realizar pequeños pasos, uno a la vez, ya que, de no ser así, es muy probable que pierdas todo el trabajo realizado y la situación empeore.

Si los movimientos no son exitosos, siempre puedes regresar a tu punto de partida e intentar otro acercamiento. La idea consiste en que el modo de la falla se mantenga estable sin

It is very important to understand that the processes are sequences that precede and proceed new events. If you understand the process and solve a problem, but now have a *new* failure, it is important to analyze if this failure is the continuation of the process. If so, it is possible that you find yourself in a case where an event is triggering a series of failures. Therefore, a more in-depth analysis must be carried out. The idea to generate is to get to the root cause and mitigate the risk.

Figure 5. Before and after of an arc at the transmission line

Figura 5. Antes y durante un arco eléctrico dentro de la línea de transmisión

7. Try Any Possibility Related to the Process Regardless of Whether the Relationship Between It and the Problem Is Not Direct

Logical thinking can solve most of the technical failures of a system. For exceptional failures, however, it is necessary to use your imagination and exhaust all possible resources, since the smallest area of interest or the least thoughtful place can be the key to solving a problem.

8. Get To Know Your Power Supplies

One of the key factors in any induction equipment is its power supplies. Power supplies are equipment that do not require such arduous maintenance compared to other systems in the industry, but if the minimum maintenance conditions are not present, they can generate high losses for the organization.

In cases where the problem is the power supplies, it is vital that the same methodical process previously described is followed. Understanding how the energy transformation process works will give you an advantage, as will knowing the elements that compose them or the type of technology used in the rectification process, in the inversion (solid state or electron tubes) and in the resonant circuit. Generally, power supplies follow the transformation in Figure 6.

importar los movimientos realizados hasta que se resuelva el problema. De esta manera lograrás contener la falla; de otra manera podrías estar dañando otros elementos sin darte cuenta.

Es muy importante entender que los procesos son secuencias que anteceden y preceden a nuevos eventos; si entiendes el proceso y, una vez resuelto el problema, ahora tienes una nueva falla, es importante analizar si esta falla es la continuación del proceso ya que, de ser así, es posible que te encuentres frente al caso de un evento que está desencadenado una serie de fallas y se haga necesario practicar un análisis más profundo. La idea general es llegar a la raíz del problema y mitigar el riesgo.

7. Intenta cualquier posibilidad relacionada con el proceso sin importar que la relación entre ésta y el problema no sea directa

Un pensamiento lógico puede resolver la mayoría de las fallas técnicas de un sistema, pero, para fallas excepcionales, es necesario utilizar la imaginación y agotar todos los recursos posibles ya que el área de interés más insignificante o el lugar menos pensado puede ser la clave para resolver un problema.

8. Conoce tus fuentes de alimentación

Uno de los factores claves en cualquier equipo de inducción son sus fuentes de alimentación. Las fuentes de alimentación son equipos que no requieren un mantenimiento tan arduo en comparación con otros sistemas en la industria, pero, de no presentarse las condiciones mínimas de mantenimiento, pueden generar altas pérdidas para la organización.

En los casos en los que el problema se encuentra en las fuentes de alimentación, es vital que se siga el mismo proceso metódico previamente descrito. Entender cómo funciona el proceso de transformación de la energía te dará una ventaja, al igual que conocer los componentes empleados o el tipo de tecnología utilizado en el proceso de rectificación, en la inversión (estado sólido o tubos de electrones) y en el circuito resonante. Generalmente las fuentes de alimentación siguen el siguiente patrón de transformación (Figura 6).

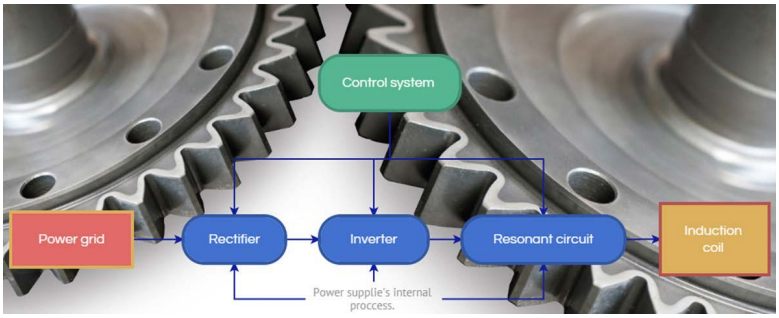


Figure 6. Flow diagram of the energy process at the power supply

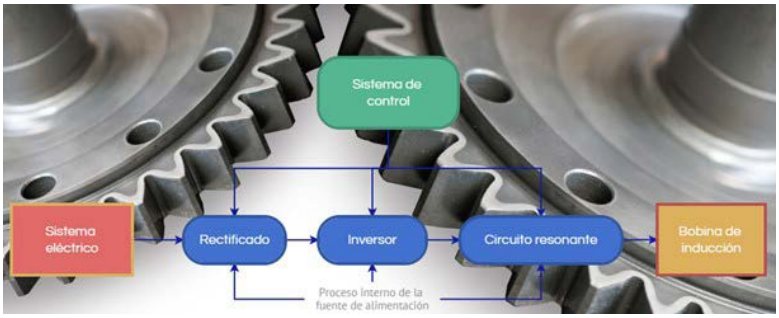


Figura 6. Diagrama de flujo del proceso eléctrico en una fuente de alimentación

9. Identify the Critical Parts of Your Induction Equipment and Prepare an Inventory

Usually, the elements that belong to the power supplies are difficult to obtain depending on the age of your equipment. With the recent microchip crisis in the market, control and automation elements have very long delivery times or the prices are very high. Therefore, it is vital that there is a list of critical parts and an inventory of these.

In addition to the elements described, induction coils are usually very characteristic and important elements in the induction process. These coils are complex elements that have been designed exclusively for the piece, so their manufacture can take several weeks, and the necessary precautions must be taken to maintain a constant maintenance movement.

Figure 7. Coil damage

Figura 7. Daño en una bobina de inducción

9. Identifica las partes críticas de tu equipo de inducción y prepara un inventario de éstas

Usualmente los componentes que forman parte de las fuentes de alimentación son difíciles de conseguir dependiendo de la antigüedad de tu equipo, y con la reciente crisis de *microchips* en el mercado, existen tiempos de entrega muy largos para los elementos de control y automatización; de igual manera, los precios de los mismos se han disparado. Por ende, es vital que exista una lista de partes críticas y un inventario de éstas.

Adicionalmente a los elementos descritos, las bobinas de inducción suelen ser elementos muy característicos e importantes en el proceso de inducción. Éstas bobinas son elementos complejos que han sido diseñados exclusivamente para la pieza, por lo que su fabricación puede tomar varias semanas, y es importante tomar las precauciones necesarias para mantener un movimiento de mantenimiento constante.

10. Perform Preventative Measurements to the System To Generate a Pattern of Behavior

When the system is working in optimal conditions, generate a measurement plan which allows you to generate information on specific points within the system. Once a new failure occurs again you can compare the measurements of failure against those of good performance. Some examples of measurements can be:

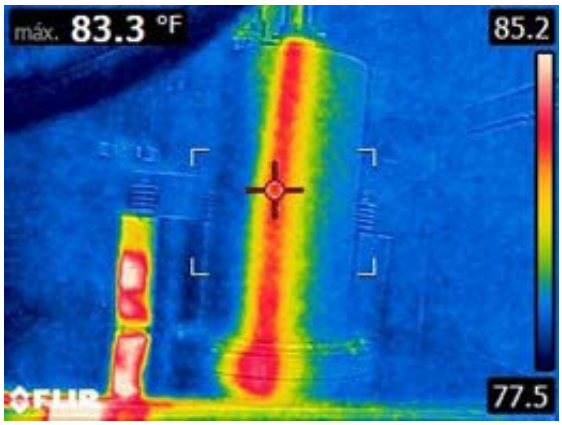
- Temperature
- Voltage
- Current
- Resistance and capacitance
- Waveforms

Summary

An orderly and documented work methodology, a good spare parts catalog, and the necessary work tools can be key elements to understand a problem and, more importantly, to solve it effectively.

It is vital that professionals are in continuous training in order to decrease downtime due to failures in induction systems. Training related to metallurgical processes would be a good way to complement your resolution skills by being able to interpret the characteristics of induction systems with the elements that compose it. HTT

(Photo Source: Contour Hardening, Inc.)



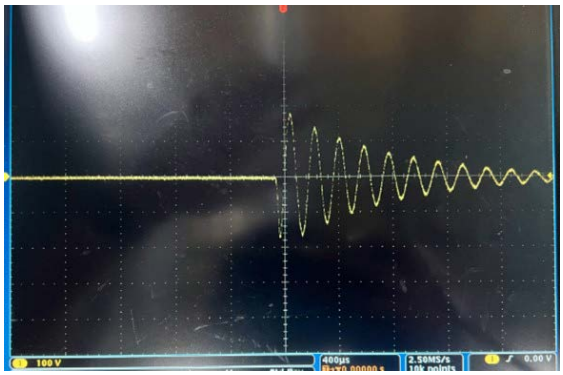


Figure 8. Possible examples of measurements

Figura 8. Ejemplo de posibles mediciones

References

Valery Rudnev and George Totten, ed., *ASM Handbook Volume 4C: Induction Heating and Heat Treatment*, (Materials Park, OH: ASM International Heat Treating Society, 2014), 581- 583.

10. Realiza mediciones preventivas al sistema para generar un patrón de comportamiento

Cuando el sistema se encuentre trabajando en óptimas condiciones, genera un plan de medición el cual te permita recopilar información de puntos específicos dentro del sistema. Una vez que se vuelva a presentar una nueva falla puedes comparar las mediciones de falla contra las del buen funcionamiento. Algunos ejemplos de mediciones pueden ser:

- Temperatura
- Voltaje
- Corriente eléctrica
- Resistencia y capacitancia
- Formas de onda

En resumen

Una metodología de trabajo ordenada y documentada, un buen catálogo de piezas de recambio, junto con las herramientas de trabajo necesarias, pueden ser elementos clave para entender un problema y, lo que es más importante, resolverlo de forma eficaz.

Es vital que los profesionales se capaciten de manera constante para mejorar los tiempos de paro debido a fallas en los sistemas de inducción. La capacitación relacionada con procesos metalúrgicos sería una buena forma de complementar tus habilidades de resolución de problemas permitiéndote interpretar las características de los sistemas de inducción, al igual que de los elementos que los componen. HTT

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Valery Rudnev and George Totten, ed., ASM Handbook Volume 4C: Induction Heating and Heat Treatment, (Materials Park, OH: ASM International Heat Treating Society, 2014), 581- 583.

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Alberto C. Ramirez graduated from the National Technical Institute of Mexico as a mechatronics engineer. He earned his master's degree in information technology administration from Monterrey Institute of Technology. With more than eight years of experience in power supplies, project management, maintenance, and automation, he currently works as a Power Supply and Automation Engineer at Contour Indianapolis. Alberto began his career at the Contour subsidiary in Mexico and due to his dedication, he is part of the staff in the United States.

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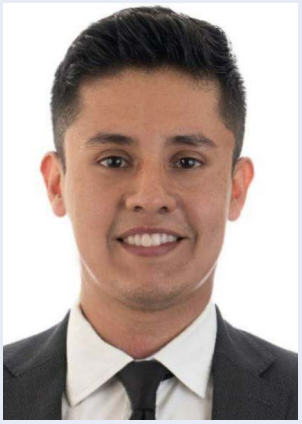

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Induction Through Heating + Intensive Quenching: A "Green Ticket" for Steel Parts

By Edward Rylicki, Vice President, Technology, and Chris Pedder, Technical Manager Heat Treat Products and Services, at Ajax TOCCO Magnethermic Corp., and Michael Aronov, CEO, IQ Technologies, Inc.

On site at heat treat operations, gas-fired furnaces can be a significant source of carbon emissions. But depending on the desired heat treatment, an alternative approach that combines induction through heating and intensive quenching could be the "green ticket." Learn about the ITH + IQ technique and discover how certain steels may benefit from this approach.

Introduction

Induction heating is a green, environmentally friendly technology providing energy savings and much greater heating rates compared to other furnace heating methods. Other advantages of induction heating include improved automation and control, reduced floor space, and cleaner working conditions. Induction heating is widely used in the forging industry for heating billets prior to plastic deformation. Induction heating is also used for different heat treatment operations such as surface and through hardening, tempering, stress relieving, normalizing, and annealing. However, the amount of steel products subjected to induction heating in the heat treating industry is much less compared to that processed in gas-fired furnaces.

