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Automotive
Medical
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Manufacturing

Heat Treat Today

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

Annual Issue

Automotive Heat Treating

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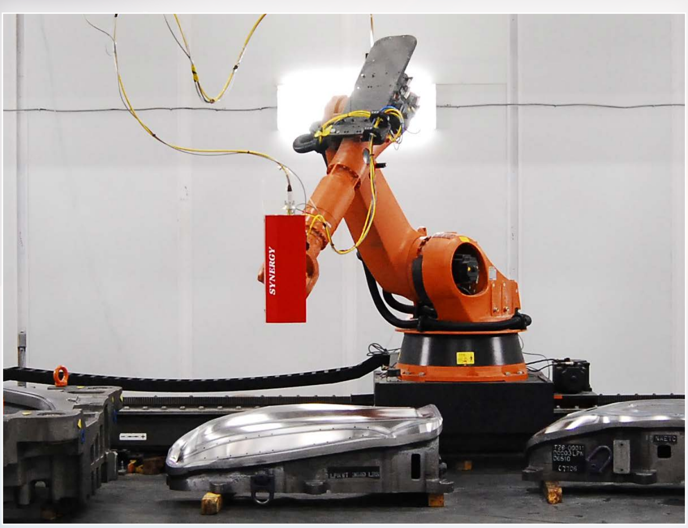

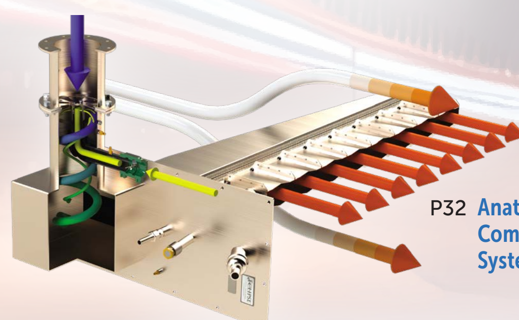

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Heat Treat Today

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WHY WE'RE HERE

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

OWNERSHIP

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

Features

Cover image source: ZF Group

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Departments

Doug Glenn, Publisher
Heat Treat Today

Letter from the Publisher

Why You Should Have Been at THERMPROCESS

There was something qualitatively different about this year's THERMPROCESS event than all the other events I've attended — and it was "all good" for North America, especially the U.S.

For those who might not know about THERMPROCESS, it is the largest high-temperature thermal processing event in the world. It is held every four years in Düsseldorf, Germany. It is roughly three to four times the size of either the ASM Heat Treat Show or Furnaces North America — North America's two largest thermal processing events — and draws significantly more attendees from nearly everywhere in the world . . . EXCEPT North America. More on that below. THERMPROCESS is held concurrently with three other metals-related events. Combined, they are called Bright World of Metals, and this year they drew a combined 63,300 visitors from 114 countries.

Cleanest Shirt in the Dirty Laundry

What made this year's event qualitatively different from past events was the demonstrable interest in the North American market. Here's a quick story to demonstrate this point.

Doug Glenn with CAN-ENG at THERMPROCESS. Left to right: Michael Klauk, Doug Glenn, Theresa Eagles, Tim Donofrio, and Scott Cumming.

At each THERMPROCESS since 1999, I spend the bulk of my time walking around visiting other exhibitors, because they are either current **Heat Treat Today** advertisers or prospects. The first question I ask prospects is, "Do you currently or are you interested in selling your product into the North American market?"

In years past, a large number of the exhibitors said "no." Not this time. My wife, who graciously joined me in 2019 and this year, mentioned the obvious difference between 2019 and 2023. She noted that nearly everyone was interested in talking with us once they found out that we were able to help them enter or grow their presence in the North American market.

Being from North America where we hear daily that our economy is on the verge of collapse, this unusually intense interest in the North American market was somewhat perplexing. Nonetheless, that was the response. More and more European, Asian, and even South American companies are showing interest in bringing their wares to our shores.

While it is true the U.S. and other North American economies are not as good as they could be, we are still the "least worst" of world economies . . . and apparently the rest of the world sees us as an example of economic growth for the next decade at least.

You Should Have Been There

This brings me to the main message of this column: You should have been there! If you work for a manufacturer who has in-house heat treat operations, a commercial heat treater, or a supplier to the North American thermal processing market, you should have been there! The breadth of technologies and variety of capabilities on display is unparalleled. There was something for everyone. Besides, it is a GREAT cultural experience to attend this event and spend some time in the evenings in Düsseldorf's Altstadt (old city) enjoying some Altbier, excellent food, and outstanding people watching!

Doug Glenn with Zircar Ceramics. Left to right: David Hamling, Philip Hamling, Doug Glenn.

THERMPROCESS Visits

This page gives a preview of several THERMPROCESS visits. You can find a more complete group of photos toward the end of this edition. See pages 50-51.

HTT

(Photo Source: **Heat Treat Today**)

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Bethany Leone, *Managing Editor*
Heat Treat Today

Message from the Editor

Maximize Your Tradeshow Walk

Q2 tradeshows ended with a bang at THERMPROCESS, and now we look to the highly anticipated ASM Heat Treat Show in Detroit. Over the last three years, I've learned some essential strategies to help make the most of these information-dense experiences to achieve my goals effectively. For the quiet industry veterans and the bright young first-timers alike, these tips will ensure you're well-prepared and ready to seize the opportunities that lie ahead.

First and foremost, it's crucial to know your **"why"** before attending a trade show. Ask yourself: Why am I attending? It could be to learn about the latest technical heat treat advances, explore digital business management tools, analyze the competition in a different market, or simply increase industry knowledge. Whatever it is, keep it clear and keep it number one. Identifying your primary goal will guide each preparation or day-of decision to help you meet any ancillary goals.

Doing thorough **research** prior to the trade show is vital. Take the time to identify who will be exhibiting and familiarize yourself with their offerings. Print out or save a digital copy of an exhibitor's map and mark the booths you intend to visit. Consider how each booth aligns with your objectives and what unique value they offer, be it new technologies on the market, equipment or process offerings, services, or industry trainings.

Track individual or companies you want to connect with using a **visit list**. This will ensure that you don't miss any important interactions that you are planning to have or that others want to have *with* you. It's especially important to maximize your networking opportunities with people who don't have a booth.

Next, prepare your **follow-up plan**.

Bethany Leone, Doug Glenn, and Michelle Ritenour at Ceramics Expo 2022

Trade shows often inundate us with information and connections, so it's essential to have a strategy for managing and leveraging these valuable insights. The follow-up plan should be tailored for the specific trade show goal, then also consider whether an email follow-up or a summarizing document method is best for you.

Information capture is a critical aspect of trade show success. With the abundance of information coming your way, it's crucial to have a plan in place. Decide how you will capture and organize the information effectively. There are various methods you can employ, such as direct uploading of images and documents using your phone scanner, utilizing an audio recorder to capture conversations and details, or opting for traditional notetaking using a notepad or the backs of business cards. Again, consider your number one tradeshow goal and how this information will transfer to your follow-up plan.

Prep a **lightweight** ensemble with **pockets**! Pant pockets, name-badge pocket sleeve, crossbody purse with pocket, or even a multi-pocketed jacket with zip pockets (though, beware the warm room temperature of the tradeshow floor). Handouts, business cards, booth tokens, or simply your room key, wallet, and phone need to go somewhere.

While preparation is key, taking care of yourself is equally important. Ensure you get a good night's **sleep** before and during the trade show. Adjusting to a new environment is a proven challenge facing restful sleep. Establish a routine that allocates buffer time to settle into your sleeping quarters and get ready in the morning. Don't side-eye sleeping aids; a bottle of water, a favorite music playlist or podcast, or even your own pillow could be the key tool to achieving a restful slumber.

Lastly, stay **open-minded** and enjoy the show! Despite all the planning and scheduling, trade shows are vibrant events with exciting experiences to offer. Embrace the atmosphere, engage with fellow attendees, and immerse yourself in the sights, sounds, and speakers. Allow serendipitous encounters to unfold and spark spontaneous conversations. Some of the most significant benefits of attending a trade show arise from these unplanned connections.

As you embark on your trade show journey, remember these insights to make the most of this valuable opportunity. Prioritize your goals, conduct thorough research, plan your follow-up strategy, capture information effectively, ensure restful sleep, and most importantly, relish the experience. It's a process that I am still learning, so join me at ASM's Heat Treat Show 2023 and we can walk it together! HTT

(Photo Source: Heat Treat Today)

Contact Bethany Leone at
bethany@heattreattoday.com

Humberto Torres Sánchez
Quality Coordinator, ZF Group

Greener Mobility from the Heat Treat Department

The trend of automotive companies in recent years has been to bet on greener ways of transportation to reduce the carbon footprint that we have left over the last decades. As heat treatment professionals, it is our duty to look for viable alternatives that do not affect the quality of heat treated products, remain safe, and above all reduce our carbon footprint.

At ZF Group, we are committed to this challenge with many heat treat efforts employing induction. In fact, the decision to incorporate induction heat treatment initially was made to reduce operating costs, improve part and plant cleanliness, and improve layout, as opposed to conventional hardening. With induction heat treat, we are able to use less quench media — avoiding waste — and work to improve the efficiency of induction heat treatment in our facilities.

As a result, we've seen major improvements. These include streamlined processes by reducing electricity consumption, reduction of air emissions, and the most important, in my opinion, the total elimination of the use of oil for tempering when using environmentally friendly tempering media.

But improvements didn't happen overnight. It took at least two years to fully incorporate induction for our automotive parts production, and streamlining the processes came about in stages. Three key steps to incorporate induction for our in-house heat treat operations were:

1. Understand required product qualities (e.g., steel quality, diameter, length).
2. Achieve the metallurgical characteristics required by drawings and making use of the parameters of the inductor machine (e.g., power, heating speed, quench flow).
3. Validate the product with functional tests (dynamic and static).

To accommodate all of these new changes, we must add continuous training with personnel. This is essential to avoid reprocessing parts, as well as to reinforce the importance of analytical and critical thinking in favor of ecological improvement.

Another important element to move towards sustainable automotive processing solutions is employing the use of low pressure carburizing (LPC) instead of conventional carburizing. Greater homogeneity of metallurgical characteristics such as hardness and effective case depth can be achieved. Using LPC, we can reduce air emissions and eliminate quenching oil.

Making automotive heat treat operations environmentally friendly is an all-encompassing endeavor. In transitioning away from oil quenchants in heat treat operations, we have been able to use cleaning detergents that are less corrosive, and which have a longer half-life within the process. In the future, the processes the industry uses will move to more environmentally friendly chemicals, and the correct preventive maintenance to avoid liquid leaks to eliminate soil contamination will be made.

Through all these efforts, ZF Group is committed to a greener mobile future. HTT

Source: Markes/Adobe Stock

About the Author

Humberto Torres Sánchez is the quality coordinator at ZF Group and is responsible for the quality department, laboratories, and special processes (heat treatment and welding). Involved in a variety of plant operations, he acts as the lead auditor for both CQI-9 and CQI-15. Learn more about Humberto from his ***40 Under 40 Class of 2022*** *profile at www.heattreattoday.com/40-under-40-2022.*

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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

› **Aero Space Power**, an MRO facility, has ordered a custom-made vacuum furnace from **SECO/WARWICK** to be utilized in repair solutions for both complex aircraft engines and gas turbines in the energy industry.

Furnace for aircraft parts and gas turbines

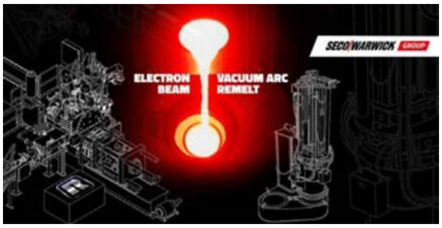
› **UPC-Marathon's** gas generator was recently installed for **Jomarca**, one of the biggest manufacturers of fasteners, bolts, nuts, and fixing elements in Brazil.

Gas generator for fastener manufacturer

› **Solar Atmospheres of Western PA** recently degassed 175,000 pounds of 6Al-4V titanium in their 48-foot-long vacuum furnace.

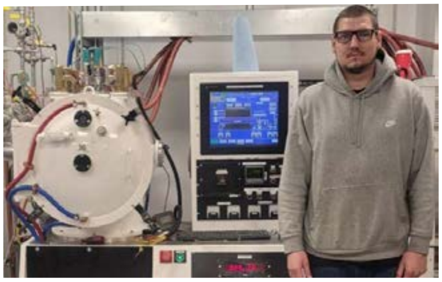
Record setting titanium load

› **Retech**, a **SECO/WARWICK Group** division, has a contract for both electron beam and vacuum arc remelt furnace technology.



Retech furnace technologies contracted

› **Mercer Vacuum Components and Services, Inc.**, a Terre Haute, IN, company, has completed the commissioning of a vacuum furnace system for a Mid-Atlantic manufacturer.



Upgrading and commissioning vacuum furnace

› At a **Schaeffler** plant in Germany, an indirectly heated roller hearth furnace with energy efficient REKUMAT® burners was put into operation by **WS Wärmeprozesstechnik GmbH** to be operated with both natural gas and H_2.

Indirectly heated roller hearth furnace

› **Wisconsin Oven** announced the shipment of an electrically heated horizontal quench system to a manufacturer of products for the automotive industry, specifically for aluminum solution treatment.

Horizontal quench system for aluminum solution treatment

› A new, fully automated quenching system from **Wakefield Thermal** is nearing completion and will be installed at **C/A Design's** heat treat facility in Exeter, NH, which serves the aerospace and defense industry.

New, fully automated quenching system

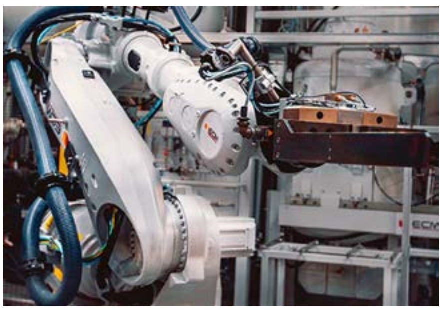
› Full-service commercial heat treating solutions provider **Akademi Metalurji** incorporated a turnkey nitriding installation from **Nitrex** to save on process gases and production time, and also process wider-dimensioned parts.

Team at Akademi Metalurji

› A global developer of power generation systems is planning to expand heat treat capabilities with **SECO/VACUUM's** 2-bar vacuum furnace.

2-bar vacuum furnace for global developer

› **SEW-EURODRIVE** has commissioned **ECM USA's** modular NANO vacuum furnace system completely integrated with advanced automation for their Lyman, SC, facility.



6 chamber, 20 bar quench NANO vacuum furnace system

› The **ANDRITZ Group** will supply **Shandong Nanshan Aluminum Co., Ltd., China** with the engineering, equipment supply, supervision of erection, and commissioning of two continuous heat treatment lines and one continuous process treatment line.

Commissioning of two continuous heat treatment lines and one continuous process treatment line

› **Assan Alüminyum** has ordered four aluminum coil annealing furnaces, which are equipped with an efficient Vortex® 2.0 system from **SECO/WARWICK**.

Aluminum coil annealing for increased heat transfer efficiency

› **KÜNNE Group** orders the world's first wire annealing furnace, from **WS Wärmeprozesstechnik GmbH**, with an innovative heating concept of burners which can use both natural gas and hydrogen.

Innovative design for wire annealing furnace

PERSONNEL AND COMPANY CHATTER

› **Retech**, a **SECO/WARWICK Group** division, will expand into a Buffalo, NY, building that will house fabrication, welding, small assemblies, and other manufacturing machinery.

New industrial space for Retech

› **Victaulic**, a manufacturer of mechanical pipe joining, fire protection, and flow control solutions, acquired **Horizon Metals, Inc.**, a foundry with heat treatment capabilities, located in Nephi, Utah.

Victaulic

HM HORIZON METALS

Acquisition for Victaulic

› The **Metal Treating Institute** recently held its 2023 Spring Meeting in Naples, FL, with a mixture of business and fun.

MTI 2023 Spring Meeting; (left to right) Jim Orr, Joe Theismann, Chad Wright, and Doug Glenn

› **Thomas Hansmann** succeeds **Hans Ferkel** as CTO and member of the Managing Board at **SMS group GmbH**.

Hans Ferkel (left) and Thomas Hansmann (right)

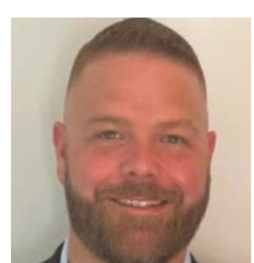
› **SECO/WARWICK USA**, a **SECO/WARWICK Group** division, has outgrown its century-old current Meadville office and is moving into the recently rehabilitated Crawford Business Park, just about two miles away.

New space for SECO/WARWICK's Meadville team

› The **Nadcap** program — which provides critical process accreditations of suppliers in the aviation, defense, and space industries — is developing a new task group for additive manufacturing (AM).**›** **Rockford Combustion**, a company in the fuel-train management and combustion safety industry, launched a newly revamped website providing educational, engineering, and e-commerce resources to enterprises that rely on fuel-fired burners for their thermal processes.

› **Solar Atmospheres of California** announces **Airbus** approval for heat treating.

Airbus approval for Solar Atmospheres of California



› **Drew Daugherty** takes on a new role as manager of National Sales at **Paulo**.

New role for Daugherty

President Gerardo Muraira for NUTEC Fibers Division

NUTEC Fibers Division has a new president – **Gerardo Muraira**. He was promoted from his previous role as general manager at NUTEC, Inc.

New role for Marc DeBruyne

Marc DeBruyne recently joined **SECO/VACUUM** as manager of Process Development for the new R&D heat treat shop going in next door to the furnace assembly shop.

KUDOS CHATTER

On March 22–24, 2023, the second **China Heat Treatment Congress (CHTC)** and first **HIP Users Conference** was held in Suzhou, China and was attended by 320+ industry professionals.

Successful industry events in Suzhou

RoMan Manufacturing's new production building will also house **RoMan University**, a comprehensive training and development program, as well as the Department of Labor approved apprenticeship program.

Groundbreaking for RoMan Manufacturing's new facility

Solar Atmospheres and **Vulcan Springs**, along with the **PMA Mid-Atlantic District**, hosted a plant tour "extravaganza."

"Extravaganza" open house a successful event

24-year anniversary for Mark Kaiser

Congratulations to President/CEO **Mark Kaiser** on his 24-year anniversary with **Lindquist Machine Corporation**.

This year is a very special one, celebrating 150 years of **SMS group GmbH**.

150 years of company history for SMS group GmbH

Positive work environment at RoMan Manufacturing

RoMan Manufacturing has been awarded the Employer of Choice award in Western Michigan.

