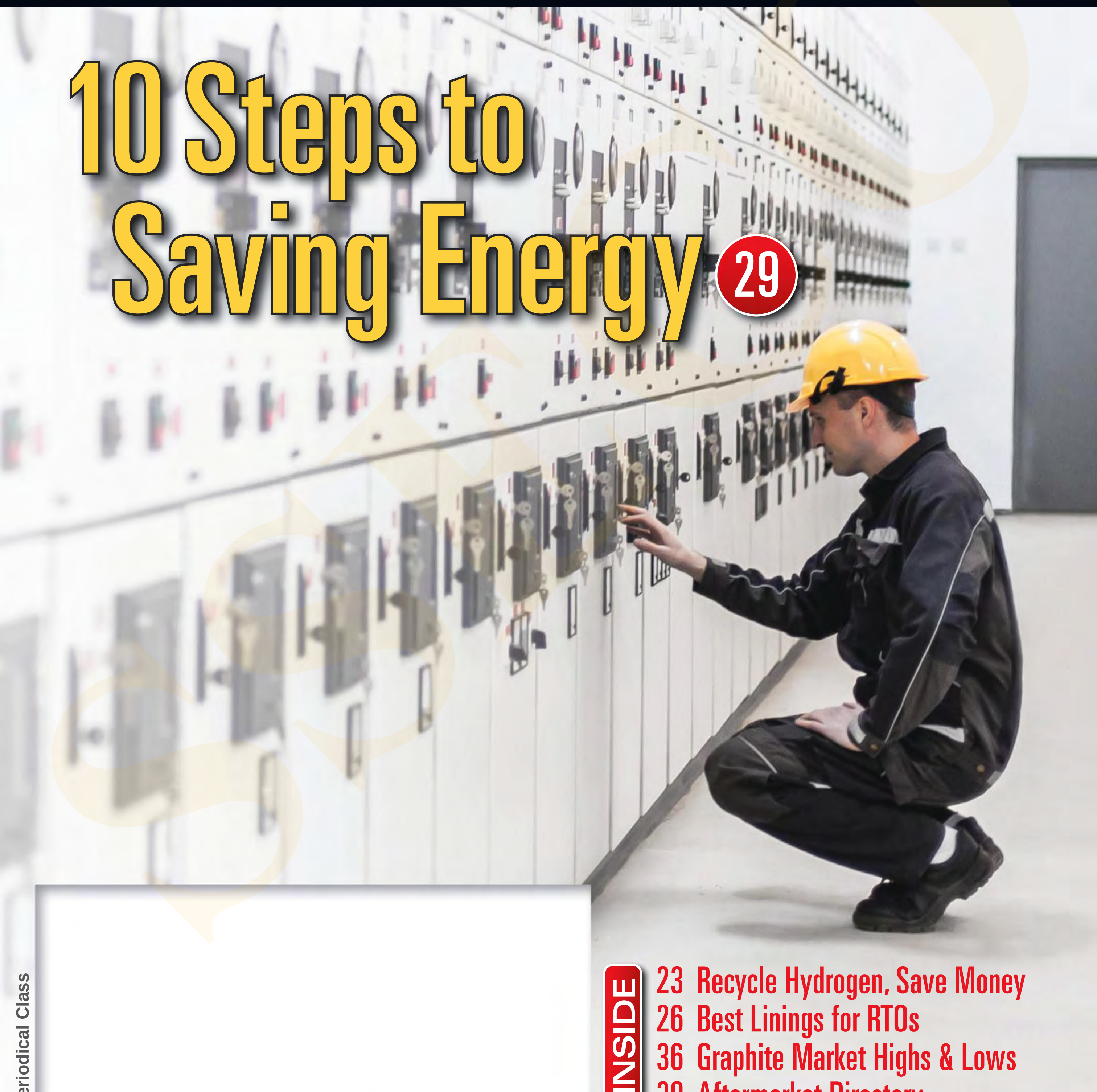
INDUSTRIAL HEATING

The International Journal of Thermal Processing
APRIL 2019



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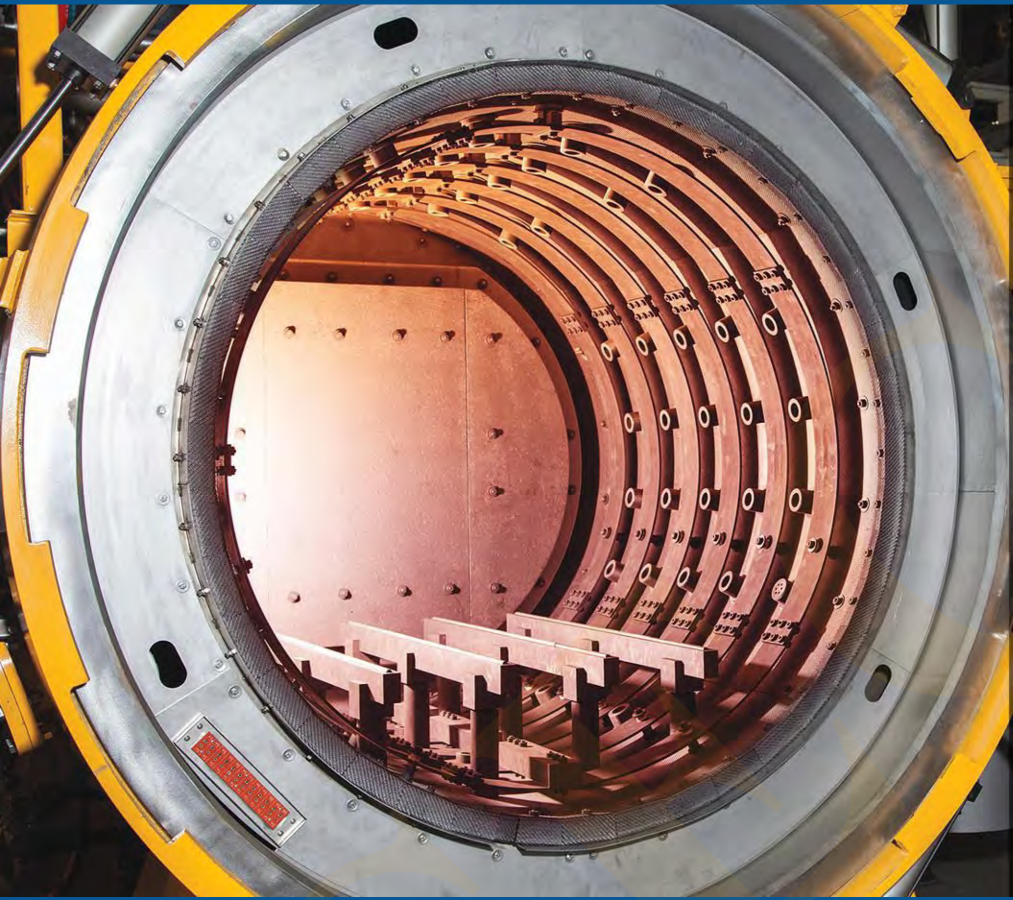

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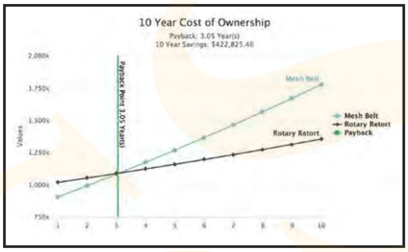

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Read it online at www.industrialheating.com/graphite.

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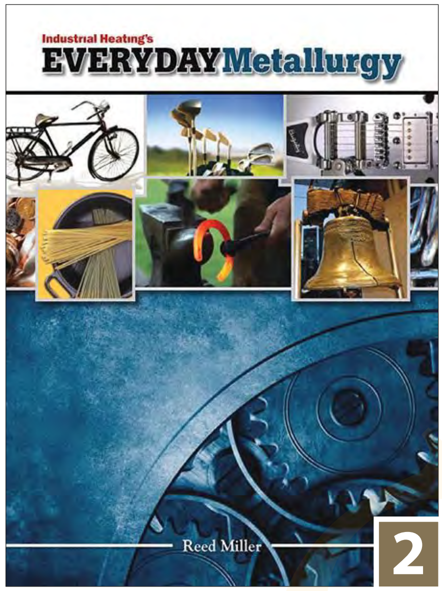

ONLINE

1 Podcast

IH Monthly Rx

Listen to *Industrial Heating* Editor Reed Miller and Dan Herring, The Heat Treat Doctor®, discuss issues of technical interest on this monthly podcast. January, February and March installments are currently available. March exclusively discusses retained austenite.

www.industrialheating.com/media/podcasts/2678

2 Industrial Heating Bookstore

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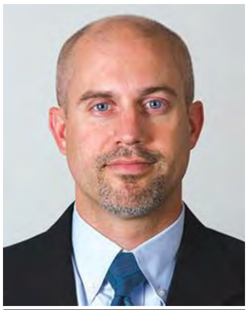
Industry Events of Note in 2019



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In what is becoming an annual April tradition, we'll take a look at some significant industry events. As the weather starts to warm, trade-show season begins heating up. Even if you can't attend the following events, it's important to know what the industry has to offer in 2019.

Ceramics Expo

In its fifth year, Ceramics Expo will host more than 300 leading global manufacturers and suppliers from across the supply chain. Held April 30-May 1 in Cleveland, industry leaders will share their technical expertise in ceramics and provide real-world case studies, new technologies and materials, and information on industry trends.

AISTech 2019

Held May 6-9 in Pittsburgh, the steel industry's premier technology event will feature technologies that help steel producers compete more effectively in today's global market. Designed for anyone involved at any level of today's steel marketplace, it provides perspective on the technology and engineering expertise necessary to power a sustainable steel industry.

Rapid + TCT

North America's pre-eminent event for innovation and networking in 3D manufacturing takes place May 20-23 in Detroit. Dedicated to additive manufacturing and 3D printing, this show promises some of the biggest product announcements of the year as well as presentations from the industry's most respected experts.

Thermprocess will be held in Düsseldorf, Germany, June 25-29, 2019.

Forge Fair 2019

North America's largest event dedicated exclusively to the forging industry hosts more than 1,650 forging professionals from across the globe. Attendees can learn about new products, make purchasing decisions and network with each other at this biennial event held May 21-23 in Cleveland. Visit FORGE magazine at booth #233 at the show.

Powdermet 2019

The leading North American technical conference on powder metallurgy and particulate materials is held June 23-26 in Phoenix. Attendees will have access to over 200 technical presentations from worldwide experts on the industry's latest research and development.

Bright World of Metals

This is the big one. Four events are held concurrently June 25-29 in Düsseldorf, Germany: Thermprocess 2019, the 12th international trade fair and symposium for thermal-processing technology; GIFA 2019, the 14th International Foundry Trade Fair with Technical Forum; METEC 2019, the 10th International Metallurgical Trade Fair; and Newcast, the 5th International Trade Fair for Castings with Technical Forum. As a whole, the event drew 78,000 attendees in 2015. About 2,000 exhibitors are expected this year.

Heat Treat 2019

Held Oct. 15-17 in Detroit, the 30th Heat Treating Society Conference & Exposition will combine new technology, exhibits, technical programming and networking events geared toward the heat-treating industry. *Industrial Heating* will be in attendance.

Conclusion

Trade shows are important because they provide education via technical sessions as well as an opportunity to network with industry professionals on the show floor. For more information on these and other industry events, visit www.industrialheating.com/events. IH

A Truly Amazing Art Form

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In April 2006, this column described the origins of the iron industry in America. Then, in April 2018, *Industrial Heating's* cover story was about blacksmithing.

I recently visited with specialty knife-maker Tony LaSeur (www.laseurknives.com) in Fredericksburg, Va. His art and its unique history in America offer a wonderful view of this niche as part of what makes our country great. Our world since Colonial times has grown and changed beyond belief, but quality metal arts have survived and improved significantly.

In the Middle Ages, the need for iron utensils for cooking and iron blades for sickles, scythes and axes grew the work and art of blacksmithing. Iron was the preferred, stronger metal despite more plentiful metals such as copper. We know this from the writings of Benedictine monk Theophilus Presbyter and because Europe is not well-endowed with quality iron ore.