Gas-fired heat treating equipment is a major source of carbon emissions in the industry. As shown in Reference 1, induction through heating (ITH) followed by intensive quenching (IQ) (an "ITH + IQ" technique) eliminates, in many cases, the need for a gas-fired furnace when conducting through hardening and carburizing processes — the two most widely used heat treating operations for certain steel parts. Eliminating gas-fired furnaces will result in significant reduction of carbon emissions at on-site heat treat operations.

The goal of this article is twofold: 1) to evaluate carbon emissions generated during through hardening of steel parts and carburizing processes when conducted in gas-fired furnaces, and 2) to discuss how these emissions can be reduced to zero using the ITH + IQ process.

Evaluation of Carbon Emissions for Through Hardening and Carburizing Processes

Most through hardening and carburizing operations for steel parts are conducted in batch and continuous integral quench gas-fired furnaces. Assumptions made for evaluating CO_2 emissions produced by a typical integral quench furnace are presented in Table 1. Note: The values of carbon emissions presented Table 1 are conservative since they don't consider the amount of CO_2 produced by furnace flame screens and endothermic gas generators used to provide a controlled carburizing atmospheree in the furnace. Also, it's assumed that the furnace walls are already heated through when loading the parts, so there are no heat losses associated with the thermal energy accumulated by the furnace walls.

Through Hardening Process in a Furnace: Temperature vs. Time

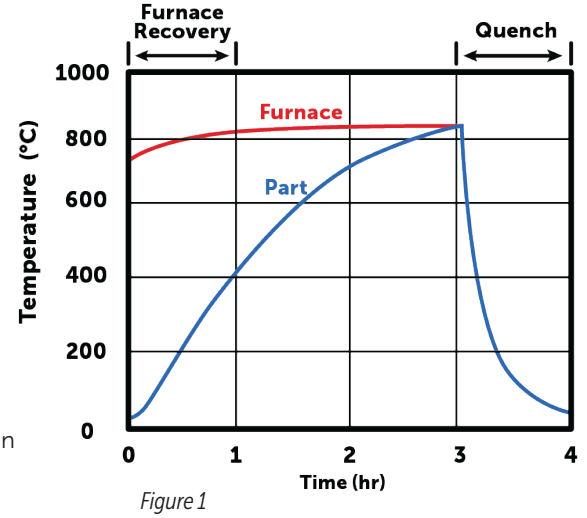


Figure 1

Emissions Generated During the Through Hardening Process

A furnace time/temperature diagram for the through hardening process considered is presented in Figure 1. Carbon emissions E_{hard} produced by the furnace considered during heating of the load to the austenitizing temperature prior to quenching are calculated by using the following equation,

(Equation 1)

$$E_{hard} = k \cdot Q_{hard}$$

where:

- k = the emission coefficient (equal to $0.050 \cdot 10^{-3}$ kg per 1 kJ of released energy when burning natural gas (see Reference 2)
- Q_{hard} = thermal energy required for heating up the above load from ambient to the austenitizing temperature

Table 1. Assumption for Calculating of Carbon Emissions by Integral Quench Furnace

Parameter	Value
Furnace working space dimensions	91 W x 91 H x 123 L cm (36 W x 36 H x 48 L in)
Furnace load	200 shafts of ø5 x 40 cm
Load gross weight	1,135 kg (2,500 lb)
Furnace thermal efficiency	65%
Furnace utilization time	85%
Furnace operation	3 shifts
Initial part temperature	20°C (68°F)
Part heating (austenitizing) temperature for through hardening process	843°C (1,550°F)
Part heating temperature for carburizing process	927°C (1,700°F)
Furnace temperature recovery time *	1 hr
Furnace soak time *	2 hr
Part carburizing time *	10 hr
Time for quenching parts in oil and for loading/unloading of parts *	1 hr
Steel specific heat capacity	0.56 kJ/kg°C
CO_2 emissions coefficient when burning natural gas [2]	$0.050 \cdot 10^{-3}$ kg per 1 kJ (117 lb per 1,000 Btu)

*See Figure 1 and 2

Table 1. Assumptions for calculating of carbon emissions by integral quench furnace

A value of Q_{hard} is calculated by the equation below,

(Equation 2)

$$Q_{hard} = M \cdot C \cdot (T_a - T_o) / Eff = 1{,}135 \cdot 0.56 \cdot (843 - 20) / 0.65 = 0.805 \cdot 10^6 kJ$$

where:

- M = load weight, kg
- C = steel specific heat capacity (kJ/kg°C)
- T_a = part austenitizing temperature (°C)
- T_o = part initial temperature (°C)
- Eff = furnace thermal efficiency (a ratio of the furnace thermal losses to the gross heat input)

From equations (1) and (2), the amount of carbon emissions produced by the above furnace during one hardening operation is 40.2 kg. To determine an annual amount of carbon emissions, calculate the number of hardening cycles per year (N_{hard}) run in the furnace. From Figure 1, a duration of one hardening cycle is 4 hours (3 hours for austenitizing of the parts plus 1 hour for quenching the parts in oil and unloading/loading the furnace). Thus, N_{hard} is equal to:

N_{hard} = 360 day • 24 hour • 0.85 / 4 hour = 1826

Annual CO_2 emissions from one integral quench batch gas-fired furnace are 40.2 • 1836 = 73,807 kg, or more than 73 t.

Emissions Generated During Carburizing Process

A simplified furnace time/temperature diagram for the carburizing process considered is presented in Figure 2.

Carbon emissions (E_{carb}) produced by the above furnace during the carburizing process are calculated by the following equation,

(Equation 3)

$$E_{carb} = k \cdot Q_{carb}$$

where:

- Q_{carb} = a thermal energy expended by the furnace during the carburizing process. A value of Q_{carb} amounts to two components:

(Equation 4)

$$Q_{carb} = Q_{carb1} + Q_{carb2}$$

Q_{carb} in the following equation is:

- Q_{carb1} = energy required for heating up the load to the carburizing temperature
- Q_{carb2} = energy needed for maintaining the furnace temperature during the remaining duration of the carburization process (for compensation of the furnace thermal losses since the parts are already heated up to the carburizing temperature)

A value of Q_{carb1} is calculated using equation (2) where the part carburizing temperature T_c is used instead of part austenitizing temperature T_a (see Table 1):

$Q_{carb1} = 1{,}135 \cdot 0.56 \cdot (927 - 20) / 0.65 = 0.887 \cdot 10^6$ kJ

A value of Q_{carb2} is a sum of the flue gas losses and losses of the thermal energy through the furnace walls by heat conduction. Q_{carb2} is evaluated from the following considerations. Since the assumed furnace thermal efficiency is 65%, the furnace heat losses are equal to 35% of the gross heat input to the furnace. Hence, the furnace heat losses Q_{loss1} during the load heat up period (the first 3 hours of the carburizing cycle, see Figure 2) are the following:

$Q_{loss1} = Q_{carb1} \cdot 0.35 = 0.887 \cdot 10^6 \cdot 0.35 = 0.31 \cdot 10^6$ kJ.

The furnace heat losses during the remaining 8 hours of the carburizing cycle Q_{loss2} are proportionally greater and are equal to:

$Q_{loss2} = Q_{loss1} \cdot 8$ hr /3 hr = 031 • 10^6 • 8 /3 = $0.827 \cdot 10^6$ kJ

Thus, the total amount of the thermal energy expended by the furnace during the carburizing cycle is $Q_{carb} = 0.887 \cdot 10^6 + 0.827 \cdot 10^6 = 1.71 \cdot 10^6$ kJ. The total amount of the CO_2 emissions from carburizing of the load in the furnace considered according to equation (3) is: $E_{carb} = 0.050 \cdot 10^{-3} \cdot 1.71$

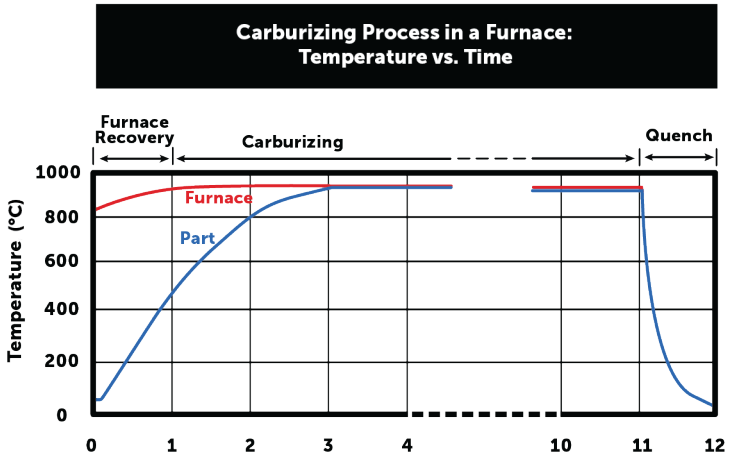


Figure 2

• 10^6 = 85.7 kg. To determine an annual amount of carbon emissions from one carburizing furnace, calculate the number of carburizing cycles run in the furnace per year. Per Figure 2, a duration of one carburizing cycle is 12 hour (1 hour for the furnace recovery plus 10 hour for carburizing of parts at 927°C plus 1 hour for quenching parts in oil and for unloading and loading the furnace). Thus, the number of carburizing cycles per year N_{carb} is:

N_{carb} = 360 day • 24 hr • 0.85 / 12 hr = 612

Annual CO_2 emissions from one integral quench batch carburizing furnace is about 85.7 • 612 = 52,448 kg, or more than 52 t.

Reducing Carbon Emissions Using the ITH + IQ Process

Reference 1 presents results of two case studies of the ITH + IQ process on automotive input shafts and drive pinions. The study was conducted with a major U.S. automotive part supplier. A two-step heat treating process was used for the input shafts, consisting of batch quenching parts in oil or polymer using an integral quench gas-fired furnace for core hardening followed by induction hardening. This two-step method of heat treatment is widely used in the industry for many steel products. It provides parts with a hard case and tough, ductile core.

Substituting the "ITH + IQ" method for the two-step heat treating process not only eliminates the batch hardening process, but also requires less alloy steel for the shafts that don't require annealing after forging. Thus, in this case, applying the ITH + IQ technique eliminates two furnace heating processes for the input shafts, resulting in the reduction of the CO_2 emissions to zero for the shafts' heat treatment. Per client evaluation, as mentioned in Reference 1, the hardness profile in the intensively quenched input shafts was similar to that of the standard shafts. Residual surface compressive stresses in the intensively quenched shafts were greater in most cases compared to that of the standard input shafts, resulting in a longer part fatigue life of up to 300%.

Per Reference 1, the environmentally unfriendly carburizing process can be fully eliminated in most cases for automotive pinions when applying the ITH + IQ method and using limited hardenability (LH) steels that have a very low amount of alloy elements. A case study conducted for drive pinions with one of the major U.S. automotive parts suppliers demonstrates the intensively quenched drive pinions met all client's metallurgical specifications and passed both the ultimate strength test and the fatigue test. It was shown that the part's fatigue resistance improved by about 150% compared to that of standard carburized and quenched in oil drive pinions. In addition, distortion of the intensively quenched drive pinions is so low that no part straitening operations were required.

Conclusion

Coupling Ajax TOCCO's induction through heating method with the intensive quenching process creates a significant reduction of CO_2 emissions produced during heat treatment operations for steel parts. For the through hardening process, eliminating just one batch integral quench gas-fired furnace will reduce carbon emissions by more than 73 ton per year. For the carburizing process, eliminating just one batch carburizing furnace will reduce carbon emissions by more than 52 ton per year. Note that for continuous gas-fired furnaces, the carbon emission reduction will be much greater due to higher continuous furnaces production rates (hence a much higher fuel consumption).

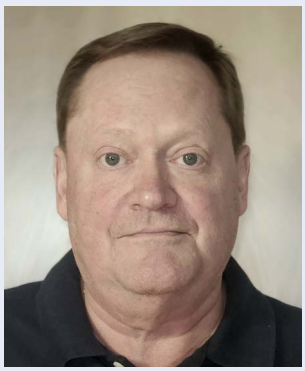
Per our experience, the ITH + IQ process can be applied to at least 20% of the currently through-hardened and carburized steel parts. Per two major heat treating furnace manufacturers in the U.S., there are thousands of atmosphere integral quench batch and continuous furnaces in operation in the U.S. That means hundreds of gas-fired heat treating furnaces can be potentially eliminated, drastically reducing carbon emissions in the U.S., supporting a lean and green economy. HTT

(Photo Source: Ajax TOCCO Magnethermic Corp.)

