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FEBRUARY 2019

Processing Aluminum 35

INSIDE

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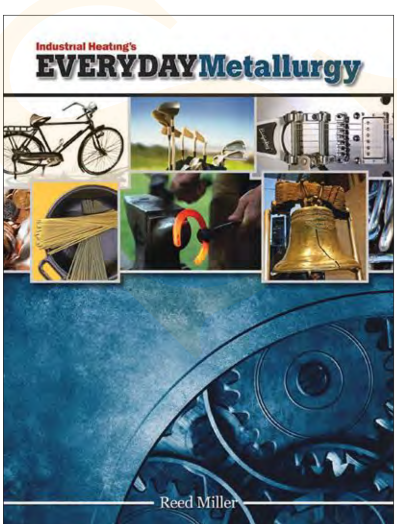
As we shine the "light" on nonferrous this month, don't miss what's included in this issue. The Heat Treat Doctor® discusses the nonferrous topic of overaging. One of this month's articles focuses on noncontact temperature measurement for aluminum extrusions. Aluminum is tricky because of its low process temperature and its emissivity. Following that article is another discussing aluminum heat-treating applications. While not exclusively nonferrous, you won't want to miss our new contributor from Carnegie Mellon University in the Academic Pulse. Additive manufacturing is his topic this month.

Including nonferrous manufacturers, we have to mention the recent report that manufacturing added 32,000 jobs in December for a total of 284,000 in 2018. This is the best calendar year for manufacturing jobs since 1997. As a frame of reference, 207,000 manufacturing jobs were added in 2017.

Tariffs

Early reporting indicated that the tariffs were going to help the aluminum industry. How did this play out throughout the year? A *Bloomberg* interview in late December with an economist at the Economic Policy Institute indicates that a total of three smelters have restarted with increasing capacity, and the downstream aluminum processors are also ramping up. A total of 22 firms have announced investments with an addition of 3,000 jobs. A few examples follow.



Braidy Industries is on track to begin operations of its greenfield aluminum mill in 2021. The facility, which will employ 700 people, will have state-of-the-art technology and include robots and AI in a high-tech factory with $580 million of new equipment.

Novelis is teaming with Impression Technologies to encourage automakers in three countries to use more hot-stamped aluminum. Novelis also plans to build at least three Customer Solutions Centers to collaborate with automakers. The first will be in Novi, Mich., with others to follow in China and Europe.

Recent news indicates that Century Aluminum is projected to achieve earnings growth of 118% this year. Looking at other numbers for companies in the aluminum industry, I noticed that two are in the FORTUNE 500. Alcoa was ranked 262 on this list, which was up (lower number is up) from 300 in 2016. Additionally, Reliance Steel & Aluminum is ranked 305th, which is also up from 320 in 2016.

New and Improved

While there are many plusses for aluminum relative to lightweighting, which results in energy savings (aka environmental benefits), the reality is that the production of aluminum creates nearly six times the emissions as steel per ton produced. A group of producers and manufacturers, including Alcoa and Apple, are working together to create "green" manufacturing standards for aluminum. The group is called the Aluminum Stewardship Initiative, and it is based in Australia. A good start is using hydroelectric power versus electric produced by burning coal.

In the new-and-improved category, did everyone see the 100% aluminum reclosable beverage can? An Austin, Texas-based startup has developed a can that is both reclosable and entirely recyclable. The patented SipNShut may be coming to a beverage store near you.

Aluminum Plus

Thinking of aluminum has brought to mind a resource that I will now shamelessly plug. *Everyday Metallurgy*, written by yours truly, is a coffee-table-type book that provides an attractive and compelling look at what we do and how it applies to everyone. Some of the nonferrous topics covered are jewelry, jet engines, artificial joints, coins, an aluminum guitar, bicycle frames, piano strings and the Liberty Bell. We even throw in the kitchen sink and much more.

If you would like to have a great way to tell or show folks what you do and why it's important, *Everyday Metallurgy* could be just the ticket. You can order your own copies by going to www.industrialheating.com/everyday-metallurgy. Enjoy!

Manufacturing Status Report

BARRY ASHBY
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Manufacturers of all types account for approximately one-third of GDP and national employment. For every employee in the industrial base, four others are employed elsewhere based on that manufacturing output.

It is essential to know that the vast majority of American manufacturing firms are quite small. Data from a few years ago shows 251,774 companies in all manufacturing sectors with all but 3,813 considered small (fewer than 500 employees) and with three-quarters of the small businesses having fewer than 20 employees. Nearly two-thirds of all are pass-through entities such as S corporations or sole proprietorships. Together, all manufacturing firms employ nearly 13 million workers – with 8 million workers in durable goods and 5 million in nondurable goods.

Data of a year ago shows the average U.S. manufacturing worker earned $84,832 annually, which includes pay and benefits. Of the 92% of these workers eligible for health-insurance benefits, 84% participated in their employer's plan. These workers' productivity has grown two-and-a-half-fold in the past two decades, with durable goods productivity growing threefold.

It is expected that nearly 3.5 million new manufacturing jobs will be needed over the next decade, with 2 million going unfulfilled due to a sagging skills gap. Regardless, world trade in goods produced by U.S. manufacturing industry increased roughly threefold in the first 15 years of this century to $12.2 trillion annually, which (taken alone) makes U.S. manufacturing equivalent to being the ninth largest economy in the world. Today, this is second only to China.

It is key to know that American manufacturers perform more than three-quarters of all private-sector research and development, much more than all other sectors combined. In doing all this, the "makers of things" in our country consume 32% of all energy used in our land each year (over 32 quadrillion BTU) and, in spite of constant efficiency improvement, pay an average per employee of $19,600 to comply with federal regulations. Except for the last bit, this all paints a very healthy and optimistic picture for America's future and economy.

Yet it is obvious that there are challenges, many of which this writer and many readers cannot relate to in any way, due to rapid changes in culture and technology over the past several decades. First, as previously stated, a 2.5 to 3 million shortfall in manufacturing workers is predicted by 2025. This shortfall must be met by workers with skillsets involving new technology, proficiency in mathematics and analytics and different abilities than in decades past to interface with data and information concepts of a non-physical reality.

Today, manufacturing industry utilizes project service automation software that uses smart machines to manage and leverage real-time data on cycle time, production runs and the injection of new information derived from data-mining capacities. All this might, for example, manage predictive maintenance and analytics or move from repair-or-replace maintenance models to predict-and-fix models for operating machinery. Technology changes are beyond belief. A lot of manufacturing industry today is different from yesterday, when a guy poured hot metal into a mold and then used a mill or a lathe to make a part.

There are many additional aspects to consider in the world of industrial manufacturing. The skilled-labor shortage is flavored with young people's view of their culture as part of your business and how your company's image is presented to the user world you serve. Then there is change in the world of cybersecurity (ransomware attacks increased 50% last year) and what is becoming an increasingly important need to instruct all employees on how to deal with its many aspects.

The matter of global competition requires recognition even by the "little guys" as they make their place known in the marketplace while protecting their technology. Then there is the matter of U.S. government regulation with everything from tax codes to trade agreements to export licensing to what you do with what's in your waste basket.

All things considered, American manufacturing is doing well. In spite of the fact that factory workers have fallen from the 1950 peak of 30% of the workforce to only 8.5% today, the world of most readers of this journal is strong. Congratulations!

How to Choose the Best Refractory Contractor

7 Tips from the Plibrico Refractory Pros to Minimize Your Risk

As domestic production of steel and aluminum continues its upward trajectory, manufacturers are running their heat processing equipment at or near capacity to meet the surging demand. This level of production makes achieving on-time and on-budget maintenance, turnaround, and refractory construction projects more important than ever for today's plant managers.

Often, maintenance departments have a rather large collection of contractors that provide skilled labor, supervision, equipment, and materials. Successful plant maintenance often hinges on the relationship between the plant stakeholder and contractors. Any disconnect between the two quickly result in increased risks, budget overruns, project delays, and millions of dollars in lost production time. The value of an excellent refractory contractor to your business cannot be overstated.

To help create a safer, more productive plant environment, here are 7 valuable tips from the Plibrico Refractory Pros to select the best refractory contractor:

1. **Safety Record:** Be sure the contractor(s) you are considering have a good safety record and exhibit an innate culture of safe work practices, recommends *Paul Fisher, Vice President at TFL, Inc.*, a Plibrico PilPartner and material distributor in Houston, Texas. He further advises that you should "meet the person who will be responsible for safety on the project." Further, *Jim Schuhl, President of McNeil Sales and Service*, a Plibrico PliPartner operating in New Jersey and North Carolina, says, "discover if the contractor is OSHA compliant, do they have a sufficient experience modification rate (EMR), used by insurance companies to gauge both past cost of injuries and future chances of risk, and are the employees OSHA trained."

2. **Track Record:** Confirm the contractor's quality track record. While the refractory contracting industry boasts several reputable players, it is also flooded with inexperienced newcomers and part-timers from other industries who jump into the business without proper resources or experience. Plibrico PliPartner, *Chris Fussell, Vice President and Chief Operating Officer for F.S. Sperry* in Memphis, Tennessee, cautions, "beware of the 'taillight guarantee', when support ends as the truck leaves your lot. Ask for a list of verifiable completed jobs across a number of different industries."

3. **Refractory Technical Expertise:** Refractories are not one-size-fits-all. Verify that the contractor possesses the refractory knowledge and genuine experience to advise and select what is best for you. "Refractory products should be matched carefully to the application, dependent on the type of furnace or processing unit, operating temperatures, exposure to abrasion, and a range of other variables," counsels *F.S. Sperry*. "What works for a furnace door jamb may not be the best material for the rotary kiln." Plant engineers and maintenance personnel cannot be expected to keep pace with all refractory technologies, so choose a contractor who is experienced and up to date on new products and the latest installation methods.

4. **Warranties:** A warranty can be defined as a representation made by one party upon which another party may rely. It is not the same as a guarantee, which can be defined as a promise to stand in for the debt of another. Warranties are a part of every construction contract, so taking the time to comprehend how warranties work will help you manage risk on projects. Understand the type of warranties or guarantees the contractor offers for materials supplied and the installation of those materials. *McNeil Sales and Service* clarifies, "Confirm the contractor stands behind their services and has full material support from a quality refractory manufacturer like Plibrico."

5. **Alternatives - Time Optimization:** *Ed Christian, Plibrico's Salem, Ohio, General Manager*, recommends asking the refractory experts for viable alternatives. "For example," he says, "you might be able to take advantage of Precast shapes. These shapes are ready to install and require no dry-out, decreasing down time. Or in some cases, you might be able to use a fast dry-out refractory material. Incorporating quick dry-out materials like Plibrico's FastTrack® can cut traditional dry-out time in half." Christian goes on to say, "Another example would be pack, grout, caulk, or 'stuffing' the area. While these processes are temporary, such repair work can give old walls several extra months of efficient, cost-effective service until you're able to conveniently schedule downtime for permanent rebuilding work."

6. **Record Keeping:** *TFL, Inc.*, suggests asking for a summary report generated at the end of the project to show the work completed, materials used, and man-hours. The report can be extremely useful in the future, and the more detailed it is, the more useful it will be.