Bill Cowell will be retiring after being with **Advanced Heat Treat Corp.** since 1999, most recently as the vice president of Plasma/Ion Nitriding.

Retirement for Bill Cowell, Advanced Heat Treat Corp.

Recently in **Fives North American Combustion, Inc.'s** Cleveland laboratory, they ran over 12 continuous hours with a newly commissioned hydrogen fuel infrastructure.

Test furnace with 12 continuous hours

The **CanCham Mexico Business Community** recognizes and congratulates **NITREX** for its first 10 years full of growth and many achievements.

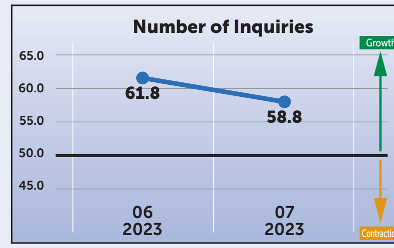
Phoenix Heat Treating receives **Pratt & Whitney** New Customer Approval CPW 21-24.

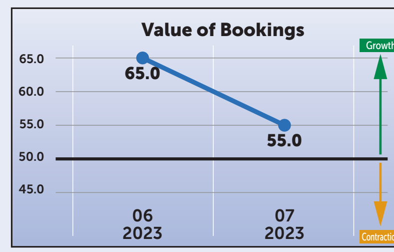
Heat Treat Today Economic Indicators

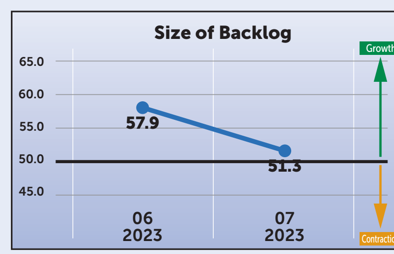
July Results

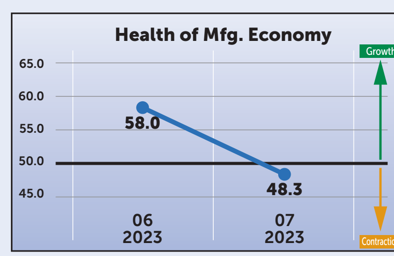
Heat Treat Today is releasing their second month of economic indicator numbers for four (4) separate heat treat industry specific indices. Data is gathered on a monthly basis from industry suppliers and are forward-looking.

The results from July's survey are as follows; numbers above 50 indicate growth, numbers below 50 indicate contraction, and the number 50 indicates no change:









July results compare activity in June with anticipated activity in July. All four indices continue to be relatively high with the exception of the Health of the Manufacturing Economy index which dips below 50. The results show that suppliers responding to the survey anticipated that July would be more robust than June. Keep in mind that there are only two data points for each index.

The four index numbers are reported monthly by **Heat Treat Today** and are available on our website.

The questionnaire from which these index numbers are derived is sent out monthly to over 800 industry suppliers.

Discover the DNA of Automotive Heat Treat: Thru-Process Temperature Monitoring

By Steve Offley, "Dr. O," Product Marketing Manager, PhoenixTM

In addressing the challenges of modern automated production flow, thru-process temperature monitoring and process validation strategies provide viable options in the automotive heat treat industry. Could they help your operations?

The Heat Treat Monitoring Goal

In any automotive heat treatment process, it is essential that the heat treat application is performed in a controlled and repeatable fashion to achieve the physical material properties of the product. This means the product material experiences the required temperature, time, and processing atmosphere to achieve the desired metallurgical transitions (internal microstructure) to give the product the material properties to perform it's intended function.

When tackling the need to understand how the heat treat process is performing, it is useful to split the task up into two parts: focusing on the furnace technology first, and then introducing the product into the mix.

If we consider the furnace performance, we need to validate that the heat treat technology is capable of providing the desired accurate uniformity of heating over the working volume of the furnace for the desired soak time where the products are placed. This is best achieved by performing a temperature uniformity survey (TUS). The TUS is a key pyrometry requirement of the CQI-9 Heat Treat System Assessment (AIAG) standard applied by many automotive OEMs and suppliers.

Traditionally temperature uniformity surveys are performed using a field test instrument (chart recorder or static data logger) external to the furnace with thermocouples trailing into the furnace heating chamber. Although possible, this technique has many limitations, especially when applying to the increasingly automated semi or continuous operations discussed later in this article.

Thru-process Temperature Profiling — Discover the Heat Treat DNA

When it comes to heat treatment, the TUS operation gives a level of confidence that the furnace technology is in specification. However, it is important to understand the need

Continued on page 16

Figure 1. Typical TUS survey set-up for a static batch furnace.PhoenixTM PTM4220 External data logger connected directly to a 9 point TUS frame used to measure the temperature uniformity over the volumetric working volume of the furnace. (Source: PhoenixTM)

Continued from page 14

to focus on what is happening at the real core of the product from a temperature and time perspective. Product temperature profiling, as its name suggests, is the perfect technique. Thermocouples attached to the part, or even embedded within the part, give an accurate record of the product temperature at all points in the process, referred to as a product temperature profile. Such information is helpful to determine process variations from critical factors such as part size, thermal mass, location within the product basket, furnace loading, transfer rate, and changes to heat treat recipe. Product temperature profiling by trailing thermocouples with an external data logger (Figure 1) is possible for a simple batch furnace, but it is not a realistic option for some modern heat treat operations.

With the industry driving toward fully automated manufacturing, furnace manufacturers are now offering the complete package with full robotic product loading — shuttle transfer systems and modular heat treat phases to either process complete product baskets or one-piece operations.

The thru-process monitoring principle overcomes the problems of trailing thermocouples as the multi-channel data logger (field test instrument) travels into and through the heat treat process protected by a thermal barrier (Figure 2).

The short thermocouples are fixed to either the product or TUS frame. Temperature data is then transmitted either live to a monitoring PC running profile or the TUS analysis software via a two-way RF (radio frequency) telemetry link or dowloaded post run.

Although thru-process temperature monitoring in principle can be applied to most heat treat furnace operations, obvioulsy no one solution will suit all

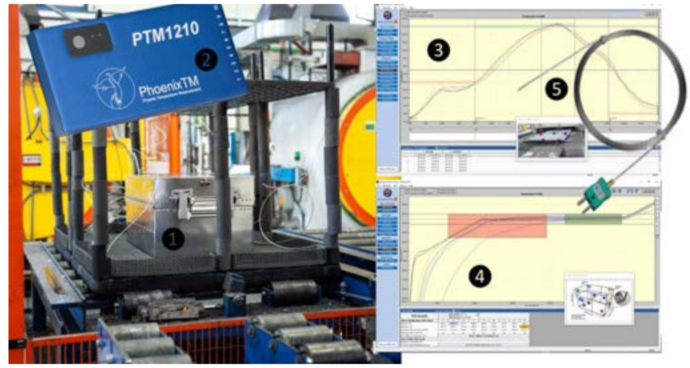


Figure 2. PhoenixTM thru-process monitoring system. (1) The thermal barrier protects internal multi-channel data logger, (2) the field test instrument, (3) the product thermal profile view, (4) the temperature uniformity survey (TUS), and (5) short nonexpendable mineral insulated thermocouples. (Source: PhoenixTM)

processes, as we know from the phrase, "One size doesn't fit all."

For this very reason, unique thermal barrier designs are required to be tailored to the specific demands of the application whether temperature, pressure, atmosphere, or geometry as described in the following section.

Product Profiling and TUS in Continuous Heat Treat Furnaces

Thru-process product temperature profiling and/or surveying of continuous furnace operations, unlike trailing thermocouples, can be performed accurately and safely as part of the conventional production flow allowing true heat treat conditions to be assessed. As shown in Figure 3, surveying of the furnace working zone can be achieved using the plane method. A frame attached to the thermal barrier positions the TUS thermocouples at desginated positions relative to

Continued on page 18

Figures 3. Temperature uniformity survey of a continuous furnace using the plane method applying the PhoenixTM thru-process monitoring system. The data logger travels protected in a thermal barrier mounted on the TUS frame performing a safe TUS at four points across the width, which is impossible with trailing thermocouples. (Source: Raba Axle, Györ, Hungary)

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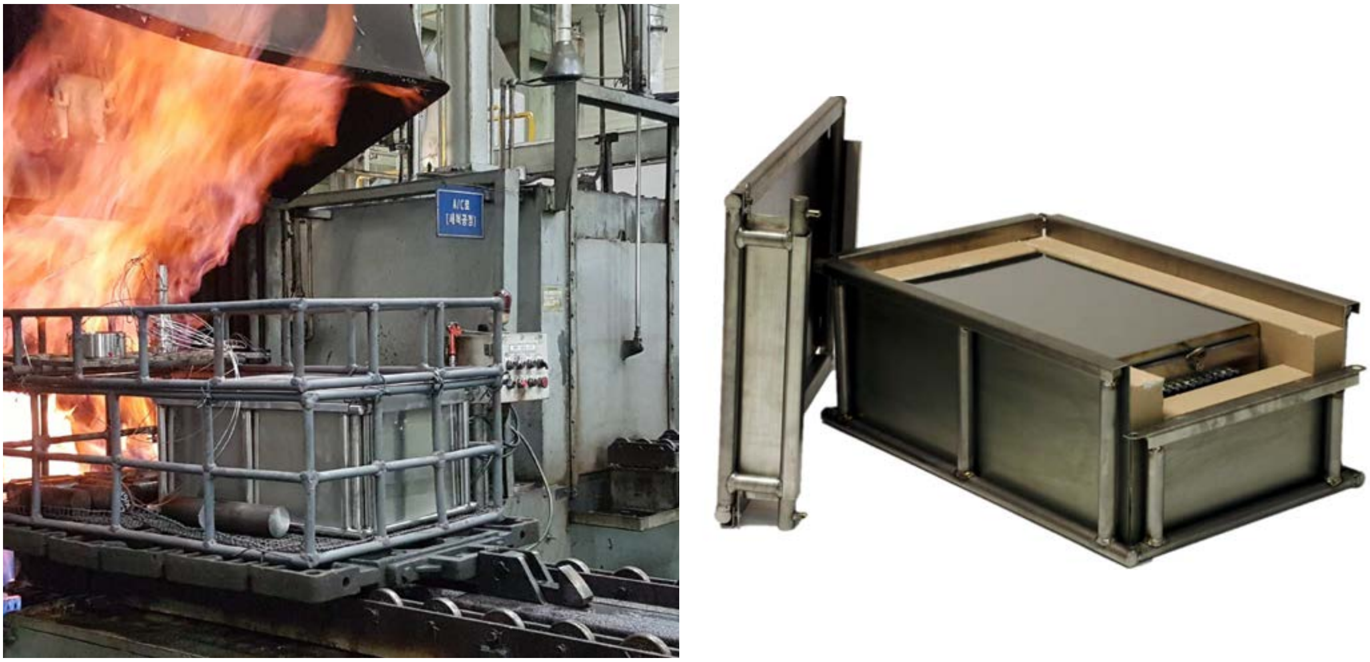

Figures 4. PhoenixTM thru-process temperature profiling system monitoring the core temperature of automotive parts in a traditional sealed gas carburizing furnace with integral oil quench. (left) System entering carburizing furnace in product basket. (right) Thermal barrier showing outer structural frame and sacrificial insulation blocks protecting inner sealed thermal barrier housing the data logger. (Source: PhoenixTM)

the two dimensional working zone (furnace height and width) as defined in the pyrometery standard (CQI-9) during safe passage through the furnace (soak time).

Sealed Gas Carburizing and Oil Quench Monitoring

For traditional sealed gas carburizing where product cooling is performed in an integral oil quench, the historic limitation of thru-process temperature profiling has been the need to bypass the oil quench and wash stations.

In such carburizing processes, the oil quench rate is critical to both the metallurgical composition of the metal and to the elimination of product distortion and quench cracks, and so the need for a monitoring solution has been significant. Regular monitoring of the quench is important as aging of the oil results in decomposition, oxidation, and contamination of the oil, all of which degrade the heat transfer characteristics and quench efficiency.

To address the process challenges, a unique barrier design has been developed that both protects the data logger in the furnace (typically 3 hours at 1700°F/925°C) and during transfer through the oil quench (typically 15 minutes) and final wash station.

The key to the barrier design is the encasement of a sealed inner barrier (Figure 4) with its own thermal protection with blocks of high-grade sacrificial insulation contained in a robust outer structural frame. The innovative barrier offers complete protection to the data logger allowing product core temperature monitoring for the complete heat treat process under production conditions.

Low Pressure Carburizing with High Pressure Gas Quench

In the current business environment, an attractive alternative to the traditional sealed gas carburizing application for both energy and environmental reasons is low pressure carburizing (LPC). Following the vacuum carburizing process, the product is transferred to a sealed high-pressure gas quench chamber where the product is rapidly gas cooled using typically N_2 or Helium at up to 20 bars.

Such technology lends itself to automation with product baskets being transferred by shuttle drives and robot loading mechanisms from chamber to chamber in a semi-continuous fashion. The sequential processing (with stages often being performed in self-contained sealed chambers) can only be monitored by the thru-process approach where the system (thermal barrier protected data logger) is self-contained within the product basket or TUS frame.

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Figures 5. (left) Thermal barrier being loaded into LPC batch furnace with TUS frame as part of temperature uniformity survey. (right) Thermal barrier shown with independent quench deflector providing protection during the high pressure gas quench. (Source: PhoenixTM)

In such processes the technical challenge is twofold. The thermal barrier must be capable of protecting against not only heat during the carburizing phase, but also very rapid pressure and temperature changes inflicted by the gas quench. To protect the thermal barrier in the LPC process with gas quench, the barrier construction needs to be able to withstand constant temperature cycling and high gas pressures. The design and construction features include:

- Metal work: 310 stainless steel to reduce distortion at high temperature combined with internal structural reinforcement
- Insulation: ultra-high temperature microporous insulation to minimize shrinkage problems
- Rivets: close pitched copper rivets reduce carbon pick up and maintain strength
- Lid expansion plate: reduces distortion during rapid temperature changes
- Catches: heavy duty catches eliminating thread seizure issues
- Heat sink: internal heat sink to provide additional thermal protection to data logger

During the gas quench, the barrier needs to be protected from Nitrogen N_2(g) or Helium He(g) gas pressures up to 20 bar. Such pressures on the flat top of the barrier would create excessive stress to the metal work and internal insulation or the data logger. Therefore, a separate gas quench deflector is used to protect the barrier. The tapered top plate deflects the gas away from the barrier. The unique design means the plate is supported on either four or six support legs. As it is not in contact with the barrier, no force is applied directly to the barrier and the force is shared between the support legs.

In LPC technology further monitoring challenges are faced by the development of one piece flow furnace designs.

New designs incoroprate single piece or single product layer tray loading into multiple vertical heat treat chambers followed by auto loading into mobile high pressure quench chamber. Miniturization of each separate heat treat chamber limits the space available to the monitoring system. The TS02-128-1 thermal barrier has been designed specifically for such processes utilizing the compact 6 channel "Sigma" data logger allowing reduction of the footprint of the system to fit the product tray and reduce thermal mass. With a height of only 128 mm/5 inch and customized independent low height quench deflector, the system is suitable for challenging low height furnace chambers and offers 1 hour protection at 1472°F/800°C in a vacuum.

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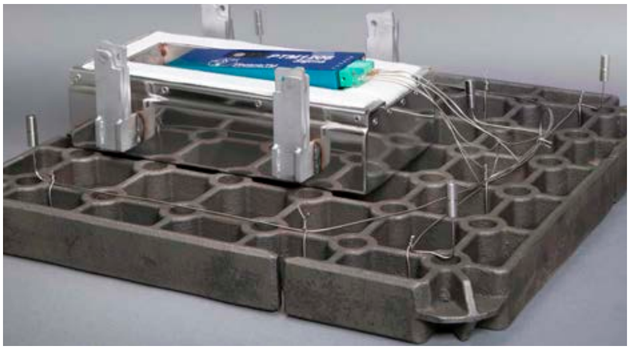

Figure 6. (left) Low profile TUS system (TS02-128-1 thermal barrier six channel Sigma data logger) designed with TUS surveying individual one-piece flow heat treatment LPC furnace chambers. (right) Thermal barrier shown with optional low profile gas quench deflector. (Source: PhoenixTM)

Rotary Hearth Furnace Monitoring — Solution Reheat of Aluminum Engine Blocks

In modern rotary hearth furnaces (Figure 7), temperature profiling using trailing thermocouples is impossible as the cables would wind up in the furnace transfer mechanism. Due to the central robot loading and unloading and elimination of charging racks/baskets, the use of a conventional thru-process system would also be a challenge.

To eliminate the loading restrictions, a unique thermal barrier small enough to fit inside the cavity of the engine block and allow automated loading of the complete combined monitoring system and product has been developed. To optimize the thermal performance of the thermal barrier with such tight size constraints, a phased evaporation technology is employed. Thermal protection of the high temperature data logger is provided by an insulated water tank barrier design keeping the operating temperature of the data logger at a safe 212°F/100°C or less. The system allowed BSN Thermoprozesstechnik GmbH in Germany to commission the furnace accurately and efficiently and thereby optimize settings to not only achieve product quality but also ensure energy efficient, cost effective production.

Summary

Thru-process product temperature profiling and surveying provide a versatile, accurate, and safe solution for monitoring increasingly automated, intelligent furnace lines and the means to understand, control, optimize, and certify your heat treat process. HTT

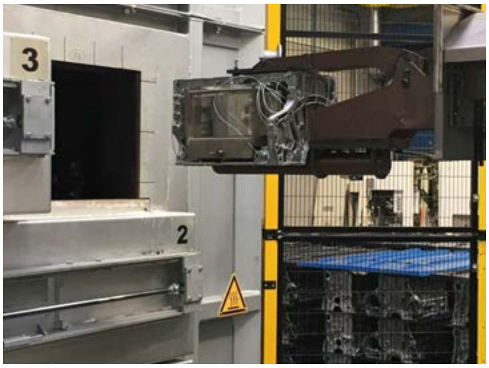

Figure 7. (left) Robot loading of combined thru-process system with engine block into BSN rotary T6 furnace. The thermal barrier is designed with a combination of thermal insulation technology capable of fitting in the engine block cavity. (right) Thermal barrier mounted within engine block assembly. (Source: BSN Thermprozesstechnik GmbH)

About the Author

Dr. Steve Offley, "Dr. O," has been the product marketing manager at PhoenixTM for the last five years after a career of over 25 years in temperature monitoring focusing on the heat treatment, paint, and general manufacturing industries. A key aspect of his role is the product management of the innovative PhoenixTM range of thru-process temperature and optical profiling and TUS monitoring system solutions.

