Combining Foundry Processes in Heat Treating Systems
Consolidated Engineering Co. (CEC), Kennesaw, Ga.

Traditional production of aluminum castings is costly and energy intensive. The flow of many casting processes consists of several independent steps, carried out without any connection to previous process steps. Castings are usually cooled to be able to carry out subsequent processes, such as removal of gating systems, mechanical de-coring, and manual cleaning. In many cases the castings are subsequently heat-treated. Individual processes and plants necessitate more labor, space, and energy; additional transportation; and increase costs.

Technologies are available for castings made in both semi-permanent and precision sand molds, where the casting is placed into the heat treatment furnace immediately after solidification. This patented Sand Lion 3-in-1 technology incorporated into CleanCast designs processes hot castings by carrying out three foundry processes simultaneously in one automated machine: de-coring and sand removal, thermal sand reclamation, and solution heat treatment.

Sand binders in the core and mold release substantial energy when exposed to hot, oxygen-rich furnace atmosphere. Castings emerge from the solution heat treatment process free of sand molds and sand cores. Sand is collected in the hopper-type bottom of the furnace, which is equipped with the fluidized bed for final cleaning of the sand wherein fine particles and binder residual are removed. Clean sand is automatically discharged as reclaimed sand for reuse without undergoing any further treatment. Exhaust and waste gases are collected and treated downstream from the furnace in cyclone, oxidizer, and heat exchanger, and finally cleaned in a bag house.

The combination of several main aluminum casting processes results in a significant reduction in production costs. The process is environmentally friendly and efficient. Audits in foundries using the 3-in-1 process show an average reduction in production costs of more than 30%.


OUTLOOK
EQUIPMENT/SERVICES/SUPPLY

Microwave-Assisted Thermal Processing
Ceralink Inc., Troy, N.Y.

Ceralink Inc. is helping manufacturers address thermal process energy issues by making cost savings technologies available, such as microwave assist technology (MAT). The technology is a hybrid heating method that offers faster product throughput, decreased energy consumption, new materials development, and in general, lower manufacturing costs. MAT combines two complementary methods of heating.

Microwave energy is applied simultaneously with radiant gas or electric heat. The microwave energy targets the product, and creates heat throughout the product via dielectric friction. The radiant heat provides the bulk of the heat to the rest of the furnace, and prevents radiation cooling from the surface of the product. The result is a highly uniform temperature profile across the thickness of the product, which minimizes thermal stresses. MAT enables faster heating cycles because of the temperature uniformity, which in turn enables greater product throughput. MAT is applicable to almost all thermal processes, including surface treating, binder removal, sintering, and calcining. This technology is proven in production firing trials to reduce the cycle time for a variety of products by an average of 50% leading to decreased energy consumption.

The advantages of using MAT to heat highly insulating materials such as refractories, ceramic insulators, bricks, sanitary-ware, ceramic filters etc. are proven. For sintering structural ceramics, studies show faster MAT firing can retain finer or even nano-grained materials. An application having great potential is the use of MAT for binder removal. Microwave energy can penetrate into the part, heat the binder in the center of the part, and help drive it outward. A more complete binder removal is possible with MAT, as the microwave energy will couple (heat) any residual pockets of binder preferentially. MAT binder removal can be applied to ceramics or powder metal components. In sintering powder metal compacts, surface species that coat fine metal particles, as well as the size of the particles, result in direct microwave heating. MAT also can be used to preheat investment casting molds and other ceramic tooling to reduce thermal gradients and improve casting uniformity.

Determining whether MAT can benefit a process requires good cost benefit and manufacturability analyses that take into account factors including energy costs, environmental benefits, through-put, process control, and the speed of upstream processes. Ceralink is taking the risk of out MAT implementation by offering low-cost feasibility studies, which if process benefit is shown, can lead to full scale cost benefit analysis through to pilot scale testing before any large capital equipment expenditure is required. Manufacturers can be assured of the benefit to their products/process prior to equipment purchases. Ceralink also seeks state and federal government funding to assist companies in offsetting MAT process development costs.

Core’s furnace designs and technical innovations provide efficient, cost effective, and reliable heat treating furnaces and related equipment. The company also provides solutions for production, quality, energy, and environmental challenges facing the metals industry. An example of this focus is its STC (short time cycle) furnace for which engineering and supply is provided through a technology licensing agreement with Daido Steel (www.daido.co.jp). The STC furnace is a roller-hearth batch-type furnace that processes up to 20% faster and than a conventional box or bell type furnace, and also uses 40% less fuel than conventional furnaces. Product variability after spheroidizing and cold shear annealing is less than 2%. The furnace currently is being used for wire, wire rod, casting, and slugs, as well as long-bar heat treating applications, and it also can process long pipe and tubular products.

Although the STC already has a proven short heating cycle compared with other furnace types, technological developments planned for 2008 will allow the STC to process loads even faster. The general concept of the technological development involves automated monitoring of the amount of fuel required to heat a load and accurately determining when the actual soaking portion of the heating cycle has ended, which will provide even shorter cycles with higher overall production rates and potentially greater energy savings.

In another area, the company now designs its rotary hearth furnaces to be equipped with self-recuperative burners to lower energy costs. The self-recuperative burners provide a significant energy savings compared with a central recuperator design.