7. **Price:** *Plibrico's Bartow, Florida, General Manager, Dale Johnson*, notes, "Although price is always an important consider-ation, it should not be the sole guiding force if you are trying to solve a refractory problem." While it might be tempting to simply select the lowest bidder, your goal in selecting a refractory contractor should be to find the right combination of price and qualifications. Evaluate if the pricing or bids are comparable to the size of the project and services required. In the end, the lowest price is not always the best, but neither is the highest price.

Bonus Tip - Prepare for the unforeseen. Often problems do not reveal themselves until the operating unit has cooled and repair begins. This reality necessitates that contingency plans are in place. Further, it underscores the importance of working with a fully stocked professional refractory contractor who has access to a refractory manufacturer that uses just-in-time manufacturing principles.

Tips from the Plibrico Refractory Pros are designed to help you reduce your risk and foster a stronger relationship between contractors and plant stakeholders. This relationship is a key element in successfully managing maintenance, turnaround, time lines, and refractory construction costs.

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Overaging

DANIEL H. HERRING
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Heat treaters like precision. When asked to achieve a given hardness value after heat treating a piece of steel, there is comfort in designing a recipe that achieves this hardness and then, by control of process and equipment variability, repeat the process and results time after time.

However, it is too often the case when heat treating nonferrous materials such as aluminum and titanium that this repeatability of hardness is not always possible. If it turns out the hardness is too high, one of the solutions heat treaters talk about is to overage the material. Is this a good practice or not? Let's learn more.

Age hardening (aka precipitation hardening or aging) is a heat treatment used to strengthen certain alloys. Resultant hardness and mechanical properties are a function of aging temperature, time and alloy (Fig. 1). Overaging is aging at a higher temperature or for a longer time than is required to reach peak aging (i.e., that required for critical particle dispersion), thus causing particle agglomeration of the precipitating phase and, as a result, loss of hardness (and strength). Overaging has been deliberately performed, for example, in certain extreme-service applications (supersonic aircraft, engines subject to high-temperature exposure) so as to avoid further loss of mechanical properties.

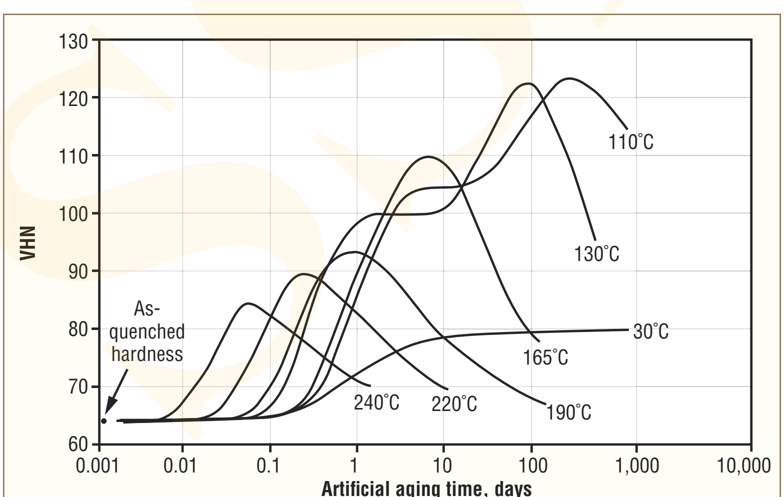


Fig. 1. Classic example of aging curves for an Al-4 wt.% Cu alloy illustrating peak hardness and hardness changes due to overaging as a function of aging temperature and time. The alloy was solution annealed for at least 48 hours at 520°C (970°F) and then water quenched at 25°C (75°F) before aging.[3]

Aging Effects on Mechanical Properties

As mentioned, mechanical properties are influenced by aging. In one study,[4] A355 (Al-Si-Mg) alloy castings were solution treated at 540°C (1004°F) for 10 hours, water quenched then refrigerated at 15°C (60°F) for 24 hours prior to aging. The aging times were varied up to 100,000 hours, the result of which were changes in mechanical properties (Table 1, Fig. 2).

Other Comparative Examples[5]

Engine blocks and other complex casting shapes produced from cast aluminum alloys such as A356-T6 or A357-T6 (Al-Si-Mg alloys) are prime examples of materials that can be affected by overaging. Their mechanical properties can become compromised after prolonged high-temperature exposure in service.[6] Lower hardness and tensile strength values for A356 castings, for example, were found after exposure to temperatures up to 200°C (390°F), which are commonly exceeded in certain automotive racing engine components.

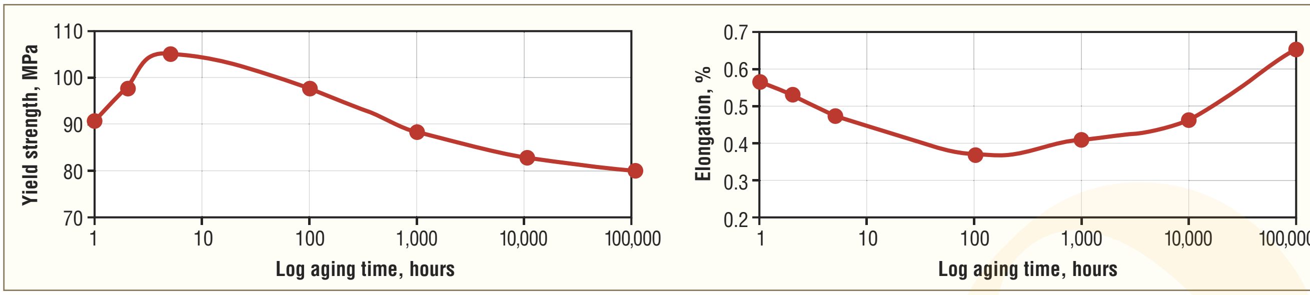
One way in which to overcome these limitations is to use other casting alloys, such as C355 (Al-Si-Cu-Mg). The effect on hardness has been studied[5] comparing A356-T6 and C355-T6 castings after overaging in the range of 170-305°C (350-580°F) for times up to 168 hours. For these alloys, the hardness was found to be basically unaffected up to 185°C (365°F) and experienced only a slight drop-off for times greater than 130 hours.

The study also compared the effect of overaging A356-T6 and C355-T6 alloys (Fig. 3, online) at 175°C (350°F) and 205°C (400°F). While both alloys had comparable hardness at the peak aged condition, the A356-T6 alloy experienced a hardness reduction of approximately 34% (113 HB to 76 HB) after over 126 hours, while the C355-T6 alloy's hardness was essentially unchanged. At 205°C (400°F), the A356-T6 alloy reached a minimum hardness value (45 HB),

15kW mid-frequency induction heater

1700°C hydrogen muffle furnace

500°F 1.9 cu ft vaccum oven with dual-stage pump



Fig, 2. Comparison of yield strength and percent elongation as a function of aging time for a fixed aging temperature of 175˚C (350˚F)[4]

while the C355 alloy experienced a progressive loss of hardness with increasing aging time, reaching a minimum hardness value of 80 HB after approximately 165 hours.

The change in mechanical properties (strength and hardness) from peak aging to overaging found that the peak-aged C355-T6 alloy exhibited slightly higher mechanical properties than A356-T6 after exposure at 210˚C (410˚F) for 41 hours (Fig. 4). The C355-T6 alloy showed a decrease in ultimate tensile strength (UTS) and yield strength (Y.S.) of 8% and 9%, respectively, while the A356-T6 alloys revealed a more dramatic loss. UTS decreased 32%, while Y.S. fell approximately 40%. Similarly, the hardness of C355-T6 decreased about 15% as a result of overaging, while the reduction of A356-T6 was in the order of 37%. Elongations to failure were comparable at approximately 5%.

Overaging Temper Designation

Finally, the -T7 temper is assigned to thermally heat-treated wrought aluminum alloys (mainly 7xxx), which are artificially overaged to obtain a compromise between exfoliation corrosion resistance, stress corrosion resistance, fracture toughness and tensile strength. The additional x digit for T7x (Table 2) indicates how much the alloy is overaged. Understanding the degree to which overaging has taken place can be especially important in preventing stress corrosion cracking and general corrosion in these high-strength 7xxx alloys.

To Overage or Not to Overage? That is the Question.

While overaging appears to be a simple solution for reducing hardness, one must always remember that the process is tricky, and its effect on microstructure, mechanical properties and ultimately in-service performance/ultimate life must be carefully evaluated. As the Doctor is fond of saying, you have climbed the mountain and reached the summit but are now sliding, a bit uncontrollably, down the other side.

References available online

Table 1. Effect of aging time on tensile strength and hardness of A355 alloy[4]

Average result of 3 samples/ sample condltlon	As cast	As treated	Aging time						
			l hr	2 hr	5 hr	100 hr	1,000 hr	l0,000 hr	100,000 hr
% Elongation	0.50	0.49	0.57	0.53	0.48	0.37	0.41	0.46	0.65
Yleld Strength (MPa)	84.27	88.28	91.05	97.95	105.75	97.94	88.87	83.22	80.1
Brinell hard-ness (BHN)	57.25	63.03	72.56	86.61	103.1	70.81	59.80	55.63	50.82

Table 2. Definition of additional digit for -T7x temper[7]

Additional digits for T7 temper	Definition
T79	Very limited overaging to achieve some improved corrosion resistance with limited reduction in strength as compared with the T6 temper.
T76	Limited overaging to achieve moderate corrosion resistance with some reduction in strength. The T76 temper has lower strength and better corrosion resistance than the T79 temper.
T74	Overaging to achieve good corrosion resistance with a greater reduction in strength than for T76. Strength and corrosion resistance of T74 are between those of T73 and T76 tempers.
T73	Full overaging to achieve the best corrosion resistance of all T7 tempers with a greater reduction in strength than the T74 temper.
T77*	Aged condition providing strength at or near T6 temper and corrosion resistance similar to T76 temper.

*T77 is designated in ANSI H35.1/H35.1(M)-2009 temper but not in EN 515 or ISO 2107.

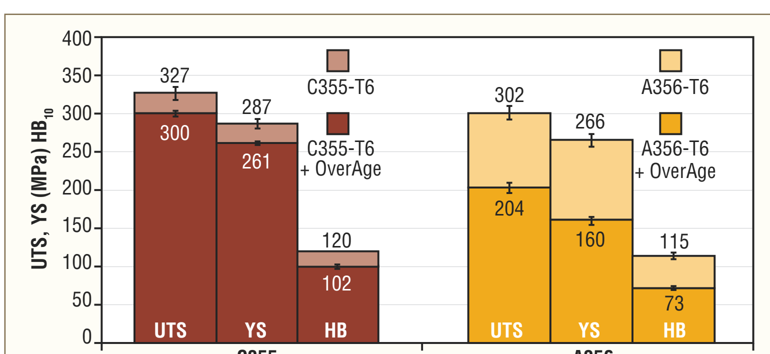


Fig. 4. Comparison of mechanical properties (T.S., UTS, hardness) at room temperature for peak and overaged C355-T6 and A356-T6 alloy castings

The Evolution of Heat Treat: When Youth Collides with Wisdom

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In today's marketplace, from the start of a college education to the day we retire, change is inevitable. The science of heat treat has been around for over 100 years. The technology and standard practices that have been developed throughout the ages have constantly been improved upon.