Blacksmith James Read arrived in Virginia at Jamestown in May 1607. One year later another arrived. In 1611, a shipload of mechanics came to assist together with four more blacksmiths. By 1619, the first colonial full-scale iron works began operation about 60 miles north of Jamestown. It was open until 1622, when all the workers were killed and buildings and equipment destroyed by indigenous people. The first sustained iron works opened in Saugus, Mass., in 1647.

Throughout the 18th and 19th centuries, ironsmiths outnumbered all other metalworkers. A Boston business directory from 1789 listed only seven other metalworkers, seven farriers and 25 blacksmiths. In 1770, the William Hunter Works in Falmouth Va., made 1.5 tons of pig iron into bars each day. In 1781, Thomas Jefferson listed eight iron works in Virginia making 900 tons of bar annually. These workers met local citizen needs and did not make or sell products for sale in Europe because of British protectionist trade regulations. (Sounds familiar; government interfering with the private sector then as well as now.)

Ultimately, higher-quality ore deposits were discovered in the 1840s in the northern Great Lakes region, and the U.S. metals manufacturing sector grew and prospered thereafter. However, the U.S. was forced to import iron rails from the U.K. until 1844. Things really changed when Henry Bessemer made steel from iron in 1855. Remember that it was not until the 1930s that automated steel production came about. So, the heart of blacksmithing had to wait many years to evolve into what it is today, with the ability to make knives from higher-quality and less-expensive materials.

There are well over five dozen types of knives in common use from craft makers, such as hunting, kitchen, fillet, razor edge and bowie. It is necessary to know the type of steel to use (tool, stainless or carbon). In blades, they go by names of O1 (tough, oil-quenched, wear-resistant), 1084 (suited to imprecise heat treating), 1075 (heat treatable with blow torch and affordable) and 1095 (high carbon, rust-resistant and easily sharpened).

If you wanted to take up the hobby, it is essential that you obtain and learn how to use a variety of tools, including:

- Metal files to perform grinding, finishing and smoothing
- Clamps to hold the blade in place while shaping it
- Hacksaw with high-quality blades
- Bench vise with a 360-degree swivel to hold the blade in place in correct orientation
- Grinding abrasives of various types
- Drill press to drill holes for handle attachment
- Sharpening stone used in last steps of fabrication
- Torch to heat the workpiece
- Anvil

You should also have safety gear (e.g., glasses, respirators and gloves) and a fire extinguisher. Getting more proficient with the hobby of blade-making will prompt adding items like a belt grinder and an oven with suitable tongs for insertion and removal of the workpiece on the anvil.

Having seen LaSeur's shop, it is evident that an artisan can fabricate beautiful works of art and utility in an ordinary workplace where any blacksmith would be comfortable. It really is "truly amazing."

A beautiful forged Damascus-steel knife

Testing to Determine Material and Mechanical Properties (Part Two: Applying the Tools)

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As was discussed last month, having the right analysis equipment is one thing; being able to use it effectively is quite another. Several case studies will illustrate the use of the various tools available to testing laboratories and universities and how they help identify the root cause of real-world problems. Let's learn more.

Case Study 1: Gear Investigation

Gears of SAE 5115 steel were failing prematurely. The parts had been low-pressure "vacuum" carburized at 960°C (1760°F) and high-pressure gas quenched from 860°C (1580°F). The quench pressure was not identified. The gears were submitted to the laboratory for evaluation of the case-hardened layer.

The critical question to be addressed was if the cooling rate used was proper. In order to address this, the following tests were selected: a full metallographic analysis of the case and core regions, including determination of grain size and retained austenite levels, hardness (macro and micro) measurements and a stress profile in the hardened layer.

Metallographic Examination

A gear-tooth section was cut from the gear, mounted, ground and polished then evaluated on a standard optical microscope. The sample was etched with a 2% Nital solution.

The microstructure of the case layer was tempered martensite with about 20-30% retained austenite (visual). Surface hardness was 61 HRC. The microstructure of the core was a combination of ferrite, pearlite and bainite.

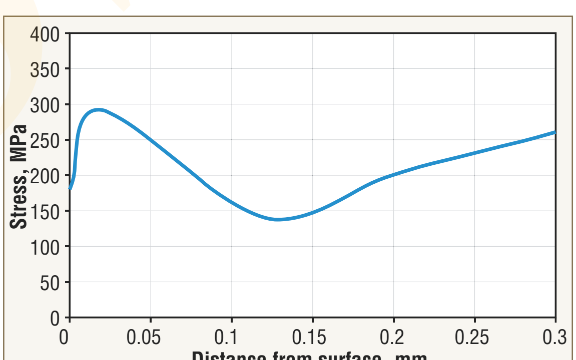

Fig. 1. Distribution of internal stresses in the case-hardened layer

Core hardness was 42 HRC. The grain size was measured as ASTM No. 10. Microhardness testing (513 HV1) revealed an effective case depth of 0.85 mm (0.0335 inch), which met specification.

Stress Profile in the Hardened Layer

Testing of residual stress present in the case layer (Fig. 1) indicated this area was in tension, which would explain the premature failure being experienced in the field. This suggested (and was confirmed by a subsequent literature study) that the gear was cooled too rapidly from austenitizing temperature.

Case Study 2: Boiler-Plate Screen Investigation

Pipes installed in the combustion chamber of a steam boiler were found to have failed prematurely (Fig. 2). The material in question was an ASTM A204 Grade-A pressure-vessel steel (16Mo3). These pipes operated at a temperature of 360°C and a pressure of 14.5 MPa (2.1 ksi). The goal of the investigation was to determine why these components failed.

The following tests were conducted:

Fig. 2. Damaged steam-boiler combustion tube. From the furnace-chamber side, the tear is approximately 400 mm (15 inches) along the pipe axis.

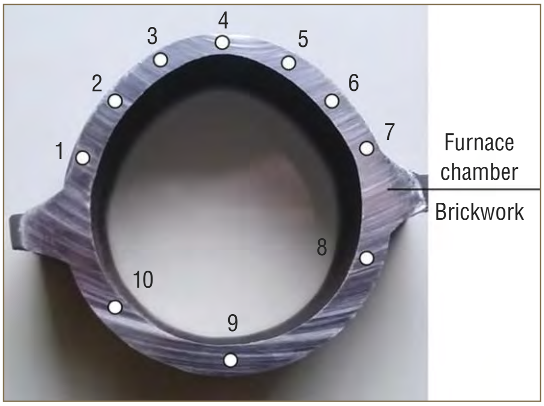

Fig. 3. Hardness variation of the tube as a function of location

Fig. 4. Baumann micrographic examination for the presence of sulfur

Table 1

Tested area	Measurement	Hardness HV10
Furnace chamber side	1	148
	2	140
	3	130
	4	126
	5	128
	6	138
	7	142
	Average	**136**
Brickwork side	8	152
	9	150
	10	152
	Average	**150.5**

visual examination, stereographic microscopy, chemical composition analysis, hardness measurements (Fig. 3), metallographic examination, endurance tests, hydrogen analysis and a Baumann micrographic examination (a qualitative test that is employed to detect the distribution of sulfur in steel and certain physical irregularities, such as cracks and porosity, by printing on photosensitive paper previously soaked in sulfuric-acid solution).

Test Results

The torn pipe edge was observed to be tough and brittle. The wall thickness was measured and found to be 3.0 mm (0.120 inch), which was below the original design thickness of 3.52 mm (0.140 inch). On the damaged section in the furnace chamber, plastic deformation (swelling) of the cross section was observed and measured at approximately 6.0%. Hardness values (Table 1) on the exposed side of the pipe averaged 136 HV10 and averaged 150.5 HV10 on the protected (brickwork) side. Additional testing confirmed the following:

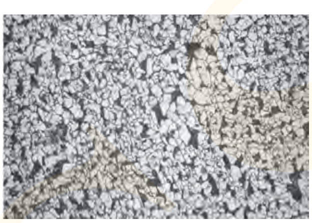

Fig. 5. Cross section from the side embedded in the brick wall. Steel grade 16Mo3, ferrite/pearlite microstructure, ASTM grain No. 10, hardness 148 HV10, 100X, 2% Nital

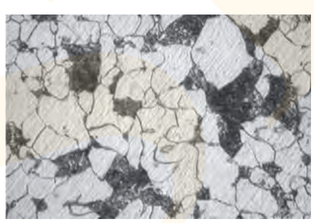

Fig. 6. Cross section from the side embedded in the brick wall. Steel grade 16Mo3, ferrite/ pearlite microstructure, ASTM Grain No. 10, hardness 148 HV10, 500X, 2% Nital

Fig. 7. Cross section from the furnace chamber. Steel grade 16Mo3, ferrite-carbide structure, separation of carbides on grain boundaries, ASTM Grain No. 10, hardness 126 HV10, 200X, 2% Nital

Fig. 8. Cross section from the furnace chamber. Steel grade 16Mo3, ferrite-carbide structure, separation of carbides on grain boundaries, ASTM Grain No. 10, hardness 126 HV10, 500X, 2% Nital

- The chemical composition was proper for the material in question.
- The damage section on the combustion chamber side was found to have a degraded microstructure (Figs. 5-8).
  Due to prolonged high-temperature exposure above 510˚C (950˚F), the primary ferrite/pearlite microstructure transformed to a ferrite/carbide microstructure. This was accompanied by a reduction in hardness (from approximately 148 to 126 HV10) with an accompanying decrease in strength.
- In the area of the pipe recessed into the brickwork, the material retained its ferrite/pearlite microstructure. As such, tensile strength and elongation values were found compliant with the requirements of the original material specification.

Analysis showed that the tube material did not pick up hydrogen, but on the side in the combustion chamber the corrosion products adhering directly to the metal saw a significant amount of sulfur present (Fig. 4).

Conclusions

The pipe was damaged due to overheating. The pipe exposed to the combustion chamber has the characteristic features of damage from prolonged overheating (estimated to be approximately 1,000 working hours), including swelling, brittle (edge) fracture, microstructural breakdown and loss of strength properties (e.g., tensile strength, hardness).

The cause of this type of damage could only be due to excessive heat or limited/inadequate refrigerant flow. The research excluded the possibility of hydrogen-assisted cracking as a potential cause.

Summary

These case studies, and many more like them, show the value of using a number of different analysis tools to find the root cause of a problem or failure so that proper corrective action can be implemented. Picking a laboratory with the type of tools needed to do the job is a critical component to understanding if a heat-treatment problem (case study No. 1) or a field operational issue (case study No. 2) is at fault.

References available online

The Evolution of Heat Treat: When Youth Collides with Wisdom

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Editor's note: This column is being re-run from February because it went to print with the incorrect attribution. The author is Kelley Shreve from Lindberg/MPH, and we wanted to make sure everyone knew that. Because of our mistake, Kelley has agreed to contribute a second column later this year.

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.

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.

The Ultimate Capacity Builder for Your Heat-Treating Operations

TOM MORRISON
CEO MTI Management
tom@heattreat.net
904-249-0448

As the economy continues to grow over the next 10-15 years, it is important for your heat-treating division to have three key elements:

1. Technically trained line staff
2. Trained managers and supervisors
3. Outsourcing partners to maximize capacity and efficiencies

You need #1 to minimize error rates and the need to micromanage. You need #2 because the top reason employees are leaving companies is a "horrible boss." With the shortage of labor in the next eight years, you can't afford to lose your top performers through bad management.

The Metal Treating Institute (MTI) solves #1 and #2 with the best in technical and managerial training at its online training site, www.MTIAcademy.com. You should check it out.

Number 3 is where I want to put focus on growth and expansion. With the heavy cost of internal expansion, it makes a lot of sense for your heat-treating division to partner externally with an MTI commercial heat treater to outsource special projects or to increase capacity.

MTI is a nonprofit trade association with member plants in 40 states and five countries. With over 260 plants, MTI is the largest network of commercial heat treaters in the world serving Fortune 500 manufacturers with every process known to heat treating.