Core also provides melt shop equipment, advanced process control, and automation, as well as a full range of technical services. Solution-based technical services for the heat treating industry, such as energy studies, furnace training, equipment tune-ups, furnace rebuilds, and evaluations, are being continually improved to meet evolving customer needs. www.corefurnace.com

**Compact Induction Power Supply**

Huettinger Electronic Inc., Farmington, Conn.

Huettinger’s line of power supplies for induction heating range in power from 5 to 500 kW, and have frequencies ranging from 5 kHz up to 13 MHz, which permits matching to many different materials and processes. A new medium frequency generator, the BIG Super Compact (Big SC), for induction heating applications is available from 10 to 40 kW output with a frequency range of 5 to 100 kHz. It can be in a broad range of applications, from classic heating processes, such as hardening, soldering, and annealing, to high tech applications, such as epitaxy and crystal growing. The compact size and universal mains input makes it easy to integrate the Big SC into new or existing equipment. Huettinger also offers custom designed work coils, temperature sensors, and controllers. An extensive application lab, staffed by experienced engineers, is available to support customer tests and process qualification. www.huettinger.com.

**Long Lasting Industrial Polymer Water-Cooling Towers**

*Delta Cooling Towers Inc., Rockaway, N.J.*

Molded polymer water-cooling towers provide significant savings in maintenance, downtime, and energy costs over traditional towers of metal construction. In the past, polymer cooling towers were considered too small for many industrial processes. For that reason, galvanized metal cooling towers were deemed the only choice for applications above 250 tons. Unfortunately, processors requiring such high-capacity cooling were forced to build these custom-designed towers on site, at a high cost in labor and materials. However, factory-assembled polymer towers such as...

**Tooth by Tooth Gear Induction Hardening**

*Induction Tooling Inc., North Royalton, Ohio*

The passage of the wind-energy bill has stimulated manufacturing in many areas of the power transmission industry. Gear and bearing manufacturers have been challenged to provide economical, efficient, and long-lasting components for the wind-generator transmissions and platform components. Bearings and gears that require outside heat treating services are now being considered for in-house control to save transportation costs and processing time. More specifically, gears that require tooth hardening for strength and wear resistance may be hardened in-house using the tooth-by-tooth method of induction.

Induction Tooling specializes in designing, building, and repairing inductors for applications used in selective hardening including gear tooth hardening. Recently, several commercial and captive heat treating customers have asked for a versatile, affordable induction gear hardening machine, resulting in a need to design and build basic multipurpose machines. Entry into this market is specific to small and medium size ring and pinion gears ranging up to a 2,000 lb (910 kg) and 60 in. (1,524 mm) in diameter. Straight and helical gears, both inside and outside diameters, can be processed. Because the unit is versatile, it is capable of being used in many other induction hardening applications including scan ball race hardening, sprocket hardening, and various single shot or scan hardening applications that are typical to the induction process.
Delta’s TM Series can now be combined to provide up to 2,000 cooling tons in a single modularized unit.

Aluminio del Caribe in Humacaro, Puerto Rico, installed a $3 million polymer cooling tower to maintain the correct temperature of water used to cool its hydraulic press oil. The company has two hydraulic extrusion presses (1,850-ton and 1,670-ton models) that are cooled by copper loops in the presses that function as heat exchangers. The hydraulic oil temperature must be kept below 130°F (55°C) at all times. The press has to be shut down if the oil gets too hot, which would mean losing four hours or possibly an entire shift. Not only would that be lost production, but it would also require pushing orders back, which would also mean delayed shipments. To meet these challenges, Aluminio del Caribe consulted with various industry representatives, and based on the advantages of maintenance-free design, installed a Delta 200-ton polymer cooling tower, and added a second tower when the second press became operational.

Modular cooling towers facilitate an extra margin of cooling capacity that can be advantageous in adjusting to operational heat load or outflow changes, or in upgrading to meet future cooling requirements. The modular design of polymer cooling towers also offers flexibility in conserving valuable real estate. By molding towers in a rectangular shape, some manufacturers enable users to cluster cooling towers in a group that occupies a much smaller footprint. www.deltacooling.com.

Polymer water cooling towers offer savings in maintenance, downtime, and energy costs.

Planning is essential. The gear product must lend itself to the tooth-by-tooth method. Considerations include material, heat treat specifications, production requirements, gear-tooth profile, and part size and weight, as well as the selection of an appropriate power supply and operating frequency. Since the tooth-by-tooth hardening method involves precise positioning of the inductor to the gear tooth, a repeatable method to hold and introduce the gear to the inductor needs to be established. The level of automation is also considered. A partly manual to a fully automated system is budget dependent. Since the motion control is expandable, a partly manual machine could be upgraded to a fully automated system at some later date at nominal cost.

A basic tooth-by-tooth induction hardener unit consists of:
- A platform to hold and position various gears
- A vertical tower to precisely move the inductor
- An expandable touch screen motion control
- An automatic or manual gear tooth indexing mechanism
- An inductor with quench heads
- A stainless steel tank to collect the quench fluid
- A quench pump, heat exchanger, filter, and plumbing
- An appropriately sized induction power supply

Training is considered the single most important aspect of any induction hardening process. For the operator technician, tooth-by-tooth hardening can be a particularly fussy procedure to initially set-up. Inductors must be designed and built for specific gear tooth pitch, inside or outside diameter, helical or straight. Inductor gaps must be repeatable and precise, power must be accurately measured and monitored, starting dwell and scan rates must be defined, and quenching must be exact. A mistake could be very expensive.