The requirements that need to be met have become well defined, and yet the basis for most heat-treat equipment has changed very little. Most of the improvements come in the form of better process control, and we are able to record more information than ever before.

Today's young engineers are coming out of college armed with new technology, ready to take the world by storm with a hunger to develop the next big thing. We strive to design something bigger, better and faster, while the veterans in the industry have spent many decades perfecting processes and equipment.

With ever-changing requirements from customers due to new developments in manufacturing practices, new materials and strict requirements for tight temperature uniformity becoming ever more important, we have reached a point where changes and improvements must be constantly made.

There is a saying: "The definition of insanity is doing the same thing, the same way, over and over again while expecting different results." With all of these new requirements emerging, a new, fresh perspective is imperative. But we study history for an equally important reason, and that is so we don't repeat the same mistakes from the past. This relationship is where youth and wisdom must comingle.

The wisdom of the heat treaters that have been in the industry for many years has been invested into developing today's standards. Throughout their careers, they have figured out what works and what doesn't. Like a young child sitting with a grandparent hanging on every word as they listen to stories of days gone by, it's crucial that the younger generations take this knowledge and experience to heart. Just as importantly, the seniors in the industry must be open-minded and allow the next generation to pursue new, fresh ideas.

Mistakes will be made, and not every new idea is going to work as planned. Both young and old must accept this. Mistakes are the fuel for learning and for gaining experience. Those of us who are part of this younger group must set youthful pride aside and humble ourselves enough to admit that not every idea is going to work every time. Those of us who have been in the industry for many years should be willing to take the younger group under our wings, and when they fall (and they will on occasion) pick them up, dust them off and encourage them to keep trying.

"He who never makes a mistake, never made a discovery."
– Samuel Smiles, 1859

For change to be successful, there needs to be a level of trust from both generations. There needs to be open communication and respectful debate.

The market is competitive in today's economy. Companies must stay ahead of the curve. They must be willing to invest time and money into beating their competition to market with that next big thing.

In the U.S., we are constantly having to go up against other countries that build similar equipment for a fraction of the cost. We must sell our expertise as innovators in our businesses from lean practices, not single-sourcing vendors and implementing tools such as process-improvement exercises to our advantage.

We need to be objective and deliberate in our thinking. It isn't easy; it takes hard work, dedication and commitment. Be proud of the work you do without being prideful, and don't ever be afraid to share your wisdom. Remember, the day you stop learning is the day you stop growing and start dying. It is dog eat dog out there in the real world, and our competitors won't think twice about eating us alive.

Reduction of Metal AM Melt-Pool Bead-Up

DR. BRYAN WEBLER
Assistant Professor of
Materials Science and Engineering
Carnegie Mellon University

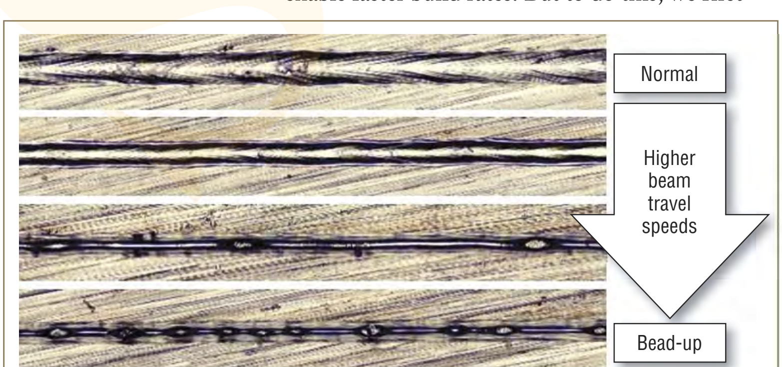
Additive manufacturing (AM) is changing how we think about making parts from metal. There are many challenges to the widespread adoption of AM fabrication, and these challenges create interesting research opportunities with the potential for real impacts on manufacturing.

My research focuses on laser powder-bed-fusion AM processing and the challenge of determining how metals react when exposed to a moving laser beam. The beam power and travel speed determine the amount of melted material (i.e., melt pool size). This determines the features we can produce on a part and how fast we can build parts.

Certain combinations of power and travel speed cannot be used, however, because they lead to parts that are not fully solid. Engineers need to understand these limits as they design and manufacture AM parts. My research is focused on a particular kind of defect referred to as “melt-pool balling” or “melt-pool bead-up.”

Bead-up of the melt pool is characterized by the melted material solidifying as a line of droplets instead of a continuous layer. This leads to parts that are not completely solid and therefore unusable. Bead-up tends to occur at high values of beam power and travel speed, so it limits how fast we can build parts. This limits AM productivity and the types of parts that can be built.

One way around this is to incorporate multiple lasers to enable faster build rates. However, more lasers mean more parts and potentially more maintenance issues. The maximum number of lasers will also be limited by space constraints. If we can find strategies to control bead-up, we could enable faster build rates. But to do this, we first need to understand when and why bead-up occurs.



The occurrence of bead-up is typically attributed to a Plateau-Rayleigh (P-R) instability, which predicts that a long column of fluid will tend to break up into small droplets. You can see this yourself if you slowly pour out a glass of water from a few feet up. Near the top, the water column is smooth, but it will break up as the water falls. There are many examples in nature of the P-R instability (e.g., the size of raindrops, the droplets of water that form on a spider web).

We can even engineer the effect to make inkjet printing possible. In the context of AM, the melt pools are hypothesized to act as a fluid column that breaks up into droplets. The mathematics of the P-R instability have been applied to predict when bead-up of melt pools will occur. However, this analysis is only an approximation because melt pools in AM are not isolated fluid columns.

We still need to have a better understanding of when the transition occurs and the factors that influence it. We also want to find ways to shift the transition to higher powers and travel speeds so that we can enable increased build rates.

We are currently studying effects of metal composition and AM process variables on the occurrence of bead-up. We are using stainless steels as test materials because we can control properties of the liquid by adding elements that cause a metal droplet to spread out. The presence of these elements tends to make the bead-up more frequent.

Investigations also involve how to best measure the transition from a normal melt pool to a beaded melt pool. Just recently, some collaborators obtained real-time video of bead-up via synchrotron radiography.

Finally, we are investigating new ways of controlling beam power and travel speed to make melt pools shorter and reduce the occurrence of bead-up. The increasing interest in AM methods has opened up many new options for manufacturing with metal. As we in the academic world research fundamental questions like applying the P-R theory to an AM melt pool, we hope to create solutions that will open up new applications for these developing technologies.

Contour

Induction Manufacturer and Service Provider

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

Although Contour has been in business for over 30 years, the Indianapolis, Ind.-based company has gone through quite an evolution. Started as an induction heating machine builder, this MTI member now provides commercial induction services … and still manufactures induction systems.

Contour was established with the goal of providing a cost-effective solution to difficult heat-treatment applications. This goal was attained through the development of an advanced computer-controlled induction heating technology known and patented as the Micropulse™ Process. Contour developed the Micropulse Process to rapidly harden gear teeth and other irregularly shaped parts. This technology minimizes distortion compared to conventional induction processing.

In 1986, the company built a system that is still used today for processing parts and developing applications for customers. Contour's patented processes have dramatically altered the traditional methods of manufacturing case-hardened gears and other irregularly shaped, complex parts requiring a high degree of dimensional accuracy. These processes have produced revolutionary improvements in customers' products. Parts exhibit less distortion and increased strength and durability.

Contour, which holds both ISO 9001 and ISO/IATF 16949:2009 certifications, provides a wide array of services, mainly for the automotive industry. These include induction processes, dimensional testing, full metallurgical analysis, shot peening, washing and automation (robotics and data acquisition). The company is obviously known for its induction services. In fact, Contour has never added additional heat-treatment services but rather focused on the automation of induction processing.

What sets Contour apart is that it builds the system around the part rather than building the part around the system. The company prides itself on providing a complete system – from receipt, processing, dimensional testing, metallurgical analysis, robotic automated processing to shipment.

Since its inception in 1986, Contour has enjoyed unprecedented growth. The company, which has approximately 70 employees, moved to a new, larger facility in the summer of 2000. This location manufactures induction hardening systems and provides contracted induction hardening services. In fall 2007, Contour created a satellite location in Silao, Guanajuato, Mexico. This facility includes purpose-designed utilities, computerized gear inspection equipment and a complete metallurgical laboratory to support customers in Central and South America.

Contour is not done evolving. The company, which earned a 2017 Supplier Quality Excellence Award from GM, installed two fully automated robotic lines in the past five months. Then, in July 2018, Contour named industry veteran Ben Crawford as its new CEO and president. Crawford was previously employed by three of North America's largest providers of heat-treat services: Bodycote, Bluewater and Paulo. When hired, Crawford said, "With the installation of robotics, Contour will advance treatment applications with controlled and repeatable processing methods."

In November 2018, Contour purchased a gas nitriding unit to expand its offerings in the automotive sector and expand deeper into the aerospace market. The company will install the unit at its Indianapolis facility in spring 2019. This purchase will allow Contour to expand services focusing on distortion-critical, complex parts. According to Crawford, the unit compliments the company's induction and dimensional services. He added that gas nitriding capabilities will be available at the Silao plant in the near future.

As for the future, it is undoubtedly bright. Contour is planning on expanding into new geographies, increasing its aerospace business and pursuing Nadcap accreditation.

Visit www.contourhardening.com for more information on Contour.

Executive Officers Recognize the Value of IHEA

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

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

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

Scott Bishop, Alabama Power; IHEA Treasurer


Scott Bishop, IHEA Treasurer

Bishop is a team leader at Alabama Power and helps industrial and large commercial customers with process improvements, energy efficiency and heat-recovery opportunities. He's extremely involved with IHEA's Infrared Division – serving as chairman, providing multiple presentations and hosting workshops and demonstrations.

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

A: Honestly, some of the biggest accomplishments are being the front-runner when it comes to industrial process training. Not sure anyone does as much as IHEA in regard to training.

Q: What is your vision for IHEA moving forward?

A: My vision is to grow the membership, which will add more value to our current membership and enhance our experts in the field of industrial heating.

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

A: IHEA is not only a great place to find quality training for your employees, it's an excellent opportunity to expand your network and identify other companies that could potentially enhance your product offerings.

Daniel Llaguno, Nutec Bickley; IHEA Recent Past President


Daniel Llaguno, IHEA Recent Past President

Llaguno is president of Nutec Bickley. Since joining IHEA, he has been an advocate for the association and its mission to drive members' success by providing the knowledge base and authoritative voice for industrial heat processing. Llaguno provides continual support and promotes the organization by sending attendees to training, online courses and webinars.

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

A: I think IHEA´s enhancement of its education programs has been great. The online courses in particular have proven to be a great way to train and prepare the future "stars" of the industry. Also, allowing other segments of the industry to participate in the association (such as end users, professional services suppliers, consultants and individuals) has helped broaden IHEA's reach and value to its membership. Lastly, IHEA's continued undisputed authoritative voice in safety and standards is something to be recognized.

Q: What is your vision for IHEA moving forward?

A: To remain the most relevant association for the industry's actors, including OEMs, system integrators, consultants, suppliers, utilities and even end users, and to improve their businesses and the industry in general.