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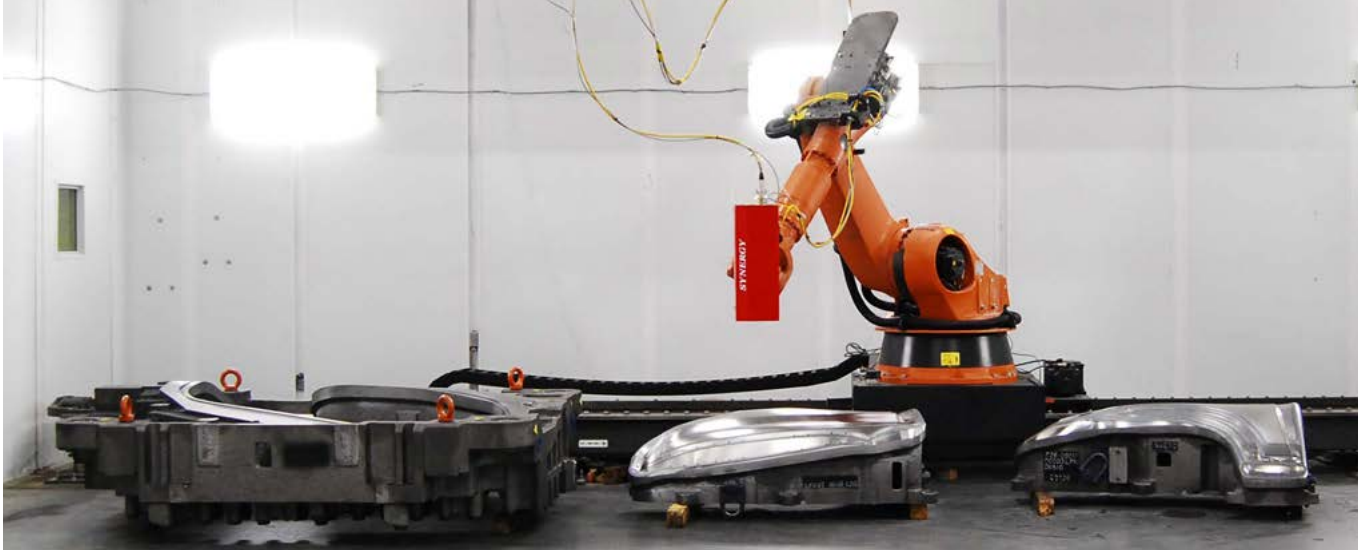

Laser Heat Treating of Dies for Electric Vehicles

By Aravind Jonnalagadda (AJ), CTO and Co-Founder, Synergy Additive Manufacturing LLC

The rise of electric vehicles (EVs) is changing the automotive manufacturing game, and laser heat treating could be the new MVP. Learn how laser heat treating is reducing cost, improving time to market, and limiting distortion.

The electric vehicle initiative and the efforts of automakers to overhaul their current vehicle lineups with electric offerings has many automakers and technology corporations rethinking automotive engineering to the most minute detail of manufacturing. The modern automotive industry not only affects automakers, but consumers, who will also transition into a diverse new market of emerging technologies. Deloitte Insight estimates that by 2030, EVs will account for 31% of total market share for new car sales. Per the report, the worldwide market for new EVs is expected to swell from 2.5 million in 2020 to 11.2 million in 2025 to 31.1 million by 2030 (Woodward, et al., "Electric vehicles").

Figure 1. Laser heat treating performed on Class A die

Figure 2. Laser heat treating of battery panel die for EV

With a surge in demand for new EVs, OEMs are racing to bring new models to the market. This demand has prompted automakers to push towards shorter product life cycles for EVs compared to their internal combustion engine (ICE) counterparts. Along with this, the recent supply chain disruptions fueled a renewed push towards new technologies and reliable partners who can accelerate the product life cycles while reducing the overall manufacturing costs. One such technology that gained a stronghold in the tool and die industry over the last few years is laser heat treating on automotive dies.

Laser Heat Treat Accelerates EV Dies to Market

Automotive dies often require all the male radii to be heat treated to reduce the wear and improve die life. Conventional heat treating processes such as induction and flame have high heat input, which distorts the die. To account for this, the die makers leave extra stock material to later come back and hard mill the die to finish dimensions.

This additional hard milling step adds substantial cost to the die manufacturing process. Conventional processes are often performed by hand and lack feedback control. This results in poor quality and inconsistencies in the heat treated surfaces. Laser heat treating, on the other hand, results in minimal distortion. The dies are machined to their final form and laser heat treated as a final step, thereby reducing the process steps such as hard milling, 2D based machining, etc. This saves substantial time and costs for the die makers, not to mention improved and repeatable quality.

The laser heat treating process involves a laser beam (with a typical laser spot size from 0.5" x 0.5" to 2" x 2") focusing on the metal surface. With proper control, the incident laser energy raises the surface temperature of the metal above its martensitic transformation temperature. The metal's thermal mass aids in rapid "self-quenching" (by removing the heat via conduction), resulting in the formation of the desired martensite microstructure. This gives the material its required hardness and wear properties. To watch a video, go to: *https://www.youtube.com/watch?v=8cUxEexAI9E*.

By utilizing a laser beam, unrivaled precision is achieved by delivering the smallest possible energy to the metal part, resulting in minimal to virtually no distortion in large automotive dies. The unique characteristics of laser technology offer the following benefits:

- Minimal to virtually no distortion
- No hard milling required on large automotive dies
- Consistent hardness depth (via. feedback control)

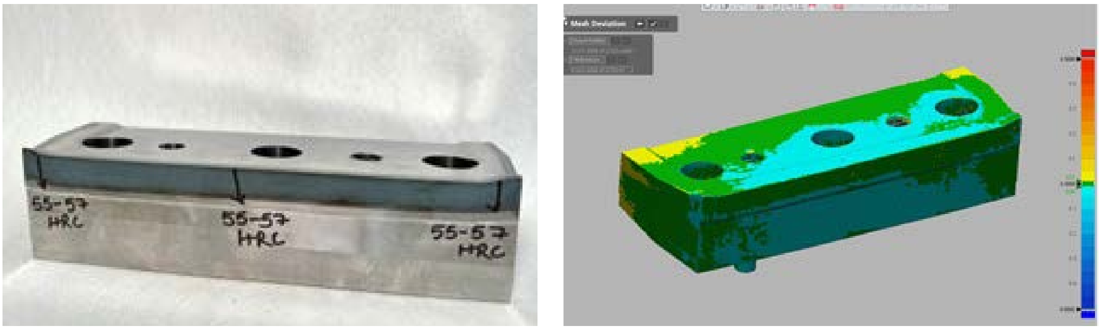

Figure 3. Laser heat treated trim inserts (approximate dimensions of 7" x 4" x 3", base material 4140) demonstrate distortion of less than 10 microns and hardness of 55–57 HRC.

Heat Treatable Materials

Any metal with 0.2% or higher carbon content is laser heat treatable. Common materials used in automotive industry include:

D6510, 0050A, A2, D2, S7, G3500, GM338, GM190, H13, 4140, 4130, 410 SS,431 SS, P20, 8620, and others.

When analyzing over 100 applicable die castings (post, cavity, and binders), Autodie LLC concluded that an average of 7-day reduction in time to market (TTM) was achieved by switching over to laser heat treating process. By avoiding hard milling operation, laser heat treating resulted in 37% reduction in machining time. Substantial savings in cutter cost were observed as the castings are now finished by 3D machining while in soft condition. Over an 11-month period, Kaizen savings had a benefit to cost average of 28.6 (Jonnalagadda and Timmer, "Laser Heat Treating").

Conclusion

Laser heat treatment offers substantial cost savings as well as reduction in TTM. This process is likely to expand into the automotive and metal part manufacturing sectors. For example, Synergy Additive Manufacturing's laser heat treating process is already being used in a variety of automotive applications such as trim dies, hot stamping dies, hem dies, restrike bars, flange dies, and molds. A variety of non-automotive parts such as large gears and bearings are also already being laser heat treated. Laser heat treatment faces no significant barriers to adoption, aside from the ones that are common to any emerging technology. These include lack of familiarity and a shortage of existing suppliers. The savings, measured by cost, schedule, quality, and energy reduction, are significant and well supported. HTT

About the Author

Aravind Jonnalagadda (AJ) is the CTO and co-founder of Synergy Additive Manufacturing LLC. With over 15 years of experience, AJ and Synergy Additive Manufacturing LLC provide high-level laser systems and laser heat treating, specializing in high power laser-based solutions for complex manufacturing challenges related to wear, corrosion, and tool life. Synergy provides laser systems and job shop services for laser heat treating, metal based additive manufacturing, and laser welding.

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Figure 4. Laser heat treating of gear tooth profile

Figure 5. Laser heat treating the OD of large industrial shaft used in paper mills

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Exo Gas Composition Changes, Part 1: Production

By Harb Nayar, President & Founder, TAT Technologies LLC

Exothermic gas undergoes a few metamorphoses from the time it is produced to the time it is cooled down after use. Explore the transformations that occur within the combustion chamber to discover the impact these phases can have on the heat treatment atmosphere of your workpieces.

Background

Exothermic gas, more commonly referred to as Exo gas, is produced by partial combustion of hydrocarbon fuels with air in a well-insulated reaction or combustion chamber at temperatures well above 2000°F. Immediately after they exit the combustion chamber, the reaction products are cooled down using water to a temperature below ambient temperature to avoid condensation. The typical dew point of the cooled down Exo gas is about 10°F above the temperature of the water used to cool down. The cooled down Exo is then delivered to the heat treat furnaces where it gets reheated to the operating temperatures between 300°F and 2100°F.

A simplified schematic flow diagram of Exo gas production followed by its cool down below ambient temperature and its final use in heat treat furnaces is shown in Figure 1.

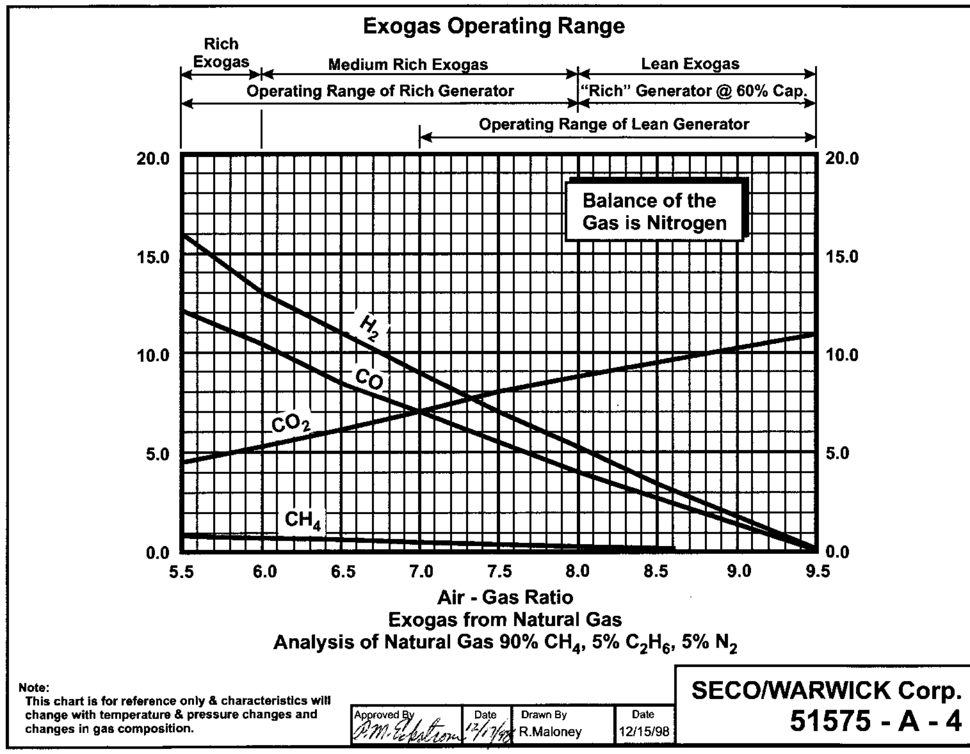

Figure 2. Exo gas operating range (Source: SECO/WARWICK)

The following aspects of the Exo gas production are clear from Figure 1:

1. There is lot of energy lost out of the reaction chamber.
2. There is additional heat lost during cooling using water.
3. A good deal of water is used for cooling.
4. The cooled down Exo gas is re-heated to the process temperature in heat treat furnaces.

Exo gas has been predominantly used and is still being used as a source of nitrogen rich atmosphere for purging, blanketing, and mildly oxide reducing applications in the heat treat and metal working industries.

Examples of applications:

- Brazing
- Annealing
- Hardening
- Normalizing
- Sintering
- Tempering, etc.

Examples of materials:

- Irons
- Steels
- Electrical steels
- Copper
- Copper-base alloys
- Aluminum
- Jewelry alloys

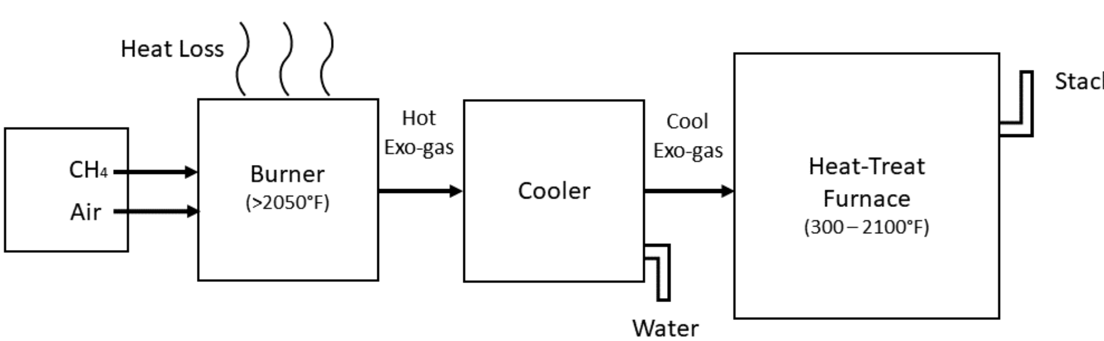

Figure 1. Schematic flow diagram showing Exo production, cool down, and its use. (Source: Morris, "Exothermic Reactions," 2023)

Examples of product sizes and shapes:

- Tubes
- Rods
- Coils
- Sheets
- Plates
- Components
- Small parts, etc.

Exo is the lowest cost gas used in furnaces operating at temperatures above about 700°F to keep air out and provide a protective atmosphere with some oxide reducing potential to the materials being thermally processed.

There are two types of Exo gases: lean Exo gas, with mostly nitrogen and carbon dioxide and very little hydrogen, and rich Exo gas, with a little less nitrogen and carbon dioxide and substantially more hydrogen and some carbon monoxide. Typical compositions are given below:

- Lean Exo: 80–87% Nitrogen; 1–2% Hydrogen; 2–4% H_20; 1–2% CO; 10–11% CO_2
- Rich Exo: 70–75% Nitrogen; 9–12% Hydrogen; 2–4% H_20; 7–9% CO; 6–7% CO_2

Figure 2 shows graphs of Exo gas composition at various air to natural gas ratios. H_2, CO, and residual CH_4 decreases with increasing air to natural gas ratio whereas CO_2 goes in the opposite direction. H_20 content not shown in the graphs is typically in the 2–4% range depending upon the temperature and cooling efficiency of the cooling system. N_2 is the balance which increases with increasing air to natural gas ratio.

The generator designs to produce lean and rich Exo gases are slightly different as shown in the schematic flow diagrams below in Figures 3 and 4:

Objective

This paper will demonstrate a simplified software program (harb-9US) developed recently by TAT Technologies LLC that can easily calculate the reaction products composition, temperature, exothermic energy released, various ratios, and final dew point for various combinations of air and fuel flows entering the reaction chamber at a predetermined temperature and pressure.

The data presented in this paper is under *thermodynamically equilibrium* conditions only, captured when the reaction is *fully* completed. It does not tell how long it will take for the reaction to reach completion. However, it can be safely said that reactions are completed relatively fast at temperatures above about 1500°F and very slow at temperatures below about 1000°F. The current software program uses U.S. units: flow in SCFH, pressure in PSIG, temperature in degrees Fahrenheit, and heat as enthalpy in BTU.

The composition of the Exo gas for a fixed incoming air to hydrocarbon fuel ratio changes from production in the combustion chamber to the cool down equipment to bring the Exo gas to below the ambient temperature and finally into the furnace where the material is being heat treated.

Understanding the changes in gas composition from Step 1 (Production in the Combustion Chamber) to Step 2 (Cooldown to Ambient Temperature) to Step 3 (At Temperature of Heat Treated Part) can help to improve the composition, quality, and control of Exo gas that will surround the metallic products being heat treated in the furnace.

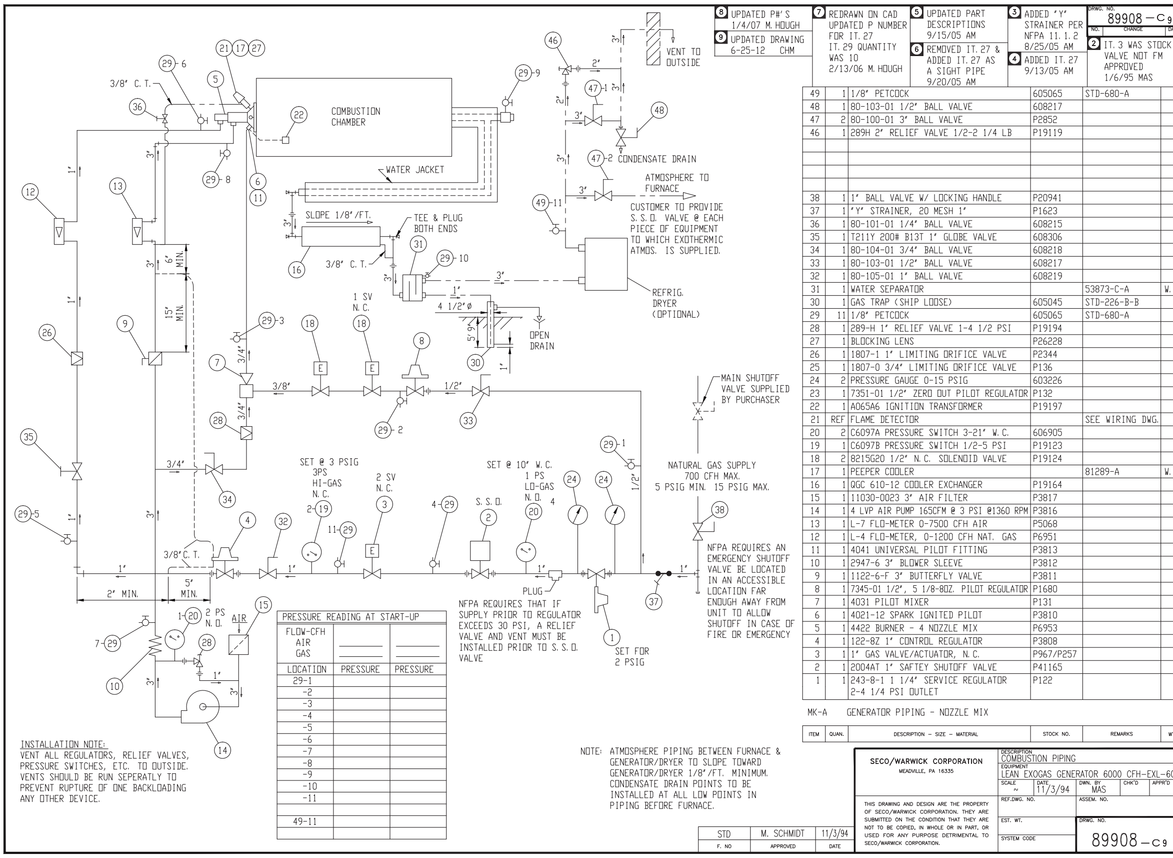

Figure 3. Lean Exo generator schematic flow diagram (Source: SECO/WARWICK)

Step 1: Composition of Exo Gas as Produced in the Combustion Chamber

Table A shows the Exo gas compositions as generated within the combustion chamber at various air to natural gas ratios supplied at 100°F and 0.1 PSIG. In these calculations natural gas composition is assumed as 100% CH_4 and air is assumed as 20.95% oxygen and balance nitrogen. CH_4 is fixed at 100 SCFH and air flow is varied to give air to natural gas ratios between 9 and 6. Typically a ratio of 9 is used for lean Exo and 7 is used for rich Exo applications. Other ratios are used in some special applications.