As the world economy grows at record levels over the next 10 years, manufacturers are going to be under pressure to minimize costs and maintain their margins in this ever-changing global economy. But how do you maximize capacity while minimizing costs?

Heat treating is one of the most labor-, energy-, safety- and capital-intensive parts of the manufacturing process. Expanding internally to meet your capacity needs and having to hire new employees in a market where labor is on short supply doesn't make much sense. Expanding externally with an MTI commercial heat treater is a highly efficient strategy.

Meeting manufacturing's needs for unique applications and varying demands creates stress on departments and headaches for managers. Having to scramble to find new equipment/labor for special/new applications, acquiring expertise to handle a new requirement, building capacity of the organization that won't be needed later, or even the stress of an extraordinary amount of overtime for the staff to meet are all difficult.

MTI offers manufacturers a "capacity expansion strategy" that lowers your stress, reduces costs per unit and increases profit margins while keeping quality at very high levels and minimizing errors.

Through expanded capacity, expertise and a focus on quality and service, MTI commercial heat treaters pursue a number of key elements to ensure they are prepared to meet your needs.

- MTI members have the highest quality standards achieving certifications including ISO 9000, Nadcap, CQI-9, AS9100 and QS9000 to name a few. There is no process or metal that is too challenging for an MTI member.
- MTI member companies are engaged in one of the top management training programs in all of manufacturing, the YES Management Training Program. Over 400 top managers have graduated from this intense and engaging training program since 2007.
- MTI member companies are a part of the MTI Online Academy, the industry's premier online technical training site. Every month, MTI graduates numerous employees from its Qualified Furnace Operator and Heat Treat Specialist Certificate programs.
- MTI members are committed to offering manufacturers expertise in metallurgy, research and development as well as line personnel.
- MTI members put a high emphasis on safety for the entire plant operations.

Don't let economic growth run your operation into the ground for lack of capacity. It's time to take a fresh new look at outsourcing. It's simple … partner with an MTI member commercial heat treater. For more information on the MTI network of commercial heat treaters, visit our outsourcing website at www.callmti.com.

Vacuum Pump Services Corp.

Repair, Reconditioning and Service

MTI SINCE 1933

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

Though it may be a new company, Vacuum Pump Services has a wealth of experience in vacuum pump repair and service.

Founded in July 2016, VPS focuses its efforts on vacuum pump repairs and rebuilds, troubleshooting and preventive maintenance, oil changes, helium mass spectrometer leak checking, and on-site consultation. The Hatfield, Pa.-based company also provides on-site training services.

The MTI associate member is owned by Mr. and Mrs. William R. Jones, who also own commercial heat treater Solar Atmospheres, vacuum furnace manufacturer Solar Manufacturing and Magnetic Specialties, a provider of transformers and power supplies.

Within the operation of Solar Atmospheres, there was a need to rebuild and repair heavy-duty Stokes-type vacuum roughing pumps and Roots-type vacuum blowers. The company wanted to have a reliable repair and service company to perform these services at a reasonable cost and to have those repairs done no more and no less than required. As a result, VPS was born, and Bob Sandora, who has over 40 years of experience in servicing vacuum furnaces, pumps and blowers, was named president.

Today, VPS services a wide range of OEM vacuum equipment for industries including heat treating, research and development, glass, medical, food processing, HVAC and pharmaceutical.

For repair and rebuilds, VPS technicians will provide teardown and a quote prior to proceeding with a solution based on vacuum requirements. Final testing of all pumps and blowers is performed with a calibrated helium mass spectrometer.

For on-site consulting, VPS technicians will visit your facility to troubleshoot and evaluate pump breakdowns, leaks, maintenance issues and other technical concerns regarding a wide variety of vacuum pumps. In emergency situations, VPS may even be able to offer a vacuum pump exchange. Services provided include:

- Installation and start-up
- Rebuilds and refurbishment
- Replacement of seals, gaskets, O-rings, springs and bearings as needed
- Performance testing
- Fault diagnostics
- Leak checking
- Preventive maintenance

Visit www.vacpumpservices.com for more information on Vacuum Pump Services.

IHEA Events in Full Swing This Spring

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

Spring has sprung, and the Industrial Heating Equipment Association calendar is filled with events for everyone. If you are involved in the industrial thermal-processing industry, join peers and training experts at one of the following events to enhance your skills, increase your knowledge and stay on top of the most current trends.

Complete details and registration information for all of IHEA's upcoming events can be found at www.ihea.org/events.

Fundamentals of Industrial Process Heating Online Course (April 15-May 26)

The online course offers the opportunity to keep current with industrial process heating in the comfort and convenience of your own workplace or home. The course is designed to give flexibility as well as interaction with an instructor and forums to communicate with other students.

This course provides an overview of the fundamentals of heat transfer, fuels and combustion, energy use, furnace design, refractories, automatic control and atmospheres as applied to industrial process heating. Students will gain a basic understanding of heat-transfer principles, fuels and combustion equipment, electric heating, and instrumentation and control for efficient operation of furnaces and ovens in process heating.

Students earn PDHs for passing the course. For a complete listing of the course topics, visit www.ihea.org/event/FundamentalsSpring19.

NFPA 86 Updates Seminar (May 14, Fabricators & Manufacturers Association, Elgin, Ill.)

Join IHEA for this new, one-day seminar, which will highlight the recent changes to NFPA 86. If you already have a good knowledge of NFPA 86, this seminar will be a great overview and in-depth summary of the recent changes to the standard and how they affect you. If you are not familiar with NFPA 86, IHEA will conduct the complete two-day Safety Standards & Codes Seminar this fall in Cleveland (details coming soon).

Noteworthy updates to NFPA 86 include the following areas: furnace heating systems; safety equipment and application; programmable logic controller (PLC) systems; safety shutoff valves; safety controls and devices; commissioning, operations, maintenance, inspection, testing and auditing.

Instructors for this course are industry experts and committee members involved in the discussions and changes to NFPA 86. They include:

- Kevin Carlisle, quality manager at Karl Dungs, has been involved in codes and standards for the past 20 years.
- Bryan Baesel, mechanical engineer at Honeywell Combustion Safety (formerly CEC), is a member of NFPA 85 and NFPA 86.
- Franklin Switzer, owner/president of S-afe Inc., serves as a committee member on NFPA 54, NFPA 85, NFPA 86 and NFPA 87.
- Aaron Zoeller, director of sales at Siemens Combustion Controls (SCC), holds seats on the NFPA 85 and NFPA 86 standard committees.

Zoeller said, "NFPA 86 has been the standard in the U.S. for industrial combustion applications since the mid-1900s. It is updated every three to four years to remain relevant with current technologies. While some guidelines have remained consistent for years, new technology in burner controls, PLCs, radiant tubes, etc. has brought important changes in the 2019 edition. Anyone working in the industry should educate themselves on the changes each time a new edition is released."

For complete details and registration information, visit www.ihea.org/event/NFPAUpdate.

EQUIPMENT NEWS

Hot Isostatic Press (HIP)

Paulo will add hot isostatic pressing to its thermal-processing services with the acquisition of a hot isostatic press (HIP) from **Quintus Technologies**. The press is equipped with Quintus' proprietary uniform rapid cooling (URC), a feature that improves material properties in additive manufacturing and investment casting. The HIP will be installed in Paulo's recently expanded Cleveland Division in Willoughby, Ohio, which provides specialized brazing and vacuum heat treatment.

The press has a work zone of 26 inches (660 mm) in diameter and 68.9 inches (1,750 mm) in height. It operates at a maximum temperature of 2552˚F (1400˚C) and maximum pressure of 30,000 psi (2,070 bar). The URC feature streamlines the steps involved in material densification by combining heat treatment and cooling in a single process, known as high-pressure heat treatment (HPHT).

www.quintustechnologies.com

Mesh-Belt Furnace

AFC-Holcroft received an order from a Midwestern facility of a U.S.-based manufacturer of safety-critical fasteners and assembly solutions for a mesh-belt furnace. The new equipment will replace an older AFC-Holcroft installation. The furnace, which will be used in the production of metal fasteners, will integrate with existing companion equipment including a loading system, pre- and post-wash systems, oil quench and temper furnace. Delivery and start-up of the new equipment are expected in the first quarter of 2019. AFC-Holcroft mesh-belt lines can be customized with a variety of options, including oil and salt quenching.

www.afc-holcroft.com

Walking-Beam Furnace

Nucor Steel Marion Inc. of Marion, Ohio, granted SMS group the final acceptance certificate for the supplied walking-beam furnace

after successful commissioning. The furnace, which went into service in the existing bar mill, is capable of delivering 120 short tons per hour of hot billets at 2255˚F (1235˚C). The NOx content of this furnace is close to 25 parts per million, making it the most energy-efficient furnace with the lowest emission values within Nucor. The furnace was designed according to specific pre-fabrication methods and features proprietary SMS ZEROFlame burners. In addition, scale loss measures less than 0.5% in weight, compared with the 0.75% guaranteed. www.sms-group.com

Furnace System

SECO/WARWICK received an order from a U.S. manufacturer of flat-rolled aluminum sheet for a sow and T-bar preheat furnace system to achieve maximum product quality, energy savings and melt safety. The furnace offers optimum airflow management and a heating system that promotes efficient heat transfer throughout the work. It includes a patented movable baffle system and fixed base airflow spacers for maximum heat transfer to varying height loads. The system is PLC-controlled with remote I/O and dual operator-interface control stations. www.secowarwick.com

Pusher Furnace

Armil CFS Inc. shipped a natural-gas-fired pusher furnace to a European manufacturer of investment castings for the medical industry. The two-row, high-production furnace will be used for the burnout and preheating of investment casting molds. It has an operating temperature range of 1650-2100˚F (900-1150˚C). Residual wax will be consumed within the furnace chamber, eliminating the need for an afterburner. A recuperative combustion system will utilize a series of medium-velocity burners and a cross-flow recuperator operating in three zones of control. The furnace also incorporates an industrial PLC and touchscreen-based HMI. www.armilcfs.com

Mesh-Belt Furnace

Can-Eng Furnaces International Ltd. commissioned a continuous mesh-belt heat-treat system for the production of high-quality automotive fasteners in the Piedmont region of Italy. The high-volume fastener system features energy-efficient combustion and waste-heat recovery systems, atmosphere-controlled mesh-belt hardening system, oil quench, post-wash system, temper furnace, soluble oil system, bi-directional conveyor discharge and Can-Eng's Level 2 SCADA system. The system was commissioned in the fourth quarter of 2018 and has exceeded the company's performance expectations. www.can-eng.com

Convection Ovens

Lucifer Furnaces supplied several convection ovens to a manufacturer of small medical parts in the southern U.S. The ovens all have a work-chamber size of 9 inches high x 9 inches wide x 18 inches long and heat to 1200˚F. Uniformity is achieved with recirculating airflow. A rear-mounted, heavy-duty fan directs air alongside wall heating elements and then through the work zone. Parts are protected from the heating elements with a 16-gauge stainless steel liner. The furnaces are insulated with 4.5 inches of multilayered firebrick and 2 inches of insulating cold-face block with

overlapped seams for reduced thermal loss. www.luciferfurnaces.com

BUSINESS NEWS

Advanced Heat Treat Completes Expansion

Advanced Heat Treat Corp. (AHT) announced the completion of the 15,000-square-foot building expansion at its corporate headquarters in Waterloo, Iowa. Three new gas nitriding units are housed in the new addition in an effort to separate the gas nitriding equipment from the ion (plasma) nitriding units. There are plans to add a fourth gas nitriding unit by the end of the year. AHT has four locations: two in Waterloo; one in Monroe, Mich.; and one in Cullman, Ala. AHT also plans to expand its other location in Waterloo, where traditional heat-treating services such as induction hardening and carburizing are offered.