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

A: If you are somehow related to the industrial heating industry, you need to be part of IHEA and get involved. You´ll immediately recognize the value IHEA has to offer.

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

EQUIPMENT NEWS

Vacuum Hot Press

Solar Manufacturing successfully completed the installation and start-up of a large 100-ton-force vacuum hot press at Refrac Systems' commercial and aerospace diffusion bonding operation in Chandler, Ariz. The press includes a 2-bar-gas fan-quench cooling system. The furnace hot zone was modified to contain a 100-ton-load hydraulic ram centered over the zone, which is configured to diffusion bond parts up to 36 inches wide

x 48 inches long x 30 inches tall. Specifically designed to diffusion bond large plastic injection-molding dies and concurrently quench harden them, the system is also finding applications in bonding advanced superalloy heat exchangers where the quench cooling offers significant improvement on performance.

www.solarmfg.com

Batch Integral-Quench (BIQ) Furnace

Surface Combustion Inc. received an order for an Allcase batch integral-quench (BIQ) furnace from East Carolina Metal Treating. Identical to a previously commissioned Allcase furnace, this furnace is configured to process 36-inch-wide x 48-inch-long x 36-inch-high workloads that weigh up to 4,000 pounds. Surface Combustion will also supply two air-cool stations, a scissor-lift table and two stationary load tables that integrate with an existing IQ line. The BIQ features a vertical radiant-tube heating system with direct spark ignition and flame monitoring, recuperated burners and plunge cooling. A maintenance platform with access stairs allows for fast and easy maintenance, and an integrated top cool chamber was provided to further expand process applications.

www.surfacecombustion.com

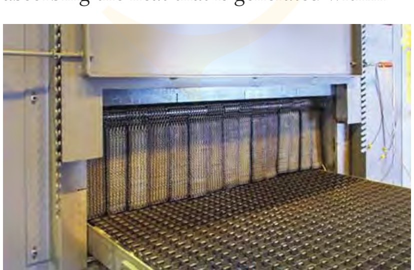
Mega-HIP

Stack Metallurgical Group is expanding its existing heat-treating and metal-processing portfolio with the addition of a Mega-HIP from **Quintus Technologies**. The hot isostatic press (HIP) is equipped with Quintus Technologies' proprietary uniform rapid cooling and includes a large-capacity work zone of 63 inches in diameter and 102 inches in height, allowing densification of large batches at 29,000 psi (2,000 bar). The HIP has a maximum operating temperature of 2280°F (1250°C). The Mega-HIP's design enables all casting areas to cool uniformly, minimizing thermal distortion and non-uniform grain growth. Heating and cooling the workload only once, in a single cycle, enhances efficiency and dramatically reduces per-unit processing costs. The order includes

full installation and commissioning at Stack Metallurgical's new 25,000-square-foot facility in Albany, Ore. www.quintustechnologies.com

Belt Conveyor Oven

Wisconsin Oven Corp. shipped a natural-gas-fired belt conveyor oven to a forging company that will use it to preheat aluminum billets. The oven has sufficient capability to heat 3,000 pounds per hour of aluminum from 70-950°F as long as the workload is configured in a manner that is capable of absorbing the heat that is generated within



the time available. The conveyor system utilizes a stainless steel flat wire belt, and a variable-frequency drive provides adjustable speed control. The oven, which has a work chamber measuring 3 feet, 6 inches wide x 25 feet long x 1 foot high, has a maximum temperature rating of 1000°F with guaranteed temperature uniformity of ±10°F at 950°F. www.wisoven.com

Equipment & Business News

BUSINESS NEWS

Aluminum Producer Increasing Production, Adding Jobs in Kentucky

Kobe Steel Ltd. announced that its U.S. subsidiary, Kobelco Aluminum Products & Extrusions Inc. (KPEX) will invest approximately $42 million to increase the production capacity of its plant in Bowling Green, Ky. This investment, which is expected to create about 90 new jobs, will help meet the growing demand for automotive extrusions and fabricated products in the U.S. Plans call for new equipment to go into mass production in the first half of 2020. When the expansion is completed, KPEX will have two melting furnaces and two extrusion presses. Production capacity will increase to 1,000 tons per month, from the current 500 tons per month.

Nucor to Build Plate Mill in Midwest

Nucor Corp. plans to build a state-of-the-art plate mill in the Midwest that is expected to create approximately 400 full-time jobs. Nucor's Board of Directors approved an investment of $1.35 billion to build the mill, which is scheduled to be fully operational in 2022 and will be capable of producing 1.2 million tons per year of steel plate products. The plate mill will produce cut-to-length, coiled, heat-treated and discrete plate ranging from 60 to 160 inches wide and in gauges from 3/16 of an inch to 14 inches in thickness. Nucor, which currently operates plate mills in North Carolina, Alabama and Texas, expects to select a site for the new mill early this year.

Bodycote Opens New Facility, Announces Further Expansion

Bodycote officially opened its advanced heat-treatment center in Rotherham, Yorkshire. The facility offers a range of heat-treatment services and has been established to support the aerospace and power-generation markets in the U.K. and Europe. Bodycote also announced plans for significant expansion at the site. Tom Gibbons, president of Bodycote's Aerospace, Defence & Energy division, said: "Due to customer demand and interest since the announcement of this new plant in July, we are investing in further capacity and technology. The additional space we secured here at Rotherham is nearly three times the size of our existing unit."

INDUSTRY EVENTS

April 9-13
Aluminium Two Thousand – 11th World Congress on Aluminium; Treviso, Italy www.aluminium2000.com

April 27-30
CastExpo & Metal Casting Congress 2019; Atlanta, Ga. www.afsinc.org/tradeshows/castexpo-2019

April 29-May 1
Ceramics Expo; Cleveland, Ohio www.ceramicsexpousa.com

May 6-9
AISTech 2019; Pittsburgh, Pa. www.aist.org/events/aistech-2019

May 6-8
Aeromat 2019; Reno, Nev. www.asminternational.org

May 13-16
Interwire 2019; Atlanta, Ga. www.wirenet.org/events/interwire

May 20-23
Rapid + TCT 2019; Detroit, Mich. www.rapid3devent.com

Top Industrial Gases & Atmospheres Articles of 2018

Bill Mayer – Managing Editor

To continue a trend we started in 2017, *Industrial Heating* will highlight a topic on our website and list the most-popular articles under that topic according to page views. We do this for two reasons: first, to showcase some of the outstanding content on www.industrialheating.com; second, to provide a useful resource for readers who have a particular interest in that topic.

As you will see, industrial gases and atmospheres covers a wide range of technologies – from combustion to endothermic generators to thermal oxidizers. Here is a list of the five most-viewed IGA articles on our website in 2018.

Combustion Technologies Improve Melting-Furnace Productivity

This article from June 2018 was clearly the most popular in this topic on our website last year. Provided by Air Products, it discussed how the unique capabilities of two new burners helped SDI La Farga increase productivity, decrease specific fuel consumption and significantly reduce burner maintenance time in its secondary copper-melting furnace. It also highlighted how new combustion technologies offer metals producers the ability to adjust the energy distribution profile and customize heat release to the requirements of a given melting operation.

SDI La Farga is a recycling operation that refines all types of processed copper to produce Cu-FRHC (fire-refined, high-conductivity) products. In 2014, the company experienced challenges with non-uniform heat distribution in their melting furnace, which led to uneven wear of the furnace lining and limited productivity. Their burners were also susceptible to frequent and prolonged maintenance delays from molten metal splashing and wear due to the corrosive atmosphere in the furnace.

SDILF's desire to address these challenges and achieve aggressive productivity targets led to the evaluation and implementation of unique combustion technologies capable of adapting to the diverse needs of the operation.

Read this article at www.industrialheating.com/meltcomb.

Endothermic Generators for Management

This article from April 2018 was comfortably in second place in our rankings. Its focus, obviously, is on endothermic generators. With a wide processing capability, endothermic (endo) gas is a common industrial process gas. And with readily available ingredients, endo gas is simple and economical to generate.

Jeff McLaughlin of McLaughlin Services looks at equipment requirements, mixing systems, heating systems, safety and energy payback in this article. Pertaining to safety, endo gas is explosive, so simple operation is a consideration. Manual control can easily create an unsafe condition with untrained operators. PLC-based control systems on new generators with automatic controls will shut down the generator before a dangerous condition can develop.

As for energy payback, did you know that many local utility companies – on top of the utility savings from normal operation – have rebate programs for energy savings from new, efficient equipment? If this is offered, do your homework because it's free money.

The bottom line here is that newer equipment offers easy-to-use operator-friendly controls and improved production costs. And, with the increasing availability of rebates from utility companies, replacement of older generators is an option worth careful consideration.

This article can be found at www.industrialheating.com/endgen.

Advanced Metal Manufacturing: Precision Heating and Cooling

This article reviews industrial-gas technologies that the metals industry can use to respond, improve and even help transform advanced metal-parts manufacturing and processing. Specifically, it covers technologies

for aluminum remelting, furnace atmosphere-control systems, deep cold treatment, powder-metal sintering and additive manufacturing.

Provided by Linde and published in October 2017 (also that issue's cover story), this article is technically a two-parter. The second installment appeared as a web exclusive in November 2017. Part 1 focuses on aluminum remelting, atmosphere-control systems and deep cold treatment, and part 2 covers powder-metal sintering and additive manufacturing.

Whatever part you read, the conclusion here is simple: Industrial gases and related process-control technology play a critical role in forming, treating and finishing advanced metal parts. Responding to challenges is an ongoing process that can yield significant cost, quality and performance advantages.

Part 1 can be read here: www.industrialheating.com/AMM.

The Value of Scheduled Combustion-System Maintenance

Provided by industry veteran Mike Shay, who has wide range of experience with single-burner and multi-burner applications, this article provides some basic information concerning the maintenance and adjustment of combustion systems.

According to Shay, experience has shown that regularly scheduled inspection and maintenance of combustion systems can provide heating processes with reliable and predictable results. In addition, lack or absence of regularly scheduled inspections and maintenance can cause poor performance, higher-than-required fuel usage, higher levels of emission and unexpected component failures that lead to unnecessary and unwanted downtime.

This article, published in October 2018 and in fourth place in terms of page views, makes the argument that regularly scheduled combustion-system inspection and maintenance can provide longer equipment life, reduced downtime, improved product quality, energy savings and reduced emissions.

Read the entire article at www.industrialheating.com/combsched.

The Impact of Thermal Oxidizer Sizing on Melt-System Capacity

Number five on our list was provided by Epcon Industrial Systems and appeared in our February 2018 issue.

Aluminum parts producers are looking to metals-recovery systems to control the costs of primary and secondary aluminum purchases and to mitigate operating costs by capturing value from byproducts. Understanding the true rate-limiting factors when configuring and sizing a metals-recovery system is critical to realizing the full potential of the system. Additionally, managing energy within the system will have a large impact on the operating costs and uptime/maintainability of the system.

The article concludes that understanding and applying best practices in aluminum scrap-recycling systems are vital to realizing the full potential of the recovery system. It suggests that by focusing on properly sizing and configuring the thermal oxidizer early in the design process, operators will be able to realize the full potential of the metals-recovery system and avoid wasted melt-furnace capacity. Focusing on addressing emissions-control rate-limiting factors – whether for a new system or a retrofit – will help ensure overall project success.

