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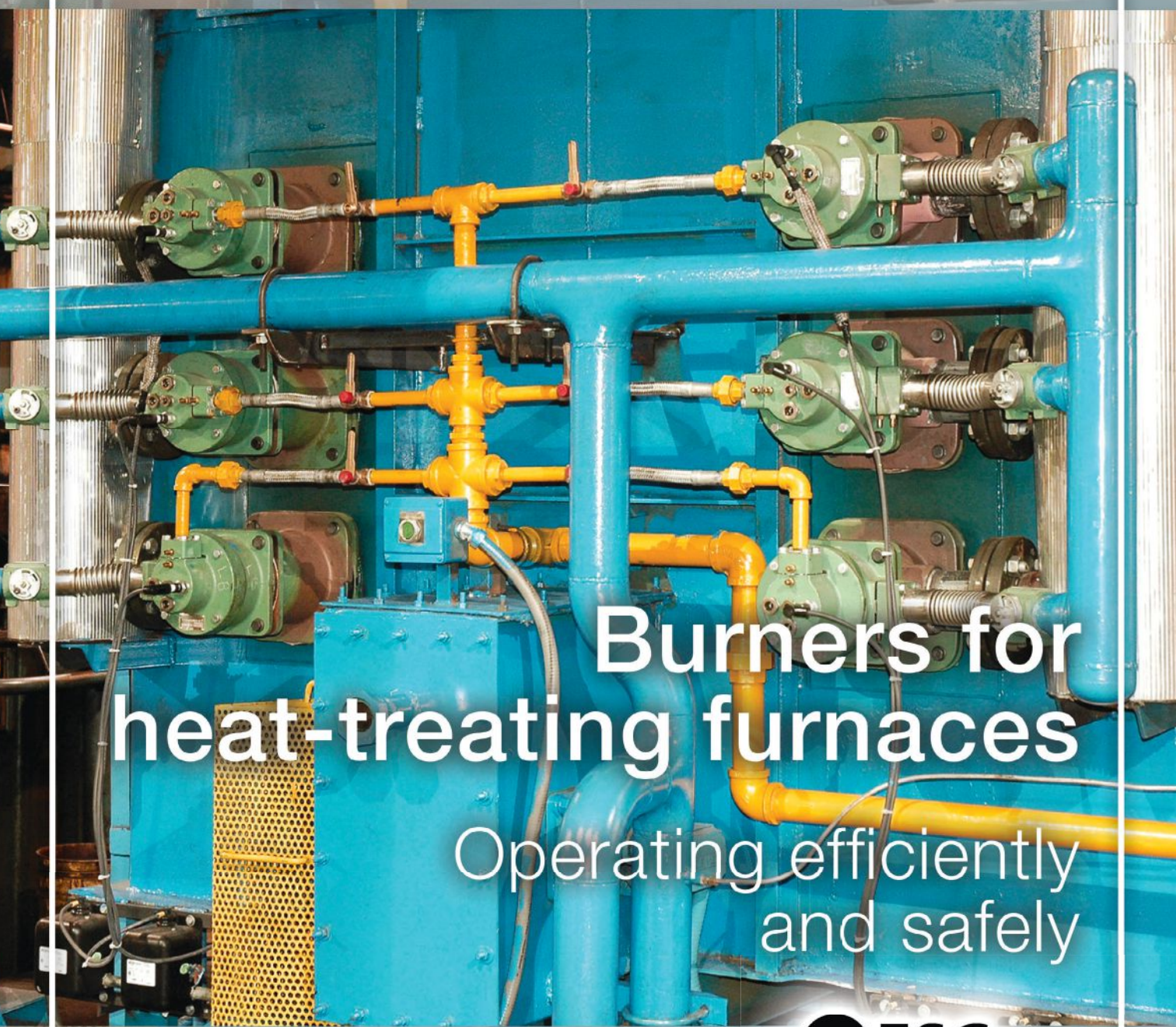

Burners for heat-treating furnaces

Operating efficiently and safely

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on the cover

Honeywell's Eclipse SER V5 recuperative radiant tube burner can be mounted in horizontal or vertical configurations and is suitable for continuous or batch type furnaces with a variety of atmospheres. The photo shows an external view of a batch-type heat-treating furnace. Photo courtesy: Honeywell Thermal Solutions

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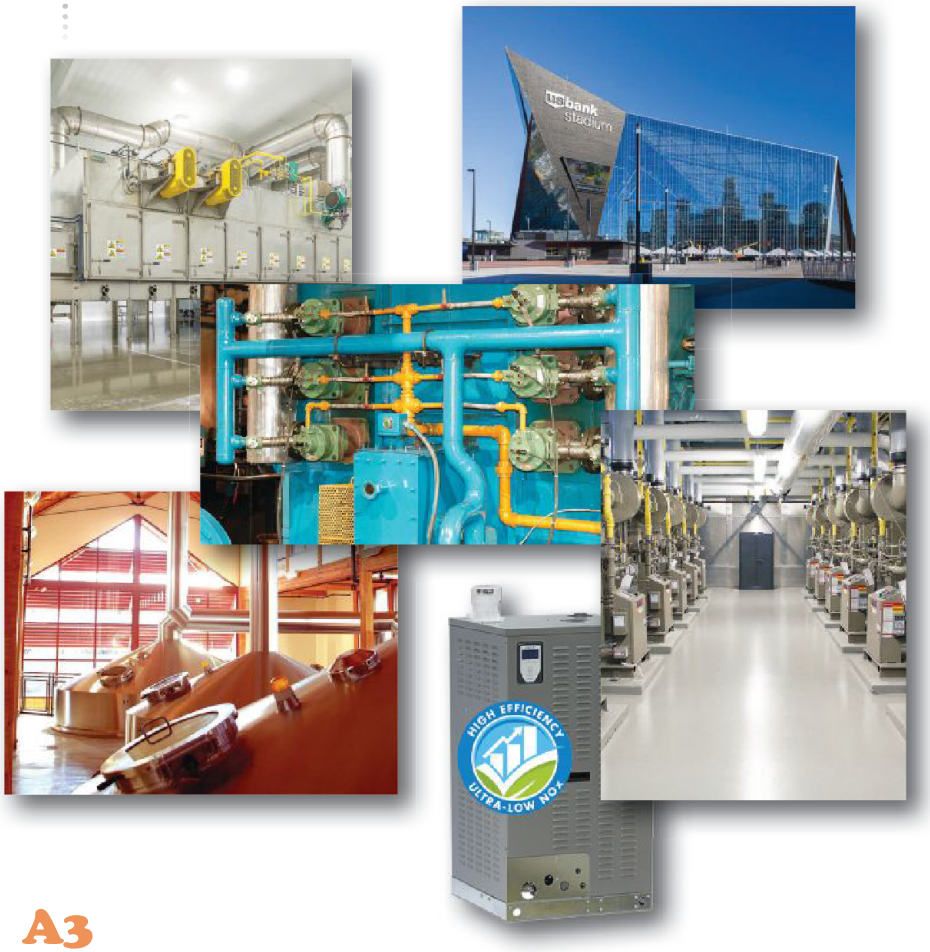


UNDERSTANDING BURNERS FOR HEAT-TREATING FURNACES

Industrial gas-fired heat-treating furnaces can operate more efficiently—and safely.