The following key conclusions can be made from Table A as one moves from air to natural gas (CH_4) ratio of 9 down to 6**:**

1. The peak temperature in the reaction chambers goes from a high of 3721°F down to low of 2865°F. Because of high temperatures, good insulation around the combustion chamber is a must. A significant portion of the exothermally generated energy within the reaction chamber is lost to the surroundings.
2. There is no residual CH_4 in the Exo gas composition at these high temperatures. There is no soot (carbon residue) under equilibrium conditions.
3. H_2O content in the natural gas (CH_4) gas in the reaction chamber is very high — from high of 19.11% to low of 15.87%. These correspond to dew point 139°F to 132°F — well above the ambient temperature. Because of the very high dew point, the Exo gas coming out of the reaction chamber *must* be cooled down below the ambient temperature to remove most of the H_2O in the Exo gas to avoid any condensation in

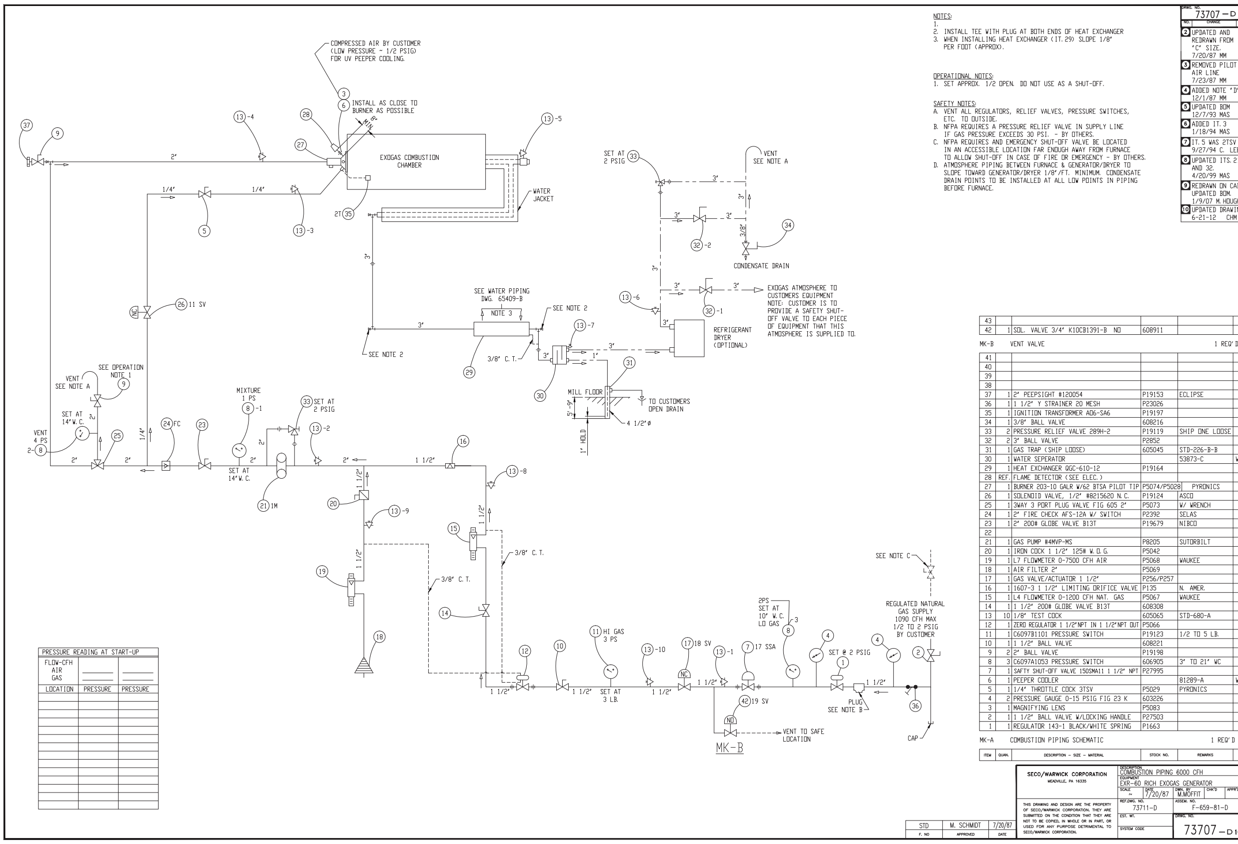

Figure 4: Rich Exo generator schematic flow diagram (Source: SECO/WARWICK)

the pipes carrying the Exo gas toward the furnace and into the furnace.

4. H_2% changes significantly from 0.67% to 9.96%
5. The oxide reducing potential (ORP) as measured by H_2/H_2O ratio changes from a very low of 0.035 to 0.628. ORP in the reaction chamber is overall quite low because of high percentage of H_2O.
6. Nitrogen content varies from 70.34% to 61.26% of the total Exo gas in the reaction chamber.
7. Exothermic heat generated varies from 95.3 MBTU to 54.34 MBTU — it gradually becomes a less exothermic reaction. Gross heating value of CH_4 (at full combustion) is 101.1 MBTU/100 cubic foot of CH_4.

Question: What happens to the composition of Exo gas as it cools from peak temperature in the combustion chamber to different lower temperatures after it exits from the combustion chamber?

Answer: It changes a LOT, assuming enough time is provided to reach its equilibrium values during cooling down to any specific temperature. Whenever there is a mixture of gases, such as CH_4, H_2, H_2O, CO, CO_2, O_2, N_2, there are a variety of reactions going on between the constituents in the reactant gases to produce different combinations of gas products and heats (absorbed or liberated) at different temperatures. The most popular and well-known reactions are:

- **Partial Oxidation Reaction:** $CH_4 + 1/2O_2 \rightarrow CO + 2H_2$ — exothermic. The reaction becomes more exothermic as O_2 increases from 0.5 to 2.

Table A: EXO Gas Compositions in Reaction Chamber at Different Air/Natural Gas Ratios

Air: 20.95% oxygen and balance nitrogen **CH_4 flow: Always 100 SCFH**

Temp: 100°F **Temp: 100°F**

Air/Natural Gas Ratio:	Lean EXO 9:1	Lean EXO 8.5:1	Lean EXO 8:1	Lean EXO 7.5:1	Rich EXO 7:1	Rich EXO 6.5:1	Rich EXO 6:1
Products of Combustion (scfh)							
H_2	6.8	14.5	23.9	34.9	47.6	61.7	77.1
N_2	711.5	671.9	632.4	592.9	553.4	513.8	474.3
CO	16.1	29.4	40.9	50.8	59.1	65.9	71.5
O_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CH_4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO_2	83.9	70.6	59.1	49.2	40.9	34.1	28.5
H_2O	193.2	185.5	176.1	165.1	152.4	138.3	122.9
Total	1011.5	971.9	932.4	892.9	853.3	813.8	774.3
Temp (°F), calculated	3721	3608	3448	3320	3182	3031	2865
H, BTU x 1000	95.2	88.5	80.9	74.3	67.6	61.0	54.3
Ratios							
H_2/H_2O	0.035	0.078	0.135	0.211	0.312	0.446	0.628
CO/CO_2	0.193	0.416	0.693	1.034	1.445	1.933	2.504
CO^2/CO_2	0.045	0.186	0.450	0.870	1.480	2.316	3.417
Volume Percentage							
Vol % H_2	0.67	1.49	2.56	3.91	5.58	7.59	9.96
Vol % H_2O	19.11	19.09	18.89	18.49	17.86	16.99	15.87
Dew Pt (F)	139	139	139	138	137	135	132
N_2 (%)	70.34	69.13	67.83	66.4	66.84	63.14	61.26

H = Heat Capacity

Table A: *Exo gas compositions in reaction chamber based on 100 SCFH of CH_4 with air 900, 850, 800, 750, 700, 650, and 600 SCFH to give air to natural gas (CH_4) ratios of 9, 8.5, 8, 7.5, 7, 6.5 and 6 respectively. Air and natural gas (CH_4) are at 100°F before entering the combustion chamber.*
(Source: TAT Technologies LLC)

- **Water Gas Shift Reaction:** $CO + H_20 \rightarrow CO_2 + H_2$ — slightly exothermic. It usually takes place at higher temperatures faster. A catalyst in the reaction chamber can help to lower the high temperature requirement. There are many catalysts. Commonly used are either Ni or precious metals.
- **Steam Reforming Reaction:** $CH_4 + H_20 \rightarrow CO + 3H_2$ — highly endothermic.
- **CO_2 Reforming Reaction:** $CH_4 + CO_2 \rightarrow 2CO + 2H_2$ — endothermic.

All of these reactions have different degrees of influences from changes in temperature. One could say that the final equilibrium composition of the Exo gas is a continuously moving target as temperature changes. Only the N_2 portion stays constant. One can make the following generalized statements covering a broad range of Exo gases (lean and rich) in the reaction chamber:

a) N_2 content does not change. It remains neutral at all temperatures.
b) H_2 content decreases with increasing temperature.
c) H_20 (vapor) content increases with increasing temperature.
d) CO content increases with increasing temperature.
e) CO_2 content decreases with increasing temperature.
f) Residual CH_4 decreases with increasing temperature.
g) Soot decreases with increasing temperature.
h) Catalysts facilitate the speed of reactions at any temperature.

Conclusion

Exo gas composition changes during its time in the combustion chamber. Reaction products composition, temperature, exothermic energy released, various ratios, and final dew point are all items that need to be taken into consideration to protect the metallic pieces that will be heat treated in the resulting atmosphere. Part 2 will demonstrate this principle and discuss Step 2 (Cooldown to Ambient Temperature) and Step 3 (At Temperature of Heat Treated Part). **HTT**

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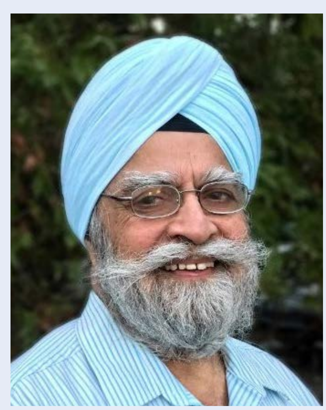

About the Author

Harb Nayar is the founder and president of TAT Technologies LLC. Harb is both an inquisitive learner and dynamic entrepreneur who will share his current interests in the powder metal industry, and what he anticipates for the future of the industry, especially where it bisects with heat treating.

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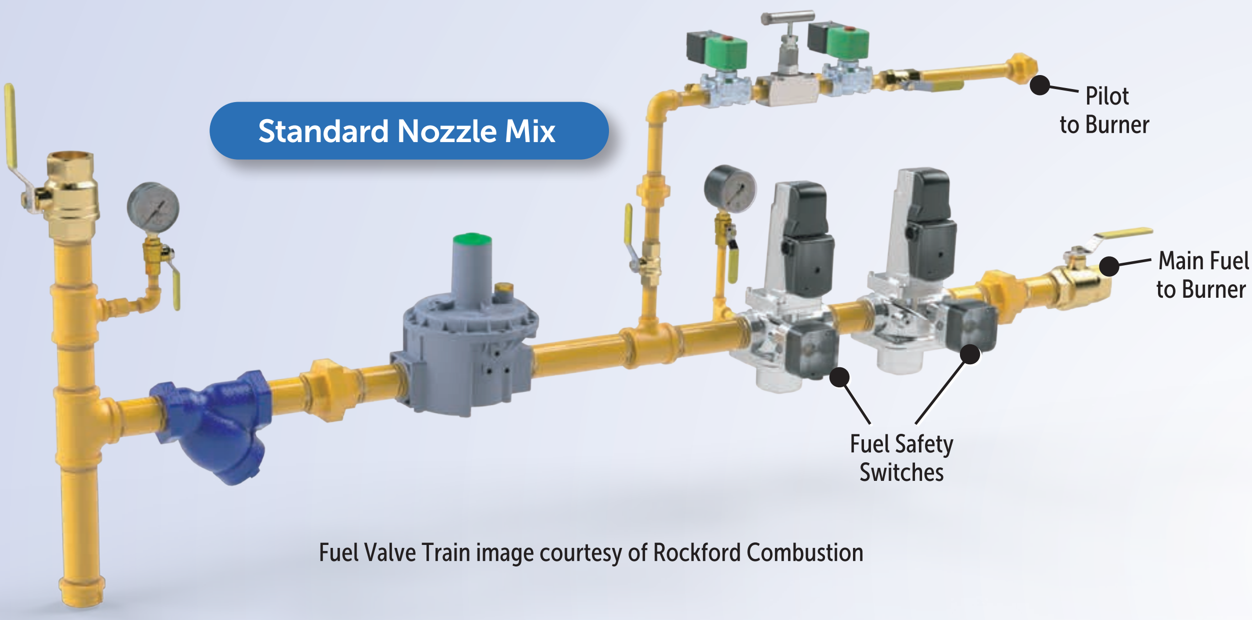
Heat Treat Today's Anatomy of Combustion Systems

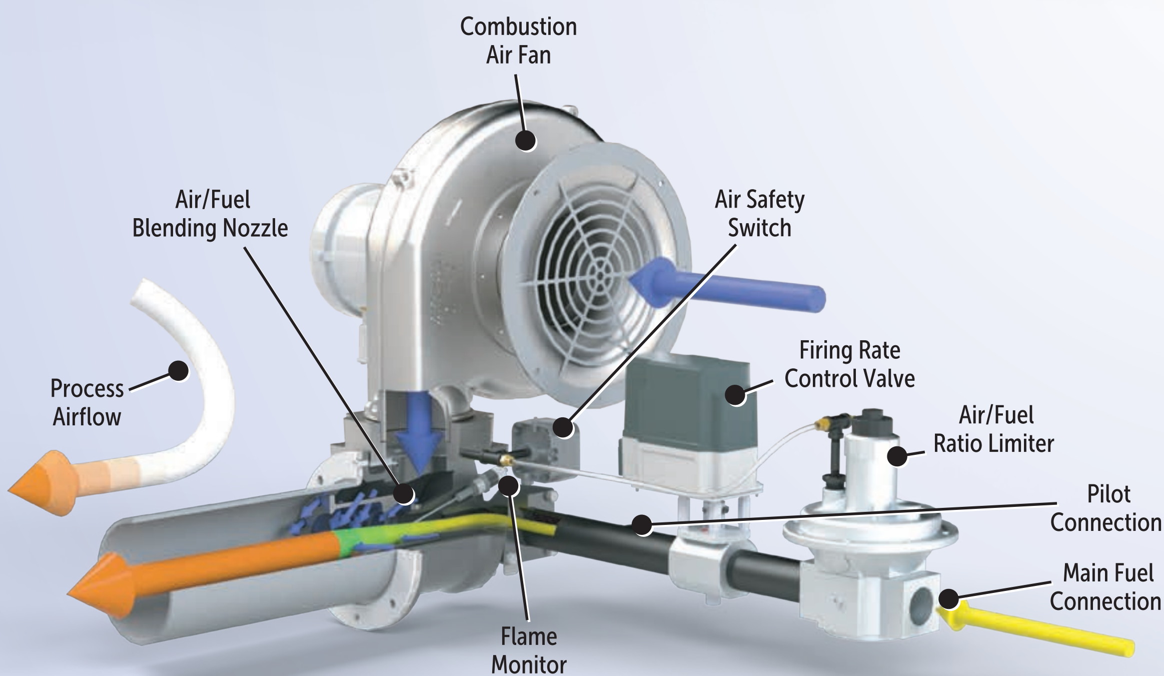
Mark-up by Robert (Bob) Sanderson, Director of Business Development, Rockford Combustion

Every feature you need to know in heat treat systems.

Consider the numerous systems in your heat treat operations. What makes up the anatomy of each furnace? In this "Anatomy of a Furnace" series, industry experts indicate the main features of a specific heat treat system. In this feature, Rockford Combustion compares two types of low-temperature combustion systems: standard nozzle mix and pre-mix combustion. As Bob describes in the following article, "low temperature" is defined as being "below the auto-ignition threshold," which varies around 1200°F.