To facilitate training, Induction Tooling has initiated a pre-purchase familiarization program for the purpose of instructing a potential buyer in the art of gear tooth hardening. Using the induction and metallurgical laboratory, individual instruction is conducted using a tooth-by-tooth scanning unit coupled with a 10 to 30-kHz power supply. Some of the instructional items covered are gear and inductor set-up, quench monitoring, and power calculation and scan rate. Final validation of the process is demonstrated by sectioning a hardened gear and metallurgical evaluation. www.inductiontooling.com.
High Alloys for all Applications
Rolled Alloys, Temperance, Mich.

Rolled Alloys continues to partner with the heat treating industry to provide new materials options along with technical assistance to ensure customers are using the most cost effective alloys for their applications. With metals prices remaining near all time highs and with projections for this to continue in 2008, making good materials decisions is critical to control costs. The company’s materials engineers and a materials laboratory can assist with material selection. In some cases, alloy 600 (76% Ni) or RA330 alloy (35% Ni) have been used for decades out of habit, when a less expensive alloy may do the job.

In non-carburizing service, a lower nickel alloy may make sense depending on the temperature. Therefore, the RA 253 MA alloy product line (11% Ni) has been expanded to include round bar in addition to plate, sheet, and pipe inventory. The material offers the potential to reduce material costs by 50% versus traditional nickel-base alloys. Beyond the initial cost advantage, RA 253 MA is actually stronger than alloy 600 and is useful up to 2000°F (1095°C), as a result, it may also provide longer service life.

Another trend is the need to increase production; More heat needs to be added to the furnace to heat-treat more parts. While the temperatures that the parts see is unchanged, the radiant tubes, muffles, and retorts operate at higher temperatures to transfer more heat in a shorter time. Alloy strength is reduced by roughly 33% for every increase of 100°F (55°C). High-performance alloy RA 602 CA offers higher strength and greater scaling resistance than both alloy 600 and 601, so it can operate hotter without sacrificing service life. For example, its strength at 2000°F is equal to that of alloy 600 at 1800°F (980°C). Alternatively, the material could extend the operating life of a muffle, for instance, because it is twice as strong as alloy 600 at 1800°F. In this case increased production comes from less frequent shutdowns for muffle replacement. RA602 CA can be used to temperatures through 2200°F (1200°C). www.rolledalloys.com.

OUTLOOK
EQUIPMENT/SERVICES/SUPPLY

Innovation Breeds Growth
G-M Enterprises, Corona, Calif.

The future is bright for manufacturers and suppliers of heat treat equipment and services to captive and commercial heat treaters specializing in niche and aerospace-related process industries. Key to growth in these unique heat treat industries is innovation, high performance, productivity, reliability, and low operation and maintenance costs. Supporting these high growth markets requires products to meet growing demand for high performance and highly productive heat treat furnaces. Over the past 32 years, G-M Enterprises developed many innovations to meet tough customer requirements in two major market areas: vacuum furnaces and retort atmosphere and coating furnaces with control systems to manage the processes.

Vacuum furnaces: The design of high-performance vacuum furnaces includes unique components such as venturi style graphite nozzles, low mass graphite elements, and variable speed vacuum pumps. Screw-in venturi-style graphite nozzles accelerate gas flow through the plenum, having a Cv (constant of velocity) of 0.97, which drives the cooling gas onto the parts with increased cooling efficiency. Thin curved, low-mass graphite elements provide rapid heating and cooling, approaching 90% of the performance of molybdenum elements. Curved elements are supported in a free-floating two-point support system, reducing stresses on the elements for long life. Variable-speed vacuum pumps reduce vacuum pump down time for more reliable, lower maintenance operation.

Obtaining high-quality parts after heat treating reduces rework and post-heat treat machining. Repeatable controlled heating and cooling rates via automated computerized control provide stable part dimensions during metallurgical transition temperatures. Reduced parts distortion can be achieved by reducing the differential temperature across the part during quenching via bi-directional (front and back exit) gas flow. GM Enterprises’ Advanced Quantum Quench directional gas quench control is achieved by varying the inlet direction of the cooling gas to the zones (top, bottom, left and right), which allows the cooling to be focused to where it needs to be. All control is done outside the furnace to minimize maintenance and downtime.

Operational costs can be reduced using various design features. Heat loss from the hot zone is a constant drain on the heating system in the furnace. This loss can be reduced by using higher grade, higher purity, and thicker graphite felt to insulate the hot zone. Heat losses can be reduced as much as 60% over thinner board and fiber insulation methods. There is also a substantial energy-cost benefit in more closely matching the fur-
nace and parts parts temperatures during heating. A furnace temperature substantially higher than the load temperature increases heat loss through the insulation to the vessel cold wall. This also improves temperature uniformity throughout the load during heating. Additionally, a slower heating and cooling rate also extends the life of the hot zone. It is important to balance the furnace load size and density with production requirements.

Total cost per piece or part is directly related to the number of parts per load. Optimizing fixturing to provide a maximum load size and density yields maximum productivity. Traditionally, aerospace parts are lightly loaded onto heavy fixtures that may have a part weight-tofixture weight ratio of 1:10. Today’s advanced materials allow parts-to-fixture weight ratios close to 1:1, thereby substantially increasing productivity. Today’s modern fixtures are often made from carbon fiber composites (CFC) and ceramic materials. CFC fixtures have little thermal expansion, reducing stresses and movement of the hearth posts, extending hearth life.