Fiat Chrysler to Invest $4.5 Billion, Create 6,500 Jobs

Fiat Chrysler Automobiles (FCA) plans to invest $4.5 billion in five of its existing Michigan plants and build a new assembly plant in Detroit. The proposed projects would create nearly 6,500 new jobs. The investment will increase capacity to meet growing demand for the company's Jeep and Ram brands, including production of two new Jeep-branded white-space products as well as electrified models.

U.S. Steel Restarts Construction of EAF

U.S. Steel announced the restart of construction on a technologically advanced electric-arc furnace (EAF) steelmaking facility at its Tubular Operations in Fairfield, Ala. The project is expected to create approximately 150 full-time jobs. The investment to complete the EAF, which includes modernization of the existing rounds caster, is expected to be around $215 million. The EAF will have an annual capacity of 1.6 million tons and is expected to produce steel rounds in the second half of 2020.

Arconic Investing $100 Million, Creating Jobs in Tennessee

Arconic Inc. will invest approximately $100 million to expand its hot-mill capability and add downstream equipment capabilities to manufacture industrial and automotive aluminum products in its Tennessee Operations facility near Knoxville, Tenn. The project, which is expected to create 70 new jobs, is already under way and should be complete by the fourth quarter of 2020.

Tenaris to Open Manufacturing Facility in Texas

Tenaris will open a sucker-rods manufacturing facility in Conroe, Texas, in July. The $70 million investment is equipped with advanced technologies to optimize efficiencies and reduce production times. The facility includes heat-treatment, threading and finishing processes; nondestructive testing (NDT); robotized forging lines; and a state-of-the-art quality testing lab. The mill also has an on-site training facility and classroom.

Equipment & Business News

INDUSTRY EVENTS

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

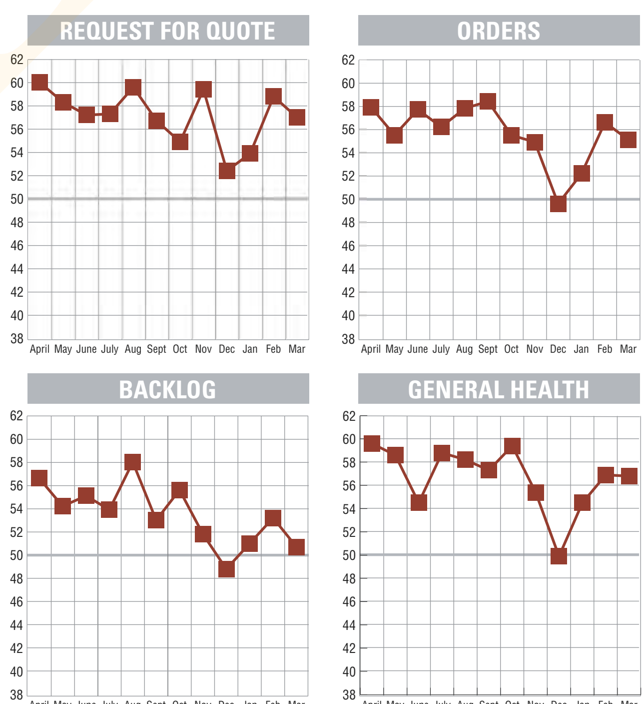
May 20-23
Rapid + TCT 2019; Detroit, Mich.; www.rapid3devent.com

June 23-26
Powdermet 2019; Phoenix, Ariz.; www.mpif.org

June 23-26
Conference on Additive Manufacturing with Powder Metallurgy; Phoenix, Ariz.; www.ampm2019.org

June 25-29
Thermprocess 2019; Düsseldorf, Germany; www.thermprocess-online.com

ECONOMIC INDICATORS



Values above 50 indicate growth or increase. Values below 50 indicate contraction or decrease.
To participate in this survey, please contact Bill Mayer at bill@industrialheating.com

Saving Operating Costs by Recycling Hydrogen

Trent Molter and Nancy Selman – Skyre, Inc.; East Hartford, Conn.

An estimated $64 billion worth of hydrogen is used worldwide in the production of metals, electronics, thin-film solar panels, edible oil processing and a variety of other applications.

Fig. 1. H2RENEW

Much of this hydrogen is used to create a hydrogen-rich atmosphere in operations to treat materials and products, such as bright annealing of stainless steel and float glass production. Once this hydrogen is used in the industrial process, it is usually then vented or flared.

Skyre has developed technology that allows manufacturers to save money by recovering hydrogen used as an atmosphere. The H2RENEW™ system (Fig. 1) uses an electrochemical process that is derived from fuel-cell technology. Fuel cells have traditionally been used by NASA and (more recently) Toyota, Hyundai, Honda and Mercedes as a way to convert the chemical energy contained in hydrogen into electrical energy.

The system uses a derivative of fuel cells to separate hydrogen from a gas stream containing other constituents. A version of this system has been under development with NASA funding for large-scale separation of hydrogen and helium gas mixtures used in space rocket-engine test operations.

H2RENEW (the system) enables heat treaters and metals manufacturers to efficiently recycle hydrogen, thereby reducing operating costs, site emissions and the carbon footprint associated with traditional hydrogen production and delivery (Fig. 2). The system can typically recover up to 75-85% of the hydrogen from industrial waste streams in a cost-effective and reliable manner. Since the cost savings of industrial gas recycling depends on the value of the recovered gas in relation to the energy consumption of the system, it is designed to minimize electrical power requirements, resulting in maximum operating savings for the hydrogen user.

Saving Typically Vented or Flared Hydrogen

Given the increasing cost and tight supply of delivered hydrogen and the competitive economic climate, the economics of hydrogen recycling can be very compelling.

Hydrogen cost is a substantial portion of operating expenses in heat-treating processes, and it is often cited as the second highest non-labor operating cost next to energy for processes that use high-concentration (75-100%) hydrogen atmospheres. Depending on how the hydrogen is produced and distributed (e.g., liquid or gaseous) and the level of purity required, the cost of delivered hydrogen is around $1.15 or greater per 100 cubic feet (CCF).

Hydrogen consumption rates vary from one industrial user to the next and are process-dependent, ranging from hundreds of CCF per day up to 100,000 CCF per day. Skyre's H2RENEW has a rated output of 423 CCF per day of recycled hydrogen gas, which is typical for certain heat-treating processes such as stainless steel bright-annealing furnaces.

Assuming optimal system operating conditions of 24/7 operations and an 80% hydrogen-recovery rate from the furnace, hydrogen recycling savings can provide a system payback in less than two years, depending on factors such as the cost of delivered hydrogen and electricity to the site. Multiple systems can be deployed to address larger hydrogen quantities.

Electrochemical Hydrogen Recovery, Recycle

The electrochemical hydrogen recycling system developed by Skyre is significantly different than the more-conventional approach that utilizes mechanical compressors, a process known as pressure-swing adsorption (PSA). PSA requires expensive compression of the entire gas stream, including non-hydrogen gases such as nitrogen, in order to process and purify the hydrogen.

In the electrochemical hydrogen recovery system, a hydrogen waste stream is fed to a "stack" of electrochemical cells. An electrical potential is applied to the cell stack, causing the splitting of hydrogen in the waste-gas stream into its constituent parts – hydrogen atoms (the smallest element on the periodic chart).

The hydrogen atoms cross through a special membrane, leaving larger gas molecules and other impurities behind. The hydrogen atoms then re-combine on the hydrogen product side of the membrane into pure hydrogen, which is returned to the industrial process (Fig. 3). H2RENEW recycles pure hydrogen back to the furnace or other process. The waste gas that is filtered out is then vented.

This electrochemical approach and proprietary control design allow the hydrogen recycling system to extract hydrogen from industrial-process waste streams without impacting the furnace's atmosphere or internal pressure. As a result, H2RENEW can be used with many types of furnaces that operate at atmospheric or near-atmospheric pressures.

The system is integrated into the existing furnace exhaust and hydrogen supply systems, thereby eliminating the potential of upsetting the heat-treating process. The system is designed for remote operation, monitoring and reporting of certain specific maintenance activities, minimizing required interaction by the end user in the operation of the device.

Skyre technology also inherently compresses the hydrogen without the need of a mechanical compressor. Pressures as high as hundreds of psi can be generated with little increase in the power required. Skyre is developing a version of the system that can compress to thousands of psi.

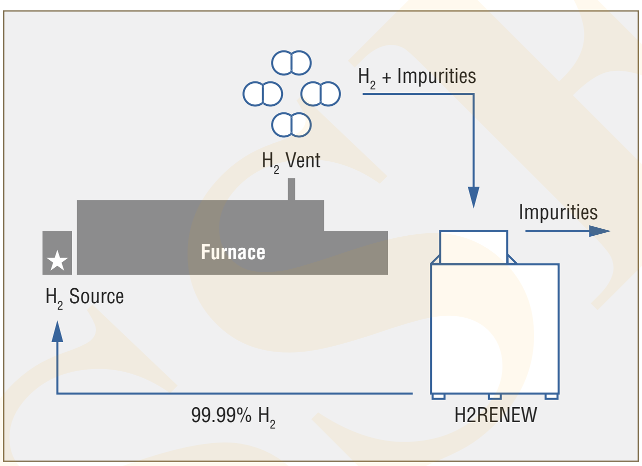


Fig. 2. H2RENEW hydrogen recycling for heat treating

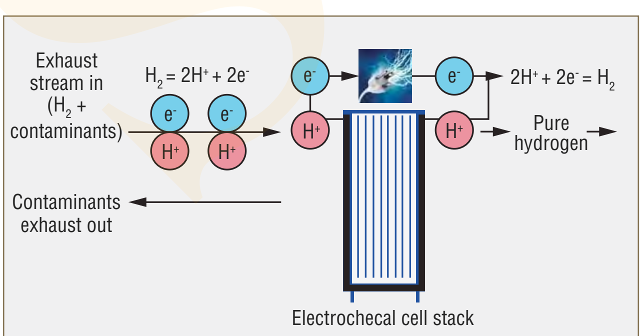


Fig. 3. Electrochemical cell operation

Filtering Impurities

The system can handle a number of gaseous impurities commonly found in heat-treating furnace gas exhaust. Gases such as carbon dioxide, ammonia, nitrogen, sulfides, carbon monoxide and water vapor are typical in waste streams of annealing and brazing operations. Most of these gases are generated from residual protective surface coatings (oils) or reactions with secondary gases such as nitrogen.

The impurities are handled by a number of proprietary methods within the system. The final gas cleanup and drying stages are

Table 1. H2RENEW specifications

Performance		
Maximum H_2 recycling output	SCFH 70˚F, 1 atm Kg/day Nm³/hr, 0˚C, 1 bar SLM, 70˚F, 1 atm	1760 100 46 830
Product H_2 purity	%	99.99
Product water content	ppm	1
Product dew point	˚C (˚F)	-76 (-105)
Input gas pressure	psig	0-1
Product hydrogen pressure	psig	0-100
Peak H_2 yield	%	95
Typical H_2 yield	%	75-85
System availability	%	>90
Power Supply		
AC supply voltage	VAC (3-phase)	480
Maximum current draw	A	100
Nominal current draw @ maximum load	A	90
Environment		
Ambient temperature	˚C	Indoor rated
Relative humidity	%	5 to 100 Non-condensing
Altitude	ft	0 to 6,500
Heat rejection	kW	60
Physical		
Dimensions	(in L x in W x in H)	74 x 48 x 94
Weight	pounds	3600
System noise	dBA @ 1 meter	84
Interconnect		
Electrical	Type (3-phase, GND)	4-conductor 2 AWG
H_2 out connection	Compression	1/2"
Furnace waste inlet connection	MNPT	2"
H2RENEW waste outlet connection	NPT	1"
N_2 supply	NPT	3/8"
Tap water connection	NPT	1/4"
Water drain connection	NPT	1/4"
Control		
Remote monitoring data transmission		Ethernet
Local communications		Ethernet

dependent on the customer's process requirements. H2RENEW is capable of delivering hydrogen at a purity of up to 99.99% or higher and in many cases with dew points well below -76˚C (-105˚F), often exceeding the delivered hydrogen supply quality.

The typical operating characteristics of the system are presented in Table 1.