HEAT TREATING IS AN INDUSTRIAL PROCESS THAT ALTERS THE PHYSICAL PROPERTIES OF METAL BY HEATING PARTS OR COMPONENTS TO EXTREME TEMPERATURES TO ACHIEVE A DESIRED HARDNESS. According to the book, "Atmosphere Heat Treatment," by Dan Herring, president of The Herring Group Inc., "Heat treatment of semi-finished goods takes place in box, pit, mechanized box, and custom-designed equipment being either batch type or continuous throughput designs, which are primarily direct or indirect-fired. Processes include annealing, brazing, case hardening (carburizing/carbonitriding, nitriding/nitrocarburizing), hardening, normalizing, sintering, stress relief, and tempering to name a few."

Typically, ovens operate at temperatures below 800°F to 1,000°F and furnaces operate above this level. Ovens and furnaces used for heat treating can be heated using electrical heating elements or gas-fired burners. This article focuses on burners for gas-fired heat-treating furnaces.

Heat-treating furnaces typically have multiple burners that can either heat the furnace atmosphere directly or through a network of radiant tubes. Increasingly, furnaces have sophisticated digital controls for temperature management, process control, and for assurance of safety through flame detection and stabilization.

Efficiency is More Important Than Ever

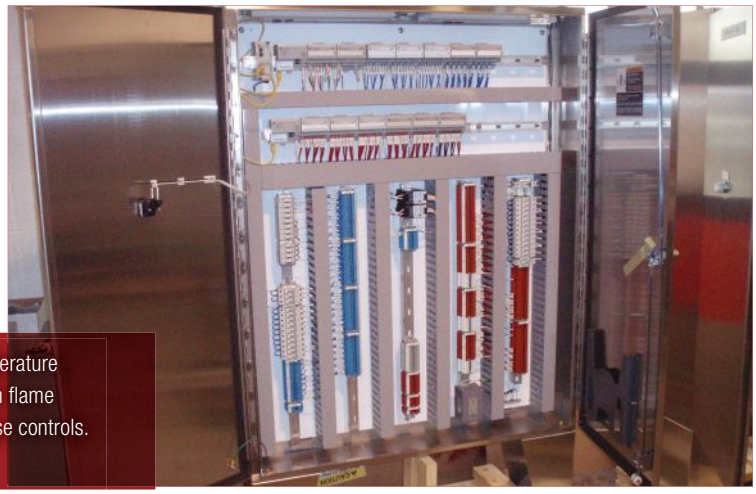
Most heat-treating furnace projects have an energy-efficient burner design incorporated into new project requirements. "As recently as the 1970s, it was not uncommon to find burner efficiencies in the range of 25% to 35% as the best available technology," said Jim Roberts, specialist-application professional, ETO (engineered to order) at Honeywell Thermal Solutions. Then came fuel shortages and rising costs. "All of a sudden, it was critical to contain the process costs associated with heat treating, and to become fuel efficient. This spurred burner companies to develop burners that recover some of the waste heat they generate, and to return it to the process. The most efficient way to do this is to preheat the air used in the combustion of fuel gases. When the air is preheated before being mixed with the gas, it can render fantastic fuel efficiency gains if done correctly." Roberts estimates that fuel efficiencies around 60% for high-temperature burners are now possible.

According to Michael Cochran, marketing engineer, combustion systems at Bloom Engineering Company Inc., while there are some efficiency enhancements due to improved materials or insulators, the biggest improvements have been made in control and process advances. "With a careful engineering analysis, it often is possible to obtain more efficiency by optimizing either process or system control. As an added benefit, in many cases, such optimization does not require substantial physical hardware upgrades."

Jerry Last, vice president of Furnace Solutions Inc., says, "Every furnace style and every application present different inefficiency issues to overcome. In regard to heat treating, a common issue is getting efficiency out of a tube-fired burner. For many years, that efficiency was limited to the tube itself, because the tube could only shed so much heat per square inch. Significant strides have come with the tube material and design that assists in that. Additionally, over the past 15 years or so, design advances in how the burner fires within the tube allows the tube to be fired uniformly along its entire length as well as more efficient "scrubbing" of the tube, which together allow for much higher tube loading."

Recuperative Versus Regenerative Burners

In order to boost efficiency, many industrial processes use heat recovery systems that will strip heat out of the waste gases and deliver it back to the process. Cochran explains that recupera-



Heat-treating furnaces have sophisticated digital controls for temperature management, process control, and for assurance of safety through flame detection and stabilization. This panel shows typical wiring for those controls. Photo courtesy: Bloom Engineering Company Inc.

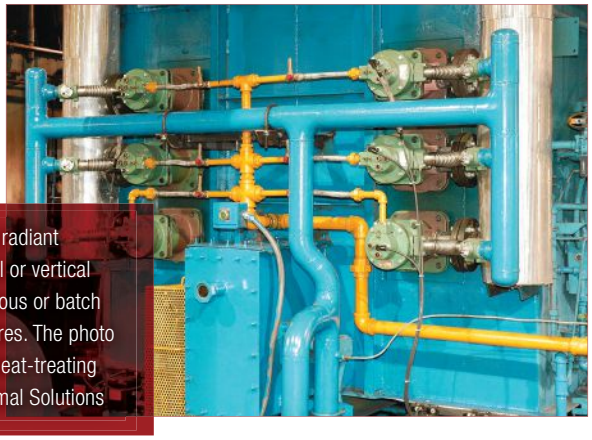
Bloom Engineering's line of radiant tube products, regenerative burners, and high thermal release (flat-flame) burners are some of the most advanced in terms of emissions mitigations, according to Cochran. Photo courtesy: Bloom Engineering Company Inc.

tive systems affect this heating by using an external (usually metallic) heat exchanger where the waste gases flow through the hot side (thus cooling off) and the combustion air flows through the cold side (thus accepting heat to return to the process). So, recuperative burners recover heat from the tube exhaust and use it to preheat fuel gases. "For a regenerator, the waste gas and air alternately flow through a common case of heat storing (often ceramic) material. As the waste gas passes through, it gives up heat to the media, and when the air passes through later, it retrieves the heat and brings it back into the process," Cochran said.