Low maintenance costs can be achieved by using stronger, lighter materials to protect the insulation. CFC woven graphite bonded fiber provides protection of the leading edge and face of the hot zone insulation, which provides a bullet proof-like surface for the vacuum furnace. The strong, durable hot face material protects insulation from physical damage from parts and operator contact. Hearth longevity can be improved by using stronger materials such as TZM molybdenum hearth posts and high density ultrastrong graphite materials for the graphite hearth post and rails. In addition, low maintenance-vessel penetrations can be achieved using non-threaded ports, high-temperature seal materials, and nonferrous flange materials to minimize vacuum leaks.

Retort atmosphere coating furnaces are used to perform hydrogen brazing, protective annealing, CVD/VPD aluminide and platinum-aluminide surface coating, and many other atmosphere processes. A retort furnace offers advantages over traditional pit-style furnaces. A visible load hearth facilitates parts loading. In special coating processes, individual coating cans used for gas containment are stacked onto the hearth. The retort is lowered over the parts and is heated in a heat chamber that is open at the bottom.

The heat chamber configuration is coupled with a dual work base, which provides about a 33% improvement in productivity over a single pit-style furnace because while one retort is running, the other retort can be loaded, purged, and unloaded without affecting production. The bottom-load configuration is more efficient to run because loading and unloading the heat chamber does not allow heat to be lost upward, but rather it is trapped in the heat chamber. Automatic computerized control with vacuum and pressure testing atmosphere purge provides fast, complete oxygen purging within the retort. Temperature uniformity surveys (12 or 9 point) are easily accomplished with built-in atmosphere-sealed thermocouple jacks, eliminating the difficulty in certifying temperature uniformity within the retort. www.gmenterprises.com.

New Induction Heating Technologies

Inductoheat is focusing on leading the market in quality induction heating and heat treating equipment by providing innovative, flexible systems for long-life performance. The company will build on its innovation in power supply design more than 40 years ago to develop today’s breakthrough technology. New products for heat treating, annealing, shrink fitting, bar/billet heating incorporate modular design using patented and/or patent-pending technology.

Inductoheat is part of the Inductotherm Group of some 40 companies worldwide to serve the metals and materials industries. Inductoheat offers full service capabilities including comprehensive process development and metallurgical laboratory, engineering design and equipment manufacturing, induction coil build and repair department, customer training, and aftermarket support and service. Customers get all the advantages plus flexibility in one company.

Equipment for Increased Production, Low Operating Costs
Recent developments include its InductoScan induction heat treating system and InductoForge billet heating system in a standardized modular design, which provides flexibility in power supplies, mechanical fixtures, controls, and operation. InductoScan allows a wide range of power supplies, controls, and components to be integrated into a common base to better match production needs. It can be customized to handle various heat treating applications such as scan, single-shot, lift/rotate, pick & place, rotary index, and linear transfer, an advantage because it can also be reconfigured by swapping in different scanning towers, power supplies, and other mechanics to accommodate an entirely new part or family of parts.

The IROSS line-frequency (60 Hz) system is a new product that heats a large variety of parts including: pipe-end, stators, rotors, and armatures. The system includes patent-pending Fluxmanager technology that enables deep, uniform temperature distribution using a shaped intensifier that focuses the electromagnetic field in the induction coil, resulting in fast, precise, repeatable, and efficient heating.

InductoForge modular billet heating system enables assembling an induction system to exactly match application requirements by adding or subtracting power modules for future production needs. The system uses power modules capable of running at a wide range of frequencies (500-6,000 Hz) with minimal change. Each module is individually controlled, resulting in a finer, more accurate control of the billet temper-
A revolutionary technology for the forging industry is the IHAZ temperature profile modeling computer program designed to set up an advanced temperature control for the InductoForge. IHAZ can be used to customize the billet temperature profile (induction heat affected zone) to best suit each application. It generates optimum running parameters and set points for standby and rapid start, which are stored as recipes in its PLC. The operator can access stored recipes from the part number or die number identifier. Also, the billet heater’s operating parameters are stored in the recipe, and together, they run the system, thus improving quality control and speeding up system set up.

Quality Control and Environmental Regulations


Automated Pulsed Plasma Nitriding


Eltro offers modern plasma heat treatment technology using its EltroPuls pulsed plasma technology. Hundreds of Eltro furnaces are in use today to cost effectively process parts to very strict customer requirements. The controller is the core of plasma nitriding, offering the shortest power-up times, loss-free storage of the process cycle, and plug and play support for external bulk memory and printers. A high resistance to interference is generated through a CAN based BUS, a deterministic control and regulation based on real-time software. Therefore, processing speed is a multiple of a SPS or a Windows-based system, which is necessary to design a reliable and effective plasma process.

To assist users inexperienced in writing an ideal treatment program, the system includes multiple well-proven programs. In addition, the furnace system now can run automatically via the process controller. An expert system in the background of the new-generation furnace supervises the plasma process, optimizing higher level algorithms, which is considered a further milestone in industrial plasma heat treatment.

Eltro offers solutions to industry-wide issues such as high energy costs, shortage of skilled labor, and increasingly stringent environmental regulations and increased production. The company’s furnaces are characterized by low consumption of energy and gas. Treatment programs are optimized to reduce treatment times, and, thereby, consumption of resources. The EltroPuls nitriding process is 100% environmentally friendly and can easily be integrated into a production line. Treated part quality is repeatable, consistent, and predictable load after load. www.eltropuls.de; www.eltroservices.com.