This article can be found here: www.industrialheating.com/TOsize.

Conclusion

There you have it – the five most-read articles on our website pertaining to Industrial Gases and Atmospheres. Our hope is that you find these articles useful if you have an interest in this important topic. If you would like to search for additional IGA articles in our archives, visit www.industrialheating.com/IGA.

Noncontact Temperature Measurement Advances for Aluminum Extrusions

AMETEK Land – Dronfield, U.K.

AMETEK Land looks at advances in noncontact temperature measurement for aluminum extruders.

The amount of aluminum extruded has increased considerably in recent years due to the metal's wide availability and relatively low cost. Extrusions offer a combination of light weight and excellent thermal and electrical conductivity, along with strength and resistance to corrosion. Aluminum also is commonly alloyed with other metals to produce products with specific advantages for a wide range of end-user applications.

Aluminum weighs less than half of an equivalent steel part and has been adopted for weight and energy savings on many types of vehicles. The ease of extruding a high-tolerance and detailed profile minimizes the need for additional finishing operations. Because of its high-strength to low-weight characteristics, the aerospace industry rapidly adopted the use of aluminum. For the same fuel-efficiency reasons, aluminum is now used for land-based transport, including autos, trucks and trains.

Aluminum products are renowned for being easy and inexpensive to recycle, which is another major factor in its increased use. Aluminum recycling requires only 5% of the energy that was originally used in the primary smelting process. As a result, greenhouse-gas emissions are reduced by almost 95%. Aluminum can be recycled unlimited times as well.

While aluminum extrusions are common, the process of extruding high-quality profiles is far from easy. An understanding of temperature and the control of press speed and quench rates during the extrusion process are critical to producing products that have the required quality and properties. The extrusion-press exit temperature, for example, affects the dimensional properties and surface finish of the final product. Should the temperature be too high, the surface finish may suffer imperfections that, apart from being unattractive, can potentially lead to cracks.

Extruding a product at an incorrect temperature means it may not achieve the design dimensions once cooled. If the extrusion temperature is even slightly too cold, the die in the extrusion press may wear more rapidly due to the increased hardness of the metal, and additional pressures are required to extrude it. As a die wears, the physical size of the extruded section changes, and new dies are very expensive. For those reasons, it is imperative to continuously monitor press exit temperature as accurately as possible.

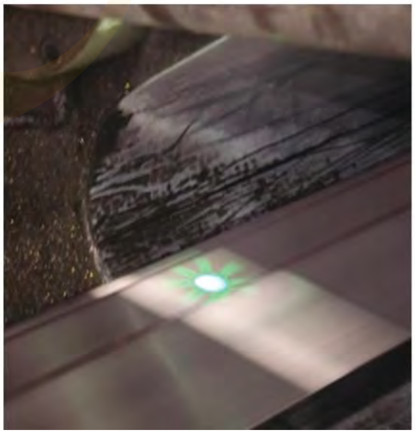


Fig. 1. Bright-green targeting LED pattern on extrusion

Contact temperature measurement methods are not well suited to the extrusion process. When these measurements are taken, they are typically done manually at a single point. In addition, many contact measurement devices require prodding the hot aluminum, which can damage the surface.

In comparison, noncontact temperature measurement sensors allow producers to continuously measure the temperature of the metal at each stage of the process. Noncontact temperature sensors (infrared pyrometers) do not touch the aluminum, so there is no opportunity to damage

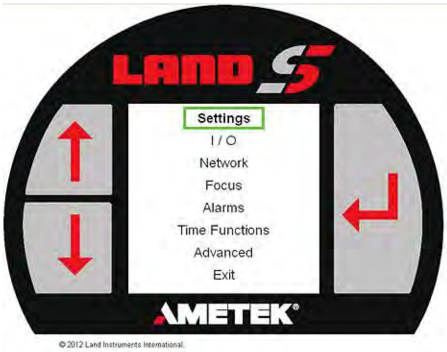


Fig. 2. SPOT AL EQS display and settings via web browser

Fig. 3. Digital outputs from the SPOT AL EQS pyrometers allow them to be integrated into control systems

Fig. 4. Pyrometer image view of the target with LED illuminated

the surface (Fig. 1). The pyrometer simply views the radiated energy that is emitted from the aluminum surface to receive and measure it.

Measuring Challenges with Aluminum Emissivity

Aluminum alloys have unique emissivity and reflectivity characteristics that challenge conventional infrared pyrometers. Emissivity is an object's ability to emit (radiate) infrared energy. Knowledge of the precise emissivity value of an object is a critical factor for accurate noncontact temperature measurement.

Aluminum alloys have very low emissivity values – sometimes under 0.1. That means the aluminum alloy emits less than 10% of its energy, which is why a hot aluminum billet does not radiate heat toward a person walking close to it. It has none of the "body language" associated with a very hot object. That lack of emissivity, if uncorrected, can lead to an apparently low-temperature reading from the infrared pyrometer. The reading needs to be compensated for by applying an appropriate emissivity (gain) correction factor. The emissivity value of the aluminum varies with the wavelength chosen, alloy grade and surface condition, including any slight oxidization.

Because the natural emissivity of aluminum is so low, infrared pyrometers need to employ high gain amplification. With such large amounts of signal amplification, any small changes in emissivity can cause errors in temperature readings. Compared with other metals like steel, aluminum is processed at much lower temperatures. Therefore, fundamentally less energy is emitted even before factoring in the effects of very low emissivity. It is extremely challenging to compensate for emissivity variations on these small signals, making accurate temperature measurements difficult to achieve.

Commonly available single-wavelength infrared pyrometers are unable to cope with the combination of both low and variable emissivity that is prevalent with aluminum alloys. Alternative-ratio (two-color) pyrometer designs are also unsuccessful because the emissivity at their two measurement wavelengths varies at different rates. The ratio pyrometer's non-greyness (e-slope) adjustment cannot compensate accurately for the diversity of aluminium-alloy types.

In the 1980s, research was undertaken by some pyrometer companies to find methods of correlating the energy emitted at many wavelengths and developing application-specific algorithms that would make sense of that radiation data. Their aim was to produce a device that could accurately measure these materials with little or no adjustment requirements. Some resulting devices demonstrated much better results than prior measurement methods. However, the limited number of infrared detectors, low-noise amplifiers and computational circuits available at that time affected the performance of these early devices.

Over the years, with improved designs and a better understanding of the applications, product performance improved greatly. Today's infrared pyrometer designer can choose from an extensive menu of high-quality and high-performance components. Advanced application-specific infrared pyrometers are now available for challenging materials like aluminum.

Most recently, following extensive site trials and data collection from many different alloys, AMETEK Land has developed SPOT AL EQS multi-wavelength pyrometers (Figs. 2-3). Complex signal-processing algorithms were developed and function in real time with the aid of powerful high-speed digital signal processing and ultra-low-noise signal amplification.

These application-specific algorithms and computational capabilities produce accurate results over a wide range of different alloys and surface conditions. The design of the SPOT AL EQS pyrometer also includes precision optics to eliminate chromatic aberrations, integrated video sighting that allows an operator to easily verify exactly what the pyrometer views and a durable sapphire protection window to ensure the pyrometer's longevity (Fig. 4).

Extrusions Begin with Aluminum Billets

Aluminum extruders measure temperatures at various locations. Here are the three most common locations.

Fig. 5. SPOT AL EQS with actuator above the press exit

Fig. 6. SPOT AL EQS at the exit of the quench

Billet Profile

At the start of the process, a billet is heated to temperature as it slowly progresses through a specialized reheat furnace. At the furnace exit, the billet temperature is measured by either a single reading on its cut face or a profile along the side of the billet from head to tail. Many extruders now prefer to measure the billet profile temperature just as the billet arrives at the extrusion press.

AMETEK Land offers a motorized actuator, which rapidly scans the SPOT AL EQS pyrometer along the length of the billet to generate a temperature profile. The actuator can either be integrated with the press control system or driven manually from a hand-held controller.

Press Exit

The press exit is where the extrudate appears from the die. A SPOT AL EQS pyrometer (set in "E" mode) is typically positioned above the press exit looking downward onto the profile (Fig. 5). Some aluminum producers are choosing a fixed installation with manually adjustable mount that can be reoriented following a die change.

Other aluminum producers have chosen a combination of the SPOT AL EQS pyrometer along with a new motorized actuator. In that instance, the pyrometer and actuator communicate with each other directly, and the pyrometer is automatically aimed at the optimum measurement position on the new profile. This temperature measurement is typically fed back to the press control system to enable dynamic press speed control. The small and well-defined measurement spot of the SPOT AL EQS, combined with its rapid 15 mS response speed, facilitates this dynamic tracking.

Quench Exit

The quench-exit measurement location is very popular, particularly with extruders who produce high-strength sections and those that produce aluminum with specialized characteristics. A SPOT AL EQS pyrometer (set in "Q" mode) is typically positioned at the exit of the quench section looking downward onto the profile (Fig. 6).

Many customers choose a combination of the SPOT AL EQS pyrometer together with a motorized actuator. In this application, the pyrometer and actuator communicate with each other, and the pyrometer is automatically aimed at the optimum measurement position on the profile. Extrusions can wander laterally at this location, and the actuator dynamically tracks any movement of the extrusion. Here too, the small and well-defined measurement spot of the pyrometer, combined with its fast 15 mS response speed, facilitates the dynamic tracking.

The same model of SPOT AL EQS pyrometer can be used at all three measurement locations. This makes keeping a spare pyrometer on hand very affordable. SPOT AL EQS pyrometers digitally communicate over an Ethernet connection via Modbus TCP.

There are versions of the AL EQS software available that combine data from multiple SPOT pyrometers and calculate quench rates, and some customers have integrated SPOT AL EQS pyrometers directly into their PLCs or press controls.

Fully integrated temperature measurements of billet "taper," extruded sections and quench rate help to ensure superior extrusions with exact dimensions and superior-finish surfaces.

Conclusion

Having consistently accurate data on exact temperatures throughout the process will allow producers to improve quality and increase production yields, providing greater consistency and a competitive advantage.

For additional information: Contact AMETEK Land, Stubley Lane, Dronfield, UK, S18 1DJ; tel: +44 (0)1246 417691; fax: +44 (0)1246 410585; e-mail: land.enquiry@ametek.com; web: www.ametek-land.com. AMETEK Land is a business unit of AMETEK, Inc., a leading global manufacturer of electronic instruments and electromechanical devices.

Various Heat-Treating Applications for the Aluminum Industry

Brian Wendt – Epcon Industrial Systems, LP; The Woodlands, Texas

Heat treating is a critical thermal process for not only aluminum parts and products but also for the coating of aluminum sheets.

Aluminum manufactured products of various sizes have been steadily replacing steel in industrial designs such as automobiles, airplanes, appliances and many more applications due to the light weight and flexibility of aluminum. Today, we are also seeing an increasing demand for affordable, lightweight, stamped metal parts, which is driving the development of specialty laminated products in coil-coating aluminum-sheet lines.