Regenerative burners are alternately fired in opposite directions and discharge exhaust through a refractory bed or case, which captures a large portion of the heat. When the refractory is heated, the flow is reversed and the opposite end of the tube collects exhaust heat. The goal of both regenerative and recuperative designs is to capture heat energy that would otherwise be wasted.

Last says that regeneration is extremely efficient and will cut most fuel bills in half. "Regeneration is relatively costly, difficult to incorporate in a retrofit, difficult to incorporate in smaller furnaces, and often more impactful is the amount of additional maintenance that is required. Recuperation is simply using a heat exchanger in the waste gas stream. The combustion air passes through the heat exchanger (recuperator), allowing the combustion air to preheat. Recuperation is very simple, less expensive, smaller footprint, easier to meet temperature uniformity at lower temperatures, easy to incorporate in a retrofit, and often will provide a fuel reduction of 30%."

According to Roberts, the Eclipse SER V5 recuperative radiant tube burners from Honeywell Thermal Solutions are well suited to retrofit burners and external recuperators in existing furnaces. The SER V5 can be mounted in horizontal or vertical configurations and is suitable for either continuous or batch type furnaces with a variety of atmospheres. For the direct fired side of heat treating, Roberts said, the Eclipse TJSR V5 is a direct fired, self-recuperative burner with a space saving, integral eductor that pulls the furnace exhaust through an internal ceramic recuperator. The recuperator preheats the incoming combustion air to very high levels, which improves furnace operating efficiency to reduce fuel usage by as much as 50% over typical ambient air burners.



Honeywell's Eclipse SER V5 recuperative radiant tube burner can be mounted in horizontal or vertical configurations and is suitable for continuous or batch type furnaces with a variety of atmospheres. The photo shows an external view of a batch-type heat-treating furnace. Photo courtesy: Honeywell Thermal Solutions

Cochran says, "While the physical burner hardware (rightly) receives quite a bit of attention, Bloom is making important contributions to the control of the system. One of our most innovative recent developments has been to reinvent the control of a regenerative system. By fundamentally changing some of the key components (physical and conceptual) in regenerative system control, we have been able to increase fuel efficiency, boost productivity, and cut yield loss. We have always been at the forefront of emissions reduction research, and many of our burner products make use of technologies to reduce NO_x emissions. In particular, our line of radiant tube products, regenerative burners, and high thermal release (flat-flame) burners are some of the most advanced in terms of emissions mitigations."

In the most general of terms, industrial heat-treating chambers, which can be furnaces, ovens, or kilns, there are two types: batch and continuous. Cochran explains the differences: "Batch furnaces take a stationary load of material and put it through a thermal cycle. A continuous process takes a load and physically moves it through a heating cycle. In the broadest terms, often batch processes, such as aluminum melting furnaces, and forge furnaces, are good candidates for regenerative systems. However, recuperative systems are common for many continuous operations, such as steel reheat furnaces. In actual application, the distinction is not so clear-cut. Most applications, with proper engineering, can generally accommodate most types of combustion systems."

Controlling Burner Operation

Controlling burners is actually done by controlling the ratio of fuel and air to them. While a thorough definition of burner control can be extensive, Cochran provides a brief explanation: "A burner control sys-

This giant tilt-top heat-treating furnace has 30 TJSR self-recuperative burners, which is both burner and heat exchanger, and also serves as the flue for the burner. According to Roberts, the TJSR can achieve very good temperature uniformity and has proven fuel savings over existing burner systems. Photo courtesy: Honeywell Thermal Solutions

tem provides the proper amounts of air and fuel for good combustion. Fundamentally, there are two main ways, (with many variations) of controlling the air and fuel flows. First, a technique generally called pressure balance modulates the flow of air, and then uses a pressure regulator to permit a corresponding flow of fuel. The fuel flow always follows the air flow. The other major type of system allows for independent control of air and fuel flows. This system uses an algorithm to determine the flows of each, meaning that they can function somewhat independently of one another. The flexibility of such a system means that it is more versatile and can handle a wide range of process requirements."

Last adds that recuperative and regenerative burners can be controlled in any manner that cold air burners are controlled. As with cold air burners, the control style is determined by the application. Last offers the following control application examples:

- Tight temperature uniformity, large temperature control ranges, and narrow firing lanes are some reasons to consider pulse firing. Note that pulse firing consists of either high/low or on/off firing. The decision between those two is primarily determined by the operating temperature range.
- Lower temperatures or incineration requirements are some reasons to consider fuel-only control.
- Higher temperatures are typically on-ratio. Very efficient and simple air primary control via a modulated valve on the air with cross-connected regulators on the gas work well. Additionally, single-zone applications often can incorporate variable frequency drives (VFDs) on the combustion blower removing the valve/actuator setup and adding another level of efficiency.
- Tube fired burners would be high/low, on/off, and possibly pulse fired.

Keeping an Eye on Combustion Safety

Because combustion necessarily involves igniting natural gas, safety is always a concern. "Some systems, such as atmosphere furnaces, require more built-in safety, and some systems, such as tube-fired burners that have explosion-resistant tubes require less," Last said. "In addition, each application requires specific items, such as self-checking ultra-violet (UV) scanners on systems operating more than 24 hours without shutting down.

"Generally, there is a strainer/drip leg to make certain the supply gas to the system is clean," continues Last. "There often is a pressure-reducing regulator to not only reduce the incoming gas pressure but also to maintain a more stable pressure to the system. There is a gas train that makes certain the gas pressures are within the high and low limits of the components and burner firing capability. The gas train has both automatic and manual shut-off valves. The manual valves are for when the system is down and for leak testing. The automatic valves are interlocked with the flame supervision, which allows gas and ignition during a trial-for-ignition period. After the trial-for-ignition period, if there is no flame proven in the burner, the gas is shut off. If the flame is proven at the end of the trial-for-ignition period, the gas remains on and the system is released to control.

"The combustion blower also is tied into the safeties by a motor-starter contact, low air-pressure switch, and typically a high proof-of-flow switch for the purge. The purge is done prior to the trial-for-ignition to remove the potential for any combustible substance in the system. The purge is typically done with the burners at 100% output and the system doors closed. The trial-for-ignition typically is done with the burners at 0% output and the system doors open. There are excess temperature controllers required to make certain there is not an out-of-control temperature situation in the furnace. Also, there is a remote shut-off valve located away from the equipment that would shut off the fuel to the system in case of an emergency."