Sécô/Warwick is looking forward to continued growth in 2008 throughout the global organization in the Americas, Europe, China, Russia, and India. New product development in all groups is focused on reducing cycle times along with energy and atmosphere consumption, process control, and system automation. Each of the company’s four product groups continues to develop technologies to improve final process quality while reducing total production costs.

Aluminum solution heat treating. A viable alternative to drop-bottom solution heat treating furnaces, Jet Impingement Technology provides high volume production with faster heating rates and tight uniformity using a semicontinuous solution heat treat furnace, water quench, and age oven. Faster heating rates achieve the soak cycle in less time, reducing the overall cycle. The furnace has achieved temperature uniformity performance as low as ±1°F of the temperature set point throughout the soak period. The furnace loads, heat treats, quenches, and discharges continually without operator assistance.

Vacuum furnace technology. The Vacuum Group introduced its ZeroFlow gas-nitriding option to standard horizontal retort tempering furnaces with vacuum purge. The new technology, a viable alternative to current industry practices, offers:

- High accuracy of nitrided layer formation using precise atmosphere control
- Process control by ammonia proportioning and flow stopping (ZeroFlow)
- Significantly lower process gas consumption and low exhaust gas emissions than in traditional processes
- Quick, accurate real-time atmosphere composition-monitoring system (no complex sampling system)
- Simple gas train system
- Low cost of ownership
- Easy adaptability to existing nitriding systems

The group is also introducing the SimVaC software package to work with the FineCarb vacuum carburizing process software as a tool to design vacuum carburizing process cycles. Users save time and reduce process errors by simulating steel carburizing process cycles prior to running actual trials. The system allows the user to choose carburizing and diffusion specifications, process, temperature, and
precooling and soak times. A steel grade is then selected from a menu of preprogrammed U.S., European, and Russian specifications along with part geometry, radius, and surface area. The system automatically computes the batch weight and surface area.

Atmosphere furnaces and generators. The Thermal Process Group updated and reintroduced a rotary retort furnace system designed to maintain consistently superior quench hardening performance required for fast, economical, and uniform heat treating of small parts. Small parts are moved through the retort by means of internal flights conveyance, and mechanism-free fluid conveyance through the quench bath minimizes lost, mixed, or damaged parts. The patented Whirl-A-Way system is designed to prevent atmosphere contamination in the furnace. The system handles a wide variety of part configurations while constantly maintaining individual quench results, providing deeper, uniform case depths. A cantilevered, one-piece cast retort is supported at one end and sealed at the charge end of the furnace. There are no seals or bearings in hot areas or at the discharge end.

Controlled atmosphere brazing (CAB). This unique air-cooled chamber design can be purchased new, or can be added to existing furnace lines. Consider replacing water jackets and piping with an air-cooled hood and fan assembly if utility costs and water quality issues are a problem. Seco/Warwick will size the new chamber, fan, and ductwork for the specific application and can provide the material, engineering, and labor for the equipment upgrade. www.secowarwick.com.
Large Furnaces Provide Economies of Scale, Improved Turnaround

Large vacuum furnace capabilities
Solar Atmospheres continues to invest in the largest capacity vacuum furnaces to handle the heaviest payloads. In early 2008, Solar Atmospheres of Western PA, Hermitage, Pa., will commence start up of the largest commercially available vacuum furnace, having workload dimensions of 5 ft × 5 ft × 36 ft long (1.5 × 1.5 × 11 m), and capable of handling loads weighing up to 150,000 lb (68,000 kg) using Solar’s patented double ended load-car design. The maximum operating temperature is 2850°F (1565°C), while maintaining vacuum levels to the 5 × 10⁻⁵ torr range. The company continues to push the envelope in vacuum furnace size to meet market demands including:
- The need for less post-heat treat metallurgical testing; running multiple smaller chamber loads with multiple witness pieces requiring individual testing is eliminated by running all in one load with only one battery of testing
- Economies of production; large capacity furnaces fulfill the need for faster product turnaround
- Achieving better build-to-finished goods ratios; goals are to produce less machining chips and nearer net shapes, meaning less distortion, which is dramatically reduced via inert-gas quenching
- Elimination of typical post heat treat operations such as pickling, shot blasting, sand blasting, descaling, burnishing, and passivation
- Enhanced pyrometry control; temperature measurement is enhanced with 48 different thermocouple locations
- Maximized cooling rates by quenching using two 300-hp motors at 5,000 rpm, and very light inert gases such as helium
- Newer alloy development predicated on the advantages of vacuum (no carburized or decarburized layers)
- Maintaining critical part straightness at high temperatures using robust load-car design

Vacuum carburizing production applications and materials continue to expand. Solar Manufacturing’s 24 in. wide × 24 in. high × 72 in. deep (609 × 609 × 1,828 mm) vacuum carburizing furnace with a unique in-

Providing Solutions to High Energy Costs
Lucifer Furnaces Inc., Warrington, Pa.

The year 2008 brings with it a myriad of problems for manufacturing industries including soaring energy costs topping the list with concerns for the environmental regulations and pollution issues following close behind. Lucifer Furnaces is addressing these issues in the heat treating industry by designing and offering economical, energy efficient heat treating furnaces and ovens.