References

[1] Michael Aronov, Edward Rylicki, and Chris Pedder, "Two Cost-Effective Applications of Intensive Quenching Process for Steel Parts,"Heat Treat Today, October 2021, https://www.heattreattoday.com/processes/quenching/quenching-technical-content/two-cost-effective-applications-for-intensive-quenching-of-steel-parts/.

[2] U.S. Energy Information Administration, Accessed March 29, 2023. https://www.eia.gov/energyexplained/natural-gas/natural-gas-and-the-environment.php#:~:text=Natural%20gas%20is%20mainly%20methane%E2%80%94a%20strong%20greenhouse%20gas&text=The%20U.S.%20Energy%20Information%20Administration,energy%2Drelated%20CO2%20emissions.



About the Authors:

Ed Rylicki has been in the induction heating industry for over 50 years. He is currently Vice President Technology at Ajax TOCCO Detroit Development & Support Center in Madison Heights, Michigan.

Mr. Chris Pedder has over 34 years of experience at Ajax Tocco Magnethermic involving the development of induction processes in the heat treating industry from tooling concept and process development to production implementation.

Dr. Michael Aronov has over 50 years' experience in design and development of heating and cooling equipment and processes for heat treating applications. He is CEO of IQ Technologies, Inc. and a consultant to the parent company Ajax TOCCO Magnethermic.

For more information:
Contact info@ajaxtocco.com or 800.547.1527

Sustainable Spotlights

Publisher's Note

While "sustainability" and "green" are all the rage these days, **Heat Treat Today** *and the North American heat treating industry, in general, have had a long-term commitment to being environmentally responsible. Whether it's the reduction of NO_x or CO_2 in combustion processes, increasing the efficiency of both gas-fired or electrically heated processes, the reduction of environmentally harmful quench media and some heating salts, or even the move to vacuum processes in certain instances, the North American heat treat industry is one of the most environmentally friendly industries you'll find.*

While this publication is not characterized by "tree-hugging" greenness, we do have a long-standing commitment to caring for the earth — to exercise dominion and subdue it in the most stewardly way possible. To that end, we're interested in telling our readers about the most environmentally friendly technologies on the market. In the following pages, that's exactly what you'll find — market-driven technologies that are environmentally responsible. We hope you'll find these technologies informative and as a result, make better decisions about your heat treat processes. Please let us know if you have any questions about any of these technologies. AND . . . if you're a technology provider and are NOT included, please reach out to our editors at editor@heattreattoday.com.

Thanks,

Doug Glenn, Publisher, **Heat Treat Today**

Sustainable Spotlights

I SQUARED R ELEMENT

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Christina Clowes,
Vice President, I Squared R
christina.clowes@isquaredrelement.com

As one of the heating industry's leading suppliers of heating element solutions, I Squared R is on the burning edge of sustainability. Over the past 59 years, through our experiences in sales and research, we have made a steady, but moderate growth to become the largest U.S. manufacturer of silicon carbide and molybdenum disilicide heating elements, and one of the world's largest manufacturers thereof.

When it comes to sustainable technologies, our capabilities include:

- Energy conversion of furnaces from gas to electricity — decarbonize processes and reduce gaseous emissions
- Waste to energy systems — reduce landfill waste and waste transportation to landfill, convert/ neutralize toxic waste products, reduce consumption of fossil fuels
- Solid Oxide Fuel Cell (SOFC) production — hybrid power generators combining SOFC + gas turbine + steam turbine technology
- Photovoltaic (PV) material production — reduce demand for fossil fuels, reduce demand on electrical grid, clean renewable energy during active service lifetime
- Battery material production — for Li-ion and solid-state batteries for battery electric vehicles (BEV) and grid energy storage and grid supplementation systems
- Thermal Energy Storage Systems (TESS) — for grid energy storage and supplementation
- Additive manufacturing (AM) — sintering of 3D printed metal components — lower mass of parts, improved lifecycle, lower energy consumption, more efficient machines
- High efficiency melting and processing of aluminum — High Pressure Die Casting (HPDC) of complete car bodies — reduced process operations, reduced scrap, reduced weight, less energy required for vehicle propulsion
- Production of low carbon and carbon free primary metals — reduced energy consumption, elimination of greenhouse gas (GHG) emissions, reduced production cost

Electrify your process and profits with us, we'll be honored to help.

A plant using Moly-D elements for sintering of technical ceramic products in hydrogen atmosphere. (Source: I Squared R)

INDUCTION TOOLING, INC.

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William Stuehr, President, CEO, Induction Tooling, Inc.

With the increased interest and investment in sustainable electrical energy, the consumption and use of this energy must be made efficient. For example, consider LED lights. Electrical induction heating when used in the selective hardening process is a proven efficient method that often exceeds 90%. If a suitable steel part is to be case hardened within a production cell, the considered application of choice is induction.

The selective hardening process focuses induction energy only where needed. Typical of this would be a case hardening requirement of an automotive wheel spindle. The material is a forged 1050 steel. The hardened area is specified from the flange area up through the ball bearing surface and continuing up the shaft. The hardness tolerance is plus or minus 3 mm. The wheel spindle will be processed while passing through a machining cell. With this information and a well-designed inductor, the engineer with induction experience can easily determine the power, frequency, and time needed to process the spindle (see Figure 1).

The cut sample photo (Figure 2) validates the efficiency of selective induction hardening. The exact amount of energy needed was 150 kW for 3.5 seconds. The acid etch shows the hardened transformation (+/- 3 mm). The transformation pattern is isolated within the specified area. None of the induced energy into the spindle was unwanted or wasted.

Figure 2. Cut sample photo (Source: Induction Tooling, Inc.)

Many automotive steel parts are currently hardened by induction. The use of efficient power is a significant advantage of induction selective hardening.

Figure 1. A well-designed inductor (Source: Induction Tooling, Inc.)

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Dan Hill, Sales Engineer
AFC-Holcroft
dhill@afc-holcroft.com

Thermal processing is critical to producing the materials of modern life, yet the processing is unavoidably energy intensive. But that doesn't mean that heat treatment systems are impervious to ways to reduce their environmental impact. In fact, there are already many climate-aware improvements to traditional heat treatment systems that can be implemented today. AFC-Holcroft looks for ideas to lessen the heat treatment carbon footprint and offers forward-thinking ways to help safeguard the environment. Some of our green initiatives target energy savings, operating efficiencies, reduced emissions, environmental safeguards, reduced carbon footprint, and general climate protection.

One energy-saving method involves upgrading the refractory in the furnace lining. This upgrade can decrease average cold face temperature of the furnace casing by 8-9°F, resulting in an approximate 18% reduction in heat loss to the facility, while reducing the initial heating costs.

By simply adding recuperation to gas heating systems, the user can also measurably lower their heating costs — averaging 9-10% — while enabling around 6% production increase.

Advance monitoring of gas flows can identify and eliminate excessive gas consumption, reducing fuel expenditure even more.

Some of these suggestions for new equipment can also be added to existing equipment on a retrofit basis.

In facilities that utilize electric heating in their operations (which in itself can sometimes lower CO_2 emissions in certain regions), the source of electric energy itself may come from what is considered a renewable green energy source, such as wind energy, solar, hydrogen, etc. As these green energy sources become more prevalent, they have the potential to drastically lower the carbon footprint and even approach carbon neutral.

No matter which type of fuel, the use of high efficiency electric motors and variable frequency drives in our furnaces and ancillary equipment can provide significant energy cost savings while reducing equipment demand for electricity.

Lightweighting of components is a worthy goal for OEM's and their suppliers. Using lighter weight materials which have been heat treated to retain the beneficial metallurgical properties can increase a vehicle's MPG resulting from the reduced weight. AFC-Holcroft has installed complete systems to component suppliers who have successfully instituted vehicle lightweighting initiatives. Our UBQA (Universal Batch Quench Austempering) system has been a key technology in these programs.

AFC-Holcroft furnace (Source: AFC-Holcroft)

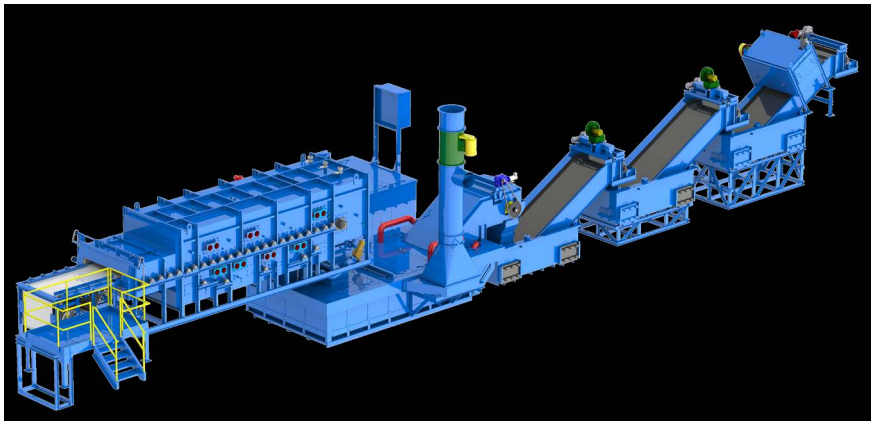
AFC-Holcroft has been the industry pioneer in the use of salt quenching, which has a number of environmental considerations:

Salt is completely soluble in water and is easily washed off in hot wash water — no detergents, chemicals or filtration systems needed.

Salt is easily recoverable/recyclable (98%+) using evaporative methods.

No oil storage/disposal issues — salt quenching vastly reduces the complexity and cost of disposal.

We're glad to offer systems like a mesh belt style salt quench systems to help heat treaters consider more environmental options.



Rendering of mesh belt austemper line (Source: AFC-Holcroft)

Super Systems incorporated

Lower Carbon Footprint with e-Trim Technology

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Phone: 513-772-0060

Damian Bratcher
Director of International Operations, Super Systems

SSi's e-Trim technology is a sustainable solution for businesses looking to lower their carbon footprint while simultaneously increasing their combustion efficiency and fuel savings. This technology is designed to optimize combustion processes by using a precise monitoring system that checks and alarms the air-to-fuel ratio, resulting in more efficient combustion and reduced emissions.

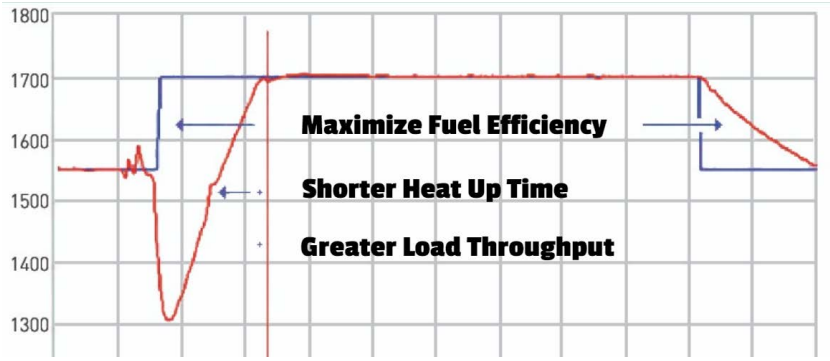
The e-Trim technology is designed to work with a variety of industrial combustion processes, including burners, boilers, and furnaces. By analyzing combustion processes in real time, the e-Trim system is able to monitor the air-to-fuel ratio to achieve the optimal combustion conditions. This ensures that fuel is burned more efficiently, reducing waste and emissions.

One of the main benefits of the e-Trim technology is that it promotes combustion efficiency, which leads to fuel savings. By optimizing the combustion process, the e-Trim system ensures that fuel is burned more efficiently, reducing the amount of fuel required to produce the same amount of energy. This results in significant cost savings for businesses, as well as a reduction in greenhouse gas emissions.

Furthermore, the e-Trim technology also has a positive impact on load capacity. A more efficient flame allows for more heat to be available to the load leading to a shorter amount of time for the load to get to temperature. By improving combustion efficiency, the e-Trim system can help businesses increase their load capacity without needing to invest in additional equipment or infrastructure. This can help businesses increase their output without increasing their carbon footprint or energy costs.