MORE info

BLOOM ENGINEERING COMPANY INC.
www.bloomeng.com

FURNACE SOLUTIONS INC.
http://furnacesolutionsinc.com

ENERGY SOLUTIONS CENTER
www.energysolutionscenter.org/gas_solutions/heat_treating.aspx

THE HERRING GROUP INC.
www.heat-treat-doctor.com

HONEYWELL THERMAL SOLUTIONS
http://thermalsolutions.honeywell.com

U.S. DEPARTMENT OF ENERGY
www.energy.gov

Take Initiative in Finding Savings

Additional information on improving furnace and burner process efficiency is available on the U.S. Department of Energy website (www.energy.gov), and from the various furnace manufacturers. Many furnaces in industrial use today that have not been recently upgraded are operating at less than optimum efficiency, and would benefit from a professional review, with a view to upgrading or replacement. **GT**

CHP: Brewing up Energy Savings

Improved efficiency, inexpensive fuel source, control over power and heat, and access to high-quality onsite-generated power and heat make combined heat and power (CHP) an increasingly attractive prospect.

COMBINED HEAT AND POWER (CHP) SYSTEMS—ALSO KNOWN AS COGENERATION SYSTEMS— generate electricity and usable thermal energy from onsite generator sets. CHP systems can reduce operating costs, increase electrical reliability, and reduce greenhouse gases. In the process of generating electrical energy, the mechanical work produces useful heat.

Instead of releasing the thermal energy into the air, the excess heat from the electrical generation process is captured and used beneficially, making the efficiency of a CHP system roughly twice that of a generator set. Typically, CHP systems are used at facilities with high heat load requirements, such as colleges, hospitals, industrial campuses, and yes, breweries.

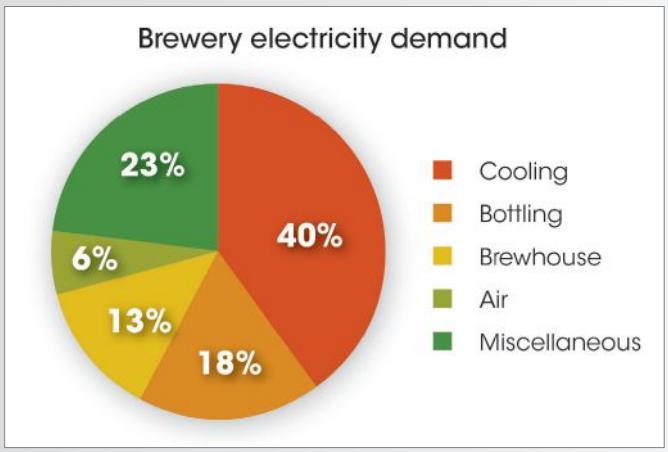
CHP system types

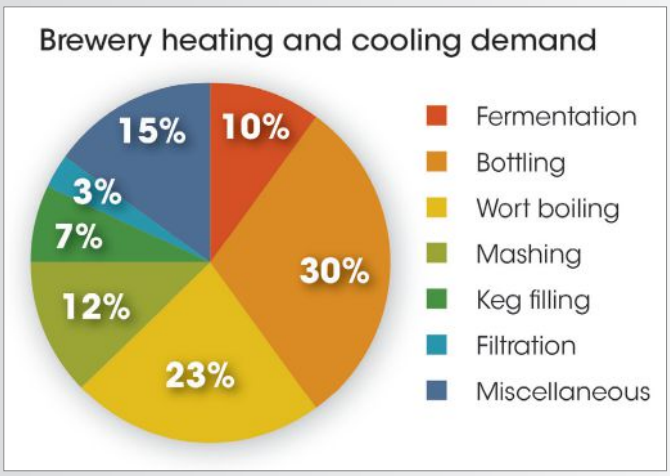
CHP system types include back-pressure, steam turbines, gas turbines, and reciprocating engines. They are identified by the prime-mover technology, configured with a generator, heat recovery, and electrical connections.

Back-pressure or non-condensing steam turbines can be matched with multifuel boilers, industrial waste heat, and gas turbine waste heat. High-pressure steam is used for the rotation of the turbine blades. The low-pressure steam is used for processes and none of it is used for condensate. Gas turbines create high-temperature exhaust heat that is well-suited to high-pressure steam production required by process industries.

Reciprocating engines total more than half of the CHP systems in place in the U.S. They produce exhaust heat ideal for hot water production and generally have a higher electrical energy-to-thermal energy output than a standard combustion turbine.

Reciprocating engine generators are often chosen for their rapid startup times, high electrical efficiencies, ability to respond to changing load patterns, and proven reliability, especially with multiple units. Byproduct heat from an engine-generator set comes from several sources. These include engine jacket cooling water and heat recovered from exhaust gases.





The graphs illustrate both the electrical (above) and thermal (below) demand in breweries. Image courtesy: Clarke Energy

Energy Efficiency Benefits of CHP

For many industrial users, natural gas-powered engine generation represents an ideal source for site electrical power, plus it offers significant byproduct heat from the engine for a wide variety of thermal applications. Today's advanced engine generators have efficiencies well beyond gensets of a few decades ago. When paired with proper CHP design, these systems provide efficiencies of more than 85%.

"When recovering the surplus heat from the generator the overall efficiency of the plant can exceed 90%," said Alex Marshall, group marketing and compliance director at Clarke Energy, (i.e., 45% electrical efficiency plus 45% thermal efficiency)."

Using CHP in Breweries

"Industrial applications, such as breweries, food processing, or tissue paper are great fit for CHP because both the thermal and

power outputs are used making the overall system more efficient," said Dalia El Tawy, director of thermal power solutions in Distributed Energy Systems Center of Competence at Siemens Energy. "Depending on the load requirements of the application, the CHP technology can be determined."

"CHP or cogeneration has significant potential in the brewery industry," says Marshall. "Electricity and heat recovered from a gas engine can be deployed at high efficiency for useful onsite use. This gives the ability to reduce operational costs and to reduce carbon emissions. Converting the heat into cooling via absorption chillers is called combined cooling heat and power (CCHP) or trigeneration and can be deployed to support the cooling requirements of the brewery."

Marshall lists benefits of CHP for the brewery industry:

- **Energy cost savings**—Overall electrical and thermal efficiencies can reach 95% using a wide fuel range
- **Resilient and robust power**—You don't have to rely on the grid alone to ensure your facility has the power it needs 24/7
- **More environmentally friendly**—Less fuel burned per MW generated at lower CO_2 emissions
- **Dry low emission (DLE)** technology can sustain lower emissions levels while eliminating system water requirements
- **Standardized design**—A smaller footprint is scalable to your unique spatial requirements

New Belgium Brewery's two dozen craft beers are brewed with the support of a CHP system fueled by organic waste from the brewing process—saving costs and improving sustainability. Photo Courtesy: U.S. Department of Energy Southwest CHP Technical Assistance Partnership