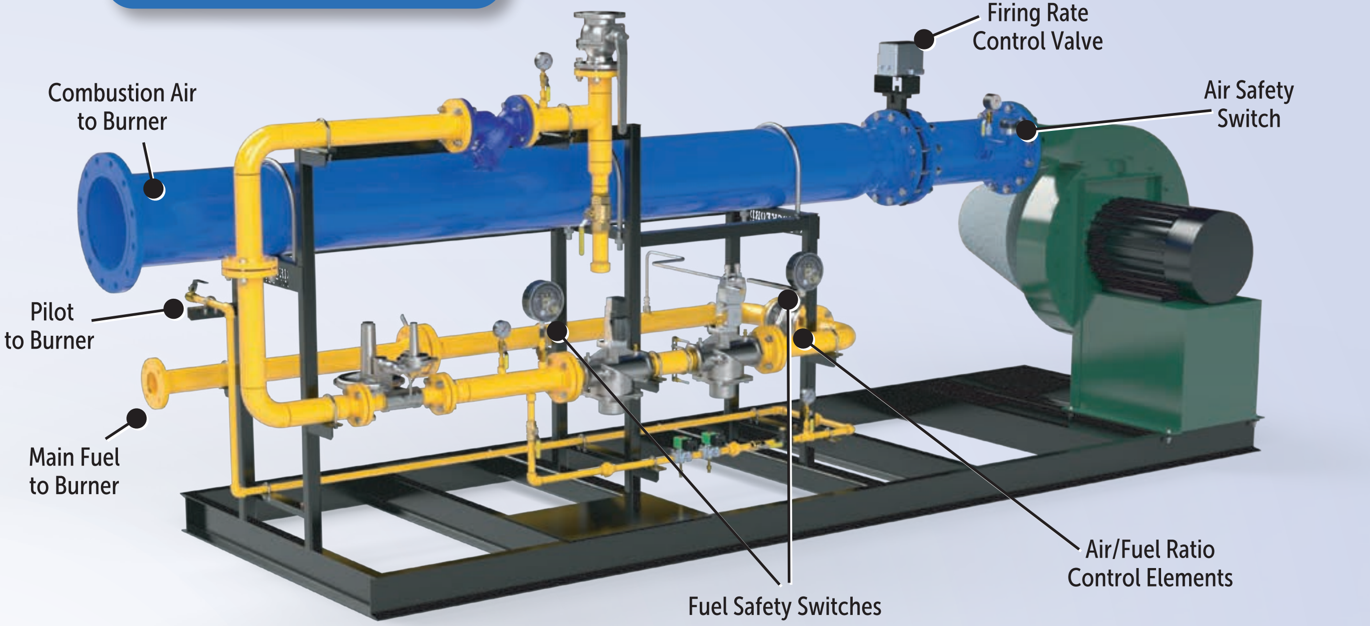


Fuel Valve Train image courtesy of Rockford Combustion

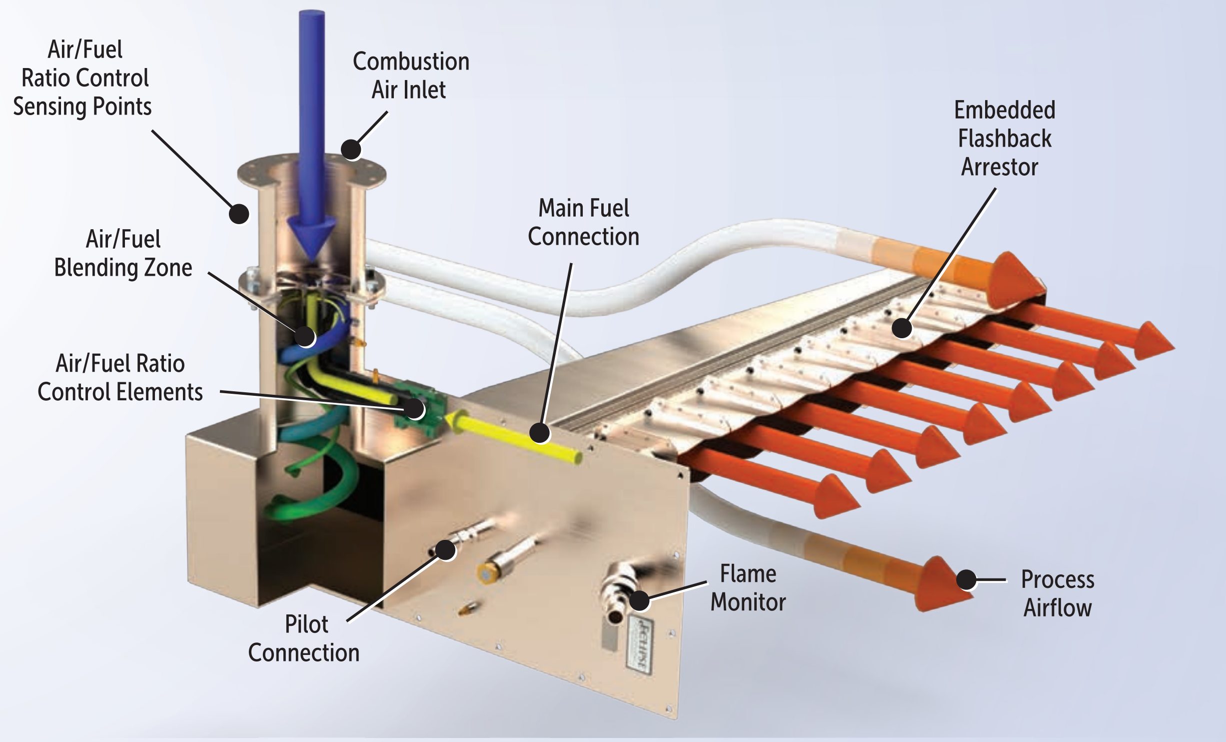


Phoenix SH packaged burner image courtesy of Algas-SDI

Pre-Mix Combustion



Packaged Valve Train image courtesy of Rockford Combustion



Linnox burner image courtesy of Honeywell Thermal Solutions

This series will continue in subsequent editions of **Heat Treat Today's** *print publications.*

For more information:
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The Layers of Low-Temperature Combustion Systems

By Robert Sanderson (PE), Director of Business Development, Rockford Combustion

Burners used in low-temperature applications are often supplied as traditional nozzle mix and (increasingly so) as pre-mix burners. The primary advantage of pre-mix burners is the reduction of comparative emissions. But converting a nozzle mix to a pre-mix burner involves more than a burner exchange. There are many factors to consider when designing any combustion system. This article is a brief outline of the functioning technology for two common low-temperature (below 1200°F) combustion systems.

What Is Low Temperature?

"Low temperature" is a nebulous term. What may be considered high temperature to one user may be regarded as low temperature by another. For this review, low temperature is any heating process where the firing chamber conditions are below auto-ignition temperature of the fuel — which, for many hydrocarbons and other combustible fuels, is about 1200°F — and sufficiently low that the chamber construction could be a metal-lined interior with external insulation.

Low-temperature applications vary, but they are commonly used to heat larger volumes of process air directly. As such, the burner's air consumption is not a factor in the overall process efficiency.

Technology In Focus: Nozzle Mix vs. Pre-Mix Burners

Nozzle mix burners come in a great variety of designs. Some are simple gas spuds, others are linear arrays of fuel jets. A step up from these basic designs are machined fuel nozzles made to blend air and fuel. Some nozzle mix burners rely upon process fans to supply combustion air while others incorporate combustion blowers.

Regardless of the specific burner configuration, low-temperature burners are often capable of large temperature lifts, high heat-flux inputs, and wide operating ranges.

The control systems for nozzle mix burners are traditional fuel and air designs that many users will be familiar with. These burners are typically capable of operating on various fuels with relatively low utility pressures.

Pre-mix burners are also available in both point and line heat release designs. Pre-mix burners commonly feature low emissions, often the driving factor for their selection. To manage emissions, the general operating characteristics of pre-mix burners often include soft heat-flux inputs, narrow operating ranges, advanced fuel/air control systems, singular fuel designs, and elevated utility pressures.

These features vary somewhat with each design, but all are aspects commonly used as emissions control mechanisms. The control of pre-mix systems is more complex, and it is common for end-users to have training to understand better the proper operation and maintenance required to uphold their safe performance.

A notable difference between nozzle and pre-mix burners is the fuel/air blending design.

Many nozzle mix designs combine the fuel and air within a fuel nozzle directly at the point of combustion. The mixing of these streams may be staged or partially blended, depending on the nozzle design. Pre-mix burners, in contrast, typically have aggressive blending zones to thoroughly aerate the fuel, producing a homogenous, combustible mixture. This mixture is then distributed to the burner's combustion zone. For safety, integrated with pre-mix burners will be a flashback arrestor or a similar fuel safety design feature.

Behind each nozzle and pre-mix burner system are fuel and air control systems. Because the two burner categories differ, each fuel control system style is unique and designed for that burner's operating parameters.

The System at Large

An appropriately designed combustion system will consider the process conditions, user needs, and burner parameters in the design of the fuel and air control systems. If any aspect is lacking, the result can be an underperforming combustion system. **HTT**

(Photo Source: Rockford Combustion)

About the Author

Robert (Bob) Sanderson has years of experience knowledge and is experienced in a variety of industries. Throughout Bob's 32+ years of experience experience in the combustion field, he has worked in automotive, abatement-oxidation, aerospace, agriculture, food and beverage, HVAC, heat treating, glass, asphalt, pyrolysis, reducing furnaces, dryers, immersion heaters, and power generation. Bob has been employed by companies such as Eclipse, Honeywell, and Haden, Inc. Bob brings systems integration and the application experience of how systems interact in various environments to his current role at Rockford Combustion. Bob is a member of the NFPA-86 technical committee.

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Optimize Working Life and Performance of Heat Treatment Alloy Castings

By Matthew Fischer, Technical Sales Manager, Castalloy Group

When it comes to optimizing the working life and overall performance of heat treatment alloy castings, proper alloy selection and design based on the intended application is a critical starting point. Discover the variables behind alloy selection and design and the additional factors that contribute: furnace maintenance, casting inspection, and cost reduction strategies.

Alloy Selection and Design Criteria

Optimal design and alloy composition for any heat treatment casting always requires careful consideration of a number of key operating variables. This is the only way to guarantee the part will deliver maximum utilization and efficiency for the intended application.

These variables include:

- Anticipated service and maximum operating temperature
- Size, orientation, and weight of the load
- Thermal cycling and/or quenching
- Range of temperature cycling
- Frequency of temperature cycling
- Rate of change of temperature
- Type of atmosphere or other corrosive conditions of the application
- Type of quenching or cooling
- Size, shape, and weight of part(s)
- How are the parts loaded and oriented? (e.g., manually, robotically, individually, bulk)
- How is the alloy supported in the equipment? (e.g., rails, hearth, rollers, piers)
- Additional processing requirements (e.g., machining, welding)
- Abrasive or wear conditions
- Ease of use (ergonomics) and replacement
- Cost — initial and total cost of ownership

In addition, there are fundamental factors that heavily influence optimal component design and alloy composition. For instance, the type of furnace used (e.g., box, pit, integral quench, continuous), alloy handling mechanism (fixture and tray), and application process (e.g., carburizing, normalizing, annealing, austempering, vacuum heat treating) all have an important role to play.

It is worth noting, however, that the decision-making process is a fine balancing act that isn't necessarily evenly weighted. While a specific alloy composition may Fiaddress the majority of performance needs, it may hinder others. Prioritizing end-use performance traits is therefore essential.

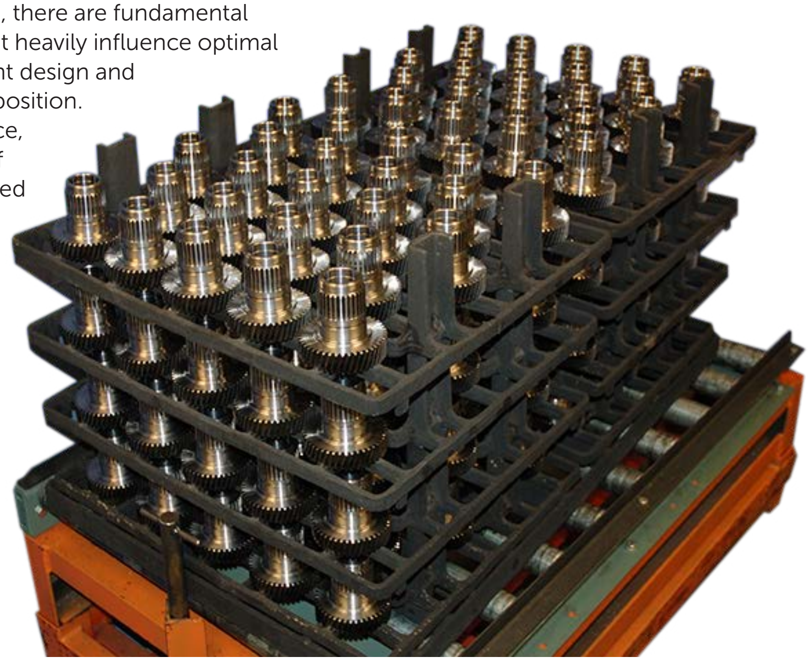

Figure 1. Cast tray and fixtures (Source: Castalloy Group)

Figure 2. Flat level surface and tray/grid (Source: Castalloy Group)

Furnace and Process Environment Maintenance

How furnaces and processes are performance monitored and maintained is also key when seeking to optimize the performance and lifespan of heat treatment alloy castings. The specific type of furnace will dictate exact equipment and process maintenance requirements, but there are several universal best practice procedures and guidance processes that should be followed.

For instance, the Automotive Industry Action Group (AIAG) has established CQI-9 (Continuous Quality Improvement) standards for heat treatment. These standards provide the guidelines for a continuous cycle of assessment, planning, and improvement with respect to heat treat processing and due care of handling customer parts.

The CQI-9 standards direct the heat treater to have and maintain the necessary equipment and associated control instruments used to monitor and record the furnace process operating parameters. They also promote the proper furnace operating process environment. However, the standards do not comprehensively address the overall maintenance requirements of the furnace and process environment equipment.

Generally, yearly scheduled maintenance is important to the long-term successful continuous operation of furnace equipment. Lack of or intermittent maintenance can lead to unplanned shutdowns.

Here are some of the most common maintenance issues to monitor and remedy:

Example 1: Support Misalignment

If base tray support mechanisms are in alignment (in the direction of travel) and flat (level throughout) to provide proper support of the base tray and associated fixtures and parts, then the tray should move through the furnace equipment without issue, provided the tray is in good operating condition. However, if there are broken rails or piers — or broken/deformed roller rails or wheels — then over time the tray may exhibit wear, deformation, cracks, or breaks.

Example 2: Transfer Mechanism Misalignment

If the transfer mechanisms are square to the tray (in the direction of travel) and level throughout, providing proper contact with the base tray, then the tray should move through the furnace equipment without issues, provided the tray is in good operating condition.

However, if there are misaligned transfer mechanisms (pusher rods, pusher head, handler head etc.), then over time the tray may exhibit associated wear, deformation, distortion, cracks, or breaks.

Example 3: Uneven Heating

Although the furnace may be able

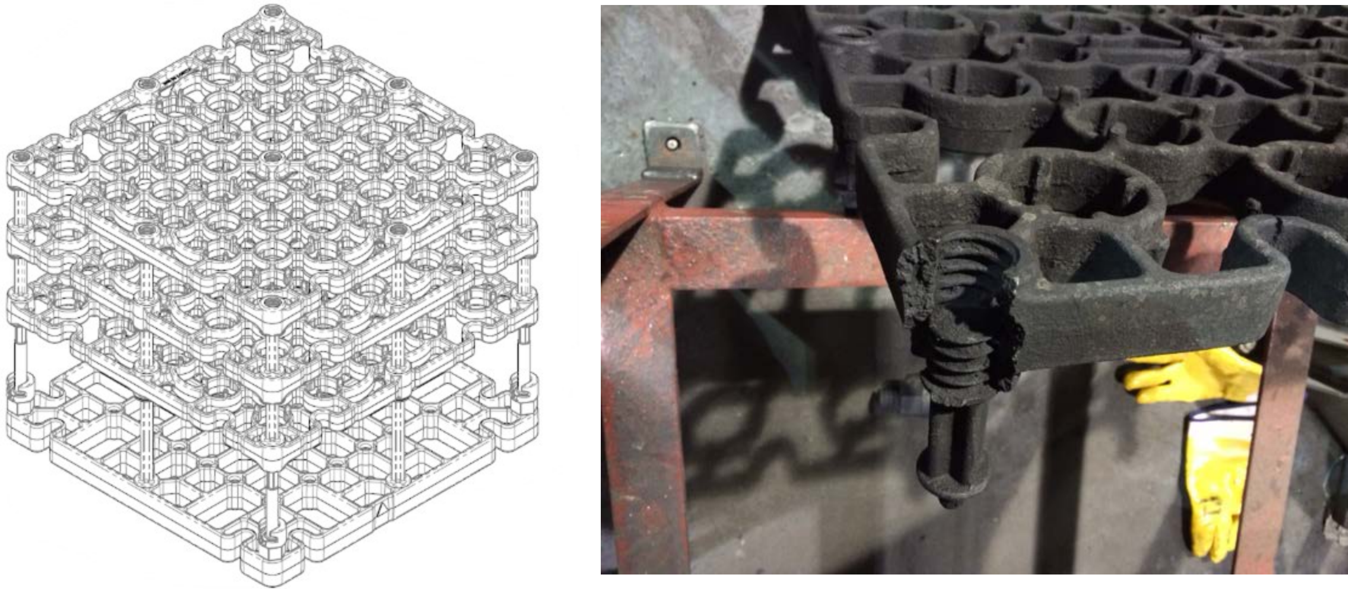

Figure 3. (left) Example of original supplied alloy casting for comparison. (right) Damaged component (Source: Castalloy Group)

to maintain an average furnace temperature as measured by a single control thermocouple, there may be uneven heating conditions (side-to-side, top-to-bottom, front-to-back) due to a variety of factors, which could result in uneven thermal cycling of the alloy castings. This potential non-uniform heating of the alloy could lead to deformation, cracks, or breaks of the alloy castings. The CQI-9 standards work to monitor and address non-uniform heating using a periodic temperature uniformity survey (TUS) of the furnace heating chamber.

Example 4: Non-Uniform Cooling

Although the quench chamber may be able to maintain an average quench medium temperature as measured by a control thermocouple, there may be uneven cooling conditions within a load due to a variety of factors, which could result in uneven thermal cycling of the alloy castings.

If left unchecked, any of these issues may result in unintended wear, deformation, distortion, cracks, or breaks of the alloy castings. Furnace material handling issues may also result in an unplanned equipment downtime and productivity loss.

Alloy Castings Inspection

Alloy castings (fixtures, trays, grids) should be inspected periodically to ensure they are in adequate working order. This inspection could be performed when the furnace equipment is taken out of operation for summer or winter maintenance inspections and shutdowns.

The main areas to consider are flatness, squareness, and proper proportion.

Flatness

Trays, grids, and fixtures should remain flat or level across the width and length. Sagging, bowing, warping, or twisting can cause material handling issues within furnaces and associated process equipment. A simple method to check the flatness is to have a table with a flat and level surface where the tray, grid, or fixture may be placed to check and observe the flatness of the alloy casting.

An alternate method to check the alloy casting flatness would be to use a level across the casting to check flatness.