In addition to these benefits, the e-Trim technology is also a sustainable solution that helps businesses *reduce* their carbon footprint. By optimizing combustion processes, the system reduces the amount of fuel needed to produce the same amount of energy, resulting in a reduction in greenhouse gas emissions. This makes it an ideal solution for businesses looking to reduce their environmental impact while increasing their operational efficiency. By promoting combustion efficiency, reducing emissions, and increasing load capacity, the system helps businesses save money and reduce their impact on the environment.

SSi's e-Trim Air/Fuel Ratio Monitoring System (Source: Super Systems, Inc.)



Maximize fuel efficiency with e-Trim Technology. (Source: Super Systems, Inc.)

The Sustainable Alternative to Atmospheric Technology: Vacuum Furnaces

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Dennis Beauchesne
General Manager, ECM-USA, Inc.

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Low pressure vacuum technology — the solution to meet your green initiatives. Vacuum furnaces use cold wall technology that enables higher temperature treatments and easy integration into machining lines. It allows for a higher throughput, but also prevents inter granular oxidation during carburizing thanks to the absence of oxygen. Vacuum also improves employee safety by removing the risk of fire hazards and open flames generated during the process. Furthermore, thanks to the higher productivity and minimized energy loss with vacuum technology, you will see an increase in production efficiency which directly influences environmental standards and green initiatives.

Figure 2. ECM FLEX vacuum furnace (Source: ECM-USA, Inc.)

ECM's most sustainable alternative to conventional heat treating? The ECO vacuum furnace system (shown in Figure 1). These systems are a double chamber installation — a vacuum furnace with integrated oil quenching cell that gives you a cleaner, safer, and more efficient heat treatment operation. It is compact and aims to replace sealed quench or IQ furnaces for hardening, carburizing, brazing, and carbonitriding. Energy consumption is minimal, CO_2 emissions are near 80% less, and safety concerns are eliminated with the removal of open flames and fire hazards. In addition to the significantly reduced environmental impact, ECM vacuum heat treatment installations improve metallurgical properties of treated parts and can be integrated into existing batch lines, using the same peripheral equipment and conveyors.

For higher production systems, our FLEX, JUMBO, and NANO furnace systems provide high production and process reliability with a sustainable process. These systems use electrically heated process cells for many processes including FNC, nitrocarburizing, carbonitriding, brazing, low pressure carburizing, and nitriding. They also provide the lowest process emission available in the industry along with the smallest footprint and energy consumption.

For the last 25 years, ECM has provided hundreds of systems around the world reducing the carbon output by millions of pounds of carbon. We strive to help each client with their environmental and production needs using the latest in vacuum furnace technology.

Our corporate structure also has the same drive for the future of green manufacturing and supply.

"Through a team of dedicated global experts, ECM's ecological goals support the heat treat industry in its ecological and social transition by designing, manufacturing, and implementing high-tech, high-performance, decarbonized (or low carbon) furnace system solutions. Together, we will achieve a more robust, responsible, and sustainable industry adhering to environmental fluctuations," states Frédéric FÈVRE, ECM Director of Corporate Social Responsibility & Ecologic Transition.

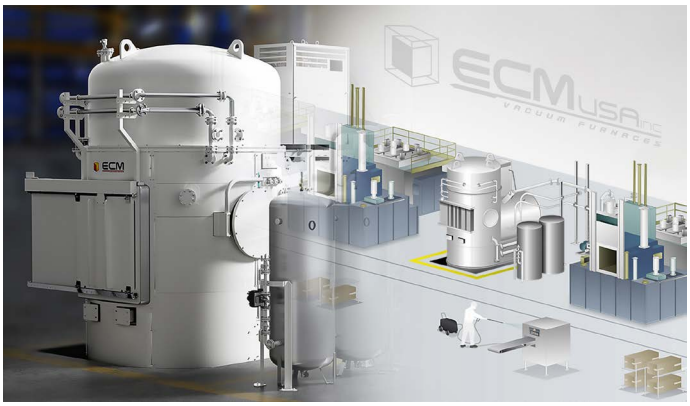

Figure 1. ECM ECO System to replace sealed quench & batch IQ furnaces (Source: ECM-USA, Inc.)

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Trevor Jones, CEO, Solar Manufacturing,
sales@solarmfg.com

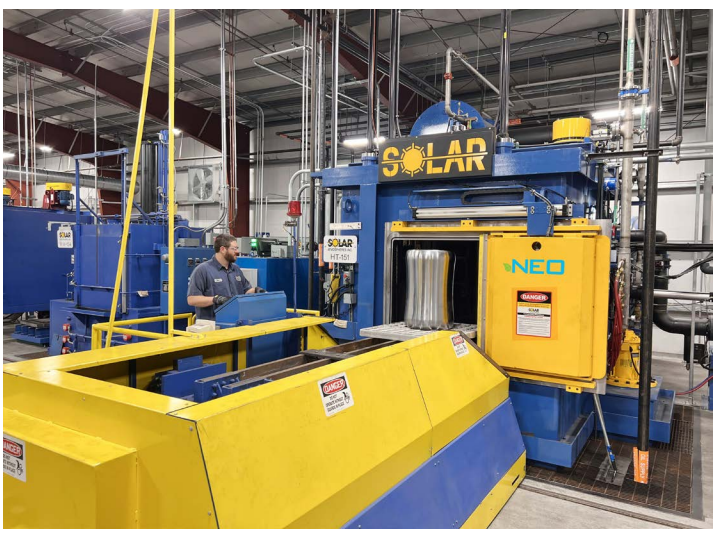
Solar Manufacturing is a valued partner to heat treaters across a wide variety of industries, bringing our ingenuity in vacuum heat treating to each client. Our vision is to remain at the forefront of vacuum furnace technology through continuous improvement of our furnace's energy efficient hot zone designs, feature-rich SolarVac® automation and controls, and high-performance gas and oil quenching systems.

Together with our affiliate, Solar Atmospheres, Solar Manufacturing offers an unparalleled proving ground to advance the science of vacuum furnace technology. We provide expertise in helping our clients choose the right vacuum furnace, replacement hot zone, spare parts, and service.

Hot zone (Source: Solar Manufacturing)

Our newest innovation is the NEO™, a batch-type vacuum oil quench furnace with a graphite insulated hot zone designed to accommodate medium-sized workloads up to 2,000 pounds. Foremost among the NEO's™ many *safety* and *environmentally green* features is its ability to properly heat treat and oil quench alloys that require cooling rates that cannot be accomplished by high-pressure gas quenching furnaces, while maintaining a contamination-free part surface. Plus, our ingenuity is *clean.* The NEO™ accomplishes these outstanding results *without* the safety concerns and environmental hazards of an atmosphere integral quench furnace, hazards such as hot exhaust gas fumes, open flames, and annoying acrid odor and soot build-up.

A new NEO™ furnace has been successfully installed at the Solar Atmospheres heat treating plant in Western Pennsylvania. Bob Hill is the president of this operation and states, "Since our new NEO™ was placed into production, it has performed flawlessly. The NEO™ has been a great addition to our operation here in western Pennsylvania."



NEO™ (Source: Solar Manufacturing)

Furthermore, like all Solar Manufacturing furnaces, the NEO™ is energy efficient and economical to operate. It is built just as rugged as all our other vacuum furnaces and replacement hot zones for longevity and outstanding value. The internal conveyance system is superior to all furnaces on the market. Another advantage of the NEO™ is that type K work thermocouples can be used for true measurement of the work temperature.

All Solar Manufacturing furnaces are designed to be safe, environmentally sensible, durable, and easy to maintain. Clients can expect each furnace to be fully tested prior to shipment and a factory service engineer to start up the furnace after installation to ensure a smooth transition to full production. All new furnaces come with a one-year warranty.

Give us a call to learn how our safe and clean ingenuity works for you or contact Trevor Jones at *sales@solarmfg.com*.

Sustainable Spotlights

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Thermal Care HFCG Series adiabatic fluid coolers are an energy efficient, green solution, which can reduce water consumption over the course of a year compared to a conventional cooling tower system. HFCG adiabatic fluid coolers are designed for outdoor use. Modular and easy to install, additional units can easily be added when there is a need to expand cooling capacity. During warm weather, units provide leaving fluid temperatures similar to evaporative cooling towers.

Minimizing Energy Consumption

Used on hot weather days, the HFCG adiabatic system decreases the air temperature as it enters the unit through wetted adiabatic pads and results in lower leaving process fluid temperatures when compared to those achieved by a standard fluid cooler using ambient incoming air.

Thermal Care HFCG Series adiabatic fluid coolers (Source: Thermal Care)

During cooler weather, the HFCG uses only ambient air for cooling. The process fluid temperatures can run low enough using only the HFCG's fans so that it is possible to support your process equipment without the use of chillers — commonly known as "free cooling."

Water Saving Control Technology

Less water is used for process cooling than with conventional evaporative cooling tower systems. Units operate as air-to-water heat exchangers to maintain a closed loop system. There is no need to replace evaporated process water or bleed-off to drain, preserving a valuable natural resource. Plus, process water remains clean and uncontaminated — reducing consumption of chemicals and frequency of cleaning the tower basin like with traditional cooling tower systems.

Sustainable Spotlights

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Phone: 877-846-7628

Tom Schultz, Sales Manager, L&L Special Furnace Co., Inc.

Seeking to help clients heat treat green products, L&L Special Furnace has also been supplying electrically heated process furnaces for years; these furnaces produce no harmful greenhouse gases or other environmentally hazardous byproducts from the heating medium, a claim few other fuel sources can make. Heater control is by means of environmentally safe solid state devices, and we're constantly improving our products' environmental impact.

When unwanted byproducts are produced from parts, L&L can include afterburners and burner extensions for the cleanup of any noxious or hazardous effluents from the byproducts of processed materials, *and* traps for non-combustible byproducts for capture/disposal by third party services.

This and more for a greener tomorrow and a happier planet.

L&L Special Furnace (Source: L&L Special Furnace Co., Inc.)

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Phone: 814-332-8520

Rafal Walczak,
Product Manager,
SECO/VACUUM

Tom Hart,
Product Manager,
Vacuum Furnaces,
SECO/VACUUM

Contact the SECO/VISORY team at info@secovacusa.com

For clean, low pressure carburizing (LPC) furnaces to integrate into your heat treat operations, SECO/VACUUM offers four models that include:

- Environmentally friendly carburizing without CO_2 emissions
- Economical on/off processing
- High quality parts without intergranular oxidation (IGO)
- A flexible operating temperature platform capable of higher temperature processes

All these furnaces can be provided with SECO/VACUUM's patented vacuum carburizing technologies and pre-nitriding, plus a patented process simulation package at no extra charge. These furnaces are defining the green scene with record of high performance worldwide.

"Vacuum technologies have an ecological edge," as Maciej Korecki, vice president of Business Development and R&D at SECO/WARWICK, has commented. "Because of their design and processes, vacuum furnaces do not interfere with the immediate surroundings and are environmentally friendly, so they can be installed in clean halls, directly in the production chain (in-line). They emit negligible amounts of heat and post-process gases which are not poisonous and contain no CO_2 at all. Gas quenching eliminates harmful quenching oil and the associated risk of fire and contamination of the immediate environment, as well as the need for equipment and chemicals for its removal and neutralization. Nitrogen used for cooling is obtained from the air and returned to it in a clean state, creating an ideal environmentally friendly solution."

One technology, the Vector®, is a single-chamber gas quenching vacuum furnace using high pressure quench (2 to 25 bar) for a wide variety of heat treating processes and applications. It provides important capabilities for producing high uniformity in heat treated parts, high consistency in workloads, and high speeds in batch processing with low consumption of power and process gases.

Another technology, the CaseMaster Evolution®, is an integral oil quench vacuum furnace that has proven to be the LPC vacuum carburizing furnace of choice for a variety of demanding industries and applications.

The third option is the UniCase Master®, a revolutionary, single-piece flow vacuum heat treatment system for low-pressure carburizing and high-pressure 4D gas quenching. In contrast to a traditional batch furnace, every single part proceeds through the system the same way and undergoes the same process parameters in terms of temperature, atmosphere, and cooling, to produce consistently high-quality results and ideal repeatability for entire part series.

Finally, the Pit LPC is an advanced 21st century pit-type vacuum furnace for low pressure carburizing (LPC) of large parts or parts requiring deep case depths. As a modern alternative for atmosphere furnaces, SECO/VACUUM's Pit LPC can reduce heat treating costs and improve production using a sustainable method in vacuum.