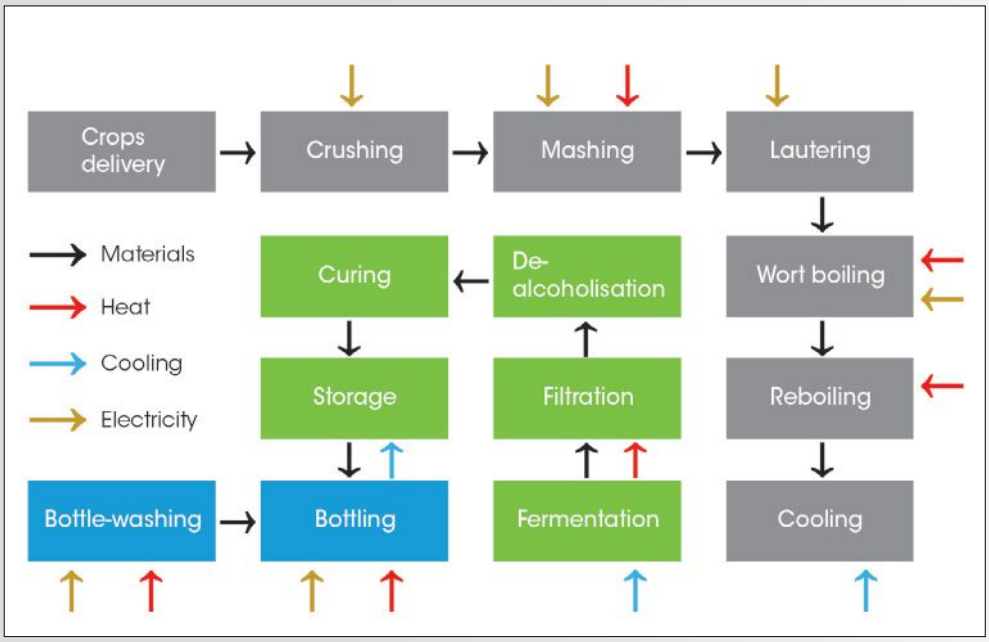
- **Flexible power**—Thermal energy can be stored for use; electricity can be fed into the public grid or used for artificial lighting, and an optional full island lighting control system is available
- **Simplified maintenance**—Fast replacement and onsite maintenance is critical for continued operation.

Marshall explains that the processing steps of wort boiling and bottle washing require more than half of the thermal energy needed in breweries. Electricity is used for refrigerating purposes in storage and fermentation. "Because the temperatures of CHP thermal discharges range from 113°F to about 356°F (exhaust gas), large potential arises from low-temperature heat consumers, such as bottle washing, which is done at a temperature around 194°F, and filtration. Two main criteria positively affect the efficiency of CHP facilities in breweries: A larger number of low-temperature processes and a constant heating and/or cooling demand," Marshall said.

High energy renewable biogas can be created from byproducts of beverage production and wastewater treatment. Instead of considering them waste, they can be converted into electricity and thermal energy to be used in your process, significantly cutting operating expenditures. CHP also reduces your electricity costs, according to Marshall.

Although not every brewery requires sufficient heat to operate a CHP facility for their production, CHP also can be financially beneficial for smaller companies such as craft breweries. Because many also offer hospitality, the combined thermal demand of brewery and guest rooms serves as a heat sink of the CHP plant. Thereby, separate sources of thermal energy for production and domestic heating become obsolete.

New Belgium Brewing Company, Fort Collins, Colo. is an example of a major craft brewery that has selected a CHP solution. New Belgium is the 4th largest craft brewery and the 7th largest brewery in the U.S. It produces more than two dozen different beers and about 960,000 barrels of beer annually. The company prides itself on environmental innovation, energy efficiency, conservation, and recycling.



The brewing process comprises three major processing stages, namely the brew house (grey), storage and fermentation (green), and bottling (blue). The processing steps within these stages require energy in the form of electricity, heating, or cooling. Image courtesy: Clarke Energy

Reasons for CHP

The City of Fort Collins was charging the brewery a large "plant investment fee" (PIF) for the construction of infrastructure to process the brewery's high-strength wastewater in the municipal water system.

Instead of paying the city's PIFs, the brewery invested the money in a 225,000 gal/day onsite process water treatment plant, including anaerobic digestion. New Belgium uses the methane produced by the digester to generate renewable electricity and heat in a combined heat and power (CHP) system.

CHP System Equipment and Configuration

The first phase of New Belgium's CHP system was a 264-kW engine with heat recovery, initially located within the Brewhouse and at the brewery's process water treatment plant. The engine was manufactured by Guascor (the Guascor reciprocating product line has been acquired by Dresser-Rand; Dresser-Rand has been acquired by Siemens. The product line has been renamed "Siemens Gas Engines"), and the system was designed by a Belgium-based Continental Energy Systems. The engine is fueled by the methane-rich biogas from the brewery's process water treatment plant.

The second phase of New Belgium's system is a 500-kW Guascor engine, which also is fueled by biogas and is located adjacent to the Brewhouse. Natural gas is used to start up and shut down the engine to mitigate corrosion risk from methane. The engine is programmed to react to coincident peak notifications, and it operates approximately 12 hours per day. Heat generated by the engine is transferred into a hot-process water storage tank, which provides water for the brewing process. At the same time that the 500-kW engine was installed, the brewery added a second methane storage balloon to the process water treatment plant, expanding the brewery's methane storage capacity.

CHP Operation

The CHP system runs 10 to 15 hours per day, depending on the amount of available biogas and the time of day. It is set to start when the methane storage balloon approaches 100% capacity and continues to operate until the methane volume is at 20%. Strategic programming also is in place to assure the CHP is running during the utility's peak loads. The New Belgium Brewing Company staff performs the required maintenance on the unit.

Case-by-Case Evaluation

Users need to evaluate project feasibility on a case-by-case basis. In the case of natural gas-fueled CHP, users trade the capital costs of equipment and increased fuel costs for lower electricity costs. Electricity savings must exceed the increased natural gas, capital, and operating costs to realize project profitability.

Many large industrial energy users are good candidates for natural gas-fired engine CHP. If your installation uses large blocks of electric power, and at the same time needs hot water or steam for process or comfort applications, now might be the time to have a qualified engineer do a study of this option. And if it has been some years since you have done such a study, it might be time to take another look. **GT**

MORE info

CLARKE ENERGY
www.clarke-energy.com

ENERGY SOLUTIONS CENTER
www.understandingchp.com

SIEMENS ENERGY
www.siemens.com/global/en/home/products/energy/power-generation/power-plants/combined-heat-and-power.html

U.S. DEPARTMENT OF ENERGY SOUTHWEST CHP TECHNICAL ASSISTANCE PARTNERSHIP
www.southwestCHPTAP.org

U. S. Bank Stadium: America's Newest Sports and Entertainment Venue

Natural gas helps to maximize the efficiency of the stadium's operations for a better bottom line.