Reduce Capital and Maintenance Costs

H2RENEW systems will be commercially available for purchase or under a leasing model in 2019. Under the leasing option, a monthly payment allows customers to pay for recycled hydrogen and includes system maintenance costs. The customer pays for utilities (mainly electricity to operate the system) and site preparation for installation. Due to low power consumption, electricity costs are around $0.25/ CCF of hydrogen processed, or less than a quarter of the cost of delivered hydrogen gas from an industrial gas company. Under the lease model, savings begin immediately after the installation of the H2RENEW system.

For more information: Contact Trent Molter, Ph.D., President & CEO, (tmolter@skyre-inc.com) or Nancy Selman, VP of Business Development (nselman@skyre-inc.com); Skyre, Inc., 111 Roberts Street, Suite J, East Hartford, CT 06108; tel: 860-652-9690; e-mail: info@skyre-inc.com, web: www.skyre-inc.com.

A Silver Lining for Regenerative Thermal Oxidizers?

Alex Powell and Tyler Ferguson –
Morgan Advanced Materials USA; Augusta, Ga.

Regenerative thermal oxidizers (RTOs) are often treated as a mandatory piece of the operation puzzle. With the right lining, however, they can add crucial advantages to the manufacturing process.

Air pollution is a hot topic globally and shows no signs of abating. According to EURACTIV, some 40 million people in the 115 largest cities of the EU are exposed to pollution exceeding World Health Organization (WHO) air quality guideline values (for at least one pollutant). The result is approximately 100,000 premature adult deaths each year.

Of course, one of the biggest contributors to air pollutants are gas streams from industrial processes containing volatile organic compounds (VOCs) and hazardous air pollutants (HAPs). Gas streams are produced by processes requiring ventilation and are commonly seen in paint booths, printing and paper mills.

To this end, RTOs have been a longstanding requirement of industrial manufacturing. Designed to treat exhaust air, RTOs use a bed of ceramic material to absorb heat from the exhaust gas. The captured heat feeds back to the incoming process-gas stream and preheats the pollutants in the exhaust air at temperatures ranging from 815˚C to 980˚C (1500-1800˚F). The preheating process makes the combustion and destruction more efficient.

While performing an important (and, in fact, mandatory) function of destroying air toxins and HAPs, RTOs are seldom seen as a priority of manufacturing operations. They are viewed as simply a means of complying with emission standards because they do not inherently add value to manufacturing production. Not running the RTO can be in breach of regulations and can result in the risk of production being shut down entirely because untreated emissions could result in severe health complications.

This is a short-sighted attitude. The correct commission and use of RTO units play an important part in minimizing operating costs and lowering the fuel burden. A reliable RTO has a long life span and requires exceptionally low maintenance, which in turn provides tangible commercial benefits.

The crucial factor in achieving this is in the insulation lining on the walls inside of the oxidization tank of the RTO.

Pyro-Bloc® High-Temperature Insulation Modules vs. Blanket-Based Modules

Ceramic-fiber modules are the most common insulation material used in RTO units. These fibers prevent heat transfer, resisting the passage of energy. In terms of gaining better fuel economy, less heat loss and lowering the fuel burden, the greater the density of the ceramic material module, the better.

From years of research, our Thermal Ceramics business has developed Superwool® Pyro-Bloc® high-temperature insulation modules. Pyro-Bloc modules are made from a unique monolithic ceramic fiber, Pyro-Log™, and offer the greatest density available on the market.

Where Value is Added

Adding value to the RTO can be done via two approaches. The first is to enhance performance and ensure that heat loss is kept to a minimum (Fig. 1).

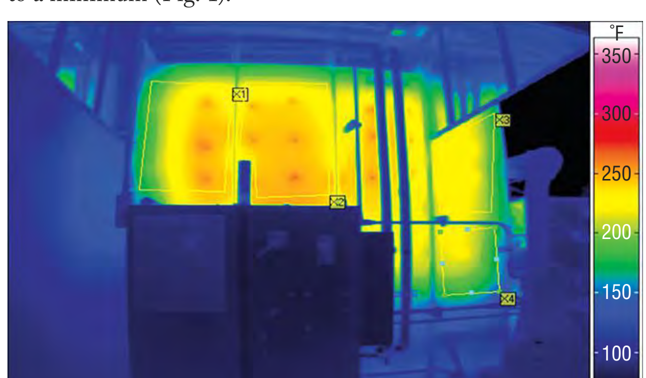


Fig. 1. Thermography prior to installing Pyro-Bloc

Fig. 2. Pyro-Bloc product

This is where Pyro-Bloc modules excel because each module has less through-joints compared to blanket-based modules (Fig. 2). Through-joints are gaps in the modules that allow heat from the process environment to escape. Fewer joints means fewer opportunities for heat loss and less fuel expense.

In turn, this means Pyro-Bloc module linings offer much more stable operating conditions. RTOs must maintain stable combustion temperatures within their unit. Fewer escape routes for heat mean users can gain better control of the combustion temperature, and the unit owner stays in compliance with emission standards.

Another unique characteristic of Pyro-Bloc modules is the ability to construct a "monolithic" cornerpiece.

Corners and similar transitions are among the highest-risk areas of RTO units. The ceramic lining can suffer from gravity and sagging. RTOs are also used in high gas-velocity environments, and this velocity can cause erosion to the lining.

Pyro-Bloc modules guard against this because they are the only module that will make the transition from vertical to horizontal plane in one piece, which reduces gaps, fiber degradation and ultimately heat loss.

A second way Pyro-Bloc modules enhance performance is in the way that they can be compressed from all directions. This gives a more uniform insulation lining and again fewer gaps and openings for heat to escape.

Where Costs Can be Reduced

Additional value from RTOs can be realized through cost reduction. Costs can be decreased by installation and maintenance, as well as by extending the life span of the RTO lining.

Pyro-Bloc modules deliver a better life span through their monolithic edge-grain attribute in comparison to folded blanket systems. This is especially the case when RTO units age when they are more susceptible to erosion by high-velocity gases.

The untreated rating of Pyro-Bloc increases as the density increases. On the 128 kg/m^3 (8 pcf) Pyro-Bloc density, the untreated rating is 100 feet/sec. Once treated, the rating can improve by up to 35%, increasing the velocity resistance up to 175 feet/sec. Pyro-Bloc fiber also has an agent that automatically

Fig. 3. Pyro-Bloc RTO lining

hardens the surface upon initial heat-up, minimizing erosion even further. With less erosion, RTO end users benefit from having longer time periods between unit maintenance and the associated product downtime.

For applications below 980˚C (1800˚F), which is the majority of the RTO market, Pyro-Bloc modules also vastly reduce labor installation costs. This is due to the fact that horizontal "batten strips" are not required to install the modules in the side walling since the modules are compressible in all directions. Instead, Pyro-Bloc can be installed in a parquet-style module orientation, which is ideal for the roof and arch sections of the unit (Fig. 3).

Easily Customizable

It is necessary to modify and cut the insulation lining's modules to properly insulate the entire unit because all RTOs are different in size and shape. It is inevitable that fabricators and installation teams will encounter odd-geometry sections inside the RTO.

Pyro-Bloc modules, due to their monolithic nature, provide the greatest ease of modification to meet this requirement while still maintaining their fiber structure. Compared to Pyro-Bloc modules, high-density blanket-based modules come with more installation challenges and require more time overall.

As the modules in high-density blankets are greatly compressed, they can become unwieldy and harder to handle. Pyro-Bloc, however, mitigates this problem with a specifically designed lubricant in the module's fibers. This lubricant greatly eases compression, therefore reducing the amount of installation time needed and overall labor costs.

Superwool Plus vs. Refractory Ceramic Fibers

For many years, refractory ceramic fibers (RCFs) have been the lining of choice in the industry due to their ability to withstand extremely high temperatures. Some RCFs have even shown they can withstand temperatures up to 1650˚C (4000˚F).

RCF has been reviewed for its environmental, health and safety (EHS) concerns in recent years. Results from a number of studies showed that high doses of respirable fibers could cause lung cancer and fibrosis. This has led to RCF being classified as a category 1b carcinogen in Europe and being placed on the "candidate list" as a substance of very high concern (SVHC) under registration, evaluation, authorization and restriction of chemicals (REACH).

Finding alternative solutions has been a high priority for manufacturers of high-temperature insulation fiber around the world. Under the EU Carcinogens Directive, substitutes to RCF should be used where technically possible. This is where the Superwool® low biopersistent insulating fiber has been leading the charge.

As well as being exonerated from any carcinogen classification under Nota Q, Superwool also offers 15-20% better thermal efficiency versus RCF linings. This is because Superwool fiber material has less shot content by weight percentage.

This means more fiber mass used in the insulation module contributes to preventing heat loss. Ultimately, Superwool offers less heat loss per equivalent lining thickness/density and less fuel expense for the end user. IH

For more information: Author Alex Powell is an applications engineer and Tyler Ferguson is product manager at the Thermal Ceramics business of Morgan Advanced Materials. Morgan Advanced Materials has a global presence with over 10,000 employees across 50 countries serving specialist markets in the energy, transport, healthcare, electronics, petrochemical and industrial sectors. To find out more about Superwool® Plus, please visit http://www.morganthermalceramics.com/RTOs.

A 10-Step Process for Energy Analysis

Michael Stowe – Advanced Energy; Raleigh, N.C.

This article will help us understand the energy used to transform raw materials into finished products with a goal of enhancing energy efficiency.

The industrial sector accounts for about 34% of total U.S. energy consumption.[1] This energy is consumed as electricity, which is purchased or self-generated, and as fossil fuels (e.g., natural gas, propane, fuel oils and coal). Understanding these energy sources and their associated uses, equipment, efficiencies, costs, availabilities and waste streams is critical to developing a sustainable energy-efficiency program.

Every manufacturing (or heat treat) plant has raw materials that come into the receiving dock and finished products that are sent out from the shipping dock. Between the receiving and shipping docks, transformation occurs. Transformation adds value to the materials in a step-by-step process, and energy is required. Evaluating the process transformation steps and energy inputs provides clues about where to look for energy savings.

Energy Efficiency and Intensity

Energy Efficiency

The total energy into a system is E_{in}, which is the amount that appears on your utility bill. The total energy out of the system is E_{out}, which represents the useful energy that adds value to the product during the process. The difference between E_{in} and E_{out} is the loss.

Loss is wasted energy that is not useful to the process and degrades efficiency. For sustainable energy efficiency, energy losses must be identified, documented, tracked, corrected and prevented from recurring. If the loss was zero, the system would be 100% efficient, which does not occur in the real world.

A simple way to envision energy efficiency is to think about water flowing through a pipe – the water represents the energy, and the pipe is the process. E_{in} would be the water into the system in gallons per minute (gpm), and a loss could be a leak in the pipe that reduces the amount of water available to add value to the product (Fig. 1).

Using the water-pipe example, we can calculate energy efficiency: E_{in} is 100 gpm, and the loss due to leaks is 10 gpm. Thus, E_{out} is 90 gpm, and the energy efficiency of the system is 90% (E_{out}/E_{in}).

While water leaking from a pipe is a useful visualization, a process heated by natural gas is more realistic. In this example, E_{in} is 1,000,000 BTU/hour of natural gas, and the fuel combustion loss is 100,000 BTU/hour, stack loss is 250,000 BTU/hour, stored heat loss is 75,000 BTU/hour, furnace wall loss is 50,000 BTU/hour, opening loss is 25,000 BTU/hour and conveyor loss is 20,000 BTU/hour – for a total loss of 520,000 BTU/hour. E_{out} is the difference between E_{in} and the total loss, which is 480,000 BTU/hour, making the energy efficiency of the system 48%. Over half of the original natural gas energy input is lost and not providing useful value-added work in the process.

Energy Intensity

The energy intensity of a manufacturing process is the amount of energy that is required to produce one logical unit of product (e.g., kWh/ton metal melted at a foundry, MMBTU/bbl of oil refined at a refinery, MMBTU/pound of polymer produced at a chemical plant). Energy intensity provides an order-of-magnitude estimate of the significance of energy in the production process, and it varies widely from industry to industry.