To help configure the perfect LPC system for your process, contact Tom Hart or Rafal Walczak.

The future of LPC (Source: SECO/VACUUM)

Sustainable Spotlights

Furnace Development for a Greener Future

furnaces@can-eng.com

www.can-eng.com

Phone: 905-356-1327

CAN-ENG continues to support Eco-Green Thermal Processing initiatives through our steadfast commitment to furnace development for the processing of electric vehicle (EV) component manufacture. We have had the opportunity to deliver to partners several newly developed furnace designs that support light weighting initiatives for body-in-white and structural component heat treatment. Furthermore, systems have been provided for the manufacture of EV drive and battery materials thermal processing. CAN-ENG also offers clients options in terms of heating system configuration and can supply systems designed using electrical or natural gas and routinely deliver electrically heated furnace and atmosphere generator systems that reduce emission potential.

In addition to electrically heat treated furnace systems and conversions, CAN-ENG continues to offer efficiency improvements in natural gas fired systems. Manufactures today have options available to them today as they gradually adjust their CO_2 emission position. To support manufactures today, CAN-ENG has developed new furnace designs that reduce greenhouse gas emissions in an effort to battle climate change. These designs have been put into practice since the early 2000s and include our Energy Reduction Systems (ERS). The ERS integrates a combination of new technologies that includes waste heat recovery and endothermic process gas atmosphere reduction design features. When implemented, endothermic gas requirements can be reduced up to 40% and a waste heat recovery feature that reduces overall natural gas consumption by 15% compared to conventional systems.

CAN-ENG supports Eco-Green Thermal Processing initiatives (Source: CAN-ENG)

Sustainable Spotlights

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www.nelhydrogen.com

Phone: 203-949-8697

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New Sustainability & Decarbonization Initiatives for Heat Treat

By IHEA Editorial Team

Searching for sustainability resources? In this first installment of the Sustainability Insights series of columns, learn from the Industrial Heating Equipment Association (IHEA) about resources available to in-house heat treaters across the industry.

One thing is certain, and it's that there is great deal of *uncertainty* about how to begin addressing issues of sustainability and decarbonization. As heat treaters begin to receive more and more questions about decarbonization, IHEA saw an opportunity to help the industry and began developing a variety of initiatives relating to sustainability and decarbonization in the industrial heating equipment industry.

Getting Started with Sustainability

The first step towards decarbonization is understanding this is a topic that will not go away. While they may not see any immediate consequences, heat treaters need to at least begin preparing now for what is quickly approaching. Before long, clients are going to be demanding heat treaters show that they are lowering their carbon emissions. Thinking, "This will not affect my business," will be detrimental in the long term.

IHEA recommends to start by considering efficiency and getting an initial assessment of carbon footprint. The fastest, easiest way to reduce carbon footprint is to burn less fuel by investing in efficiency improvements. As a side benefit, operating costs are also reduced. IHEA's current combustion courses do have content on efficiency and low carbon fuels and a webinar series specifically designed to help everyone understand how to determine their initial accounting of their carbon footprint.

Future Plans

The deeper driving forces that will affect our industry regarding sustainability are regulations, incentives, and energy economics. Rapidly changing environmental policy, growing technology incentives, and a shifting relative cost of fuels (and alternate fuel options like hydrogen) are opening new pathways for businesses to factor carbon footprint and sustainability into their operations.

Because of these upcoming changes, IHEA is developing a wide array of services and tools that will help those looking to lower carbon emissions determine the best approaches for their heat treat facilities. An entirely new body of content will be developed that will be at the leading edge of this industrial revolution.

To kick things off, IHEA has developed a Sustainability area on their website that features the foundation of information the industry needs. The Sustainability area includes the following sections: Sustainability FAQs, Sustainability Terms & Definitions, and Sustainability Resources. The Sustainability section will continue to expand by adding content and resources on a regular basis.

Additionally, IHEA is launching a series of webinars that will start the process of walking companies through the complicated issues related to decarbonization:

- May 11: Thermal Processing Carbon Footprint
- June 15: Defining Greenhouse Gas (GHG) Emissions to Target NET-ZERO
- July 20: DOE Tools and Programs for GHG Reduction
- August 24: Ongoing Sustainability: Industry Best Practices for Continual Improvement

The goal is to provide unbiased education for everyone involved in the process heating industry. The webinars are complimentary. Visit ***www.ihea.org*** and click on the "EVENTS & TRAINING" tab.

Brian Kelly, President, Honeywell Thermal Solutions

Recently elected IHEA President Brian Kelly of Honeywell Thermal Solutions says, "IHEA is taking a leadership role because we see that this will be an ongoing and changing landscape for the industry for years to come. With the years of collective expertise of our membership we feel that we can provide information, education, and guidance to help everyone navigate what is sure to be a challenging environment." Kelly continued by saying, "In the end, we want to be a source to count on to help our entire industry in their sustainability journey as it will be a long and winding road that will be different for everyone."

For more information:

Visit *www.ihea.org*.

What Should Heat Treaters Be Doing NOW?

Joe Coleman
Cybersecurity Officer
Bluestreak Consulting™

Introduction

Along with determining if CMMC (Cybersecurity Maturity Model Certification) applies to your business, this 7th article in the series from Heat Treat Today's Cybersecurity Desk will give you a better understanding of what the certification is all about and the requirements to become certified. Also, we will cover the changes that were made to CMMC 1.0, the current status of CMMC's proposed rule, and what you should be doing NOW to prepare for when the CMMC 2.0 rule is finally released.

What Is Changing in CMMC 2.0

In November 2021, the Department of Defense (DoD) announced a major update to the CMMC program. To safeguard sensitive national security information, the DoD launched CMMC 2.0, a comprehensive framework to protect the Defense Industrial Base's (DIB's) sensitive unclassified information from frequent and increasingly complex cyberattacks. Manufacturers or suppliers that handle sensitive or Controlled Unclassified Information (CUI) in any way or those within the DIB need to pay attention. CMMC 2.0 condenses the original 5 CMMC maturity levels into 3 levels, eliminating levels 2 and 4, and removing CMMC unique practices and all maturity processes. They have also revised the number of controls required for each of the three new levels. Level 1 includes 17 controls, Level 2 has 110 controls, and the total number of controls in Level 3 is still to be determined. There are also several other changes made that somewhat relax the requirements from CMMC 1.0.

Who Does CMMC Impact?

Manufacturers in the DIB are going to be held accountable to safeguard sensitive information and must comply with CMMC 2.0. Any contractor, subcontractor, supplier, or manufacturer that provides parts or services to the DoD or anyone within the DIB (no matter how minuscule) will need to comply with one of the three levels of CMMC compliance.

What Should Heat Treaters Be Doing Now?

Although CMMC 2.0 is still in the rulemaking phase, the new CMMC proposed rule is expected to be released sometime in mid-2023. This will give some much-needed clarity on how to move forward and will help streamline the implementation of CMMC. Warnings will be issued to the DIB through DoD primes and will be passed down through the supply chain. Manufacturers that do not comply will be at risk of losing contracts.

If you (or your clients) are doing work for any DoD primes (or NASA), such as Raytheon, Lockheed Martin, McDonnell Douglas, Northrup Grumman, or L3Harris (and many more), then this applies to your business. If you are unsure, check the fine print in your contracts, and/or ask your clients about their requirements.

If you handle CUI in any way, you need to be at a CMMC Level 2 or Level 3. The most common level is Level 2. If you don't handle CUI in any way, but you do handle FCI (Federal Contract Information), you will need to be certified at a Level 1.

On average, it can take a company of up to 100 employees between 12 to 18 months for NIST 800-171 (CMMC Level 2) implementation. Meaning, even though CMMC 2.0 is not completed yet, don't wait until it is. You're already a year behind if you haven't started your NIST 800-171 implementations and you want to be ready for when the CMMC 2.0 rule is released.

CMMC certification requires government oversight whereas NIST 800-171 compliance can be self-attested. You should always hire a qualified CMMC consultant to ensure that you're "audit-ready" for your certification audit.

What's the Difference Between FCI and CUI?

FCI is information not intended for public release. FCI is provided by or generated for the Federal Government under a contract to develop or deliver a product or service. CUI and FCI share important similarities and a particularly important distinction. Both CUI and FCI include information created or collected by or for the government, as well as information received from the government. However, while FCI is any information that is "not intended for public release," CUI is information that requires safeguarding and may also be subject to dissemination controls. In short: All CUI in possession of a government contractor is FCI, but not all FCI is CUI.

If you have any questions about the information in this article, please feel free to email me at *joe.coleman@go-throughput.com*. HTT

Scan to download a list of cybersecurity acronyms.

News from Abroad

Heat Treat Today partners with two international publications: heat processing, a Vulkan-Verlag GmbH publication that serves mostly the European and Asian heat treat markets, and Furnaces International, a Quartz Business Media publication that primarily serves the English-speaking globe. Through these partnerships, we are sharing the latest news, tech tips, and cutting-edge articles that will serve our audience — manufacturers with in-house heat treat.

In this issue, sample the new and the old: a brand new EAF furnace in Canada, a 50-year-old blast furnace in Germany, and new 3D tech. Also read about skyrocketing profits for one international company.

International Heat Treat and Metallurgy Company Sees Doubling Profits

"The great results of the Group were influenced by several factors. The growth of production activities in China and dynamic market development in America. Furthermore, the huge number of orders [are] related to the electromobility industry expansion. In the first three quarters of 2022, the company had over 100% more profit than in the previous year. Sales revenues amounted to PLN 448.87 million in this period (PLN 335.09 million in 2021). . . For SECO/WARWICK, 2023 will be the year of American companies."

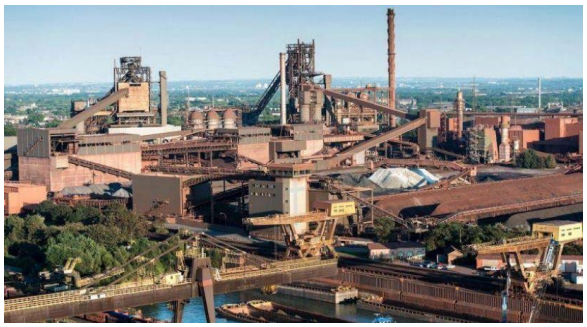
Read More: *"SECO/WARWICK Group doubles its profits in 2022"* at heat-processing.com

SECO/WARWICK's positive figures for 2022 (Source: SECO/WARWICK)

The Black Giant Turns 50

"A blast furnace in operation at thyssenkrupp Steel's Schwelgern steel mill in Germany, turned 50 years old on 6 February. Known officially as Schwelgern 1 – the Black Giant – the blast furnace is 110 meters in height and has a daily capacity of 10kt of pig iron; it is regarded as one of the biggest blast furnaces in the western world."

Read More: *"Thyssenkrupp Steel's Black Giant blast furnace turns 50!"* at furnaces-international.com



German blast furnace is 50. (Source: Furnaces International)

New Electric Arc Furnace in North America

"Tenova, supplier of sustainable solutions for the metals industry, has recently completed the start-up of the new 70t EAF at the Valbruna ASW Inc. plant, located in Ontario, Canada. Valbruna ASW is a specialty steel producer that produces steel and stainless-steel, based in Ontario. Tenova's latest generation EAF unit has replaced an older EAF vessel. The spout shape of the new furnace will provide an increase in melt shop productivity, says Tenova, as well as an improvement to the production reliability of manufacturing specific high-quality steel and stainless-steel grades."

Read More: *"Tenova supplies Canadian EAF"* at furnaces-international.com

System aids in the production of various steel grades. (Source: Tenova)

Predict Cold Dimensions Quickly

"At METEC 2023, nokra will be showing for the first time its new alpha.hot3D system for 3D laser-based measurements of hot forging specimens. The system can predict the cold dimensions of a forged part in a matter of seconds after forging. This makes it possible to verify as early as the first few parts have been produced that the forming process is working without a hitch. If it is not, you can immediately take measures to adjust it."

Read More: *"Prediction of Cold Dimensions in a matter of seconds after forging"* at heat-processing.com

"The hot forged parts are picked up as they leave the press and directly placed into the measuring cell." (Source: nokra)

Heat Treat Shop

Heat Treat Today believes that people are happier and make better decisions when they are well informed. To get a sense of what options the market has for you, check out some of the heat treat components, parts, services, and supplies listed below. These products have been featured in our monthly e-newsletter called **Heat Treat Shop**, where manufacturers with in-house heat treat departments — especially in the aerospace, automotive, medical, and energy sectors as well as general manufacturing — can easily share this information.