U.S. BANK STADIUM, TOUTED AS THE LARGEST PUBLIC WORKS PROJECT IN MINNESOTA HISTORY, is more than just a location. It is an epicenter of excitement, opportunity, and Minnesota pride. Football is an important part of Minnesota's heritage and the relationship between the Vikings and the citizens of Minnesota runs deep. But the stadium is not just the home of the Minnesota Vikings; it's a facility that will host major national and international events that create economical, fiscal, and social benefits to the region. At nearly twice the size of the old Metrodome, this facility has seven levels, two concourses, and seating for more than 66,000 people.

Stadium Food is Modern, Memorable, and Minnesota

The drinking and dining opportunities cater to the desires of fans and foodies hunting for fresh flavors to traditionalists seeking familiar game-day fare. In creating the menu, the stadium's foodservice concessionaire worked with the theme "Modern, Memorable, and Minnesota" to create a mix of food from vendors big and small, incorporating many local and well-known brands that have long standing traditions to the Twin City market. With more than 66,000 seats, the venue serves as center stage for prominent national and international programming including sporting events, concerts, family shows, conventions, general sessions, trade/consumer shows, weddings, and other large special events. And with the many pieces of high-efficiency gas cooking technologies employed throughout the facility, the culinary team consistently produces high quality products.

Multi-kitchen facility incorporates these gas cooking technologies:

- 26 – Vulcan TR45 fryers
- 4 – Vulcan convection ovens
- 4 – Vulcan VTEC charbroilers
- 15 – AccuTemp steam griddles
- 6 – Blodgett Convection ovens
- 5 – Rotisol infrared rotisseries
- 2 – Cleveland steam kettles
- 4 – Alto Shaam Single Combi ovens
- 4 – Alto Shaam double Combi ovens

Total combined cooking equipment load more than 7,000,000 BTU/hour

Gas fryer savings
1 fryer used 5 hours/day
Gas = $3.60
Electric = $11.00

Comparison based on natural gas cost of $.60/CCF and electricity at $.10/kwh.

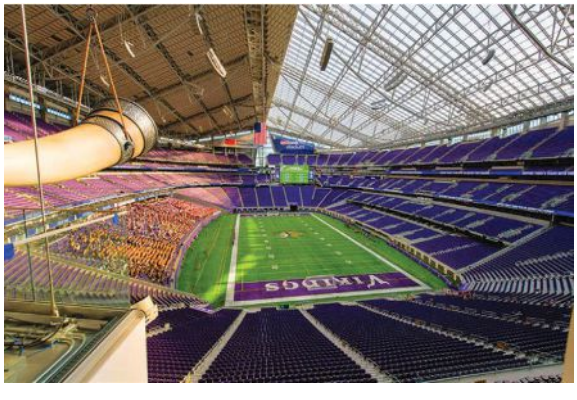
MORE info

CENTERPOINT ENERGY
www.centerpointenergy.com/foodservice

ENERGY SOLUTIONS CENTER INC.
www.energysolutionscenter.org

U. S. BANK STADIUM
www.usbankstadium.com

Natural gas has proven to maximize the value and efficiency of the overall energy needs for the stadium and its massive food service operation. Factoring in the CenterPoint Energy food service rebates, which helps reduce the installed cost of natural gas equipment makes gas equipment an easy choice. Minnesota Sports Facilities Authority (MSFA), owner and operator of U.S. Bank Stadium, worked closely with CenterPoint's Food Service Energy Efficiency Expert Ann Lovcik in monitoring available gas equipment incentives, which amounted to more than $37,000 for this project. Many gas utilities offer similar programs that can significantly reduce the cost of installing natural gas equipment. **GT**



Advances in Dryer Design

Industrial Dryers are overcoming unique challenges.

INDUSTRIAL DRYERS ARE AMONG THE MOST VERSATILE PIECES OF EQUIPMENT WITHIN THE INDUSTRIES THEY SERVE. There are many configurations for many applications. They are widely used for drying wood, paper, painted surfaces, plastics, livestock feed, pharmaceuticals, food products, and many more materials. They range from large conveyor dryers to small batch units and are most commonly fueled by natural gas.

Overcoming Unique Drying Challenges

Food and feed dryers can be complex because of the need for energy efficiency, process control, drying uniformity, and sanitary designs. Food dryer technology changes constantly. The most recent improvements are seen in energy efficiency, process control, and drying uniformity. Developments in controls that allow more precise control of temperatures throughout the process account for energy efficiency advances.

"We have unique applications, such as gelatin, where we must have intimate process knowledge to control the rate of drying without degrading or destroying the material," said Frank Poandl, associate chief engineer at Bühler Aeroglide, a major manufacturer of drying equipment. "Drying gelatin noodles is counterintuitive to most drying applications. For most wet products, we gradually use a high-to-low air temperature profile because the high inlet moisture evaporates and keeps the product temperature cool. However, gelatin is extremely sensitive to the air temperature and we must slowly increase the product temperature because the gel has a low melting point. If the gel begins to melt, then the air gaps between the noodles seal and mass transfer of water from the product to the air is inhibited."

Each compartment of this pet food dryer installed in Canada can be accessed for cleaning. Photo courtesy: Bühler Aeroglide

Food and livestock feed aren't the only applications that present unique drying challenges. Kiln-drying lumber is another demanding drying application. Drying lumber requires many days, and aggressive attempts to reduce the drying time can result in the wood either splitting or cracking.

Overcoming drying challenges, such as uniformly drying nonuniform products and reducing the drying time of heat-sensitive products, also can be difficult. For example, molded-fiber packaging products, such as egg cartons and protective packaging used during transit, need ample drying time. Thin-wall products can dry in less than 10 minutes, whereas engineered thick-wall protective packaging could take up to an hour to dry. For every pound of dry fiber that enters a dryer, there typically is up to four times as much water by weight, which requires a lot of energy to adequately dry. Advanced controls, such as proportional-integral-derivative (PID) temperature controllers that can run sophisticated ramp-and-soak profiles typically overcome these types of challenges.

Matching the Dryer with the Application

"Conveyor dryers are best suited for steady state continuous processes, where the product has a uniform shape and size distribution," Poandl said. "Our conveyor dryers gently handle products and expose them to conditions that are carefully monitored and controlled for individual zone control. In these zones, we are able to adjust process parameters such as temperature, hu-

Inline roasters, such as this almond roaster installed in California, are an economical solution for low-capacity lines. Photo courtesy: Bühler Aeroglide

midity, and airflow to control the rate of drying."

"Rotary dryers are best suited for random-sized bulk materials where size degradation during drying is not a concern," said Michael Whaley, principle process engineer at Bühler Aeroglide, which offers both continuous conveyor and rotary dryers. "The combination of air movement and mechanical forces create a differential in retention time in rotary dryers that allows the different sized particles to achieve uniform moisture content at the discharge."