Squareness

Trays, grids, and fixtures should remain square across the width and length. Being out of square can cause material handling issues within furnaces and associated process equipment. A simple method to check the squareness is to have carpenter's square tool where the

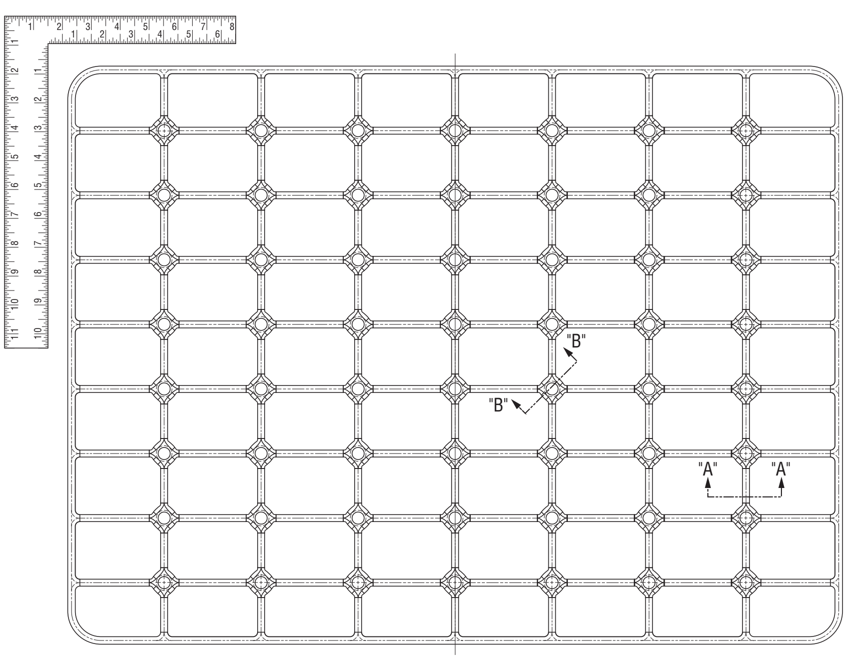

Figure 4. Square tool and tray/grid (Source: Castalloy Group)

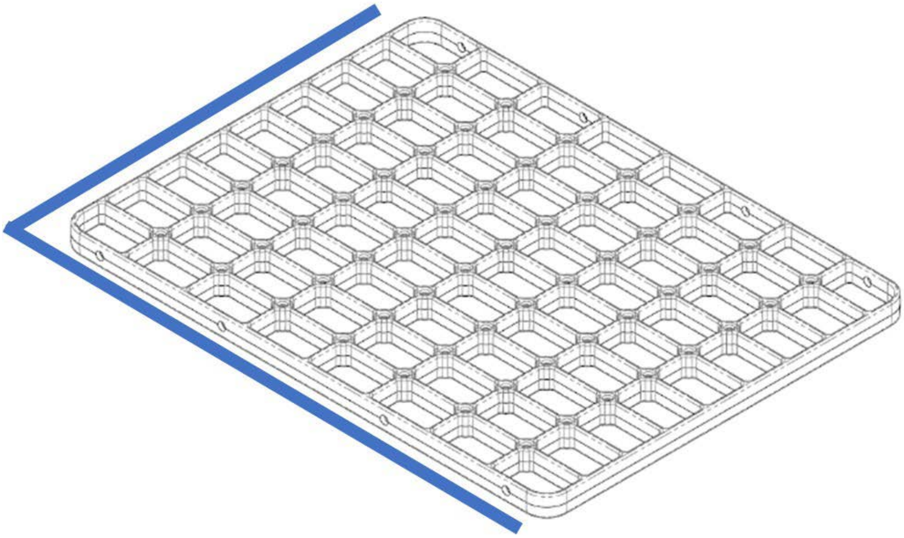

Figure 5. Jig tool to check proportion (Source: Castalloy Group)

tray, grid, or fixture may be examined to observe the squareness of the alloy casting.

If the tray used in the heat treatment equipment is an assembly of trays, then each tray should be examined for squareness in all four corners.

Trays that are out of square may cause tracking problems in the material handling of the furnace, or associated equipment, and should be replaced.

Proper Proportion

Trays, grids, and fixtures should remain in proper proportion as originally designed. Having bulges or large breaks that are outside of the alloy dimensional alignment compared with the originally supplied alloy casting can cause material handling issues within furnaces and associated equipment.

A simple method to check the dimensional proportion is to have a picture or drawing of the originally supplied alloy casting. The tray, grid, or fixture can be compared with this in order to observe the overall soundness of the alloy casting.

Suspect castings should be removed from daily operation to prevent potential material handling and associated equipment maintenance issues.

An alternative to visual inspection is to make a simple jig that can be used to confirm the dimensional integrity of the alloy casting.

Observable patterns of proportional changes within a common area of the alloy castings may indicate a potential issue occurring within the heat treat equipment that should be monitored and investigated before it becomes a major equipment issue and causes an unplanned equipment shutdown.

Chart of Alloy Purchases Initial and Subsequent Periodic

	Time 0	Year 1	2	3	4	Capital Outlay
Initial Alloy Purchase	$$$					**Full**
Replacement Purchase					$$$	**Full**
1st Periodic		$				**Partial**
2nd Periodic			$			**Partial**
3rd Periodic				$		**Partial**
Overall Periodic						
Equivalent Purchase	Initial =	Partial +	Partial +	Partial	Value =>	

Figure 6. Visual demonstration of capital flow for initial and subsequent alloy purchases (Source: Castalloy Group)

Optimizing Alloy Castings Using Periodic Purchases

Periodic purchases of alloy castings should be planned and budgeted annually to maximize casting working life, to minimize process interruptions due to potentially expired useful life of alloy castings, and to manage future expenditures for replacement alloy casting purchases.

In general, budgeting for a percentage of alloy purchases over a two to three-year period, depending on current and planned future operations, would be supportive of continuous production operations. The periodic alloy purchase is then integrated into the existing production operations and suspect alloy castings, if any, can be removed from daily production operations.

There are multiple approaches that can be implemented and adjusted according to individual plant production needs:

One approach to consider is the purchase of one-third of the total alloy purchase per year over the following three years after an initial purchase. In a continuous daily production operation, the initial purchased quantity of alloy castings will have been replaced, if needed, over the elapsed time.

An alternate approach to consider is a staggered percentage over three years. For example, 20–25% replacement the first year; 30–35% replacement the second year; 35–40% replacement the third year, adjusted as necessary based on current operating and business conditions.

This approach would also be useful for ramping up alloy quantity needs to meet increasing demand over time and could be an opportunity to address potential delivery time requirements with coordinated planned periodic purchases.

Additionally, intermixing newly purchased alloy castings along with production alloy castings, may provide for extended life for the latter.

Scrap Alloy Recycling: New Alloy Purchase Credit for Returning Your Scrap Alloy Material

When alloy castings are no longer usable in daily heat treatment operations, it can be advantageous to sell them back as scrap to the alloy supplier. The supplier should be able to provide a scrap repurchase credit that can be used for future purchases of new alloy castings.

Generally, this scrap alloy repurchase credit may be used in whole or in part as directed by the customer for new replacement alloy casting purchases.

As well as being cost-efficient, scrap alloy castings recycling supports the long-term sustainable use of metals, minimizes the potential negative impact on the earth's environment, and reduces the overall carbon footprint of both alloy user and supplier.

Summary

To review, improving the working life of heat treating cast alloys starts with design and is maintained with factors that account for the full alloy casting life:

- Choosing the right design and alloy composition for heat treatment castings is fundamental to optimizing their working longevity and performance. This decision can only be made by carefully considering key aspects of the intended casting application.

Figure 7. Typical scrap alloy trays and grids (Source: Castalloy Group)

- Maintaining furnace equipment and process environment operating conditions will also assist in maximizing the working life and overall performance of the alloy castings.
- Alloy casting inspection will support heat treat operations and minimize potential equipment downtime by providing evidence of furnace equipment issues or malfunction.
- Periodic budgeted alloy casting purchases support heat treat operations, will help maximize uptime, and minimize potential downtime associated with suspect or failing alloy castings.
- Scrap (expired useful life) alloy repurchases can be used to offset the costs associated with new alloy casting purchases. Scrap alloy recycling also minimizes negative impact on the environment. HTT

(Photo Source: Castalloy Group)

About the Author

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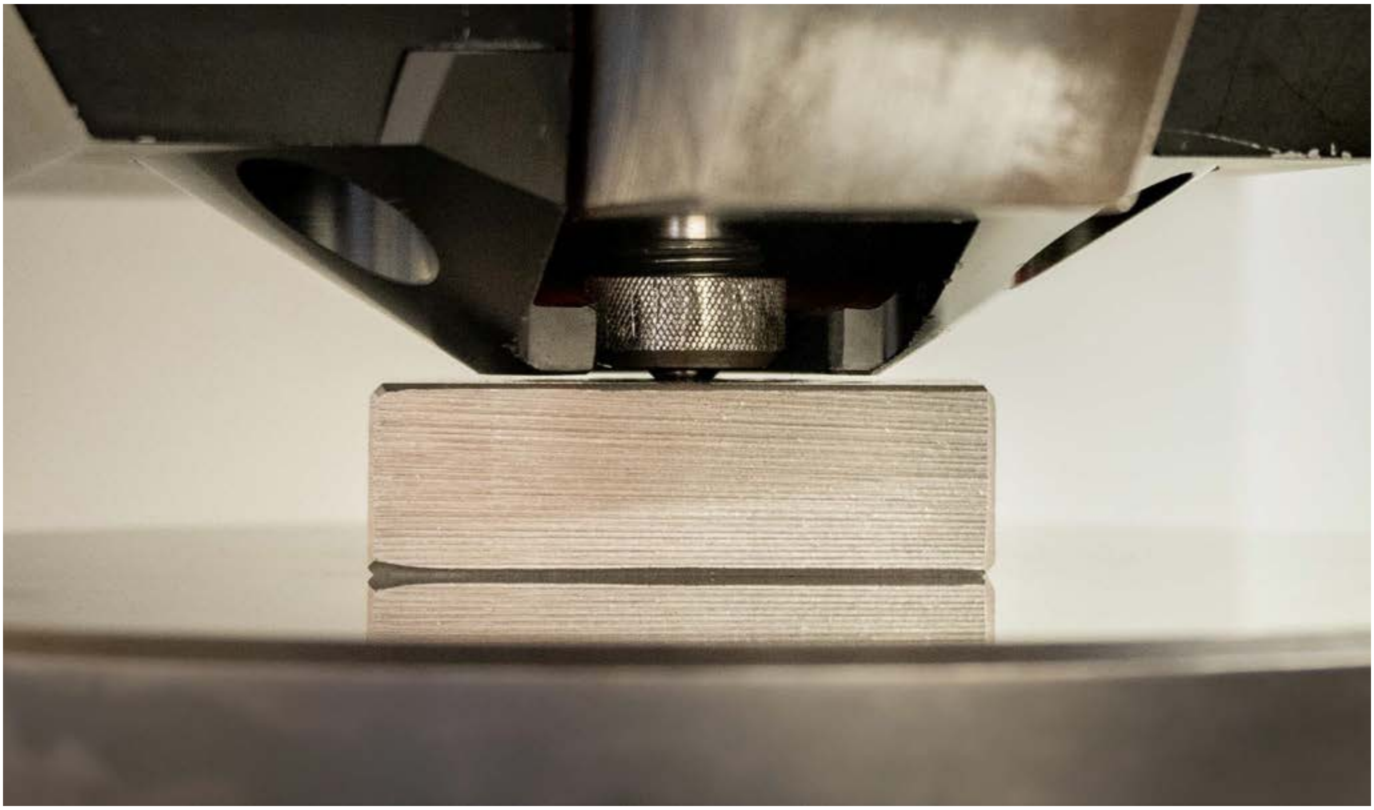


Brinell Hardness Testing 101

By Alex Austin, Managing Director, Foundrax Engineering Products Ltd.

What are the most desirable attributes of a Brinell hardness tester? Does it belong in your heat treat department? Read this equipment overview to decide.

All heat treatment companies must test hardness; many with a Brinell tester. Existing since 1900, a review of this time tested method is in order.

The Brinell test requires a tungsten carbide ball indenter to be forced vertically into the surface of the test material, placed on a rigid anvil. The diameter of the indentation made by the ball is then measured across both its x and y axes as a minimum, and the average of these measurements is taken as the working figure. The technician can then either feed that figure into an equation to determine the hardness or read from a "diameter-to-hardness" chart.

There are various forces and indenter diameters available for Brinell testing reflecting the very wide range of metals that need to be assessed, but most tests involve a 10 mm ball under a 3,000 kg load. In large, floor-standing machines, the indenter is usually motor-driven, but some machines use levers and weights, while others are hydraulic or pneumatic.

The Brinell test remains the default method for hardness measurement in many heat treatment facilities, for three primary reasons.

El ensayo de dureza Brinell para principiantes

Por Alex Austin, gerente, Foundrax Engineering Products Ltd.

¿Cuáles son las características más deseables de un probador de dureza Brinell? Esta reseña del equipo le permitirá evaluar si debe o no incorporarlo a su departamento de tratamiento térmico.

Toda empresa dedicada al tratamiento térmico deberá practicar ensayos de dureza, algunos de ellos utilizando la medición Brinell que data desde el año 1900, lo que lleva a que se amerite el análisis de tan perdurable técnica. La prueba en mención requiere de un penetrador de bola de carburo de tungsteno que impacte de manera vertical sobre la superficie del material a ser ensayado, previamente ubicado éste sobre un yunque fijo. Paso seguido, se mide el diámetro de la "huella" generada por la bola, mínimo por los ejes "x" y "y," y se toma el promedio de estas mediciones como cifra operativa de la que se pueda valer el técnico para establecer la dureza, bien sea alimentando una ecuación o mediante la lectura de una tabla de valores en la que se relacione diámetro frente a dureza.

Para el ensayo Brinell se dispone de una amplia gama de cargas de fuerza, al igual que de diámetros de penetradores, reflejando la gran variedad de metales a ser probados; no obstante, en la mayoría de ensayos se implementa una bola de 10mm bajo una carga de 3.000 kg. En las grandes máquinas de apoyo a suelo por lo general el penetrador es motorizado, aunque otras operan a partir de palancas y pesas, mientras que también las hay hidráulicas o neumáticas.

Existen tres razones principales por las que la prueba Brinell

1. Surface Preparation

Preparing the surface of a sample for Brinell testing takes just a few seconds with a grinder. Provided the sample is sitting steadily on the anvil and the top face of the sample is perpendicular to the direction of force of the indenter — as mandated by the standards — the surface does not need to be particularly smooth.

2. Surface Contamination

Minute surface contaminants under a Brinell indenter are unlikely to cause a "mis-test." By comparison, during Rockwell testing, the most widely used method across all industries, a tiny diamond indenter penetrates the surface by less than one hundredth of an inch, and any contaminants or surface abnormalities (including parallelism) that could impede or assist the progress of the indenter are a problem, which means that Rockwell samples must be carefully prepared before testing.

3. Portable

Perhaps most significant, rugged, hand-held portable Brinell testers with hydraulic test heads enable large, heavy, and awkwardly shaped components of rough surface finish to be tested in situ. This feature is of such utility in industry that the international standards authorities give a dispensation — a special designation — to portable machines, although their performance cannot be directly verified like their floor-standing cousins.

no deja de ser el método más opcionado para la medición de la dureza en muchas industrias de tratamiento térmico.

1. Preparación de la superficie

La preparación de la superficie de una muestra para las pruebas Brinell toma solo unos segundos con una amoladora. Siempre que la muestra esté firmemente asentada sobre el yunque presentando la cara superior en dirección perpendicular a la dirección de la fuerza del penetrador, de acuerdo a lo exigido por las normas, no es necesario lograr una superficie demasiado lisa.

2. Contaminación de la superficie

Es poco probable que los contaminantes diminutos en una superficie generen una "prueba errónea" bajo un penetrador Brinell, a diferencia de la prueba de dureza Rockwell (el método más común en la industria). En esta prueba un pequeño indentador de diamante penetra menos de una centésima de pulgada, arrojando como resultado el que cualquier contaminante o anomalía en la superficie que pueda impedir o favorecer el progreso del penetrador (incluído el paralelismo) represente un problema, y obligando a que las muestras para la prueba Rockwell se deban preparar cuidadosamente antes de realizar la misma.

3. Portabilidad

Quizás el factor más significativo es que los robustos equipos portátiles de mano Brinell, con cabezales de prueba hidráulicos, permiten probar, in situ, piezas grandes, pesadas, de superficies rugosas o formas irregulares. Esta característica es de tal utilidad en la industria que ha motivado a que

With forces ranging from 3000 kg down to 1 kg and indenter balls as small as 1 mm, Brinell testing can be used on a vast range of metal, but forges, foundries, heat treatment plants, quality control areas, and laboratories are the places one would most likely find a test machine working at 10 mm/3000 kg. It was mentioned earlier that the surface of test samples doesn't need to be particularly smooth, in fact roughly-ground surfaces on materials with a coarse grain structure can be measured quite safely because the diameter of the indentation is so large relative to any irregularities on the surface.

Figure 1. Heavy-duty Brinell tester in situ
Figura 1. Robusto probador Brinell in situ

In Figure 2, a calibration-grade Brinell tester drives the tungsten carbide ball into the test sample. The ball is being held in position to stabilize plastic deformation.

ASTM E-10 and ISO 6506 — the authoritative documents for Brinell testing — lay out standards in detail, but the practical procedure for workshop technicians is very straightforward; training should not take longer than an hour. When testing forgings, billets, and other samples, one indentation should suffice but in certain critical applications more than one indentation may be used for assurance.

The question of whether to test every sample in a batch will depend on how inconsistent those samples might be; it has nothing to do with any issues with

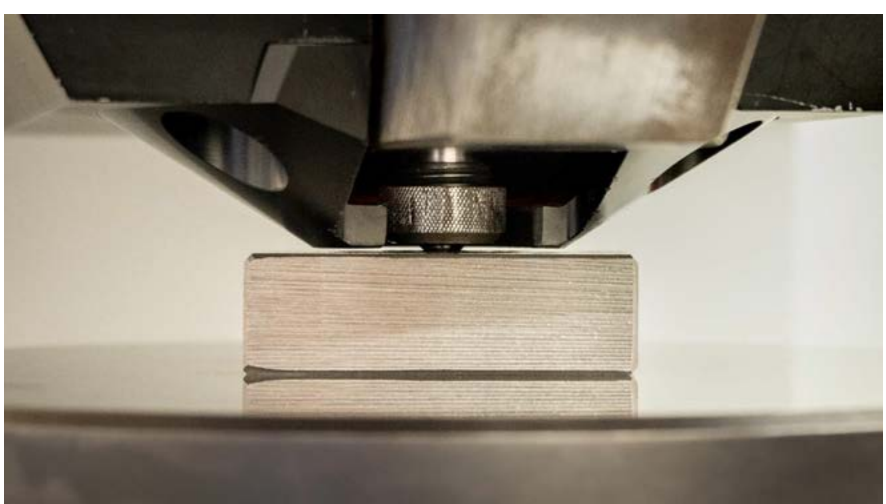


Figure 2. Close-up of a calibration-grade Brinell tester
Figura 2. Probador de Brinell, grado calibrador, en primer plano

los órganos de normalización internacional otorguen una dispensación especial, una excepción si se quiere, a las máquinas portátiles, pese a que la ejecución de las mismas no sea susceptible de verificación directa como sí lo es la de sus equivalentes, las máquinas fijas.