Want to see your product listed here? Contact Doug Glenn at doug@heattreattoday.com.

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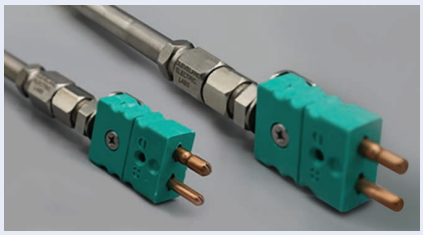

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Pacific Metallurgical, Inc.

Heat Treat Today's
MTI MEMBER PROFILE

Family-owned, aerospace prime approved, Nadcap certified, and fully capable of keeping up with the heavy competition in the Northwest. That's Pacific Metallurgical, Inc.

Pacific Metallurgical, Inc. (PMI) began in 1968 in Washington state as a part of Pacific Steel Treating. The goal in 1968 was to create a close connection to Boeing and the aerospace sector in the Northwest. The company initially struggled until Doug Allan purchased it in 1972, using his business background to revamp the failing endeavor. In 1982, Doug hired his son-in-law, Dave Fallen, to assist in managing the business and later sold the business to Dave and his wife, Doug's daughter Cathy. In 2001, Doug's son, Derek, switched careers to join the ranks at the family's business. Currently, Derek runs the business, as Cathy is now retired.

Located in the tech-heavy Northwest, the company is not only competing with aerospace giants like Boeing and Blue Origin for employees, but they are also competing with tech giants, like Amazon and Microsoft. As a family business, employees are treated as extensions of the family, and this attitude is a competitive advantage when compared to the giants in the region. PMI currently has 52 employees in their "family."

The once father-son-in-law duo turned into a major competitor and has a distinct focus on heat treating for the aerospace industry which inspires their desire to tailor their work to fit Nadcap and client requirements. PMI now has approvals from companies such as Boeing, Gulfstream, Bell Helicopter, and more. Aerospace isn't all they do, though. The military and medical industries are also on their list of target industries.

Interior view of Pacific Metallurgical, Inc.'s facility

Offerings of the company include vacuum/atmosphere processing (endo, argon, nitrogen), aging (aluminum and steel), gas carburizing, solution treating, and more. Additionally, they provide certified heat treating of steel, aluminum, and special alloys. Along with their aerospace approvals, the company employs four full-time metallurgists available to answer any questions clients may have. These metallurgists help navigate specification requirements and have aided the company in creating a name for itself as a single-source supplier for aerospace heat treating applications.

In addition to aerospace prime approved heat treating processes, PMI also offers inspection services. Hardness testing (including Rockwell hardness testing and microhardness testing) are among their specialties. A captive laboratory offers inspection of metallography, case depth analysis, and more. Aside from defense work, the most unique workpieces Pacific Metallurgical, Inc. ever heat treated were propeller blades for the Washington State Ferries.

In the next five to ten years, finding more members to join the PMI family and keeping up with the industry demand post-pandemic are at the top of the priority list. As the family continues to evolve to meet Nadcap requirements and client demand, it will continue to invest in thermal processing equipment and technology for more accurate monitoring and processing heat cycles. Quality control, innovation, and client service are key elements of their mission, and they hope to continue providing these values well into the future.

(Photo Source: Pacific Metallurgical, Inc.)

Pacific Metallurgical, Inc. offers a variety of thermal processing and inspection services.

For more information, contact

Pacific Metallurgical, Inc.
925 5th Ave S
Kent, WA 98032
United States
Phone: (253) 854-4241
www.pacmet.com
derek@pacmet.com

Heat Treat Classified

In this section you will find classified advertisements for Used Equipment, Employment, and Aftermarket products and services. Each ad is clearly marked with one of those categories. Employment/help wanted ads tend to be toward the front of the section and Used Equipment ads tend to be toward the back with Aftermarket sprinkled throughout.

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Qualifications/ Experience Required:

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- Ability to travel domestically and internationally

Responsibilities:

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- Check-out of all mechanical, electrical and piping sub-systems, ensuring the overall system and individual components operate safely and as designed per engineering drawings, operating instructions, vendor literature and applicable specifications.
- Provide direction in resolving non-contractual customer and contractor issues.
- Document all problems encountered during the installation and start-up of the equipment and the status of a verification of results of any field revisions.
- Assist customer personnel with the initial operation and testing of processing performed by the equipment.
- Train customer personnel in the safe, efficient operation and maintenance of the equipment.
- Provide frequent reports and checklists, detailing progress, planned dates for major tasks and all open issues.
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www.go-bluestreak.com/cybersecurity-consulting-2

Employment

Seeking Employment

Eric Roth, recipient of the Metal Treating Institute's (MTI's) 2022 Founders Scholarship and recent graduate of University of Arizona with a degree in Materials Science/Metallurgy is seeking employment in the heat treat industry preferably with a company that has their own in-house heat treat operations. Eric has interned at Phoenix Heat Treating in Phoenix, AZ, and at ECM-USA in Wisconsin.

Reach Eric at ericsroth@gmail.com or call/text 520-343-8092

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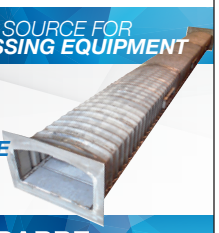

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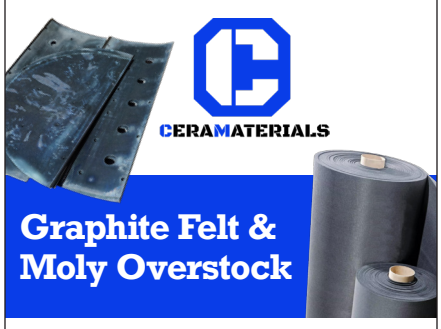

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An induction generator that is compact, portable, affordable and easy to integrate with automation. Purchase for immediate delivery or request a rent-to-own option.

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gholland@emag.com (248) 630-7756
Learn More: http://bit.ly/3xGQYOH

Aftermarket

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be responsible

Aftermarket Services

We offer non-halogenated solvents (e.g. modified alcohols) to help heat treaters meet precision cleaning requirements for critical applications such as gas nitriding, ferritic nitrocarburizing and low pressure carburizing. With no requirement for water, our solvent solutions enable a resource-efficient, cost-effective and sustainable cleaning process. Get in touch for a free consultation.

Chris Tivnan
Sales Manager North America
+1 774 764 1492
c.tivnan@safechem.com
www.safechem.com

Aftermarket

Conax Technologies' ISO/IEC 17025:2017 accredited calibration lab

AMS 2750 compliant sensors for demanding applications and heat treating processes

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Used Equipment

INTEGRA ASSET SOLUTIONS

For Sale

Heat Treatment & CNC Machining

- Minster 1200-Ton Transfer Press
- Aida Knuckle Joint & Forging Presses
- Asahi Sunac and Sakamura Cold Formers
- AFC-Holcroft Annealing Furnaces
- Takisawa CNC Lathes
- Die Cast Machines
- Mitutoyo CMM's
- Gear Grinders & Shapers
- Keyseaters & Spliners
- Vertical Turning Centers
- Milling & Turning Centers
- Horizontal Boring Mills
- Gantry Mills
- Cylindrical & Internal Grinders
- Welding Manipulators & Positioners
- Heat Treat
- Bridge & Jib Cranes

Contact: Mark Reynolds
708-765-3989 | mark@integra-as.com

Aftermarket

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Have Equipment to Sell?

Heat Treat Today's classified advertising section is the place to start. With North America's largest collection of used heat treat equipment, you're sure to reach the right people. AND ... everything you list is also listed ONLINE at no extra charge.

Contact Eunice Pearce
at **(616) 401-4723**
or email:
eunice@heattreattoday.com
for pricing and availability.

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Employment

WS FLOX

Help Wanted: Field Service Technician

WS Thermal Process Technology is a leading manufacturer and world class provider of environmentally friendly combustion systems with over 35 years of experience providing an innovative and award winning product line. Our focus is on the highest possible energy efficiency with minimal emissions. We are proud to be prepared for the future: We are Green Gas Ready!

WS Inc. has an immediate opening in our Field Services Department in Lorain, Ohio. We are currently expanding our field services department and seeking a service technician to join our team. Our products are widely used in heat treating furnaces, steel processing and other high temperature applications. We offer a great career opportunity for the right candidate to join a growing organization working in an exciting industry.

Person filling the position will work with a team of experienced service technicians. Duties will include equipment start up, maintenance, troubleshooting and documentation. Extensive U.S. & local customer base requires approximately +50% over-night travel.

WS Thermal Process Technology Inc.

8301 West Erie Avenue | Lorain, OH 44053 | USA

Fon +1 440 385 6829 | Fax +1 440 960 5454 | Email: wsinc@flox.com

Employment

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Wisconsin Oven is a leading industrial oven manufacturer, and we're looking to add more dedicated employees to our team! Our employees receive competitive wages, great benefits, and opportunities for career advancement. We are hiring now for the following positions:

- Field Service Engineers
- Production Planner
- Electrical Engineer
- Assembler/Fabricator
- Sheet Metal Operator

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Used Equipment

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Thermal Care Sales

847-966-2260

sales@thermalcare.com

THERMAL CARE

USED EQUIPMENT

Accuchiller TSE 100 Ton Central Chiller

Model - TSEW100SB40001100N

Serial Number - II312012110

Date of Manufacture - 10/2021

Condition - Excellent

Warranty - 90 days

Voltage - 460/3/60

Capacity - 100 tons

List Price - $68,510

Net Price - $61,659

Used Equipment

L&L Special Furnace

USED EQUIPMENT

Tom Schultz
Sales Manager
L&L Special Furnace
610-459-9216
tom@llfurnace.com

L&L Special Furnace Model FNC5366 Retort Furnace (Retort Not Included)

Work Zone: 60"W x 36"H x 72"D. 650°C Max Temp. 2,000lb Max Load.

Eurotherm E+PLC Control System with E-Pack SCR Heater Controls.

Inert Atmosphere Inlet. ThermoStack Exhaust Afterburner. Venturi-assist Chamber Cooling.

SBS Corp. Water Circulation System for Retort Seal.

Motorized Load Cart with Integrated Hearth Tray.

480/3/60 - 236 FLA.

Located outside Boston, MA.

Used Equipment

Surface Combustion

Surface Combustion has two (2) used Uni-DRAW® Batch Tempering furnaces for sale!

They have an electrical heating source, are piped for nitrogen atmosphere, and are externally cooled. Size: 36" (w) x 48" (l) x 36" (h) with a load capacity of 4000 lbs.

CONTACT SURFACE TODAY
TO FIND OUT MORE: ***1-800-322-7278***

Used Equipment

"BIG BERTHA"
is ready for immediate sale!

Fully refurbished, AMS2750G & Nadcap ready.

10' Long Work Zone!