One way for a manufacturing company to reduce energy costs and reduce its environmental impact is to bring heat treating in house. Advantages of this over outsourcing the heat treatment step in the manufacturing process includes eliminating costs of transportation and shipping. Performing heat treating in house saves time and avoids minimum-lot charges. In addition, improving part processing turn around time translates into increased production. In house heat treating allows better control over the quality of processed parts.

Lucifer Furnaces produces a range of products for many different applications. All furnaces are built with energy efficiency in mind. Insulation includes lightweight firebrick insulation and mineral wool block, or ceramic fiber insulation for even greater energy savings. A well insulated furnace prevents heat from reaching the shell of the furnace where it is lost to the environment. Solid, continuous insulation around door components further reduces unnecessary energy consumption. Well insulated furnaces heat up at faster rates, saving energy consumption while increasing production.

One must consider the cost of purchasing a furnace compared with outsourcing heat treating. Lucifer Furnaces offers a variety of furnaces to meet every budget. Its economy line of furnaces, the Red Devil Series, is particularly suited for the occasional heat treater whose goal is to reduce energy costs, save money and shorten turn around time for heat treating. Red Devil furnaces are available as single or dual chamber batch furnaces or as recirculating ovens for tempering applications. Dual chamber models are space saving, stacking a hardening furnace above a tempering oven to reduce demands on floor space. Economical and dependable, the Red Devil models make heat treating affordable. www.luciferfurnaces.com.
Solar Manufacturing also produces electrically efficient furnaces. Improved power efficiency is accomplished using a state-of-the-art power transformer (FCS 2000 Smart Power Supply). To make a major increase in output power, the FCS-2000 ramps smoothly to the new desired level and decreases power with lesser demand. It is designed to extend component life in both the power supply and furnace. The transformer is built by Magnetic Specialties Inc., an affiliate company of Solar Atmospheres. Although vacuum furnace use of electrical power is significant, precise temperature control makes the process lean; only the required energy is used because of programmable controls and the MSi Smart Power supply. www.solaratm.com.

**MTECH**'s patented environmentally friendly Core Thermal Technology (CTT) offers advantages over conventional heating methods such as furnace and induction heating by focusing magnetic fields to create precisely controlled heat uniformly in all metals. The technology is fast, competitively priced, and energy efficient. Benefits include:
- Simultaneous uniform heating of core, half core, and surface of the workpiece
- Up to 50% energy savings over induction and more over furnace heating
- Rapid heating (measured in terms of seconds)
- Precise temperature control
- Operating simplicity
- Producing quality metallurgical results
- Lower capital and operating costs

Heating needs that could warrant the consideration of using CTT include lower energy consumption, shorter heating cycle, heat uniformity, temperature consistency, minimal space requirement, new product development (investigate new technology), simplicity of use, temperature requirement lower than 1300°F (700°C), accuracy and dependability, and flexibility to heat a single part, batch, or automate line.

CTT heating systems can be adapted to modular and flatbed configurations.

**Modular heating unit:** CTT systems in modular form enable heating large workpiece areas. Modules can be inverted to sandwich the workpiece to intensify the heat and shorten the cycle time. Applications include preheating molds, preheating for welding; stress relieving, annealing, and tempering.

**Flatbed heat unit:** This tabletop or free standing unit (~ 3 ft sq) heats to a temperature of 1000°F (540°C) in minutes, and is intended for lab purposes, but also can be used in industrial applications. Applications include heating test samples, metal sheet heating, preheating molds, and stress relieving.

CTT is a true uniform thermal heating technology. Temperature can be precisely controlled—stepped up, maintained, and stepped down—within several degrees of accuracy, which enables better control of microstructures. Furthermore for particular applications, CTT can be incorporated into robotics, automation, on-line, or stand alone processes. www.mtech.se.

**Advanced Heat Resistant Alloys**

**Steeltech Ltd., Grand Rapids, Mich.**

Rising energy costs and the competitive nature of the global market has put a strain on the heat treat industry, which leaves heat treaters searching for ways to lower operating costs and become more competitive. Steeltech’s alternative energy saving (AES) alloy radiant tubes. AES radiant tubes reduce natural gas consumption and lower ramp-up time, saving time and money. The tubes also provide extended life compared with standard alloy tubes.

Another product to fight rising operating costs is Steeltech’s Advanced Alloys (AA), designed to outperform traditional heat resistant alloys in operations such as normalizing, annealing, carburizing, nitriding, and carbonitriding atmospheres. Compared with traditional heat resistant alloys with the same load configuration and at the same temperature, furnace parts made of AA have a substantially longer service life, which reduces the number of costly shutdowns, resulting in more output and lower maintenance costs. www.steeltechLtd.com.
Surface Combustion has been a leader in thermal processing equipment since 1915. Innovative developments over the past nine decades have been among the most sought after technologies. Whether atmosphere, vacuum, continuous, or batch furnaces, Surface believes constantly developing innovative, more efficient designs is the key to growth in today’s dynamic business atmosphere.

Process control and flexibility. Well-developed products like Surface’s Allcase® furnace line offers add-on capability to grow as production requirements grow. Similarly, Surface’s new vacuum carburizing technology provides modular add-on capability of chambers as production scales up. The technology is based on a high-purity, low-cost carbon source that is easy to control, repeatable, and dependable.