Multiple Batch Aging Ovens with Guillotine Doors

This article highlights two different heat-treating (annealing) systems designed for the aluminum industry. The first project features a batch-type aging oven designed for the manufacture of automotive parts. The second featured system is a curing oven with an integrated air-pollution-control system designed for coil coating laminated aluminum rolls.

These systems illustrate the challenges in designing specialized industrial ovens for the aluminum industry and the material benefits to precision and uniformity in the heat-treating process that allow for the proliferation of aluminum products in our everyday lives.

Heat-Treating Batch Ovens for Precision Aging of Aluminum Parts

Several alloys are heat treated to increase the ease of forming or the strength of the finished product. Unlike steel or iron, aluminum requires rigid heat control to achieve optimal results, so specialized industrial ovens and equipment are required.

With great attention to detail in the oven design, proper heat-treating methods result in aluminum alloys that are easy to work during the forming process. Following that, a hardening process helps the material resist wear and corrosion for a lasting aluminum product.

The following project case study outlines the workings of multiple custom-engineered, gas-fired, batch-type aging ovens with cooling capabilities for aluminum structural components for a Tier 1 automotive supplier (Fig. 1). While some alloys can be processed at near-ambient temperatures, the more specialized parts often use custom alloys that require a heat-treating process called aging to fully precipitate the dissolved elements and reach their maximum hardness. This process is also called

Fig. 1. Batch-type aging ovens with cooling capabilities for aluminum structural components

Fig. 2. Oven design includes supply plenums installed on both sides of the work chamber with the return plenum mounted on the ceiling of the work chamber.

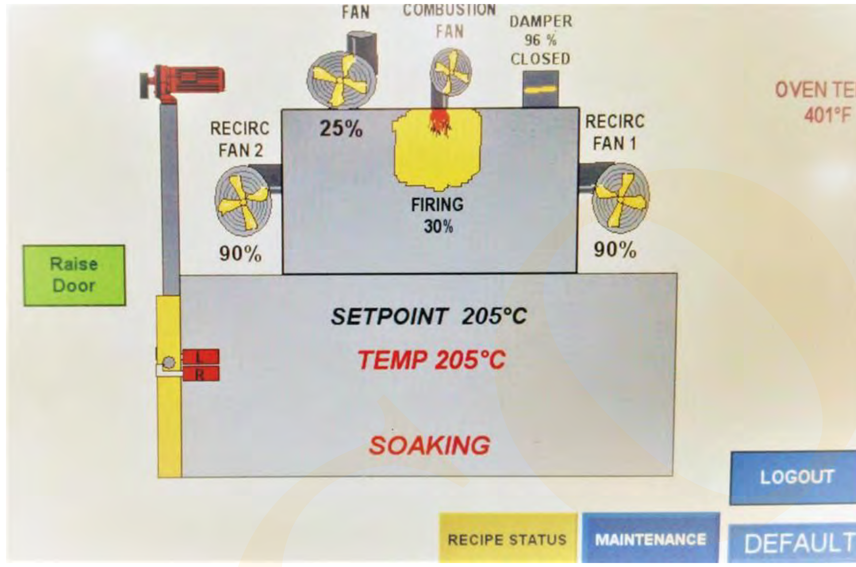


Fig. 3. Batch oven operating controls

Fig. 4. Coil-coating continuous-oven system

precipitation hardening. While each alloy has an optimal aging temperature, precipitation hardening typically happens between 240-460˚F. Similarly designed ovens are also often used by aerospace parts manufacturers.

These ovens are used to control the heating and cooling of the aluminum products loaded into the batch chamber. Featuring a multiple-tiered rack system that holds stackable wire heat-treat bins, the unit has sufficient capability to handle multiple bins per batch.

At maximum loading capacity, the ovens can heat 6,500 pounds of aluminum from 70-400˚F in under two hours. In addition, the system was designed to meet stringent temperature-uniformity requirements of +/-5˚F (+/-3˚C) at setpoints of 320˚F (160˚C), 375˚F (190˚C) and 401˚F (205˚C) with a guarantee to meet all CQI-9 requirements.

The recirculation system utilizes combination airflow to maximize heating rates and temperature uniformity of the product. This is achieved by adding two recirculation fans inside the oven, each at 10,000 CFM capacity. Each motor is equipped with variable-frequency drive (VFD) to regulate the airflow.

The oven chamber itself is constructed from 18-gauge aluminized-steel interior, which allows for the precise control of temperature by modulating the fuel and combustion-air supply.

Continuous airflow is also a key element, so the oven design includes supply plenums installed on both sides of the work chamber with the return plenum mounted on the ceiling of the work chamber. This allows the recirculation air to return through the ceiling-mounted plenum back into combustion/recirculation chamber (Fig. 2).

Creating uniform temperature throughout the oven is a challenge because of its high velocity with very high heat-transfer coefficient. The oven work or "batch" chamber is also used as a cooling zone. The cooling in the oven chamber is achieved using a modulating fresh-air cooling damper and exhaust fan.

After the heating soak cycle is complete, the burners shut off. At the same time, the fresh-air VFD cooling-damper control regulates the exhaust-fan speeds to the desired cool-down tolerances, and fresh air is drawn back into the oven via the combustion chamber and supply-plenum nozzles for effective cooling. The cooling fresh-air pneumatic damper is installed on the oven combustion chamber, and the cooling fan is on top of the working chamber to ensure proper airflow.

The guillotine door system is an integral design element for these batch ovens. These heavy-duty guillotine doors are equipped with pneumatic latches on both ends of the door to prevent leakage and heat dissipation. To ensure operational ease, the door latch mechanism is operated through a touch-screen button configured on an HMI screen (Fig. 3) with a mechanical safety latch and a rod lock assembly to hold the door open for personnel safety.

Fig. 5. Coil-coating oven combustion chamber

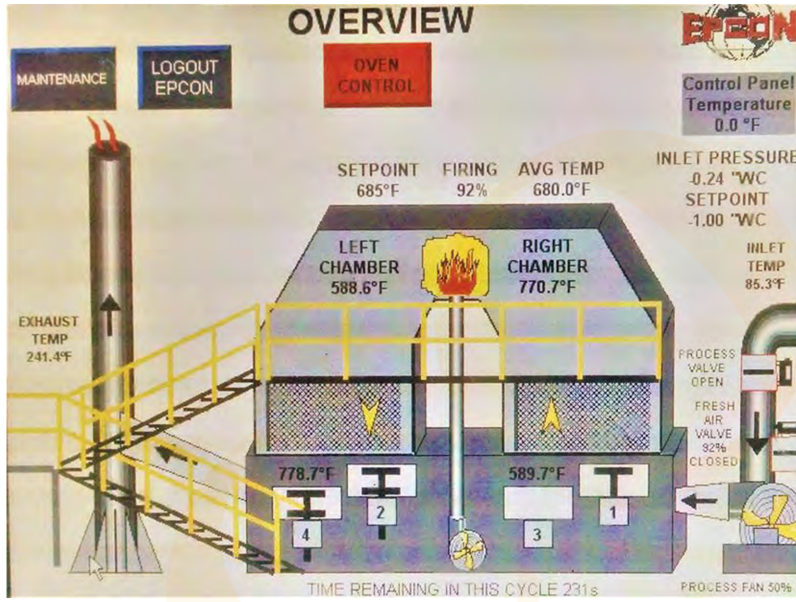


Fig. 6. Integrated air-pollution-control system control panel

Coil-Coating Oven and Thermal Oxidizer

The increasing demand for affordable, lightweight, stamped metal parts has driven the development of specialty laminated-aluminum products. These engineered materials combine the attributes of different gauges and grades of metal sheet with those of high-density polymer-mastic dampening materials. Together, the completed laminated product provides outstanding strength, weight and vibration-dampening performance at a lower total overall cost.

Producing these materials at affordable prices requires large-scale coil-laminating production lines. Ensuring a consistent and uniform cure of the polymer mastic is critical to product performance.

Cure Uniformity Critical To Laminated Aluminum Sheet Performance

A leading developer of laminated-aluminum sheet required a continuous-cure oven system for their new line. The system not only cures the applied coatings, it also heat treats the aluminum in the process. It required heat-treating expertise to develop a custom and innovative continuous-oven system to deliver a solution that achieves peak metal temperature (PMT) uniformity within +/-0.5% of target across the 5-foot-wide multilayered laminated sheet traveling at speeds of approximately 270 feet per minute (Fig. 4).

Utilizing an energy-efficient zone control, highly specialized temperature-control modules were key to delivering the high velocity and high-flow heat required to achieve the outstanding PMT uniformity seen in production. Each energy-efficiency zone's control module includes tandem VFD controlled-recirculation fans directed to dedicated top and bottom recirculation plenums that incorporate a custom, proprietary nozzle design specifically for this application (Fig. 5).

A major advantage to coil coating is the energy savings. Not only does the process utilize high-speed material processing, but it also allows for thermal recycling of the majority of the painted coil's VOCs back into the curing ovens, where they are reused as fuel.

This particular project required that the oven systems for coil coating large aluminum sheets had VOC emissions controls integrated into the overall design. These integrated air-pollution-control systems can often be optimized with the heat-treating system via primary and secondary heat-recovery methods to ensure maximum fuel efficiency (Fig. 6).

For example, the three-zone continuous-oven system recovers heat from the custom-integrated air-pollution-control system, which is engineered to direct hot, clean air from the oxidizer exhaust to the various zone controllers. This approach facilitates the highest energy recovery with the smallest overall footprint.

Conclusion

Heat treating of aluminum is a key production process for a wide variety of manufactured goods and consumer products. Whether it is the aging of cast parts or curing of coated sheets, oven design is a critical aspect of the overall quality of the finished aluminum product.

Before selecting a specialized oven type and design for any aluminum process, it is important to first consult process engineers that can optimize your operations and integrate all necessary air-pollution-control technology into the thermal-system design.

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Reheat Furnace Start-up Using Ceramic Coatings

Greg Odenthal – International Technical Ceramics, LLC; Fort Worth, Texas

As our economy continues to strengthen and steel production increases in the U.S., several of the mills that have been idled for years are beginning to come back on line. With the increase in production rates – up over 6.1% from last year – the demand for U.S. steel is on the rise.

Fig. 2. The veneering process

The increase in steel demand has led to the start-up of several mills that have been permanently closed due to hard economic times and the rise in imported steel. One such mill is Georgetown Steel (aka, ArcelorMittal Georgetown Steel), which is now Liberty Steel, Georgetown after the acquisition of assets by Liberty House Group of the U.K.

The mill is capable of producing 750,000 tons of wire rod annually and is the primary wire-rod producer in the U.S. Georgetown Steel produces wire rod that is used in rubber tires (tire cord and tire bead), wire rope and pre-stressed concrete strand. It also supplies various industrial-quality wire-rod grades from low- to high-carbon content and several types of micro-alloy and medium-alloy steels.

Furnace History

In 2008 when the steel economy was at its peak and gas prices were too ($10 per million BTU), ArcelorMittal Georgetown Steel decided to invest in a means to reduce the fuel consumption associated with their reheat furnace. In addition to reducing fuel costs, Georgetown Steel was also interested in reducing their high cost of refractory maintenance.