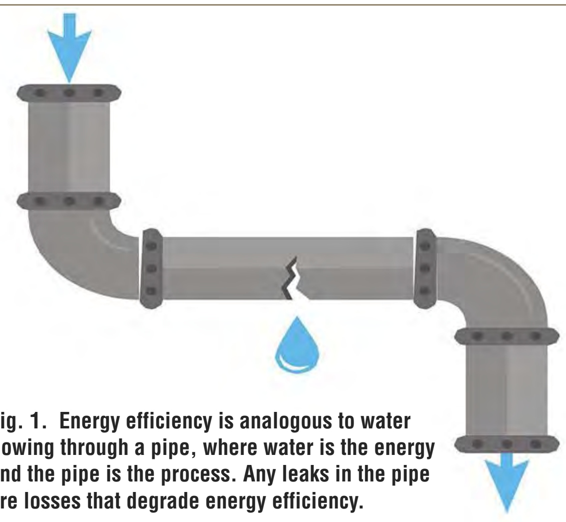


Fig. 1. Energy efficiency is analogous to water flowing through a pipe, where water is the energy and the pipe is the process. Any leaks in the pipe are losses that degrade energy efficiency.

The 10 Steps for Process Energy Analysis

Manufacturing processes and the transformation steps that involve heating, tempering, annealing, drying, curing and others are ripe with potential for energy savings. Understanding these processes and their associated equipment, technologies and support systems is key to finding energy-efficient solutions.

This article discusses energy efficiency, energy intensity and transformation, and it presents a 10-step method for conducting an industrial process energy analysis. The technique focuses on a process block diagram that shows energy inputs, energy wastes, energy recovery and possible energy improvements. Understanding the type and magnitude of the energy inputs helps to prioritize projects for energy improvements and can uncover new technology application opportunities.

1. Identify the raw materials
2. Identify the final products
3. Tour the plant
4. Develop the process block diagram
5. Identify energy inputs
6. Identify energy wastes
7. Identify energy-recovery possibilities
8. Identify energy-efficiency opportunities
9. Identify new technology opportunities
10. Implement solutions

Transformation

Each step of the transformation process should add value with minimal waste. Every step requires some type and amount of energy to carry out the transformation. Certain steps require a large amount of energy, while others require very little. Outlining each step and the required energy inputs is useful for planning and prioritizing energy projects.

To understand transformation, consider the process that produces a vase from a lump of clay. Figure 2 depicts a step in the process with energy inputs from manual human labor and possibly an electric motor to turn the wheel. This step adds value by transforming the clay into a useful shape. Table 1 presents the full details of this transformation. The steps that require a kiln are the obvious big energy users and would be logical candidates to evaluate for energy savings.

The same approach of evaluating each transformation step can be applied to complex manufacturing systems. A process block diagram is useful for outlining the transformation steps in a process. Consider the process to manufacture formaldehyde (Fig. 3), which will be referred to throughout the remainder of the article.

The 10 Steps

Step 1. Identify the Raw Materials

Some industrial processes have one main raw material, while others have dozens or even hundreds. Raw materials can come into the process at many places along the transformation journey. To determine the type and amount of energy required in the system, first consider these aspects of the raw materials:

- Type of material (e.g., metal, chemical, mineral, textile, vegetable, finished goods)
- Physical state (e.g., solid, liquid, gas, subassembly)
- Delivery method (e.g., tanker ship, tanker truck, common carrier, railcar)
- Delivery storage (e.g., dry bulk, tank farm, warehouse, sacks, pallets, cardboard boxes)

Defining the raw materials and their details is an initial step in creating a process block diagram. We will follow these materials on their journey to their final destination while evaluating the energy use at each point along the way.

Step 2. Identify the Final Products

The final product is the destination of the transformation journey. Manufacturing plants are in the business of making money, so raw materials are brought in, transformed into something useful and then sold for a profit. The plant adds value, hopefully very efficiently, to the raw materials and produces a final product of a designated design and quality.

Step 3. Tour the Plant

There are many possible ways to get from Point A (raw materials) to Point B (final product). Touring the manufacturing site with process operators and maintenance personnel as guides is essential to defining

Fig. 2. Modeling produces a useful shape from a raw lump of clay but requires energy inputs from human labor and an electric motor.

Table 1. The process steps to transform a lump of clay into a finished vase

Process Step	Energy Input	Value Added
Storing the clay	Storage warehouse, utilities, e.g. lights, heating/cooling, ventilation	None
Modeling the clay vase	Human labor, electric motor	Create a useful shape
Firing the clay vase in a kiln	Electric resistance heat	Strength, durability
Painting a glaze on the vase	Human labor	Aesthetics
Refiring the glazed vase in a kiln	Electric resistance heat	Aesthetics, protective coating
Storing the finished clay vase	Storage, warehouse, utilities, e.g. lights, heating/ cooling, ventilation	None

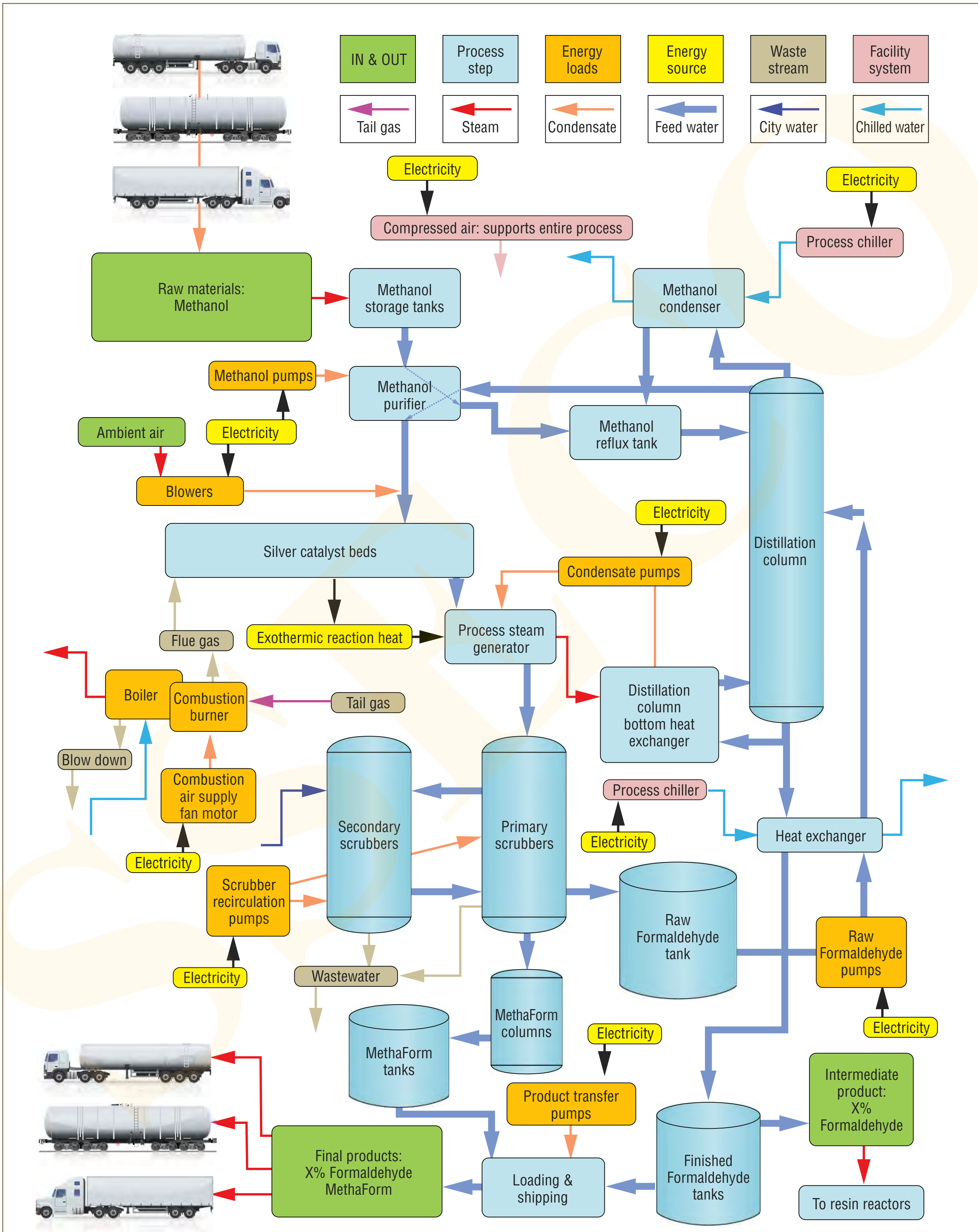


Fig. 3. Example process block diagram

the transformation steps and developing the process block diagram. The walk-through should ideally be conducted chronologically, from raw materials to finished products.

When you tour the plant, bring a blank process block-diagram template that indicates the raw-material starting point and final product end point and has empty boxes in between to take notes. The tour may last anywhere from a couple of hours to a couple of days, depending on the size and complexity of the plant. Ask your tour guides questions and get their contact information for follow-up requests. Record or photograph nameplate data for large pieces of equipment that you know consume a lot of energy.

Step 4. Develop the Process Block Diagram
You have done your homework and completed a detailed tour of the manufacturing site. Now you are ready to flesh out the process block diagram. Use your notes, conversations, utility data and possibly some online research to document the transformation steps in the process. The product of your work should look something like Figure 3, which shows the basic steps necessary to transform methanol and air into formaldehyde. Next, evaluate each block to identify the energy components, including energy inputs, energy wastes, energy-recovery possibilities, energy-efficiency opportunities and new technology opportunities (steps 5-9).

Step 5. Identify Energy Inputs
Each step of the process block diagram must be reviewed to identify the primary energy inputs required to perform the transformation. Energy inputs may be direct energy (e.g., electricity, natural gas, propane and fuel oil) or derived energy (e.g., compressed air, steam and chilled water). Repeating this analysis for every step helps to produce an overall qualitative energy-usage model.

Completing an energy-input analysis for each block in the diagram creates an overall picture of the process-energy consumption. If available, information to help quantify the energy input is valuable, including motor horsepower, actual metered cubic feet of natural gas, electric process sub-metering, etc.

Step 6. Identify Energy Wastes
Energy is wasted to some degree in every step of the manufacturing process. Major wastes should be identified when you are analyzing the process block diagram. Identifying process waste streams is the first step to minimizing them, recovering valuable energy from them and reducing their environmental impact.

Step 7. Identify Energy-Recovery Possibilities

The energy waste streams should be examined for their energy-recovery potential. Observations of the waste streams in Figure 3 might include:

- The waste tail gas from the scrubbers is already being used to generate site steam, which is good.
- In the tail-gas boiler, hot stack flue gas could be used to preheat tail-gas boiler combustion air and tail-gas boiler feedwater.
- In the tail-gas boiler, hot blowdown could be used to preheat tail-gas boiler makeup water.
- There may be an economical way to extract valuable methanol or formaldehyde from the scrubber wastewater.

Step 8. Identify Energy-Efficiency Opportunities

Each block in the process block diagram should be evaluated for energy-efficiency opportunities. Depending on the energy input for the process operation, a variety of options may be available to reduce energy consumption. The motors, compressed air, chilled-water supply and boiler/steam supply in Figure 3 have the potential for energy-efficiency improvements.

Step 9. Identify New Technology Opportunities

Implementing new or existing process technologies can provide energy savings in addition to those identified in step 8. A goal is to reduce energy intensity, and a different technology may lower the energy required to transform one logical unit of product. Look for opportunities to improve process equipment with new technology.

In Figure 3, for example, the wastewater from the scrubbers could be handled differently. In the current process, the wastewater is drained away to an on-site wastewater-treatment plant. Membrane filters or reverse-osmosis systems could clean the wastewater and extract valuable methanol or formaldehyde from the stream. The energy and financials would need to be evaluated to see if the idea is feasible, but this type of new-technology investigation can frequently provide energy-efficiency and energy-intensity solutions.