The use of 20-bar high-pressure quenching offers the benefit of lower part distortion. The technology is available as part of the Surface Cloverleaf™ vacuum carburizing system. Gas quenching also eliminates the need for parts washing, as required with conventional oil quenching. Vacuum oil quenching is available for conventional lower grade materials. In addition to vacuum carburizing, the Cloverleaf also can do conventional vacuum processing such as hardening, annealing, and brazing. Cloverleaf furnaces equipped with both oil and gas quenching offer a heat treater the ultimate in flexibility.

The company’s simple, rugged designs translate to years of dependable service with minimal maintenance requirements. Soon to be released is an enhanced version of Surface’s Heat Treat Management (HTM™) software. The new system is easier to use and more powerful, providing data reporting, remote viewing, and load/part number tracking.

Environment. Surface offers patented gas-fired vacuum furnace designs in which the customer can substitute electrical heating with the fuel source for energy savings. RX® generators are the standard for endothermic gas, and with an industry-leading 6:1 turndown ratio, production consumption is minimized by automatic controls adjusting capacity needs. Maintaining heat by using recuperative technologies and simply by retaining heat in loads rather than cooling in between processing steps are also gaining more favor. Environmental concern for thermal processing exhaust emissions is growing, leading Surface to purchase the Morgan-Isley ejector stack product line and to make new developments in incinerators, such as ammonia incinerators for gas-nitriding furnaces, to enable better control of process off gases.

Reliability. Surface Combustion is known for rugged construction and long equipment life, and the company stands behind its equipment with Rebuild Retrofit and Aftermarket Services, including an inventory of original equipment spare parts and field service to maintain equipment or facilitate training of the next-generation workforce.

Surface continues to be a leader in the heat treat market by dedicating thousands of hours to various professional organizations, including many board-level positions and committee assignments in organizations such as the ASM Heat Treating Society, MTI, CHTE, and IHEA. In this way, the company offers its experience as a foundation for the advancement of the entire thermal processing industry. www.surfacecombustion.com.
Trends in Ceramics Impact Thermal Processing
Blasch Precision Ceramics, Albany, N.Y.

There are a number of factors working together to make the future very bright for using ceramics in heat treating. Innovations continue to raise the performance of engineered ceramics to survive the challenges of heat treating applications. For example, new alumina-bonded materials provide better resistance to degradation in hydrogen atmospheres for both metal and powder injection molding (MIM and PIM) furnace-tile applications. Alumina bonding also provides high hot strength and resistance to hot load deformation for use in high temperature applications.

In addition, the price of metals is rising much faster than the price of ceramics. Consequently, as the cost of metals maintains its climb, it becomes increasingly more attractive to use ceramics in heat treating applications. Since the performance of ceramics typically surpasses many metals in heat treating processes, choosing ceramics is the smart choice for both performance and ROI.

Further, ceramic companies such as Blasch are constantly advancing the state of the art with regard to ceramic formulations suitable for heat treating applications and in sophisticated manufacturing processes that produce near-net-shape ceramic parts having tight tolerances, low shrinkage, and controlled porosity and density.

Expensive machining costs are avoided by casting rather than machining parts to the correct shape and dimensions. In addition to containing costs, this is significant because machining can introduce stresses and microcracks, which can potentially lead to premature failure of the material, particularly during thermal cycling. Since heat treatment often produces severe thermal cycles, and since thermal shock resistance is critical, the need to maintain the integrity of the material is paramount.


of carbon fiber in its shift to composite bodies and structures. The confluence of these factors has led to a shortage of high-temperature insulation, which comes at a time when high energy prices have increased pressure on heat treating companies to reduce costs through improved furnace efficiencies and reduced cycle times.

To help alleviate this material shortage, GrafTech has invested heavily to increase its graphite insulation production capacity in 2007. In addition, GRAFOAM was introduced, providing structural strength to its insulative and handling properties. These products help reduce cost through lower energy consumption, improved furnace efficiency, and reduced cycle times. GRAFOAM, the strongest known thermal insulator for temperatures to 2500°C (4530°F), is easily machined into complex shapes, and is especially suited for applications where the insulation panels need to provide structural support or bear weight.

GRAFSHIELD heat management solutions include GRI, GRIG, GRAF BOARD and AMW compact, lightweight, and durable products that effectively manage radiant, conductive, and convective heat transfer, increasing furnace efficiency and operational profitability. GRI and GRIG products are carbon-bonded carbon fiber rigid insulations with low thermal conductivities. They withstand furnace temperatures of up to 5400°F (3000°C) and are significantly more cost effective than metallic radiation shields. Their low density means a much lower thermal mass to heat up resulting in very low power draws to reach equilibrium operation temperature. And, because graphite cools rapidly, more run-cycles are possible every day. Unlike rolled felt insulation, GrafTech’s rigid insulations do not suffer voids or hot spots, nor do they distort when subjected to rapid changes in pressure and temperature. Their rigidity makes them easy to handle, easy to install, easy to repair and easy to clean.

GrafTech offers the largest sizes of rigid insulation and carbon foam monolithic blocks in the market. Multipiece board stock and hollow or solid cylinders can be fabricated in larger sizes by the machined “shiplap” joint techniques. When bonded with UCAR grade graphite cement and cured, the joints are stronger than the original insulation and will not lose joint integrity in normal operations.

Vacuum Oil Quenching of Aerospace Components

Vac Aero International Inc., Oakville, Ontario, Canada

As a leader in vacuum oil quenching of large aerospace components, Vac Aero is preparing for increases in commercial aircraft production that are forecast over the next few years. Despite the fact that production for portions of these programs continues to move offshore, the company expects to be installing additional vacuum oil quench capacity to support forecast increases in demand in North America. Some new large-aircraft programs will require the largest vacuum oil quench furnaces ever constructed by Vac Aero.