Con fuerzas que van desde los 3000 kg hasta 1 kg, y bolas penetradoras tan pequeñas como 1 mm, las pruebas Brinell se pueden usar en una amplia gama de metales, pero los lugares en los que existiría la mayor probabilidad de encontrar un equipo de 10mm/3000kg son las forjas, las fundiciones, las plantas de tratamiento térmico, los laboratorios y las áreas de control de calidad. Previamente mencionamos que no se requiere que la superficie de las muestras de prueba sea absolutamente lisa; de hecho, es posible medir con un grado importante de precisión las superficies irregulares en materiales de configuración gruesa ya que el diámetro de la hendidura es tan grande en relación con cualquier irregularidad en la superficie.

En la Figura 2 se puede apreciar cómo un probador Brinell de grado calibrador introduce la bola de carburo de tungsteno en la muestra de prueba. Se mantiene la bola en posición para estabilizar la deformación plástica.

Las normas que rigen de manera detallada las pruebas Brinell son la ASTM E-10 y la ISO 6506, pero el procedimiento

Brinell testing itself. In certain industries, every single product is tested because the risk of failure is too high. A good example of this is the production of links for the tracks used on tanks and other armored vehicles. Every link in every tank track in use by the British Army has been Brinell tested on a high-speed, fully automatic machine that features a powerful integral clamp to keep the component rigid during the test. You can view the machine in Figure 1 on page 44. Subject to reasonable care, a heavy-duty Brinell tester will perform many hundreds of thousands of tests. The machine in Figure 1 has performed several million.

Tests take approximately fifteen seconds. The indenter must be driven uniformly into the material with no possibility of either a rebound or a speed that would "punch" the indenter into the material. Also, the metal must be loaded for a sufficient length of time to ensure the indentation is properly (plasticly) deformed, that is, the risk of an indentation shrinking very, very slightly after the indenter is withdrawn is kept to a minimum.

Measuring the indentation is more challenging. After carefully making the indentation and withdrawing the test sample from the "jaws" of the test machine, one must measure the indentation across at least two diameters. Given that Brinell indentations are at most 6 mm across and that 0.2 mm difference in diameter might equal 20 hardness points, getting the measurement right is critical — and tricky. Most technicians will use an illuminated microscope to do this, but even then it can be a challenge. Consider Figure 3 on the next page.

práctico para los técnicos es muy sencillo, tanto que el entrenamiento no debería tardar más de una hora. Para ensayar piezas forjadas, palanquillas y otras muestras, una hendidura debería bastar aunque, desde luego, en ciertas aplicaciones de extrema importancia se podrá utilizar más de una para mayor seguridad.

Saber si analizar o no cada muestra en un lote determinado deberá decidirse con base en la inconsistencia de las muestras mismas, más no responde a problemática alguna con las pruebas de Brinell en sí. En ciertas industrias se prueba cada pieza que se produce debido a que el riesgo de error es demasiado alto. Un buen ejemplo lo encontramos en la producción de los componentes de los eslabones para las orugas utilizadas en tanques y maquinaria pesada (retroexcavadoras y demás). Cada eslabón de cada oruga de un tanque en uso en el ejército británico ha sido probado por Brinell en una máquina totalmente automática, de alta velocidad, que cuenta con una poderosa abrazadera integral para mantener el componente absolutamente rígido durante la prueba. Por cierto, esa máquina es la de la primera foto. Con un cuidado adecuado y razonable, un probador Brinell robusto podrá generar cientos de miles de pruebas; de hecho, el probador de la Figura 1 ha realizado varios millones.

Las pruebas duran aproximadamente quince segundos ya que el penetrador se debe dirigir hacia el material de manera uniforme sin permitir la posibilidad de un "rebote" y evitando por completo llegar a golpear el material. Por otro lado, el metal debe recibir la presión por un período de tiempo suficiente que garantice que la hendidura se deforme

Making an indentation leaves a "ridge" at the indentation perimeter because metal is not just pushed downwards, but also sideways. This ridge can obscure where the real indentation begins, and three different technicians can easily make three different estimates of where that is. And this variation in operators' interpretation of results is why, for over 80 years, the Brinell test was seen as a little "rough and ready," for the workshop machinist, perhaps, but probably not for the laboratory scientist.

Manual measurement microscopes have improved over the years, and a relatively "clean edged" indentation with a crisply illuminated graticule can be less challenging for

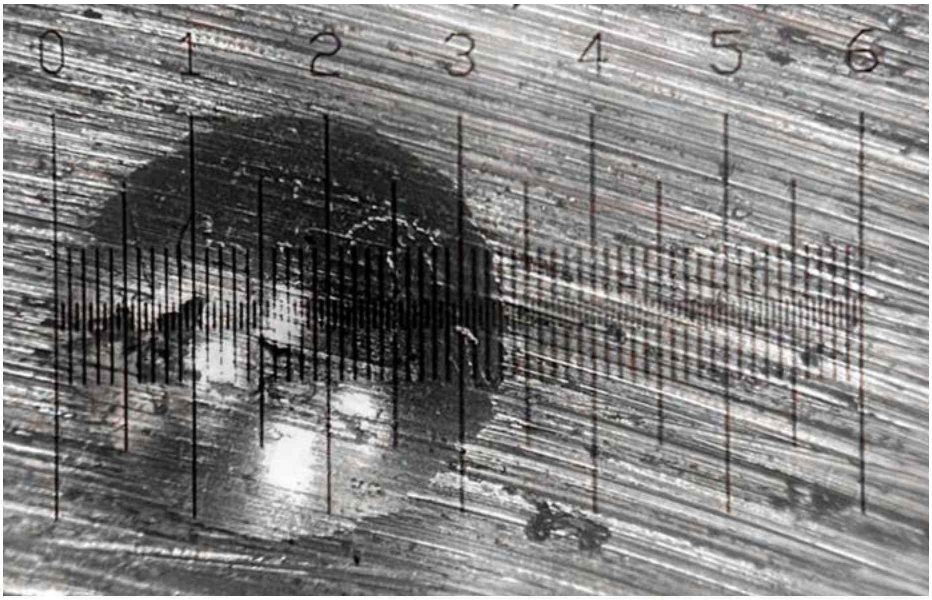


Figure 3. Measurement of Brinell hardness test indentation

Figura 3. Medición de una hendidura de prueba de dureza Brinell

de la manera más plástica posible, es decir, minimizando al máximo el riesgo de la más ligera contracción de la hendidura una vez retirado el penetrador.

Sin embargo, es en este punto que se presentan las complicaciones. Después de generar cuidadosamente la hendidura y retirar la muestra de prueba de la "boca" de la máquina probadora, es necesario medir la hendidura en al menos dos diámetros. Dado que las hendiduras de Brinell tienen como máximo 6 mm de ancho y que una diferencia de 0,2 mm en el diámetro podría equivaler a 20 puntos de dureza, obtener la medición correcta es esencial y de alta complejidad. La mayoría de los técnicos usan un microscopio iluminado para lograrlo, pero aún así the experienced technician to make an accurate measurement. Figure 4 is a less difficult scenario than the one above. Even so, how can we know if we have really judged the position of the edge precisely?

In 1982, the first automatic reader hit the markets. This was the culmination of years of research and used proprietary software that pushed the computers of the day to their limits. The equipment could make hundreds of measurements across the indentation and calculate the mean diameter in a split second. Not long afterwards, it was available as an integral part of a Brinell test machine. Word of this equipment

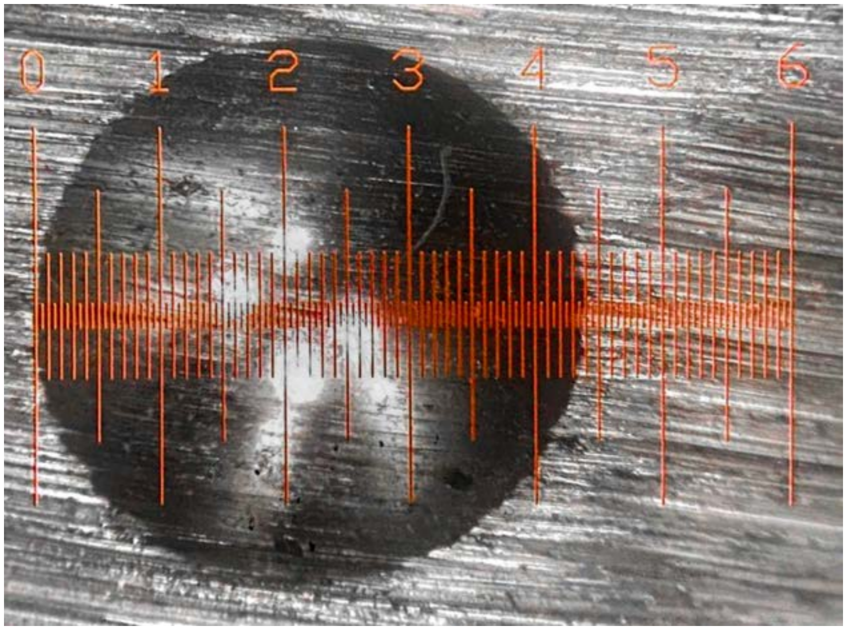


Figure 4. Measurement with improved microscope and well-illuminated graticule

Figura 4. Medición con microscopio mejorado y retícula bien iluminada.

puede ser un desafío. Considere la Figura 3.

Al crearse la hendidura se genera un cordoncillo en el perímetro de la misma debido a que el metal no solo presiona hacia abajo, sino también hacia los lados. Este cordoncillo puede dificultar la ubicación del punto en el que comienza realmente la hendidura, y tres técnicos diferentes pueden hacer fácilmente tres estimaciones diferentes de su lugar de inicio. Es esta variación en la interpretación de los resultados por parte de los operadores la que ha llevado a que, durante más de 80 años, la prueba Brinell se haya considerado un poco "ordinaria", apta tal vez para el maquinista en el taller, pero de dudoso valor para el científico en el laboratorio.

Figure 5. Latest version of the automatic microscope in action

Figura 5. La última versión de ese microscopio automático en acción.

soon reached critical users in the oil tool industry, and they mandated its use to their suppliers. Within 15 years, the use of this technology was widespread and the perception of the Brinell test's accuracy had been transformed. The Brinell test, in a sense, had come of age. See Figure 5 for the latest version of that automatic microscope in action.

Finally, like any important measuring equipment, regular calibration and servicing is desirable, if not compulsory. Manufacturers typically stipulate a service schedule which must be considered alongside the calibration rules dictated by international agencies.

When considering options for hardness testing of heat treated samples, there are ultimately three test methods: Brinell, Rockwell, and Microhardness (Vickers or Knoop).

While Brinell testing isn't suited to very small or very thin samples, it is relatively "immune" to small contaminants, the indenters are not expensive, and the width of the indentation means that testing of coarse grained and roughly finished surfaces is not problematic. With the development of reliable automatic indentation measurement, the one serious deficiency of the Brinell test was overcome, providing the assurance that was vital to critical components suppliers in all types of industries such as oil and gas, aerospace, defense, and transportation. HTT

(Photo Source: Foundrax Engineering Products Ltd.)

Los microscopios de medición manual han mejorado a lo largo de los años, y cuando se obtiene una hendidura relativamente "limpia" con una retícula nítidamente iluminada, se le puede facilitar al técnico experimentado realizar una medición precisa. La Figura 4 presenta un escenario menos complejo que el anterior pero, aun así, ¿cómo podemos saber si realmente se ha juzgado con precisión la posición del borde?

En 1982 llegó a los mercados el primer lector automático, siendo éste la culminación de años de investigación, y valiéndose de *software* privado que llevó a las computadoras de la época a sus límites. El equipo podía hacer cientos de mediciones de un lado a otro de la hendidura y calcular el diámetro medio en una fracción de segundo. Poco después llegó a ser parte integral de una máquina de prueba Brinell. La noticia de la aparición de este equipo pronto llegó a algunos usuarios importantes en la industria de las herramientas petroleras quienes exigieron a sus proveedores valerse de él; quince años más tarde se había diseminado ampliamente el uso de esta tecnología generando la transformación de la percepción que se tenía de la prueba Brinell. Podríamos decir que la prueba Brinell había llegado a la mayoría de edad.

Desde luego, como con cualquier equipo de medición importante, la calibración y el mantenimiento regulares son aconsejables, si no obligatorios. Los fabricantes mismos suelen estipular un cronograma de mantenimiento que se debe tener en cuenta junto con las reglas de calibración establecidas por las agencias internacionales.

Al considerar las opciones para la prueba de dureza en muestras con tratamiento térmico, en última instancia existen tres métodos: Brinell, Rockwell y Microdureza (Vickers o Knoop).

Pese a que no es adecuada para muestras muy pequeñas o demasiado delgadas, la prueba Brinell es relativamente "inmune" a los contaminantes pequeños, los penetradores no son costosos, y, gracias al ancho de la hendidura, las pruebas de superficies con acabado áspero e irregular no presentan dificultades. Con el desarrollo, hace 40 años, de la medición automática de la hendidura, se superó la única deficiencia grave de la prueba Brinell, proporcionando las garantías que tan vital importancia revestían para los proveedores de piezas esenciales en industrias de toda índole, incluídas las de petróleo y gas, aeroespaciales y de defensa y transporte. HTT

(Fuente de fotografías: Foundrax Engineering Products Ltd.)

About the Author

Alex Austin has been the managing director of Foundrax Engineering Products Ltd. since 2002. Foundrax has supplied Brinell hardness testing equipment since 1948 and is the only company in the world to truly specialize in this field.

Alex sits on the ISE/101/05 Indentation Hardness Testing Committee at the British Standards Institution. He has been part of the British delegation to the International Standards Organization advising on the development of the standard ISO 6506 "Metallic materials – Brinell hardness test" and is the chairman and convenor for the current ISO revision of the standard.

For more information:

Contact www.foundrax.co/uk

Conozca al autor

Alex Austin se viene desempeñando desde 2002 como gerente de Foundrax Engineering Products Ltd. Foundrax es proveedor de equipos de prueba de dureza Brinell desde1948, siendo en realidad la única compañía en el mundo especializada en el campo.

Alex funge en el Comité de Prueba de Dureza por Hendidura ISE/101/05 del British Standards Institution. En su calidad de miembro de la delegación británica de la Organización Internacional de Normalización, ha aportado como consultor para el desarrollo de la norma ISO 6506 "Materiales metálicos–prueba de dureza Brinell" y preside en la actualidad la revisión ISO de dicha norma.

Mayor información en www.foundrax.co/uk

THERMPROCESS 2023 at a Glance

While you can read all about THERMPROCESS 2023 in Doug Glenn's Publisher's Page (Page 4), see how North America was represented at the largest heat treat trade show in the world.

Doug Glenn with Furnaces International *staff*

Doug Glenn & Jason Safarz in the Karl Dungs booth

Liu YeDong, Sławomir Woźniak, CEO, Piotr Skarbinski, and Mariusz Raszewski from SECO/WARWICK with Doug Glenn

BJ Bernard & John Gottschalk (l-r) from Surface Combustion with Doug Glenn

David & Phil Hamling from Zircar Ceramics Inc. with Doug Glenn

Doug Glenn with Bryan Welch & Rob Goldstein of Fluxtrol

The team from Super Systems Inc. including Jim Oakes (center) with Doug Glenn (far right)

Clint Hall from Combustion 911 & Olsträd Engineering Corporation with Doug Glenn

Doug Glenn (in the back row) with Michael Klauck, President of CAN-ENG Furnaces Intl. Ltd., Theresa Eagles, Tim Donofrio & Scott Cumming

Doug Glenn with Scott Robinson in the Centorr Vacuum Industries booth

(Left to right) Doug Glenn in the Selas Heat Technology booth with Jeff Rafter, VP Sales

Doug Glenn with Ann Thompson from Gefran

Justin Dzik & Mark Hannum with Doug Glenn in the Fives booth

Doug Glenn with Jan Philipp Massholder & Marco Baretti in the TAV/Furnacare booth

Joe Wuenning from WS Wärmeprozesstechnik GmbH presenting at THERMPROCESS 2023

Doug Glenn (l), Mary Glenn (center), Timo Wuerz, CECOF Executive Vice President (2nd from right) with Arlen LUO (far right) and his colleague in the VDMA booth.

Dave Schalles of Bloom Engineering with Doug Glenn


Charles Mouiroud with Mary & Doug Glenn in the ECM booth

Steve Mickey of WS Thermprocess with Doug Glenn

Steve Offley ("Dr. O") of PhoenixTM with Doug Glenn

Doug Glenn with Yvonne Edenholm in the Kanthal booth


Doug Glenn with René Branders, Chairman of CECOF

Doug & Mary Glenn with Christoph Bollgen & Michael Klose from JUMO

Reducing the Carbon Footprint of Your Heat Treating Operations

By Brian Kelly, Manager of Application Engineering at Honeywell Smart Energy and Thermal Solutions (SETS) and President of the Industrial Heating Equipment Association.

The need to understand the impact of greenhouse gases (GHGs), especially carbon-based emissions, on climate change is gaining much more interest recently from organizations that have industrial heating processes. Most industrial heating processes are fueled by carbon-based fossil fuels such as natural gas, propane, fuel oil, diesel, or coal. In basic terms, if you have combustion processes in your organization, you are emitting carbon (CO_2). Impacts on climate change due to these carbon emissions have prompted government and corporate actions to reduce carbon. These actions are creating unique new opportunities for more sustainable and lower carbon process heating methods.

In this article, we will focus on ways to reduce carbon in typical fossil fuel fired heat treat thermal processes.

First step: Figure out where you are today. Do you know?

Assess Your Carbon Footprint

More and more companies are interested in understanding their GHG/carbon footprints, so they can determine what processes are their biggest CO_2 offenders, and on what assets to focus on in order to have the largest impact on reducing carbon. Whether your thermal processes are being heated by fossil fuels (typically natural gas) or electrically, each will have a carbon footprint. Fuel gases are being burned to provide the heat and they produce CO_2 as a result. Most electrical power is currently being produced by fossil fuels, so electricity will have a CO_2 amount associated per kW. What can be done to burn less fuel in your furnaces or ovens, which directly relates to reducing CO_2?