Step 10. Implement Solutions

After you perform the process energy analysis and develop the process block diagram, the next and most important step is to implement some of the energy-saving solutions you have identified. Savings will not be realized until the results are actually applied.

Your analysis will produce a detailed set of opportunities for energy improvements. Compile the results in a table or spreadsheet so they can be evaluated, prioritized, budgeted and tracked for implementation. Then repeat the approach periodically for continual improvement.

Closing Thoughts

Pursuing energy improvements often produces benefits in other areas as well. These non-energy benefits may include greater plant productivity, higher product quality, fewer process bottlenecks, improved worker safety, more available floor space and lower emissions and waste-stream volumes.

When exploring new technologies, a combination may produce the best energy-saving results. Depending on the process, there may be numerous technology opportunities available. Any idea must be subjected to rigorous energy and financial analyses to prove its feasibility prior to implementation.

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The Ups and Downs of the Worldwide Graphite Electrode Market

Benjamin Sarkoezy – GES Europe GmbH; Gelnhausen, GERMANY

It is widely known that graphite is used in the automobile and steel industries. Besides the classical markets, there are new and ever-growing markets, such as lithium-ion batteries, being driven by the megatrends of digitalization and the Internet of Things. Of global graphite production, 70% is being accumulated by China.[3]

For meeting its own population's huge demand, China is already trying to keep the graphite inside of its own borders by applying export duties. Not least, these measures caused the increase of graphite prices, which oscillated $500-600 around the turn of the millenium. Reaching their peak in 2012 at roughly $3,000 per metric ton (mt), the prices quickly plummeted under the level of $2,000.

After the market cool-down, however, massive turbulences erupted in spring 2017 (Fig. 1). Panic purchases by steelworks managers, unreliability of many partners and general upheaval were the consequences. The result was an unprecedented high in graphite electrode prices rising from $2,000/mt to over $10,000/mt by February 2018.

But what caused this turbulence? We found a total of four main factors.

1. The decrease of available raw materials for graphite
2. An increase in demand for steel
3. The Chinese government introduced bold restrictions and shut down several electrode plants.
4. Partners involved acted unpredictably, and contracts were broken by some producers and traders.

As a result of all these factors, chaotic market situations emerged, which complicated the situation further. The common denominator? The biggest graphite producer – China!

The Well-Known Game of Supply and Demand

After the previous year's weak markets, the demand for graphite electrodes skyrocketed in 2017 due to steel demand. Unfortunately, the steel industry, which was driving the recovering global economy, faced empty warehouses because producers quickly sold most of their stock at relatively low price levels after they began to rebound.

Governance and Contracting Parties

Just as in the West, China is increasingly interested in environmental protection. The former workbench of the world wants to get rid of its dusty image and face a clean future. In order to solve this tremendous task, the government tightened environmental regulations to a strangling degree. This caused many graphite electrode producers to halt their production until inspections by the government, shrinking the total output in spring 2017 to almost zero.

Facing this supply bottleneck, end users paid double or triple the regular prices for graphite electrodes, causing further price increases. The Chinese suppliers noticed that willingness, disregarded contracts and sold in favor of the highest bid. Consequences were not to be feared, since the contracting parties were too far abroad. On the other hand, Western contractors also disregarded contracts in the hope for better conditions, causing further insecurity.

Why do graphite electrode prices still remain high?

Why have prices not come back to a level of $2,000 as in 2016 and before? Will they ever drop to this level again? We do not think so. And we have found mainly three reasons to support

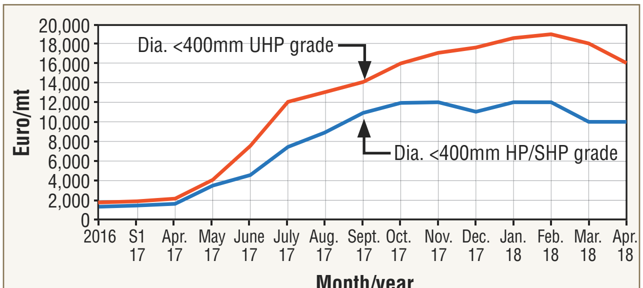

Fig. 1. Price trend for graphite electrodes in the European market

our claim. What follows is our attempt to explain those reasons mostly from an inside-China perspective because China is both the biggest producer of graphite electrodes as well as a fast-growing user. The relevant time period is April 2018-March 2019.

Reason 1: Global Market Demand Remains High

Due to new environmental regulations introduced in China, most of the heavily polluting basic oxygen furnaces (BOF) have been forced to shut down. Most of the induction furnaces were replaced by electric-arc furnaces (EAF), which consume graphite electrodes to melt steel scrap.[4] In China, 353,600 mt of graphite electrodes have been consumed, which marks a 3.06% increase compared to 2016.[2]

The demand for Chinese graphite electrodes worldwide increased even more sharply than the domestic consumption. The steel industry is increasingly relying on EAF technology worldwide and demands for made-in-China electrodes.[4] In 2017, the total output of Chinese electrodes was 590,900 mt, from which 237,300 mt were exported to overseas markets, an increase of 47.39% compared to 2016.[2]

Reason 2: Limited Stock Inventory

Compared to 2016 and before, stock inventory levels are still low, with batch productions mainly happening after orders are placed – make-to-order (MTO) instead of make-to-stock (MTS). Some sizes still need to be ordered many months in advance. The manufacturing time of most electrode grades takes at least 65 days, and the highest grade (UHP electrode grade) takes 90 days to produce.

Most of the manufacturers stopped production at the end of 2016 due to the depression of the electrode market. When the demand suddenly increased in spring 2017, manufacturers without strong capital backing and production resources had difficulties restarting their production. Therefore, stock inventories could not level off, and they remained insufficient to match market demand.

Reason 3: Overcapacities of Electrode Producers

While market supply and demand are reaching a balance, producers' capacities have yet to be fully realized due to the still-high raw-material prices and scarcity of production resources.

The current capacity utilization of Chinese producers is approximately 60%. In particular, smaller manufacturers with lower market capitalization are struggling. In 2017, raw-material costs and production costs made up 83.65% of total costs for graphite giant Fangda. In the prior business year, the raw-material cost position had increased 15%.[1]

Additional capacity limitations are set by the manufacturers' make-or-buy decisions, and most manufacturers choose to outsource graphitization and machining. Only a few

manufacturers actually invest to integrate both stages. Graphitization of electrodes constitutes a long process cycle requiring vast experience. Machining is a key process that influences the overall quality of the electrodes and also requires high technical standards.

Several factories specializing solely on graphitization/machining processes are in high demand. As a reaction to sudden market price increases of electrodes, these outsourcing factories may also raise their processing fees. They often do this disproportionately since the run for electrode graphitization is so great they can practically choose their customers. Those are often the electrode producers with the highest willingness to pay.

Will new electrode manufacturers bring relief?

The year 2019 will bring about major changes in the global market for graphite electrodes. New entries are happening right now. The newcomers see their opportunities in a still-lucrative market with high average returns on their investments. New investments in 2017 will free up the capacities for an additional 524,000 mt of electrodes that might start operations by the middle of 2019.[2]

According to a recent OECD report (2018) and a GF Securities analysis (2018), steel production capacity increases taking the EAF route are projected as follows:

- The increase of world output capacity without China amounted to 37 mmt in 2017 and is projected to be 88 mmt in 2018/2019.
- China planned to increase its capacity for steel by 31 mmt in 2017.
- In 2020, the whole world demand for graphite electrodes will be 1.3 mmt.

If we assume an average electrode consumption rate of between 1.0 kg and 2.0 kg for each ton of steel output, then the additional electrode consumption needed for 2018 and 2019 will be somewhere from 119,000 mt to 238,000 mt.

Let us compare these overestimated demand figures

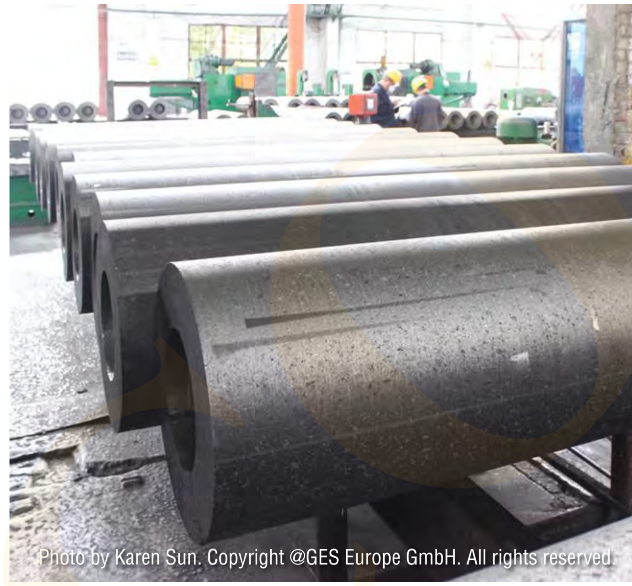

Photo by Karen Sun. Copyright @GES Europe GmbH. All rights reserved.

with the projected capacity increases of Chinese electrode manufacturers alone. This was predicted to amount to 524,000 mt, and we can see that supply will be exceeding demand by far. We write “overestimated” because we compare the increase in steel production capacity but not the actual increase in steel production.

Summary

Electrode prices between April 2018 and late 2018 were still high because of constantly rising global demand, scarce stocks and overcapacities at electrode manufacturers.

On the other hand, GES forecasts a dramatic increase in the number of manufacturers for 2019. As a result, the supply of graphite electrodes will far exceed demand. Whether or not prices will fall back to a level of $2,000/mt will be determined. After all, the factories have to be put into operation and also deliver high-enough-quality products. GES Group will therefore be very intensively involved in the analysis of new producers and their products as well as the impacts on both quality and prices.

Supplementary note

After submission of this article in late 2018, predictions by GES have proven to be correct. Since the beginning of December 2018, prices for graphite electrodes have dropped significantly by about $3,000-4,000/mt and have stabilized at a level of $4,000-6,000/mt, depending on the grade and size.

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Sources available online

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www.du-co.com

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Ircon/Fluke Process Instruments

Phoenix Induction Corp.
Pillar Induction
Premier Furnace Specialists/ BeaverMatic
Radyne Corp.
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Convectronics Inc.
Du-Co Ceramics Co.
Durex Industries
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Induction Professionals
Inductoheat Inc., an Inductotherm Group Co.
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Pillar Induction
Premier Furnace Specialists/ BeaverMatic
Radyne Corp.
SMS Elotherm North America LLC
Taylor-Winfield Technologies Inc.
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ANCILLARY EQUIPMENT

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Alhern-Martin Industrial Furnace Co.
Alpha 1 Induction Service Center
Blasdel Enterprises Inc.
Casso-Solar Technologies LLC
CMI Industry Americas Inc.
Delta Cooling Towers

Dry Coolers Inc. KEEPIN' IT COOL SINCE 1985

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Giltron Inc.
Heat Treat Equipment Co.
Hi-Tech Furnace Systems Inc.
HydroThrift Corp.
Induction Professionals
➡ **Ipsen, Ipsen Customer Service (ICS)**
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Lanly Co.
Madison Co.
Mangold Engineering Inc.
Metro Services Inc.
Nitrex Metal Inc.
Nitrex Metal Sp. z o.o.
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Premier Furnace Specialists/ BeaverMatic
Radyne Corp.
RISE IVF AB
Signature Vacuum Systems Inc.
Sticker Corp.
Taylor-Winfield Technologies Inc.
Tenova Inc.
Vacuum Processes Inc.

Software

CMI Industry Americas Inc.
Conrad Kacsik Instrument Systems Inc.
DANTE Solutions Inc.
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Marathon Monitors and Control Systems Corporation (Beijing) Ltd.
Mitutoyo America Corp.
Nabertherm Inc.
Premier Furnace Specialists/ BeaverMatic
RISE IVF AB
SECO/WARWICK Corp.
Super Systems Inc.
United Process Controls GmbH
United Process Controls Inc.
United Process Controls SARL
United Process Controls Sp. z o.o.