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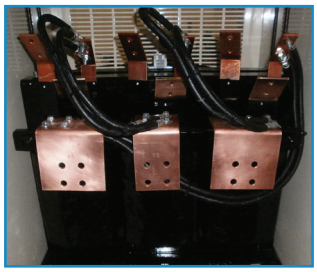

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Used Equipment

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Established by John L. Becker

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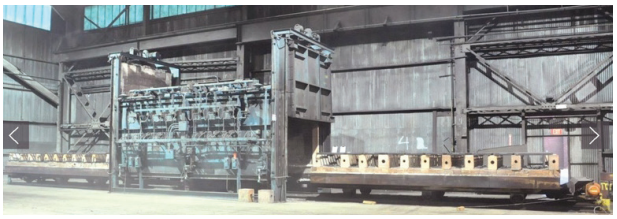
Phone: 734-331-3939
Fax: 734-331-3915
heattreatequip.com

Surface Combustion U-3805
Allcase Integral Quench Furnace



Heated/Max Demand:	Natural Gas (3175 CFH - 1,000 BTU/cuft)
Max Temp:	1800°F
Power:	460 V, 3-phase, 60 Hz, 70 KW
Working Dim's:	36" wide x 48" deep x 30" high
Waukee Flow Meters:	(5) air, ammonia, natural gas, endo, nitrogen
Controls:	Honeywell High Limit & Quench High Limit Honeywell Multipoint Recorder Allen Bradley PanelView 1000
General:	System 1 rear handler

Armil CFS V-1200
Car Bottom Furnace



Type:	Double Ended Car Bottom Furnace
Heating:	Natural gas – 9.72 MM BTU
Max Temp:	1750°F
Workable Dim's:	8' wide x 23' long x 4' high
Power:	460 V, 3-Phase, 60 Cycle
General:	2 full-length motorized cars Cylinder activated fiber bottom seals
Controls:	Free standing control panel Barber Coleman controller Honeywell controller

Furnaces, Ovens & Baths, Inc.
EQUIPMENT FOR SALE

ATMOSPHERE GENERATORS

- 3000 CFH Endo, Gas Fired, 2000°F, Lindberg, Air Cooled
- 3000 CFH Endo, Electric, 1950°F, Gasbarre, Water Cooled
- 3000 CFH Endo, AFC, 1950°F, Gas - 2 Available
- 5600 CFH Endo, Gas Fired, 1950°F, Rogers Engineering
- 6000 CFH Gas Atmospheres Exothermic, Gas Fired, 1950°F

BOX FURNACES

- 30"W x 30"H x 48"L, J.L. Becker/Surface, 1400°F, Gas Fired
- 30"W x 30"H x 48"L, 1750°F, Electric, Surface Combustion
- 10'6"W x 6'H x 35'L, Gas Fired, 1650°F, Drever, Atmosphere
- 36"W x 36"H x 72"L, Surface Combustion, 1750°F, Gas Fired
- 15"W x 12"H x 18"L, Lindberg Sinterall, 2100°F, H2 Atmos.
- 30"W x 30"H x 48"L, Selas, 1450°F, Gas
- 30"W x 30"H x 48"L, Surface, 1450°F, Gas
- 30"W x 30"H x 48"L, Surface, 1400°F, Gas
- 30"W x 20"H x 48"L, Surface, 1250°F, Gas
- 30"W x 20"H x 48"L, Surface, 1250°F, Gas
- 60"W x 60"H x 60"L, Lindberg, 1250°F, Gas
- 72"W x 42"H x 78"L, Grieve, 1250°F, Inert Atmosphere

BELT OVENS

- 18"W x 5"H x 10'L, 500°F, Electric, Despatch
- 30"W x 15"H x 10'L, Grieve, 400°F, Electric
- 18"W x 23"H x 12'L, Jensen, 550°F, Gas Fired
- 30"W x 18"H x 15'L, Despatch, 650°F, Gas Fired, REBUILT
- 24"W x 20"H EACH, Wisconsin Oven, 2 Lane Belt Oven, 650°F, Gas

INTEGRAL QUENCH FURNACES

- 36"W x 36"H x 48"L, Surface, Electric, 1750°F
- 24"W x 18"H x 48"L, 1850°F, Gas Fired, Ipsen T-8, 2 Zones
- 36"W x 36"H x 48"L, AFC, Gas, 1750°F

ROTARY HEARTH FURNACES

- 50" Dia, 18"W x 9"H Door, Electric, 1600°F

INDUCTION HEATING/MELTING

- 125 kW, 3 kHz, 300 Lb. VIM Melter
- 200 kW, 3 kHz Pillar w/Scanner
- 100 kW, 30-50 kHz Inducto-Heat
- 150 kW, 30 kHz, Inducto-Heat
- 100 kW, 10 kHz Inducto-Heat
- 300 kW, 3/10 kHz Inducto-Heat BSP5
- 100 kW, 3/10 kHz Inducto-Heat BSP
- 150 kW, 3/10 kHz Tocco Inductron II
- 100 kW, 10 kHz Ajax/Tocco, 48" Scanner
- 150 kW, 3/10 kHz Ajax/Tocco, 60" Scanner

WALK-IN OVENS

- 48"W x 72"H x 48"L, Precision Quincy, 1000°F, Gas, Solvent
- 55"W x 60"H x 30"L, 350°F, Electric, Precision Quincy
- 48"W x 72"H x 60"L, Grieve, 500°F, Gas
- 36"W x 60"H x 48"L, Grieve, 350°F, Electric
- 36"W x 72"H x 48"L, Gruenberg, 300°F, Electric
- 36"W x 72"H x 68"L, Gruenberg, 500°F (140°F w/Solvents), Class A
- 72"W x 72"H x 72"L, JPW, 500°F, Gas Fired
- 36"W x 72"H x 36"L, DIS, 550°F, Gas Fired, 4 Compartments (NEW)
- 48"W x 72"H x 48"L, Grieve, 500°F, Electric

CABINET OVENS

- 36"W x 48"H x 24"L, Electric, 600°F, Blue M, Class "A"
- 25"W x 20"H x 20"L, Electric, 650°F, Inert Gas, Blue M
- 48"W x 36"H x 24"L, Electric, 500°F, Inert Gas, Blue-M
- 20"W x 20"H x 18"L, Blue M, 1100°F, Electric, Atmosphere
- 48"W x 72"H x 48"L, Despatch, Electric, 500°F
- 25"W x 20"H x 20"L, Blue M, 1100°F, Inert Gas
- 66"W x 42"H x 53"L, Grieve, 500°F, Gas

MANY MORE AVAILABLE PLEASE VISIT OUR WEBSITE
www.fobinc.com

PIT TEMPERS/NITRIDERS

- 28" Dia x 48"Deep, L & N, 1200°F, Electric, NITIRIDER
- 28" Dia x 28"Deep, Lindberg, 1250°F, Gas
- 38" Dia x 48"Deep, Wisconsin, 1250°F, Electric, 2 Avail.
- 38" Dia x 48"Deep, Lindberg, 1250°F, Electric, 3 Avail.

WASHERS CONVEYOR & BATCH

- 24"W x 10"H, SS Belt Washer, Electric, Wash & Blow-Off
- 12"W x 12"H, SS Belt Washer, Electric, W/R and Blow-Off
- 36"W x 18"H, SS Belt Washer, Gas, W/R/Blow-Off
- 24"W x 18"H, SS Belt Washer, Electric, W/R/Blow-Off
- 30" Diameter Rotary Drum Wash, Gas Fired, Stainless Steel
- 40"W SS Conveyor Washer, W/R/R/Dry-Off, Gas Fired
- 24"W x 24"H x 24"L, Ipsen, Dunk & Spray, Gas
- 30"W x 30"H x 48"L, Surface Combustion, Spray, Gas
- 30"W x 20"H x 48"L, Surface Combustion, Spray, Electric

SHOT BLAST

- Pangborn 8LK 96" Diameter Table Blast w/Dust Collector
- Pangborn 4LK 48" Diameter Table Blast w/Dust Collector

MISCELLANEOUS

- 48"W x 36"H 48"L, Despatch Quick Quench Drop Bottom, Electric 1000°F
- 36 x 48 AFC Charge Car, Double Ended, 2 Available
- Several 36 x 48 scissors lift tables and stationery tables
- 30 x 48 Surface Combustion System 1 Charge Car
- 30 x 48 Lindberg Pacemaker Charge Car

CALL OR E-MAIL YOUR REQUIREMENTS

Jeffrey D. Hynes, 248.343.1421 or sales@fobinc.com. For a complete inventory listing with photos visit www.fobinc.com

Heat Treat EQUIPMENT

Established by John L. Becker

Heat Treat Equipment

Ready to Deliver.

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Phone: 734-331-3939
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Batch Temper Furnaces

C0189	Williams Industrial Batch Temper Furnace (30"W x 48"D x 30"H, 1250°F, gas)
U3697	B&W Temper Furnace (36"W x 72"D x 36"H, 1400°F, gas)
U3737	Wisconsin Oven Batch Temper Furnace (24"W x 48"D x 24"H, 1250°F, elect, 48kw, 66amp)
U3764	Lindberg Batch Temper Furnace (33"W x 65"D x 36"H, 1400°F, gas)
U3765	Sunbeam Batch Temper Furnace (30"W x 57"D x 34"H, 1200°F, gas)
U3782	Williams Batch Temper Furnace (36"W x 72"D x 36"H, 1450°F, gas)
U3785	Unique Batch Temper Furnace (40"W x 40"D x 51"H, 1200°F, gas)
U3810	Surface Combustion Temper Furnace (36"W x 48"D x 36"H, 900°F, gas)
U3811	Surface Combustion Temper Furnace (36"W x 48"D x 36"H, 900°F, gas)
U3837	Surface Combustion Temper Furnace (36"W x 54"D x 30"H, 1250°F, elect)
U3838	Surface Combustion Temper Furnace (30"W x 48"D x 30"H, 1250°F, elect)
V1170	Grieve Batch Temper Furnace (48"W x 48"D x 48"H, 1100°F, gas)
V1182	Wisconsin Oven Temper Furnace (24"W x 18"D x 36"H, 1250°F, gas)
V1196	Surface Combustion Temper Furnace (36"W x 72"D x 36"H, 1600°F, gas)

Batch High-Temp Furnaces

UV1130	Onspec High-Temp Batch Furnace (72"W x 96"D x 48"H, 2400°F, gas)
V1185	Cooley High Temperature Batch Furnace (12"W x 32"D x 16"H, 2000°F, elect)

Car Bottom Furnaces

C0198	Williams Car Bottom Furnace (80"W x 192"D x 60"H, 1450°F, gas)
V1166	Rockwell Car Bottom Furnace (60"W x 121"D x 72"H, 1000°F, gas)
V1179	Tilt-Up Car Bottom Furnace (8'W x 16'D x 8'H, 1600°F, gas)
V1200	Armil Car Bottom Furnace (8'W x 23'D x 4'H, 1750°F, gas)

Internal Quench Furnaces

C0187	Pacific Scientific Straight-Thru Furnace (24"W x 36"D x 18"H, 1750°F, gas)
C0193	Surface Combustion IQ Furnace (30"W x 48"D x 30"H, 1850°F, gas)
U3687	Surface Combustion IQ Furnace with Top Cool (36"W x 72"D x 36"H, 1750°F, gas)
U3718	Surface Combustion IQ Furnace (36"W x 48"D x 36"H, 1750°F, gas)
U3768	AFC IQ Furnace with Top Cool (36"W x 48"D x 36"H, 1800°F, gas)
U3805	Surface Combustion IQ Furnace (36"W x 48"D x 36"H, 1800°F, gas)
U3807	Surface Combustion IQ Furnace (36"W x 48"D x 36"H, 1800°F, gas)
UV1082	Holcroft IQ Furnace with Top Cool (36"W x 48"D x 30"H, 1850°F, gas)
V1173	AFC IQ Furnace with Top Cool (36"W x 48"D x 36"H, 1800°F, gas)
V1193	Surface Combustion IQ Furnace (36"W x 48"D x 30"H, 1800°F, gas)

Oil Quench Furnaces

C0199	Abar Ipsen Vacuum OQ Furnace (36"W x 48"L x 30"H, 2300°F, elect)

Vacuum Furnaces

C0170	Seco Warwick Vacuum Carburizer Furnace (36"W x 48"D x 32"H, 2300°F, elect)
C0179	Vacuum Industries Vacuum Furnace (24"W x 36"D x 24"H, 2100°F, elect, 171kw)
U3759	Abar Ipsen Vacuum Furnace (36"W x 48"D x 30"H, 2500°F, elect)
U3831	Surface Combustion Vacuum Furnace 2-Bar (36"W x 48"L x 36"H, 2400°F)
V1131	Abar Vacuum Furnace 2-Bar (24"W x 60"D x 24"H, 2450°F, elect, 150kw)
V1138	Ipsen Vacuum Furnace 5-Bar (24"W x 36"L x 14"H, 2400°F, elect, 112.5kw)

Mesh Belt Brazing Furnaces

UV1035	Seco Warwick Mesh Belt Brazing Furnace (18"W x 12"H x 10' heated, 2100°F, elect)

Pit Nitriding Furnaces

U3727	Surface Combustion Nitriding Pit Furnace (27"Dia x 35"D, 1050°F, electric, 90KW)

Steam Tempering Furnace

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

Heat Treat Lines

U3687	Surface Combustion IQ Furnace Line (36"W x 72"D x 36"H, 1750°F, gas)
UV1082	Holcroft IQ Furnace Line with Top Cool (36"W x 48"D x 30"H, 1850°F, gas)

Scissors Lifts, Holding Tables, Conveyors

U3690	Surface Combustion Scissors Lift (36"W x 72"D)
U3825	Abar Ipsen Scissors Lift (36"W x 48'L, 18K lbs)
U3826	Abar Ipsen Double Holding Station (36"W x 96"L)
UV1086	Holcroft Scissors Lift & (2) Holding Tables (36"W x 48"D)