Vacuum oil quenching offers environmental and economic benefits over traditional hardening techniques in salt bath and controlled-atmosphere furnaces. Because vacuum furnaces are inherently leak tight, control of surface chemistry is precise, and decarburization and high-temperature oxidation problems associated with traditional processes can be eliminated. Vacuum oil quenching also allows manufacturers of aircraft landing gear and structural components to finish machine critical surfaces on components prior to heat treating, thereby reducing final machining costs. As a result, the process is favored for many aircraft landing gear heat treating applications, which has made Vac Aero a key supplier of vacuum oil quench furnaces ever constructed by Vac Aero.

Vac Aero operates three of the world’s largest vacuum oil quench furnaces (some of which have been used in service continuously since 1989,) designed and manufactured by the company’s Furnace Manufacturing Div. The largest of these furnaces can process loads up to 72 in. in diameter by 126 in. high (1,829 by 3,200 mm). Large vacuum oil quench furnaces are complex in construction and require skill and experience to operate and maintain. Maximizing operation uptime is of major importance to meet increasing competitive pressures from lower cost manufacturing regions abroad and in responding to price reduction demands from the customers. Technology transfer and operator training is receiving greater focus, with education in the safety and quality aspects receiving as much attention as technical training. Vac Aero holds AS9100, NADCAP, and numerous customer approvals for heat treating, welding, and tensile testing.

The company continues to expand its international operations, such as in Poland, where it offers vacuum heat treating and brazing, thermal spray, and inorganic paint services to an increasing number of turbine engine-component manufacturers. The Polish operations will continue to expand in 2008 by installing additional processing equipment and plant space. Vac Aero also is investing in research into new coating techniques, such as cold spray, through its High Temp Furnaces of India has completed its first vacuum gas quench furnace, which is being installed in the new High Temp Vac Aero facility near Bangalore. The joint venture offers both heat treating services and vacuum furnace manufacturing to customers in India. Aerospace manufacturing continues to grow in India and is expected to be a big market for Hightemp Vac Aero. www.vacaero.com.

Vacuum Pump Refurbishment

MHV is a supplier of vacuum pumps and rebuilding services to the thermal process industry. The company strives to respond to customer needs quickly with the best solution whether it’s a full rebuilding job or totally new pumps and vacuum equipment. Vacuum carburization produces optimum metallurgical microstructures for durability, and also minimizes part distortion so it is a key in the cost-effective manufacturing of precision gearing. Customers rely on MHV to help keep their vacuum pumps and blowers working. The company supports Tuthill/ Kinney, Stokes, Leybold, and other pumps with repair parts and exact replacements, which helps keep customers’ costs in line. www.methivac.com.
New Quenchant Extends Applications
Dow Chemical, Midland, Mich.

New for 2008 are Dow’s next-generation Ucon polymer-based quenchant products for the heat treating industry, formulated without nitrates and providing superior corrosion protection and bacteria resistance. Ucon Ultraquench Plus Series quenchants are nonflammable, aqueous polymer solutions that contain a nonnitrite corrosion inhibitor package, which protects not only the parts being heat treated but also the quenching bath and fixtures. The first product to be introduced is Ultraquench RL Plus, which allows quenching medium to high carbon steels and most alloy steel grades including 300 or 400 series stainless steels. The quenchant is particularly suitable for induction hardening and direct quenching from the forge or continuous cast quenching processes. It outperforms other similar materials including water, PVA, and soluble oils.

Ucon Ultraquench Plus Series quenchants cut down on emissions; they do not produce smoke, soot, or other waste products related to oxidation. Reduction in the amount of soot and smoke is beneficial to those who must work in close proximity to these processes and it also helps support Dow’s 2015 Sustainability Goals, which represent critical milestones in the company’s continuing transformation and leadership in the area of sustainability and environmental, health, and safety performance. www.dow.com.

Kiln Rollers Take the Heat
Bolt Technical Ceramics, div. of Morgan Advanced Ceramics Inc., Fairfield, N.J.

The Bolt Technical Ceramics’ HALSIC high-performance silicon carbide (SiC) materials and SILLIMANTIN mullite rollers for continuous roller kilns provide absolute dimensional stability and thermal shock resistance despite extreme mechanical strain in high temperature applications. Three HALSIC grades offered in the U.S. (HALSIC-R recrystallized SiC, HALSIC-I silicon infiltrated SiC, and HALSIC-RX, an extremely oxidation-resistant silicon carbide material that can be used in rotating roller applications up to 1650°C, or 3000°F, are manufactured in MAC’s Haldenwanger facilities in Germany. Due to their high load-bearing ability, HALSIC rollers are ideal for kilns used for the production of sanitary fixtures, porcelain, heavy clayware, and technical ceramics, even at very high temperatures and in highly-oxidizing atmospheres. Standard rollers are available in diameters from 20 to 60 mm and lengths of over 3,300 mm (~0.75 to 2.36 in. and 130 in.). All rollers are available with straight open ends, notched ends, and with thermal fiber stuffed in the ends to help reduce heat loss. Bolt offers design assistance and customized solutions. www.morganadvancedceramics.com.

Emisshield coating on furnace refractory reduces energy costs.