The hot mill consists of one pusher-type reheat furnace capable of producing 750,000 tons annually. 2008 production rates were approximately 88 tons per hour and averaged 1.5 MM BTU/ton of steel produced with a total usage of 3,168 MM BTU per day. The furnace's designed production rate of 120 tons per hour could not be attained due to heat loss from the badly spalled and cracked refractory lining as well as major BTU losses through the skids due to missing pipe refractory shapes.

The furnace lining consisted of 9 inches of plastic refractory and 3 inches of lightweight castable in the roof as well as 16 inches of plastic refractory and 3 inches of lightweight gunnite refractory on the sidewalls. The operating temperature was 2150˚F (1177˚C), and it was run approximately five days a week (225 days a year). On weekends the furnace was throttled back to approximately 1600˚F (871˚C).

With the badly consumed and aging refractory lining and under these current operating conditions, Georgetown Steel needed to address two major challenges:

1. Excessive heat loss and shell temperatures on roof and sidewalls
2. Minimal time and financial resources to completely reline the entire furnace

Facing these two constraints, Georgetown Steel looked to ceramic coating technology as an economical means to repair and prolong the life of their refractory lining as well as reduce heat losses and fuel consumption plaguing their operation.

Engineered Solution

In the summer of 2008, Georgetown Steel partnered with International Technical Ceramics (ITC) to apply their ceramic coating to the entire inside of the reheat furnace, roof, sidewalls, end walls, and both charge and discharge doors. This engineered approach consisted of spray coating the entire hot-face surface area with a proprietary high-temperature, energy-


Fig. 1. Spraying bullnose with ITC coating


Fig. 3. Final spray application


Fig. 4. Completed installation

efficient ceramic coating.

Next, the entire hot-face surface area was veneered with ½-inch-thick ceramic-fiber blanket cut into 12-inch x 12-inch squares, saturated in the ceramic coating. Once the veneering process had air-dried for 24 hours, the entire surface was again sprayed with the ceramic coating, creating a complete monolithic installation. Figures 1-4 show the installation, the veneering process on the sidewalls and bullnose and the completed installation.

This veneering process allows ITC to completely seal off all badly spalled and cracked refractory where heat can penetrate through the lining to the shell and be lost to the outside atmosphere. The coatings themselves can only be applied mils thick, so the saturated ceramic fiber helps bridge the gaps and cracks in the refractory, which keeps heat inside the furnace.

The major benefit of the coatings is its ability to re-radiate approximately 90% of all the radiant energy or BTUs put out by the burners. At these elevated temperatures the major mode of heat transfer required for reheating is through radiation (T^4) and if the refractory lining is in poor condition, heat loss through the lining can be very costly.

$$Q = E_h \times \quad \times (T_h^4 - T_c^4)$$

Q = Re-radiated energy (BTU/hour-feet²)
E_h = Emissivity of hotter surface
= Stefan-Boltzmann Constant
T_h = Temperature of hotter surface
T_c = Temperature of colder surface

After six months of operation with the new ceramic-coated lining, ArcelorMittal decided to idle the mill due to declining economic conditions. During those six months that the furnace ran, however, the benefits attained through the use of the coatings were quite impressive. Georgetown Steel was able to reduce their fuel consumption and the amount of energy required for the process, increase throughput due to additional energy available and reduce the amount of scale being generated.

Benefits Attained

Before and after thermal images of the roof and sidewalls showed a significant reduction in lost heat. Initial calculations done on the sidewalls predicted a drop in shell temperature of 38˚F, or approximately 17%. Based on thermal images, the actual drop in shell temperature was in the range of 100˚F on average, or approximately 36%. Calculations done for the roof predicted a drop in cold-face temperature of approximately 60˚F (20%). However, thermal images showed the actual drop in cold-face temperatures was approximately 85˚F, or 25%. Initial BTU savings were estimated at 1.9 MM BTU per hour, but with the above reduced heat loss through the furnace refractories, the actual savings was 2.2 MM BTU per hour.

Upon start-up of the furnace after the installation, operators found that if they attempted to maintain the operating temperatures at pre-installation levels, they were beginning to melt the billets. The mill was able to drop normal furnace operating temperatures as indicated by their thermocouples from 2150˚F to 1840˚F as well as increase furnace throughput from 88 tons per hour to as much as 120 tons per hour. This is due to the ability of the ITC coatings to reflect radiant energy back into the furnace and maintain a much more even heat distribution.

With the billets now coming to temperature much more quickly in the heating zones, the burners in the soak zone were cut back while the speed of the billets through the furnace was increased. This reduction in operating temperatures led directly to additional fuel savings as well as reductions in NOx emissions.

With the increase in throughput and a decrease in soak-zone temperatures, ArcelorMittal gained an approximate 2% increase in yield due to substantial reductions in scale generation. Furnace operators indicated that the scale boxes that were previously emptied on a daily basis are now only being emptied on the weekends. This increased yield was calculated at an additional 9,000 tons of saleable product per year based on the mill operating at full capacity. Figures 5 and 6 show the veneered lining condition six months after installation.

A summary of the benefits provided by ArcelorMittal are:


Fig. 5. Heat zone looking into soak zone


Fig. 6. Heat zone looking into soak zone

Fig. 7. Soak-zone roof and sidewall

Fig. 8. Bullnose

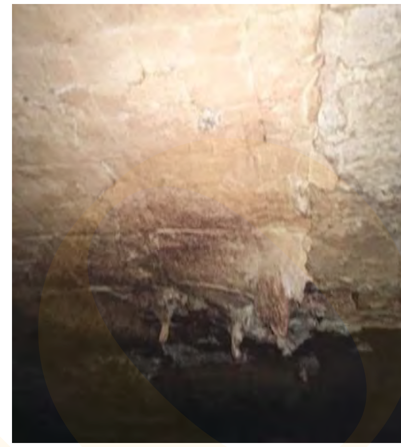

Fig. 9. Heat-zone roof with minimal damage

- The combination of lower heat losses through the refractory, lower operating temperatures and increased furnace throughput has dropped the heat required per ton of steel produced from 1,500,000 BTU/ton to 800,000 BTU/ton. The plant ran five days a week, 50 weeks per year with a 90% operating availability, which is equivalent to 225 days per year.
- The previous production rate of 88 tons per hour at 1.5 MM BTU/ton gives a total usage of 3,168 MM BTU per day.
- The new production rate of 120 tons per hour at 0.8 MM BTU/ton gives a total usage of 2,304 MM BTU per day.
- With an approximate fuel cost of $10 per mm BTU, the annual savings in fuel would be approximately $1,950,000 per year.
- The increased production due to a 2% increase in yield based on the reduction in scale is approximately 9,000 additional tons per year. At $400/ton, this is an increase of $3,600,000 per year in additional steel.

With the furnace operating at full capacity, the total annual potential savings and increased production amounts to $5,550,000. Based on this figure and the total cost of coating installation at roughly $200,000, payback for this project was approximately 9 days.

Current Furnace Condition

In the spring of 2018, Liberty House Group finalized the acquisition of all assets of Georgetown Steel from ArcelorMittal. The mill sat idle for nearly two and a half years and went through two hurricanes and major flooding in the fall of 2015, yet the plant remained in relatively good condition.

During the second quarter of 2018, the plant was fully commissioned, the first heat was tapped and the reheat furnace produced its first billet. The current condition of the reheat furnace was operational but in need of refractory repair to both the roof and sidewalls. Overall, minimal damage to the furnace refractories and ceramic coating took place during the shutdown (Figs. 7-12).

Upon start-up of the furnace, Liberty Steel reviewed the benefits and saving potential of the coatings from the previous operation and has elected to replace all damaged areas and recoat the complete furnace. Although natural gas prices are lower today than in 2009 ($10.00 per MM BTU versus roughly $3.00 per MM BTU today), fuel-consumption savings will still be significant.

The reduction in fuel required to produce a ton of steel is expected to remain at approximately 46%, or 0.8 MM BTU/ton, based on a production rate of 120 tons per hour. Additionally, the reductions in scale will continue to generate an increase of roughly 2% additional yield per year. If the same yearly increase of 9,000 additional tons at today's current cost for hot-rolled coil steel of $740.00 per net ton is assumed, revenue would be increased by $6,000,000.00.

Lastly, by recoating the furnace, Liberty Steel will continue to achieve lower heat losses through the refractory lining, thus increasing the furnace efficiency while increasing product quality, improving temperature uniformities and reducing the overall high cost of refractory maintenance required.

Conclusion

An efficient furnace lining is essential for reducing overall maintenance costs and ensuring that the hot mills' reheat furnaces run smoothly without unwarranted revenue loss due to downtime. High-temperature, energy-efficient ceramic coatings for refractories – no longer "theoretical" technology – are being used successfully in furnace applications to reduce energy consumption, improve temperature uniformity, reduce maintenance and increase production while improving product quality.

The potential application of these coatings cuts across a wide spectrum of thermal-processing industries and types of equipment. Numerous installations have proven successful in steel plants, both in the melt shop and hot mill, across the globe. ITC offers a full line of high-temperature, energy-efficient ceramic coatings used on both refractory and metal substrates. These products are water-based, so no solvents are required for

Fig. 10. Heat-zone roof

Fig. 11. Burner wall with minimal damage

Fig. 12. Damaged burner wall

dilution or cleanup. On curing they are environmentally inert and do not require special handling or disposal.

International Technical Ceramics, LLC continues to look for new and challenging opportunities in the steel industry where coating technology has yet to be used. How can we help you?

For more information: Contact Greg Odenthal, director of engineering & technical operations, International Technical Ceramics, 13001 Old Denton Rd. Fort Worth, TX 76177; tel: 412-498-7270; e-mail: greg@itccoatings.com; web: www.itccoatings.com

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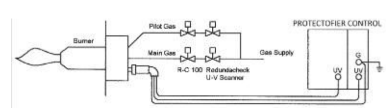

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- V1024 PIFCO Batch Temper Furnace, Skid Hearth (36"W x 48"L x 30"H, 1200°F, electric)
- V1068 Surface Combustion Oil Quench Furnace (30"W x 30"D x 48"H, 1950°F, gas-fired)
- V1095 Surface Combustion Temper Furnace (30"W x 48"D x 30"H, 1250°F, gas-fired)
- V1096 Surface Combustion Temper Furnace (30"W x 48"D x 30"H, 1400°F, gas-fired)
- V1106 Dow Batch Normalizer Furnace (45"W x 84"D x 32"H, 1800°F, gas-fired)

Batch High-Temp Furnaces

- U3556 Pacific Industrial Batch High-Temp Furnace (24"W x 36"L x 18"H, 2800°F, electric)
- U3637 Pacific Scientific Batch Temper Furnace (30"W x 48"D x 24"H, 1600°F, gas-fired)
- U3643 Surface Combustion Temper Furnace (30"W x 48"D x 42"H, 1400°F, electric, 81kw)
- V1013 Thermolyne High-Temp Batch Furnace (10"W x 14"L x 9"H, 2000°F, electric)
- V1067 Seco Warwick High-Temp Batch Furnace (24"W x 36"D x 24"H, 2000°F, electric)
- V1068 Surface Combustion Oil Quench Furnace (30"W x 30"D x 48"H, 1950°F, gas-fired)
- V1130 Onspec Slot Forge Furnace (72"W x 96"D x 48"H, 2400°F, gas-fired)

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

Drop Bottom Furnaces

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

Internal Quench Furnaces

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

Mesh Belt Brazing Furnaces

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

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

Pit Furnaces

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

Pusher Furnaces

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

Roller Hearth & Rotary Furnaces

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

Salt Pot Furnaces

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

Steam Tempering Furnace

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

Tip Up Furnaces

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

Vacuum Furnaces

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

Endothermic Gas Generators

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

Exothermic Gas Generators

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

Material Handling - Conveyors

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

Ovens - Cabinet

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

Ovens - Walk-In

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

Freezers

- V1129 Webber Freezer (-120°F, electric)

Blowers

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

Charge Cars

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

Scissors Lifts & Holding Tables

- V1086 Holcroft Scissors Lift & (2) Holding Tables

Heat Exchanger Systems

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

Holding & Cooling Stations

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

Water Cooling Systems

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

Washers

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

Transformers

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Baskets & Boxes

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Heat Treat Lines

- V1137 T-6 Annealing & Aging Furnace Line

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  OR:
- High School Diploma and 5 years heat treating and/or brazing experience, preferably in the aerospace and / or medical device industries.
- Hands-on experience with some of the following heat treating processes: steels, aluminum, titanium, heat resisting alloys, brazing, carburizing and nitriding
- Familiarity with AMS 2750
- Familiarity with Industry Specifications
- Familiarity with Heat Treating equipment
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Baker Gas Fired Oven with Cooling, 7'W x 7'H x 8'L (Heating chamber), 7'W x 7'H x 8' L (Cooling chamber), vertical rising door between chambers, 600°F, 750,000 BTUH, powered carts, stainless steel interior and controls.