Ovens - Cabinet & Batch

U3699	Wisconsin Cabinet Oven (25"W x 24"D x 25"H, 650°F, elect, 12kw)
U3752	Precision Quincy Batch Oven (36"W x 36"D x 36"H, 500°F, gas)
U3753	Blue M Batch Oven (24"W x 20"D x 20"H, 1300°F, elect, 25amps)
U3754	Blue M Batch Oven (16.5"W x 16"D x 20"H, 482°F, elect, 3kw)
U3792	Grieve Batch Oven (24"W x 24"D x 24"H, 1250°F, elect)

Ovens - Walk-In

C0195	Grieve Walk-In Oven (60"W x 72"D x 72"H, 500°F, elect)
U3788	Wisconsin Walk-In Oven (96"W x 240"D x 96"H, 650°F, gas)
U3791	Jensen Walk-In Oven (72"W x 72"D x 72"H, 600°F, gas)
U3799	Walk-In Oven (72"W x 72"D x 72"H, 800°F)
U3802	Sahara Walk-In Oven (48"W x60"D x 55"H, 500°F, elect)
U3834	TPS Walk-In Oven (68"W x 72"L x 65"H, 842°F, elect)
V1181	Grieve Walk-In Oven (52"W x 76"D x 72"H, 750°F, elect)

Charge Cars

U3688	Surface Combustion DE Charge Car (36"W x 72"D)
U3762	Surface Combustion Charge Car DE/DP (36"W x 72"D)
U3763	JL Becker Charge Car DE (30"W x 48"D)
U3820	Abar Ipsen Charge Car (36"W x 48"D)
UV1085	Holcroft Charge Car DE/DP (36"W x 48"D)

Washers

C0134	Surface Combustion Washer SDA (60"W x 60"D x 48"H, 180°F, gas)
U3689	Surface Combustion Washer - spray only (36"W x 72"D x 36"H, elect) with holding station
U3711	AFC Holcroft Washer SD (24"W x 36"D x 24"H, gas)
U3800	Ipsen - Spray/Dunk Washer (36"W x 48"D x 24" H, elect)
V1177	AFC Washer SDA (36"W x 48"D x 36"H, 190°F, gas)
UV1084	Holcroft Washer SD (36"W x 48"D x 30"H, 190°F, elect)

Endothermic Gas Generators

C0194	Lindberg Endothermic Gas Generator (1500 CFH, 1950°F, gas)
U3594	Atmosphere Furnace Endothermic Gas Generator (3000 CFH, gas)
U3635	Lindberg Hydryzing Endothermic Gas Generator (6000 CFH, gas)
U3836	Sunbeam Endothermic Gas Generator (1,000 CFH, gas)

Exothermic Gas Generators

U3652	Surface Combustion Exothermic Gas Generator (10,000 CFH, gas)

Salt Bath Furnace

C0173	Upton Salt Bath Furnace (60"W x 96"D x 72"H, 1100°F, gas)

Ammonia Dissociators

U3767	Nitrex Ammonia Dissociator 500cf
V1180	CI Hayes Ammonia Dissociator (500 cfh)

Heat Exchanger Systems

U3787	SBS Air-Cooled Heat Exchanger, 2 fans
U3801	MRM/SBS Heat Exchanger, 1 fan
U3833	Dalkin Heat Exchanger - 7.5 Ton
V1197	SBS Oil Cooler

Water Chiller

U3710	Koolant Koolers Chiller (HCR 20,000 PR-MB)

Water Cooling Systems

U3565	Hytrol Conveyor - Roller (48"W x 10'D each)
U3646	HydroThrift, Duplex Pump Base, Water Cooling System

Holding & Cooling Stations

Many other holding & cooling stations - ask for details

Baskets & Boxes

Extensive inventory of heat treat baskets and boxes

Transformers

Extensive inventory of all types of transformers for any and all applications

Since 1936

Celebrating 87 Years

THE W.H. kay company

Used Heat Treating Furnaces and Ovens

BELT FURNACES/OVENS

6" x 48" x 3"	Hayes (Atmos)	Elec 2100°F
32" x 24' x 12"	OSI Slat Belt	Gas 450°F
24" x 16' x 12"	Lewco	Elec 350°F
48" x 20' x 48"	Thermation	Gas 500°F
2000 #/HR	AFC Pusher Hardening (Atmos)	Gas 1750°F

MISCELLANEOUS

Combustion Air Blowers (All sizes)
12" Diam. x 48" Mellen Tube FCE. Elec 2300°F
24" x 36" Lindberg Charge Car (Manual)
36" x 48" Surface Scissor Lift (2)
24" x 36" x 24" Ipsen D&S Washer Gas
36" Diam. Viking Rotary Table Washer Elec
Garden City Alloy "Plug" Fans (2) - 1350°F
30" x 48" x 36" Surface Washer Gas
30" x 48" x 30" Surface Washer (2) Gas
(2) Bell & Gossett "Shell & Tube" Heat Exchangers
30" x 30" x 30" Subzero -105 to 375°F Elec.
30" x 48" Surface Charge Car (System 1)
30" x 48" Lindberg Charge Car (2)
30" x 48" x 30" Surface D&S Washer Gas
AFC Pusher Line (Atmos.) Gas 1750°F
36" x 48" AFC Scissor Lift(6) Elec
36" x 48" Charge Car(DE) AFC - Elec (2)
48" x 53" x 48" Guyson Spindle Blaster Elec
36" Wide Table- Rotary Hearth (Atmos.) Elec 1850°F
36" x 48" Holcroft Charge Car (DE)
24" Wide Table Surface Rotary Hearth Gas 1750°F
SBS Air/Oil Coolers (8)

OVENS/BOX TEMPERING

8" x 18" x 8"	Lucifer	Elec 1250°F
12" x 16" x 18"	Lindberg (3)	Elec 1250°F
14" x 14" x 14"	Blue-M	Elec 1050°F
14" x 14" x 14"	Blue-M	Elec 650°F
14" x 14" x 14"	Gruenberg (solvent)	Elec 450°F
19" x 19" x 19"	Despatch	Elec 850°F
20" x 18" x 20"	Blue-M	Elec 400°F
20" x 18" x 20"	Despatch	Elec 650°F
20" x 18" x 20"	Blue-M	Elec 650°F
20" x 18" x 20"	Blue-M (2)	Elec 800°F
20" x 20" x 20"	Grieve	Elec 1000°F
22" x 42" x 22"	TM (Vacuum)	Elec 750°F
24" x 24" x 36"	New England	Elec 800°F
24" x 24" x 48"	Blue-M	Elec 600°F
24" x 36" x 24"	Demtec (N2)	Elec 500°F
24" x 36" x 24"	Grieve	Elec 1000°F
24" x 42" x 24"	Pacific	Elec 1450°F
25" x 20" x 20"	Blue-M	Elec 650°F
24" x 36" x 48"	Gruenberg	Elec 500°F
25" x 20" x 20"	Blue-M	Elec 1300°F
25" x 20" x 20"	Blue-M (Inert)	Elec 1100°F

OVENS/BOX TEMPERING (CONT.)

26" x 26" x 38"	Grieve (2)	Elec 850°F
30" x 30" x 48"	Process Heat	Elec 650°F
30" x 38" x 48"	Gruenberg (Inert) (2)	Elec 450°F
30" x 48" x 20"	Surface (2)	Gas 1250°F
30" x 48" x 24"	Selas	Elec 1450°F
30" x 48" x 30"	Surface (2)	Gas 1400°F
30" x 48" x 30"	Surface (2)	Elec 1400°F
30" x 48" x 24"	Ipsen	Gas 1250°F
30" x 48" x 30"	Selas	Gas 1450°F
36" x 36" x 36"	Blue M Environment Chamber	(-18°C to +93°C)
36" x 36" x 60"	P-Quincy	Gas 500°F
36" x 48" x 30"	Lindberg	Elec 1250°F
36" x 48" x 36"	Grieve (Inert)	Elec 1250°F
36" x 48" x 36"	TPS (Environmental)	Elec -40°C to +200°C
36" x 60" x 36"	CEC (2)	Elec 650°F
36" x 108" x 36"	Wisconsin	Elec 1250°F
37" x 25" x 37"	Despatch	Elec 500°F
37" x 25" x 37"	Despatch	Elec 1000°F
38" x 20" x 26"	Grieve	Elec 500°F
48" x 48" x 20"	Lindberg (Hyd. Press)	Elec 1250°F
48" x 48" x 72"	Blue-M	Elec 600°F
48" x 34" x 52"	Heat Mach. (2)	Elec 350°F
48" x 48" x 48"	L+L (Atmos)	Elec 1200°F
48" x 48"x 60"	Blue-M	Elec 400°F
48" x 48" x 72"	Grieve	Gas 650°F
40" x 52" x 63"	Despatch	Gas 650°F
60" x 60" x 60"	Lindberg	Gas 1250°F
60" x 60" x 60"	P-Quincy	Gas 500°F
60" x 96" x 72"	Grieve	Elec 450°F
60" x 96" x 72"	P-Quincy	Elec 650°F
60" x 120" x 72"	P-Quincy	Elec 450°F
72" x 78" x 42"	Grieve (Inert)	Elec 1250°F
84" x 264" x 84"	Lewco (2010)	Elec 500°F
96" x 192" x 96"	Despatch	Gas 650°F
96" x 360" x 48"	Sauder Car Bottom	Elec 1400°F

ATMOSPHERE GENERATORS

500CFH	Ammonia Dissoc. Drever	Elec
500CFH	Endothermic Lindberg	Gas
750CFH	Endothermic Ipsen	Gas
800CFH	Endothermic Surface	Gas
1,000CFH	Exothermic Gas Atmos.	Gas
1,500CFH	Endothermic Lindberg (Air)	Gas
3,000CFH	AFC - (2) Air Cooled	Gas
3,000CFH	Endothermic Lindberg (4) - Air	Gas
3,600CFH	Endothermic Surface	Gas (2)
6,000CFH	Exothermic Modern Equipment	Gas

BOX FURNACES

12" x 24" x 10"	Lindberg (Atmos.)	Elec 2000°F
13" x 24" x 12"	Electra Up/Down	Elec 2000°F
12" x 24" x 10"	Lindberg (Atmos.)	Elec 2500°F
12" x 24" x 12"	Hevi Duty (2)	Elec 1950°F
17" x 14.5" x 12"	L&L (New)	Elec 2350°F
18" x 36" x 18"	Lindberg (Atmos)	Elec 2500°F
18" x 36" x 18"	Lindberg (Fan)	Elec 1850°F
20" x 48" x 12"	Hoskins	Elec 2000°F
30" x 48" x 30"	Surface (RTB)	Elec 1750°F
36" x 84" x 24"	Lindberg	Gas 2000°F
48" x 168" x 60"	Ohio (Car)	Gas 2300°F
60" x 216" x 48"	IFSI (Car Bottom)	Gas 2400°F
96" x 360" x 48"	Sauder Car Bottom	Elec 1400°F
108" x 156" x 84"	American (Car)	Gas 2300°F
126" x 420" x 72"	Drever "Lift-Off" (2) (Atmos.)	Gas 1450°F

PIT FURNACES

22" Dia x 26"D	L + N (2)	Elec 1200°F
22" Dia x 36"D	L + N	Elec 1400°F
28" Dia x 48"D	L + N Nitrider	Elec 1200°F
38" Dia x 48"D	Wisc Oven (2)	Elec 1250°F
38" Dia x 48"D	Lindberg (3)	Elec 1250°F
72" Dia x 72"D	Flynn + Dreffein (2) (Atmos.)	Elec 1400°F

VACUUM FURNACES

12" x 20" x 12"	Abar	Elec 2400°F
24" x 36" x 18"	Hayes (Oil Quench)	Elec 2400°F
48" x 48" x 24"	Surface (2-Bar)	Elec 2400°F

INTEGRAL QUENCH FURNACES

24" x 48" x 18"	Ipsen T-8 (2 Zone)	Gas 1850°F
30" x 48" x 20"	Surface	Gas 1750°F
30" x 48" x 24"	Surface	Gas 1750°F
30" x 48" x 30"	Ipsen T-9	Gas 1750°F
30" x 48" x 30"	Surface "Top Cool"	Elec 1750°F
30" x 48" x 30"	Surface	Elec 1750°F
36" x 48" x 36"	Surface	Elec 1750°F
36" x 48" x 36"	AFC	Gas 1850°F

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