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CAN-ENG Furnaces International Ltd.
CMI Industry Americas Inc.
Fives North American Combustion Inc.
Furnace Rebuilders Inc.
➡ **G-M Enterprises**
Honeywell Combustion Safety
➡ **Ipsen, Ipsen Customer Service (ICS)**
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Keith Co.
Lanly Co.
Magnetic Specialties Inc.
Metro Services Inc.
Nutec Bickley
Raytek/Fluke Process Instruments
SECO/WARWICK Corp.
Stelter & Brinck
Tenova Inc.
WS Thermal Process Technology Inc.

Heat Recovery

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Solvent Recovery

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www.acrossinternational.com

Radiant Tubes

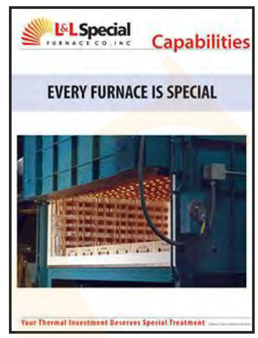
INEX Incorporated

INEX Incorporated offers a line of silicon/silicon carbide radiant tubes capable of temperatures of 2450°F. These tubes have been in use in heat-treat furnaces since 1988 and have proven that their superior performance and long life can significantly reduce maintenance and operating costs.
www.inexinc.net

Materials Testing Equipment

Applied Test Systems

This brochure gives an overview of ATS' extensive line of affordable yet uncompromising materials testing equipment. ATS is large enough to offer an extensive line of standard products. However, it is and always will be flexible enough to custom-tailor any systems for a specific application.
www.atspa.com



Furnaces & Ovens

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L&L Special Furnace Co. Inc. designs and builds high-temperature furnaces, ovens, kilns, quench tanks and heat-treating systems. We specialize in batch production furnaces and ovens, particularly applications requiring high uniformity and controlled atmosphere. L&L sells and services equipment worldwide.
www.llfurnace.com

Vacuum and Controlled Atmosphere Furnaces

Centorr Vacuum Industries

The MIM-Vac M is specifically for the metal injection molding (MIM) market. It is designed primarily for second stage binder removal and sintering and has a number of design improvements specific for use with MIM feedstocks.
www.centorr.com

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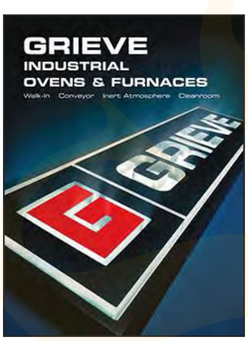

Ovens and Furnaces

Grieve Corp.

Over 400 standard ovens and furnaces, with temperatures to 2700°F, are described in this catalog from Grieve. Custom-designed heat-processing systems are also included. Grieve offers laboratory, bench, cabinet, truck, walk-in and conveyor ovens; clean-room and pharmaceutical ovens; laboratory and industrial furnaces; environmental test chambers; and more.
www.grievecorp.com

Vacuum Furnaces

SECO/Vacuum Technologies

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

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www.isquaredrelement.com

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www.surfacecombustion.com

Thermal Processing Products

Fixed Infrared Sensor

Palmer Wahl Instruments

The R10 series of fixed infrared sensors is designed for use in OEM equipment and industrial process control and monitoring applications. All models have a temperature range of 32-932˚F (0-500C) and feature 4 – 20 mA output. The non-contact sensors are powered by 24VDC to easily interface with standard PLCs, temperature controllers or panel meters. The 20:1 distance-to-spot ratio is suited for measuring smaller target areas or in applications where the distance between the sensor and the measurement area is larger. The rated accuracy is ± 1% of reading, and the fixed emissivity at 0.95 is suitable for measuring a wide variety of materials. www.palmerwahl.com

Horizontal Forging Reciprocator

Industrial Innovations

A horizontal forging reciprocator features Spra-Rite technology. The electronic servo-driven controls package and high-speed linear assembly of the reciprocating sprayer deliver precision and smooth operation at speeds of 50 inches/second. This helps to achieve faster cycles for more parts per hour, improved part quality and reduced lubrication consumption. This automated sprayer has been developed specifically for harsh environments using both graphite and synthetic release agents. A user-friendly controls system includes an 8-inch touchscreen with built-in prompts. There is 100 recipe program storage capability for quick recall of die setups. www.industrialinnovations.com

Non-Hazardous Hydraulic Fluids

Non-Haz Hydraulic Fluids LLC

Non-Haz 32 and Non-Haz FRHF 46 feature biodegradable, water-based, non-glycol formulas, offering a premium, completely non-hazardous solution for hydraulic systems. Non-Haz FRHF 46 hydraulic fluid is Factory Mutual-approved and has unique fire-resistant and non-hazardous advantages. It contains enough water to prevent fire ignition with no flash or fire point. Globally accepted Non-Haz 32 and Non-Haz FRHF 46 fluids are ideal for the die-casting and manufacturing industries, but they can be used for any industry that needs optimal performance from its hydraulic energy systems while being completely non-hazardous. Unlike other water-based fluids or straight oils, their advanced anti-wear components and exceptional heat-transfer properties lower maintenance costs by extending pump life and increasing lubricity with wear. Non-Haz FRHF 46 also protects high-pressure, high-temperature machines from fire and corrosion. www.non-hazhydraulicfluids.com

Lubricant

Sisu Chemical LLC

Scibond SL-87 is an environmentally friendly blend of water-based polymers that is applied as a coating, rather than a reactive bath like zinc phosphate. The one-step lubricant can replace both the zinc phosphate system and halogenated oils. This lubricant reduces the process to simply an application onto bare metal and drying (either air or oven dried). There are no hazardous wastes or residual chemicals to handle. Water rinses are not required, and no additional water is necessary during processing except to dilute the lubricant, eliminating waste streams to municipal water-treatment plants. Scibond SL-87 has passed extensive production trials for tube drawing of welded carbon steel. Preliminary trials have also shown that it is suitable for forging applications such as cold heading, stamping and large tube bending. www.sisuchem.com

Metrology Vision System

L.S. Starrett Co.

The AV450 Automatic Vision System allows users to cost-effectively achieve high throughput in their inspection process. It is ideal for both repetitive, larger part-run applications and routine quality assurance. Featuring a larger X, Y, Z measuring envelope of 18 inches x 14 inches x 8 inches, the AV450 has high-resolution video zoom optics and can be pre-programmed (CNC) for repetitive part inspection or driven manually via a trackball for individual measurements. Throughput is enhanced by either QC5000 or MetLogix M3 software that controls video edge detection and multiple-channel fiber optic or LED illumination. The AV450 has an external motion control unit and includes a Windows-based operating system with an operator interface via desktop PC with a 24-inch touchscreen monitor and Wi-Fi network connectivity. CAD files can be imported/exported, and reports can be generated and archived. www.starrett.com

Dry Screw Pump

ULVAC Technologies

The LS series of dry screw pumps is a more compact and lower-cost replacement to multi-stage dry Roots pumps for a wide range of vacuum applications. With four pumping speeds from 120 to 1,000 m^3/h, the LS series provides high pumping speed and low power consumption. The pump features a pair of conical-shaped, variable-pitch, deeply machined steel screws that allow the pump to be 1/3 shorter in length and 1/3 lighter in weight than other screw pumps in the same pumping speed class. This design also increases the pumping speed near atmospheric pressure, allowing the LS pump to deliver a 20% faster pump-down time while using less power. A built-in silencer reduces the noise level to no more than 61 dB(a). www.ulvac.com

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Surface 20 22 36 2 bar, High vacuum, Graphite hot zone

TM 12 x 12 x 24 6 Bar: New graphite CFC hot zone, 6 Bar positive quench

Abar HR 26 2 Bar: 2400˚F, 18" x 24" x 36" graphite hot zone, High vacuum, 2 bar Pressure Quench

C.I. Hayes 24 x 24 x 36 Vacuum Temper: 1450˚F

Ipsen 72 x 72 Bottom load, 2 Bar

Vac Aero 60 x 60 Rebuilt bottom load 2 bar.

Ipsen 14 x 24 x 36 5 Bar, very little use on new hot zone

Borel 18 x 24 x 36 Hydrogen Retort Furnace: 1832˚F

TM 12 x 12 x 20: graphite hot zone, high vacuum, internal quench, 5 psig positive quench

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email: grm@mowryenterprises.com

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Price is what you pay. Value is what you get. –*Warren Buffett*

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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.

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.

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 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
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
INTEGRAL QUENCH FURNACE, 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
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750CFH	Endothermic Ipsen	Gas
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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"	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" x 72" x 42"	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
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"	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

MISCELLANEOUS

Combustion Air Blowers (All sizes)		
24" x 36"	Lindberg Charge Car (Manual)	
30" x 48"	Surface Scissor Lift (Just Added)	Elec
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 30"	Surface Washer (2)	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
24" Wide Table	Surface rotary Hearth	Gas 1750°F
30" x 30" x 30"	Subzero	-105 to 375°F Elec.

MISCELLANEOUS (continued)

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 (2) (Just Added)	
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
24" x 20" x 20"	Blue-M	Elec 1000°F
24" x 24" x 24"	Grieve	Elec 500°F
20" x 24" x 20"	Despatch	Elec 1350°F
24" x 24" x 36"	New England	Elec 800°F
24" x 24" x 48"	Blue-M	Elec 600°F
24" x 36" x 24"	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
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 (2)	Elec 1400°F
30" x 48" x 30"	Surface	Elec 1250°F
36" x 36" x 36"	Grieve	Elec 1000°F
36" x 36" x 36"	Grieve	Elec 350°F
36" x 36" x 36"	Blue M Environment 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 850°F
37" x 25" x 37"	Despatch	Elec 500°F
37" x 25" x 37"	Despatch	Elec 850°F
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 60"	Blue-M	Elec 400°F (Just Added)
48" x 48" x 72"	Gruenberg	Elec 500°F
54" x 68" x 66"	Despatch (2)	Elec 500°F (Just Added)
55" x 30" x 60"	Precision Quincy	Elec 350°F
48" x 48" x 72"	Blue M	Elec 400°F (Just Added)
72" x 72" x 72"	Despatch (2)	Gas 500°F
72" x 120" x 72"	Despatch	Gas 500°F (Just Added)
72" x 120" x 72"	Precision Quincy	Elec 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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Batch

C0052 Surface Combustion Temper Furnace (30"W x 48"L x 30"H, 1200°F, gas-fired)
C0068 Despatch Aluminum Aging Box Furnace (60"W x 72"D x 66"H, 395°F, electric)
U3624 Lindberg Nitrogen Temper Furnace (24"W x 36"D x 18"H, 1350°F, gas-fired)
U3656 Despatch Batch Temper Furnace (56"W x 72"D x 55"H, 1400°F, electric)
V1010 Dow Batch Temper Furnace (30"W x 48"L x 20"H, 1250°F, gas-fired)
V1024 PIFCO Batch Temper Furnace, Skid Hearth (36"W x 48"L x 30"H, 1200°F, electric)
V1095 Surface Combustion Temper Furnace (30"W x 48"D x 30"H, 1250°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)

Car Bottom Furnaces

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

C0064 Lucifer IQ Furnace (18"W x 24"D x 18"H, 1900°F, electric)
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)
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)
U3529 CI Hayes Mesh Belt Brazing Furnace (18"W x 6"H x 8' heating, 2100°F, electric)
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)

Mesh Belt Tempering Furnaces

C0044 CGS Moore Mesh Belt Curing Oven (22"W x 20'L x 10"H, 500°F, gas-fired)
C0073 Heat Machine Mesh Belt Tempering Furnace (24"W x 10'L x 4"H, 1000°F, gas-fired)
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)

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)

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)
U3658 JL Becker Gas Generator (8,000 CFH Exo, gas)
V1075 Lindberg Gas Generator (3,000 CFH Endo, gas)

Exothermic Gas Generators

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

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)
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)

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Heat Treat Lines

V1137 T-6 Annealing & Aging Furnace Line

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- Bob Muto, Plant Manager

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