Tune Your Combustion Systems

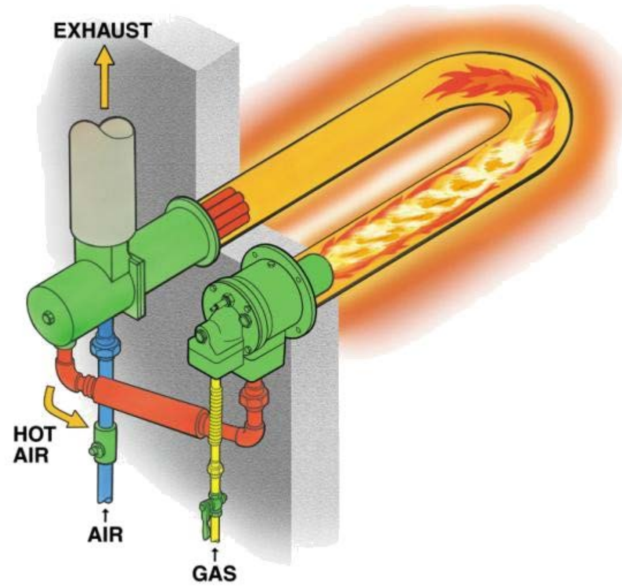
Over time combustion systems drift and are not at their optimum air/fuel ratio. By simply tuning your burner system on a routine basis, you can fire at the optimum air/fuel ratio for the process and be as efficient as possible. For example, if a furnace is firing on natural gas, operating at 1800˚F, and currently operating at 35% excess air, tuning your burners to 10% excess air could save approximately 15% in fuel consumed. The fuel costs will be reduced, and the resulting CO_2 will be reduced by that same percentage!

Maintain Your Furnaces/Ovens

A simple review of your furnaces or ovens to observe any hot spots, openings, faulty seals, or refractory issues will identify areas that will cause your systems to operate less efficiently, thus using more energy. Repairing these problems and consistently maintaining them will have the systems running more efficiently and producing as little carbon as possible.

Upgrade Your Firing Systems To Be More Efficient

Incorporating preheated combustion air into furnace combustion systems can significantly reduce fuel consumption and therefore the resulting carbon. The two main methods for introducing hot air into a combustion system are recuperation and regeneration.



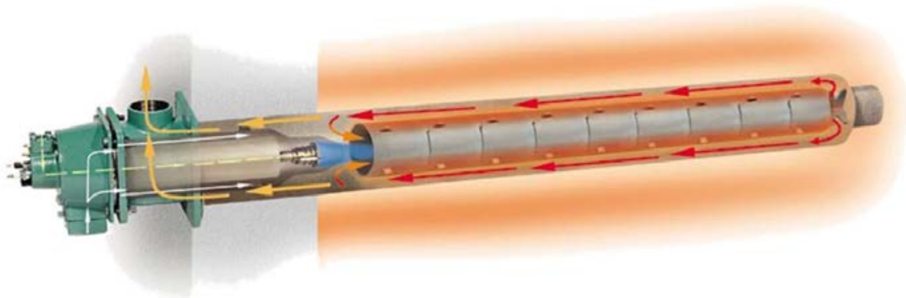
Radiant tube burner with plug recuperator in a U-tube


Direct fired self-recuperative burner

The most popular air preheating method in heat treating applications is recuperation. For a direct fired furnace, this can take the form of a central stack recuperator or self-recuperative burners. Self-recuperative burners have grown in popularity in recent years as they get rid of the need for hot air piping, recuperator maintenance, and most are often pulse fired, which will not only maximize efficiency but also promote temperature uniformity in the furnace and often be lower in emissions.

For indirect fired (radiant tube) furnaces, you can apply/add a plug recuperator to an existing cold air fired burner in a furnace that has a U or W-tube to preheat the combustion air or apply self-recuperative burners installed in Single-Ended Radiant (SER) tubes to optimize your furnace firing.

The SER tube material can be upgraded to silicon carbide which allows higher



Single ended self-recuperative radiant tube burner

temperatures/flux rates that can provide the opportunity to increase throughput and reduce the possible CO_2 per cycle.

Combustion air preheating can result in energy savings of close to 25% over cold air combustion.

Renewable Fuels/Hydrogen

Renewable fuels or hydrogen have entered the scene as these are fuels that contain little or no carbon. So, no carbon in the fuel means no CO_2! These fuels present an excellent opportunity to significantly reduce carbon. Hydrogen has been of interest because it has the opportunity to be a zero-carbon industrial fuel when produced with renewable energy such as wind, solar, hydro, or nuclear power. As these methods become more prevalent, they bring down the price of hydrogen and increase its availability. This could be a significant driver to greatly reduce CO_2 in thermal processes.

These topics as well as many others are being discussed in an on-going Sustainability Webinar series hosted by IHEA to provide education and insight into the ever-changing sustainability landscape. **HTT**

(Image Source: Honeywell)

About the Author

Brian Kelly is manager of Application Engineering for Honeywell Smart Energy and Thermal Solutions (SETS) and current president of the Industrial Heating Equipment Association (IHEA).

Not Using 2FA or MFA? Your Data Is Not Secure

Joe Coleman
Cybersecurity Officer
Bluestreak Consulting™

Introduction

This 9th article in the series from Heat Treat Today's Cybersecurity Desk will explain the significance of 2FA (2-Factor Authentication) and MFA (Multi-Factor Authentication), their benefits, and how they can help secure your data and your clients' data.

2FA and MFA have proven to be effective methods to enhance online security. And, if you provide any products or services to a DoD (Department of Defense) contractor, this is mandatory for all users accessing your computer systems and critical data. Implementing 2FA is a minimum requirement and is better than just a username/password combination. MFA takes your security to a whole new level.

Bluestreak CONSULTING™ Cybersecurity | Compliance NIST + CMMC

CYBERSECURITY ACRONYMS
(DFARS, NIST, CMMC, DHS)

Prepared by Joe Coleman, Cyber Security Officer, Bluestreak Consulting™

Heat Treat Today

Acronym	Definitions
3PAO	Third Party Assessment Organizations
3PSP	Third Party Service Provider
AAL	Authenticator Assurance Levels
AC	Access Control
ACL	Access Control List
AD	Active Directory
ADM	Asset Definition and Management
AIA	Aerospace Industries Association
AIO	Adapt, Implement, and Operate
AM	Asset Management
AM	Audit Management
AMI	Amazon Machine Image
AO	Authorizing Official
API	Application Programming Interface
APN	Access Point Name
APNs	Apple Push Notification service
APS	Advanced Planning and Scheduling
APT	Advanced Persistent Threat
ASM	Attack Surface Management
AT	Awareness and Training
ATO	Authority to Operate
ATP	Advanced Threat Protection
AU	Audit and Accountability
AUP	Acceptable Use Policy
AWS	Amazon Web Services
BaaS	Backup As A Service
BCM	Business Continuity Management
BCP	Business Continuity Plan
BIA	Business Impact Analysis
C-Suite	CEO, CFO, COO & CIO
C3PAO	CMMC Third Party Assessment Organizations
CA	Security Assessment
CAC	Connection Admission Control
CACard	Common Access Card
CAP	CMMC Assessment Process
CATM	CAICO Approved Training Materials
CBI	Confidential Business Information
CCA	Certified CMMC Assessor
CCB	Change Control Board
CCI	Certified CMMC Instructor
CCIS	Covered Contractor Information Systems
CCM	Cloud Controls Matrix
CCO	Corporate Compliance & Oversight
CCP	Certified CMMC Professional
CCPA	California Consumer Protection Act

Acronym	Definitions
CDA	Cyber Defense Agency
CDCs	Cleared Defense Contractors
CDI	Covered Defense Information
CERT	Computer Emergency Response Team
CERT RMM	CERT Resilience Management Model
CFG	Configuration Management
CFR	Code of Federal Regulations
CI	Continuous Improvement
CIAS	Confidentiality, Integrity, Availability and Safety
CIEM	Cloud Infrastructure Entitlements Management
CIRP	Cybersecurity Incident Response Program
CIRT	Computer Incident Response Team
CIS	Center for Internet Security
CIS	Control Implementation Summary
CISA	Cybersecurity & Infrastructure Security Agency
CISO	Chief Information Security Officer
CM	Configuration Management
CMDB	Configuration Management Database
CMMC	Cybersecurity Maturity Model Certification
CMMC AB	CMMC Accreditation Body
CMMS	Computerized Maintenance Management System
CMP	Configuration Management Plan
CMS	Content Management System
COI	Chemical of Interest
COMM	Communications
COMP	Compliance
COOP	Continuity of Operations Plan
COTS	Commercial Off The Shelf
CP	CMMC Certified Professional
CQAP	Code of Professional Conduct
CRA	Cybersecurity Risk Assessment
CRAP	Critical Resources & Acquisition Path
CSA	Cloud Security Alliance
CSAM	Cyber Security Assessment and Management
CSF	Cybersecurity Framework
CSI	Customer Support Identifier
CSO	Cloud Service Offering
CSOP	Cybersecurity Standardized Operating Procedures
CSP	Cloud Service Provider
CTI	Controlled Technical Information
CTRL	Control Management
CTS	Compatibility Test Suite
CUI	Controlled Unclassified Information
CVE	Common Vulnerabilities and Exposures

Page 1 of 4

ACRONYM Updated 10/11/22

What Is 2FA?

2FA adds an extra layer of security to the usual username/password combination. It requires users to provide a second authentication factor, typically something they possess, in addition to their password. Common examples include a one-time verification code sent via SMS, email, or generated by an authentication app like Google Authenticator or Authy. By requiring the combination of something known (password), along with something possessed (authentication factor), an additional level of security is provided.

What is MFA?

The strengths of Multi-Factor Authentication (MFA) take security a step further by incorporating multiple authentication factors beyond the customary two. These authentication factors can be categorized into three main types: something you know (password or PIN), something you have (smartphone or security token), and something you are (biometrics like fingerprints or facial recognition). MFA offers increased security as it requires multiple factors to be verified before granting access.

Is MFA Better than 2FA?

In terms of security, the more the better should be the correct mindset. MFA is a more secure method than 2FA, because a user must respond to more checkpoints, especially if authentication factors disperse through different access points that aren't available online (like a token or security key) and require a physical presence.

Proving user identity multiple times instead of just submitting items of proof twice (i.e., 2FA), lowers the chance of a breach and helps achieve security compliance requirements.

Implementing 2FA or MFA

Enabling 2FA and MFA is becoming a more and more accessible option across many platforms and services. The most popular websites, email providers, social media networks, and online banking institutions offer 2FA and/or MFA options. Users can typically find the necessary settings in their account security or privacy preferences. It is crucial to follow the provided instructions for setting up and managing these authentication methods properly.

In an age where cyber threats are always rising, protecting our online presence is critical. 2FA and MFA have proven to be effective methods in safeguarding our digital lives. By implementing these extra layers of security, companies can enhance their defenses and protect their data and their clients' data.

What About Your Outside Personnel Support?

Many companies have outside vendor support, and maintenance personnel access their network and systems on a regular basis. For example, they may use VPN access that requires the user to "punch a hole" in the firewall, making it much more vulnerable to unauthorized access. Additionally, it is typically a configuration nightmare for your network and the IT folks to get it working properly.

There is a better way. Through much research and testing, we have found that BeyondTrust is a great tool to use to allow outside vendors secure access to the information they need to see without connecting to your network. It is currently used by 20,000+ organizations worldwide with much success and security. BeyondTrust also records their entire online session so you can see exactly what they accessed and did during the online session. Check out www.beyondtrust.com for more information. HTT

Contact Joe Coleman at
joe.coleman@go-throughput.com

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: new equipment, new investment, a new association member, and a new report.

Investing in the production of high-performance electrical steel in Shanghai. (Source: Baowa)

New Electrical Steel Lines for EV Motors

"Fives, a leading engineering group with broad expertise in steel processing and technology, has designed and delivered thermal sections for a new annealing and pickling line (APL) and two new annealing and coating lines (ACL). The lines, designed to produce high quality non-grain oriented (NGO) grades for electric vehicle motors, delivered their first coil between December 2022 and February 2023."

Read More: *"Fives and Baowu launch new electrical steel lines"* at heat-processing.com

Addressing the issue of plastic waste management. (Source: worldsteel)

Successful Trials Will Help Manufacturer Reduce Carbon Footprint

"Integrated steel manufacturer JSW Steel has accomplished a 'significant breakthrough in environmental sustainability' by successfully injecting waste plastic into Blast Furnace 3 at its Vijayanagar steel plant following extensive trials."

Read More: *"JSW Steel successfully completes waste plastic injection trial"* at furnaces-international.com

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Left to right: Huang Ligang, general manager, Kilnpartner; Zhang Yuejin, Chairman of the board, Kilnpartner; Michael Reisner, CEO, Aichelin Ges.m.b.H.; Christian Grosspointner, CEO, Aichelin Holding; and Fan Xiaochun, CEO, Kilnpartner, after signing the contract. (Source: Aichelin)

AICHELIN Cooperation Agreement

"The thermal processes used to treat the essential components of Li-ion batteries represent a key technology in this process. These include the cathode as LFP (lithium iron phosphate) or NMC (nickel manganese cobalt) and the active anode material. Only through a highly accurate heat treatment can the crystal structure and morphology of the material be trimmed to 'peak performance.' In order to achieve this goal, each manufacturer has its own processes. The common basic requirement is flexible and reliable plant technology, the so-called 'kilns.'"

Read More: *"New heat treatment cooperation for battery materials"* at heat-processing.com

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, energy, and general manufacturing sectors — can easily share this information.

Want to see your product listed here? Contact Michelle Ritenour at **michelle@heattreattoday.com**.

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https://afc-holcroft.com/company/downloads

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For more information:
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Modern Industries, Inc.

Heat Treat Today's
MTI MEMBER PROFILE

Herb Sweny, a returning WWII veteran, founded Modern Industries, Inc. in 1946 with this foundational mission: Do the Right Thing and Do the Thing Right. This meant a tough, fair, and honest business practice with a focus on improvement. Today, these characteristics have led the company to become a primary source of heat treating services in Northwestern Pennsylvania.

Flame curtain (safety feature) for atmosphere furnace

To do the right thing and do the thing right, the company uses four vertically integrated divisions of manufacturing and industrial support services. The first division, heat treat, is made up of over 40 furnaces of varying type, size, and process capability. These furnaces are capable of various heat treating processes: carburizing, annealing, vacuum processing, and many more. Certifications in Nadcap, AC-7102, IATF 16949, an ITAR registration, and several zero-finding audits over the past five years aid the heat treat division in doing the thing right.

The three other divisions — machining, lab testing, and products — work with heat treat to be a one-stop-shop for certified parts. The machining division provides production manufacturing and sub-assembly. The lab testing department consists of an on-site laboratory which, through the research division, provides the ability to combine process, testing, and certification. The product department creates work and tool holding products.

Loading vacuum furnace

Herb Sweny's tough, fair, and honest business practices are now applied to the automotive, aerospace, medical, and military industries, as well as others. A second-generation family business, Modern is committed to providing certainty of outcome and demonstrating quality turn-around time. These qualities have propelled the business forward, and the company now supports customers in the U.S., Mexico, and Canada with services that were historically "local" at Erie and Kersey, PA facilities.

For Modern Industries, the final element of doing the right thing is a continued focus on improvement. Over 75 years of business, the company has seen the evolution of heat treating capabilities and changing best practices. In the next five to 10 years, they hope to use this experience to continue to maintain adaptability and meet the evolving market requirements. Their most recent investment in this goal was the addition of the area's largest 10 bar capable vacuum furnace. A new operating furnace control system is also advancing them towards improvement. With deep roots in the past, Modern Industries is looking steadily toward the future, doing the right thing and doing the thing right.

(Photo Source: Modern Industries, Inc.)

MODERN INDUSTRIES

For more information

613 W. 11th Street
Erie, PA 16501
United States
Phone: (814) 455-8061
modernind.com
MichaelP@ModernInd.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.

WANT TO ADVERTISE?
If you have employment needs, aftermarket parts or services to promote, or used equipment to sell, please contact Eunice Pearce at (616) 401-4723 or **eunice@heattreattoday.com** for pricing and availability. All classified ads appearing in the print version are also listed online at no extra charge.
See the latest at **www.heattreattoday.com/classifieds**

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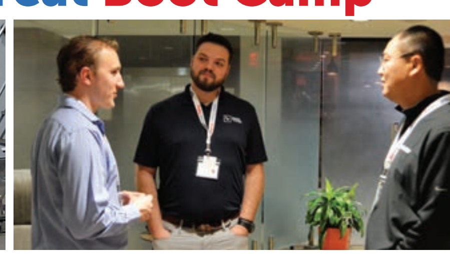
Heat Treat Today wants to recognize the service that heat treaters have done for the industry and for the nation.

If you know someone who is a **Heat Treat Veteran** and can supply some information about this veteran's U.S. military service, fill out the **Heat Treat Veterans** form.

www.heattreattoday.com/veterans-nomination-page

3 Good Reasons To Attend Heat Treat Boot Camp



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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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Aftermarket

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Used Equipment

Heat Treat EQUIPMENT
Established by John L. Becker

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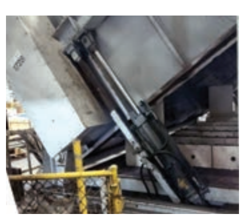
Canton, MI 48188
Phone: 734-331-3939
Fax: 734-331-3915
heattreatequip.com

Item V-1202/3/4 – Furnaces – (2) Tip Ups, Quench & Washer with Manipulator



Manufacturer:	Atmosphere Systems
Type:	(2) Direct-Fired Tip-Up Furnaces
Load Dim's:	168" wide x 108" deep x 84" high (44"high from top of piers to under burners)
Fuel/Max Temp:	Natural gas / 1800°F
Power:	480 volts, 3-phase, 60 Hz
Burners (each unit):	Five (5) North American Tempest 4442-4-S 890,000 BTU / burner / 4,450,000 BTU total
Controls:	SSI Temperature & High-Limit Controls Eclipse control system for furnace pressure

Item U-3803 – Abar Ipsen 6-Bar Vacuum Furnace

Type:	6-Bar Horizontal Vacuum Furnace
Load Area:	36" wide x 72" deep x 30" high
Maximum Temp:	2500°F / 1371°C (uniform within ± 10°F
Ultimate Pressure:	10-3 Torr range
Maximum Load:	3500 pounds gross
Heating Elements:	Molybdenum one (1) zone
Electrical:	460V / 3-Phase / 60Hz
Cooling Fan:	2-speed: 125 HP/31 HP at 3600/1800 RPM
Temp Control:	Honeywell UMC 800
Vacuum Control:	Recorder/Controller with partial pressure point

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Coming in November
Annual Vacuum Heat Treating Issue