Keeping an Eye on Efficiency

Most dryer users in North America are interested in reducing energy costs and exhaust volumes, according to Whaley. Many of the large multinational companies have directives to reduce the greenhouse gas emissions, he said.

Poandl says that Bühler Aeroglide is addressing energy efficiency by (depending on the process) exploring options for energy conservation through reusing exhaust air from cooler, cascading airflow inside the dryer, as well as heat recovery through external features, such as flash steam systems, air-to-air heat exchangers, air-to-water/glycol coils, heat pumps, and hot waste water/fluid from other processes. Some of the applications with relatively high evaporation rates financially justify the additional equipment cost with an excellent return on investment and payback periods.

Poandl explains that the principle design feature of the Bühler Aeroglide dryers is that a large portion of the air used for drying is recirculated. "We introduce dry makeup air and expel wet exhaust air as necessary to promote energy efficient drying. Energy consumption depends highly on the evaporation rate from the product so it is difficult to generalize across markets and show a fixed quantity or percentage. We balance exhaust and make-up air volumes to maintain absolute humidity levels that are optimal for drying and energy efficiency," he said.

Because the evaporation of water is an energy intensive physical phenomenon, Whaley suggests investigating methods to reduce the moisture content of the product prior to drying.

Keep Maintenance a Priority

As with any industrial equipment, preventive maintenance is an important aspect of dryer operation. Most of today's dryers are built to a high reliability standard, but this can breed complacency in performing recommended inspections or activities, such as lubrication and belt replacement. Because drying often is a key step in a longer process, a dryer outage can stop an entire line, cause loss of product, and require considerable labor to get the process moving again.

After initial dryer startup, a regular PM program should be established to eliminate unscheduled downtime. Regular inspections should be scheduled by a qualified engineering expert with a goal of anticipating mechanical or structural failure.

A Long-Term Relationship

Because dryers have proprietary design and operation features, the process of selecting a dryer manufacturer should be carefully done, with a look toward the long term. After the dryer is selected, owners will likely maintain a relationship with its manufacturer for years. For that reason, industrial buyers should look not only at the equipment, but at the manufacturer's ability to support the product, promptly provide parts and service, and train plant operators and maintenance staff.

Look for a provider within the industry that has a history of customer support. Take advantage of the energy-conserving features of the newest dryer designs, as these will become increasingly important. Because you will be living with it for a long time, make sure your new dryer is a good match for your product. **GT**

MORE info

BÜHLER AEROGLIDE
www.buhlergroup.com/northamerica/en/process-technologies/drying.htm

ENERGY SOLUTIONS CENTER
www.energysolutionscenter.org/gas_solutions/process_equipment_dryers.aspx

INDUSTRIAL GAS HUMIDIFICATION

Gas humidification systems are becoming increasingly popular across North America due to the relatively low cost of natural gas.

GAS-FIRED HUMIDIFICATION IS A GROWING MARKET IN NORTH AMERICA as companies realize the importance of humidification for the health of their employees and of their equipment. Gas humidification is being chosen over other technologies because of its simplicity and the cost-effectiveness of natural gas. Gas humidification is being used in printing facilities, high-tech manufacturing plants, schools, hospitals, and office buildings.

Humidification in Industrial Environments

In general, between 30% and 60% relative humidity (RH) is optimal, according to Phil Lilja, product manager at DriSteem. "The recommended RH level can vary by application so we encourage those responsible to reference the DriSteem humidification handbook with RH levels recommended for processes and ASHRAE 55-2017: Thermal Environmental Conditions for Human Occupancy for more detail on acceptable ranges for humidity," Lilja said.

Chris Habets, business development manager for energy and sustainability at Nortec Humidity says that humidity levels strongly depend on the process and suggests that a 40% to 60% RH is required for many industrial processes. This level is ideal for preventing electrostatic discharge and for employee health without risking condensation forming on equipment.

Humidification systems are installed in industrial facilities to eliminate electrostatic discharge (ESD), hygroscopic material protection, health, and human comfort. "Fluctuating and low relative humidity levels contribute to a number of problems in commercial applications including production line disruptions or failures, loss or degradation of materials, inconsistent environmental conditions in labs and other critical applications, and negative effects on occupant health," said Lilja.

Habets added, "Companies humidify their industrial environments to meet air-quality standards for their processes and for their employees. Many production environments require that the RH around the equipment and products be maintained to prevent damage from electrostatic discharge, to ensure material maintains the correct properties for processing, or to ensure paints adhere properly. Additionally, proper humidification can prevent infection spreading among employees."

Eliminating ESD is important not only for worker comfort and safety, but also to protect settings and calibration on electronic devices including process controls. Hygroscopic materials including wood, paper and leather require higher ambient humidity levels to assure dimensional stability and product quality. Printing operations and paper storage require especially tight controls on humidity to prevent paper from shrinking, curling or jamming in processing equipment.

DriSteem recently introduced the GTS humidifier LX series, which is the only high efficiency gas-fired humidifier combined with ultra-low NO_x in one unit. Photo courtesy: DriSteem

Gas Versus Electric Humidifiers

Although there are other approaches to adding humidity to a building, such as direct steam injection into the air stream, which would require the facility to have a steam boiler, only natural gas and electric humidifiers are considered for this comparison.

The choice of humidification system depends on many factors including the energy source available, capacity required, supply water, available space, and maintenance requirements. Lilja explains the different types and their advantages:

- Gas-fired humidifiers have the lowest operating cost for a steam-generating humidifier, and a broad capacity range
- Electric resistive humidifiers have a broad capacity range and very accurate control capabilities
- Electrode humidifiers are easy to maintain—simply replace the cylinder—and the lowest first cost
- Adiabatic humidifiers provide humidification and evaporative cooling at the same time.

According to Lilja, if natural (or LP) gas is available as an energy source and there is the ability to vent flue gases to the outside, gas-fired humidifies, such as the recently introduced GTS humidifier LX series, are an excellent choice for museums, libraries, government/military facilities, and industrial facilities (manufacturing, pharmaceutical, biotech, etc.).

Operational cost is the main advantage of gas humidifiers over electrical units. "The operational cost of efficient gas fired humidification typically provides a very fast payback over electric humidification," Habets said. "Additionally, natural gas humidifiers can provide much higher loads out of a sin-

Case Study: Gas Humidification Keeps Museum Artifacts Safe

The Glenn H. Curtiss museum in Hammondsport, N.Y. is dedicated to preserving the history of flight. Rooms are filled with artifacts dating back to the first flight of Glenn H. Curtiss in 1908, which was the first official, pre-announced public flight in the U.S.

Visitors can take a trip back in time to the early days of flight, viewing actual aircraft, replicas, and objects that are a part of early aviation history. But what the observer of these historical objects won't see is that the preservation of artifacts in this institution was once in danger because of a lack of proper humidification.