SELAS

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

WISCONSIN

SOLD

WISCONSIN GAS FIRED BATCH OVEN, 6' x 6' x 6', 1,2[illegible] MBTUH complete with vertica[illegible] tracks for load cart, cart included and controls.

SHERWOOD

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

VACUUM INDUSTRIES (CENTORR)

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

CAR BOTTOM FURNACE

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

ABAR

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

ABAR

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

INDUSTRIAL HEATING EQUIPMENT

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

PARK THERMAL

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

PARK THERMAL

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

SURFACE COMBUSTION

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

SURFACE COMBUSTION

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

AFC - HOLCROFT

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

SURFACE COMBUSTION

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

SURFACE COMBUSTION

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

HOLCROFT

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

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1,500CFH	Endothermic Lindberg (Air)	Gas
2,000CFH	Ammonia Dissoc. Drever (3)	Elec
3,000CFH	Endothermic Lindberg (3) - Air	Gas
3,600CFH	Endothermic Surface (2)	Gas
5,600CFH	Endothermic Surface (2)	Gas
6,000CFH	Gas Atmos. Nitrogen Generator	Gas

BOX FURNACES

12" x 24" x 10"	Lindberg (Atmos.)	Elec 2000°F
12" x 24" x 10"	Lindberg (Atmos.)	Elec 2500°F
12" x 24" x 12"	Hevi Duty (2)	Elec 1950°F
12" x 32" x 12"	L&L (Retort)	Elec 2000°F
13" x 24" x 12"	Electra Up/Down	Elec 2000°F
17"x14.5"x12"	L&L (New)	Elec 2350°F
18" x 30" x 13"	Hevi-Duty	Elec 1850°F
18" x 36" x 18" (Just Added)	Lindberg (Atmos)	Elec 2500°F
18" x 36" x 18"	Hevi Duty	Elec 2000°F
18" x 36" x 18"	Lindberg (Fan)	Elec 1850°F
20" x 48" x 12"	Hoskins	Elec 2000°F
36"x72"x42"	Eisenmann (Car Bottom)	Gas 3100°F
60"x216"x48"	IFSI (Car Bottom)	Gas 2400°F
60"x156"x60"	Lindberg Car Bottom	Gas 1850°F
96"x360"x48"	Sauder Car Bottom	Elec 1400°F
126"x420"x72"	Drever "Lift-Off" (2) (Atmos.)	Gas 1450°F

PIT FURNACES

14" Dia x 60"D	Procedyne Fluid Bed	Elec 1850°F
28" Dia x 48"D	Lindberg	Elec 1250°F
72" Dia x 72"D	Flynn+Dreffein (2) (Atmos.)	Elec 1400°F
60" Dia x 52"H	"Bell" Nitrider (Retort)	Elec 1200°F

VACUUM FURNACES

12" x 20" x 12" (Just Added)	Abar	Elec 2400°F
24" x 36" x 18"	Hayes (Oil Quench)	Elec 2400°F
24" x 36" x 24"	TM - Temper	Elec 1400°F
48" x 48" x 24"	Surface (2-Bar)	Elec 2400°F
48" x 48" x 36"	Ipsen "Like New"	Elec 2400°F
60" Dia x 96"H	Ipsen "Bottom Load"	Elec 2400°F
72" Dia x 96"H	Abar "Bottom Load" (5 Bar)	Elec 2400°F

INTEGRAL QUENCH FURNACES

24" x 36" x 24"	AFC (Top-Cool-Line)	Elec 1850°F
30" x 48" x 20"	Surface (2)	Gas 1750°F
30" x 48" x 24"	Surface	Gas 1750°F

BELT FURNACES/OVENS

10" x 6' x 7"	Abbott (Brazing) "Like New"	Elec 2150°F
24" x 12' x 18"	Gruenberg	Elec 450°F
24" x 18'L	Thermal Basic Belt Line	Gas 1750°F
32" x 24' x 12"	OSI Slat Belt	Gas 450°F
36" x 24' x 8"	Surface Cast Belt (Line)	Gas 1750°F
60" x 30' x 10"	Sherwood	Gas 500°F
60" x 40' x 14"	GE Roller Hearth (Atmos)	Elec 1650°F
60" x 40' x 14"	Wellman Roller Hearth (Atmos)	Elec 1650°F
72" x 25' x 12"	Wisconsin	Gas 500°F

MISCELLANEOUS

Combustion Air Blowers (All sizes)		
24" x 36"	Lindberg Charge Car (Manual)	
30" x 48"	Surface Charge Car (SE-ER)	
SBS Air/Oil Coolers (4)		
24" x 36" x 24"	Salt Quench Tanks (2)	Elec 1000°F
30" x 48" x 30"	Surface Washer	Gas
30" x 48" x 36"	Surface Washer	Gas
(2) Bell & Gossett "Shell & Tube" Heat Exchangers		
26" x 15' x 15"	Belt Washer/Dryoff	Gas
36" x 48"	AFC Charge Car (DE)	Elec

MISCELLANEOUS (continued)

24" Wide Table	Surface rotary Hearth	Gas 1750°F
30" x 30" x 30"	Subzero	-105 to 375°F Elec.
SBS Air/Oil Coolers (4)		
AFC Pusher Line (Atmos.)		Gas 1750°F
36" Wide Table – Rotary Hearth (Atmos.)		Elec 1850°F
30" x 48"	Surface Roller Table	
36" x 48"	Holcroft Charge Car (DE)	
48" x 60" x 60"	Steel "Roll-in" Carts (3)	
54" Dia x 108" H	Ebner Bell (Atmos.)	Gas 1650°F

OVENS/BOX TEMPERING

8" x 18" x 8"	Lucifer	Elec 1250°F
12" x 16" x 18"	Lindberg (3)	Elec 1250°F
14" x 14" x 14"	Blue-M	Elec 1050°F
14" x 14" x 14"	Gruenberg	Elec 1200°F
14" x 14" x 14"	Blue-M	Elec 650°F
14" x 14" x 14"	Gruenberg (solvent)	Elec 450°F
15" x 24" x 12"	Sunbeam (N_2)	Elec 1200°F
20" x 18" x 20"	Blue-M	Elec 400°F
20" x 18" x 20"	Despatch	Elec 650°F
20" x 18" x 20"	Blue-M	Elec 650°F
20" x 18" x 20"	Blue-M (2)	Elec 800°F
20" x 18" x 20"	Blue-M	Elec 1300°F
24" x 20" x 20"	Blue-M	Elec 1000°F
24" x 24" x 24"	Grieve	Elec 650°F
24" x 24" x 24"	Despatch	Elec 1350°F (Just Added)
24" x 24" x 36"	New England	Elec 800°F
24" x 24" x 48"	Blue-M	Elec 600°F
24" x 36" x 24"	Grieve	Elec 500°F
24" x 36" x 24"	Demtec (N_2)	Elec 500°F
24" x 36" x 24"	AFC (N_2)	Elec 1250°F
24" x 36" x 24"	Grieve	Elec 1000°F (Just Added)
24" x 36" x 24"	Trent	Elec 1400°F
25" x 20" x 20"	Blue-M	Elec 650°F
24" x 36" x 48"	Gruenberg	Elec 500°F
25" x 20" x 20"	Blue-M (Inert)	Elec 1100°F
26" x 26" x 38"	Grieve (2)	Elec 850°F
30" x 30" x 60"	Gruenberg	Elec 450°F
30" x 30" x 48"	Process Heat	Elec 650°F
30" x 38" x 48"	Gruenberg (Inert) (2)	Elec 450°F
30" x 48" x 30"	Surface (3)	Elec 1400°F
30" x 48" x 30"	Surface	Elec 1250°F
36" x 36" x 36"	Grieve	Elec 1000°F (Just Added)
36" x 36" x 36"	Grieve	Elec 350°F
36" x 36" x 36"	Blue M Enviroment Chamber	(-18°C to +93°C)
36" x 30" x 36"	Trent	Elec 1400°F
36" x 42" x 72"	Gruenberg	Elec 450°F
36" x 48" x 36"	Pollution Control Burn Off	Gas 850°F
36" x 48" x 36"	Grieve	Elec 350°F
36" x 48" x 36"	AFC	Gas 1250°F
36" x 48" x 36"	TPS (Environmental)	Elec -40°C to +200°C
36" x 60" x 36"	CEC (2)	Elec 650°F
36" x 36" x 78"	Despatch	Elec 1050°F
36" x 84" x 36"	Lindberg (1996)	Gas 800°F
37" x 25" x 37"	Despatch	Elec 500°F
37" x 25" x 37"	Despatch	Elec 850°F (Just Added)
38" x 20" x 26"	Grieve	Elec 500°F
42" x 72" x 36"	Despatch	Elec 1350°F
48" x 24" x 36"	Blue-M	Elec 600°F
48" x 48" x 20"	Lindberg (Hyd. Press)	Elec 1250°F
48" x 34" x 52"	Heat Mach. (2)	Elec 500°F
48" x 48" x 48"	TPS - Environmental	Elec 392°F
48" x 48" x 72"	Gruenberg	Elec 500°F
55" x 30" x 60"	Precision Quincy	Elec 350°F
60" x 60" x 60"	Precision Quincy	Gas 800°F (Just Added)
68" x 72" x 72"	Gruenberg	Elec 450°F
72" x 96" x 72"	Michigan Oven	Gas 500°F
72" x 252" x 60"	Precision Quincy "Car Oven"	Gas 500°F
96" x 360" x 48"	Sauder Car Bottom	Elec 1400°F
108" x 96" x 65"	Eisenmann (3)	Gas 1200°F

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