The Glenn H. Curtiss museum in Hammondsport, N.Y. uses the DriSteem GTS gas-to-steam humidifier to keep its artifacts at the proper humidity level. Photo courtesy: DriSteem

The Importance of Maintaining Proper Humidification

The Curtiss museum is filled with hundreds of objects containing a variety of materials, such as wood, canvas, fabric, and paint that are subject to cracking, chipping, peeling, and distortion without proper humidity levels—ideally 40% to 60% relative humidity (RH). When the Curtiss Museum opened, a humidification system was not installed, and the RH level hovered between 3% and 10%. Jim White, the museum's engineer, knew that he needed to maintain humidification at an RH level of at least 40% with minimal fluctuation (±3%), or jeopardize the preservation of the museum's contents.

Meeting the Museum's Specifications and Budget

White had specific objectives in choosing a humidification system. "My first consideration was to find a system that could handle a large area yet fit in the limited floor space I had available," said White. The local DriSteem representative, Brian Willemsen of R.L. Kistler, suggested a steam-to-steam humidification system. This system provides chemical-free steam to the space and, because it uses boiler steam as the heat source, it has very low energy costs.

There was just one problem: The museum does not have a boiler. "We knew the steam-to-steam product would work for the museum, but to operate the system, the facility would have to invest in a boiler," Willemsen said, "and we just didn't want them to have to make that extra investment."

Because the museum has natural gas as an energy source, Willemsen told White about the DriSteem GTS gas-to-steam humidifier, which can provide chemical-free, low-cost humidification with the control the museum required and fit in the allotted space, without adding additional equipment. "What excited me most about the GTS humidifier was the fact that it was a direct-fired, stand-alone unit that could be provided with an area-type steam distribution system designed to distribute steam in large spaces without ductwork," said White. "And, I was certainly excited about the lower energy costs we would incur by using natural gas instead of electricity."

Meeting Humidification Demands

"The GTS humidifier from DriSteem has met all of my expectations," White said. "I thought we may need to add one more unit to humidify the 2,000 cfm continuous outdoor air supplied by our rooftop air conditioners. But we're up and running at ideal RH levels and the single GTS humidifier is performing beautifully."

Now White can claim with confidence that the artifacts in the Glenn H. Curtiss museum are being preserved for future flight history enthusiasts. Visitors can continue to explore their fascination with man's ability to fly and see firsthand the history of aircraft at the Glenn H. Curtiss museum.

gle unit than an electric unit, which reduces installation time and controls complexity."

Both electric and gas humidifiers are efficient. "While electric humidifiers are nearly 100% efficient in operation, the cost of electricity per energy unit is two to three times higher than that of natural gas," said Lilja. "DriSteem's GTS LX series gas-fired humidifiers operate at up to 93% efficiency, making the cost of operation much less than that of an electric steam humidifier."

In the following table, Habets describes an example of switching a building from electric steam to natural gas. The example uses New York weather and rates and 175 lb/hr loading.

Gas Humidifier Industry Offers Help

When looking for any humidification system, Habets says to take into account the actual humidification design load of the system, which is often during peak airside economizer season. "Ensure that the building design allows for proper venting—either vertically or horizontally—per the manufacturer. Don't forget to consider efficiency of different gas-fired humidifiers, and don't be afraid to reach out to a manufacturer or their representative for more information," he said.

Lilja says that DriSteem's EnergyCalc calculator allows users to compare gas and electric humidification costs in their area. In many locations, the savings from switching to gas are so significant that they can replace old electric units with new GTS gas humidifiers from DriSteem and let the energy savings pay for the cost and installation. **GT**

MORE info

DRISTEEM
www.dristeem.com

NORTEC HUMIDITY
www.humidity.com/gs-series-gas-steam-humidifier

ENERGY SOLUTIONS CENTER
www.energysolutionscenter.org/gas_solutions/humidification.aspx

GAINING EFFICIENCY FROM HYDRONIC BOILERS

Hydronic systems are gaining popularity due to their ease of installation, quiet operation, and safety compared to other heating technologies.

HYDRONIC HEATING CAN BE USED FOR MANY APPLICATIONS. Typical applications include hydronic building heat, snow melting (sidewalks, loading docks), indirect domestic hot water (where showers, sinks, dishwater, etc. are heated indirectly through a heat exchanger), indirect pool heating, water-source heat pumps, and reheating. There also are process applications including the food and beverage industry, automotive and aerospace painting facilities, and various other niche manufacturing processes.

Lower water temperature means higher efficiency

Condensing hydronic boilers can operate at efficiencies higher than 90%. The key is to have incoming feedwater at temperatures below 140°F, and to be able to either modulate the boiler or have sufficient redundancy that operating units can be held near their optimum efficiency.

Kyle D. Bottorff, product manager at Fulton Heating Solutions Inc. explains how this works. "Lower water temperatures allow the heat exchanger material to get below the dewpoint temperature of the combustion flue gases. When this occurs (typically when operating at return water temperatures lower than 137°F for natural gas), the water vapor in the flue gases condenses to liquid, releasing 8,340 Btus for every gallon formed. This heat passes through the heat exchanger into the process fluid (water or water/glycol solution). As the system return water temperature decreases even further, the amount of condensate formed increases, therefore increasing thermal efficiency. There are variables that can affect the dewpoint temperature, such as fuel type and excess air percentage that the selected burner technology requires," he said.

The photo shows a commercial installation of three Endura 1,000 MBH firetube condensing boilers. All photos courtesy: Fulton Heating Solutions Inc.

Condensing versus noncondensing boilers

Noncondensing boilers can operate up to a peak thermal efficiency of 88%. However, according to Bottorff, their efficiency typically will be between 82% and 86%. They also require special installation considerations, such as low temperature protection, perhaps with three-way valves, and typically need primary-secondary piping.

"Condensing boilers are capable of operating at up to 99% efficiency, with typical efficiencies ranging anywhere from 92% to 97% depending on the product design and technologies," says Bottorff. They are intended for installations where lower return water temperatures are present or can be achieved during part-load conditions. Condensing boilers require Category IV positive-pressure condensing style (typically stainless-steel material) flue gas vents.

Due to better heat exchange technology, a condensing boiler typically will operate at a thermal efficiency several points higher than a noncondensing boiler, even at noncondensing conditions, according to Bottorff. However, the best return on investment will be at lower return-water temperature conditions. Even a system designed around noncondensing operating temperatures will not require these temperatures throughout the entire year. An outdoor temperature reset schedule is used to automatically lower the operating temperatures when the weather is mild, which accounts for the majority of the heating season. This allows a condensing boiler to condense the majority of the heating season, even for systems that require noncondensing design temperatures on the coldest day of the year.

A bus garage is using 14 Vantage 3,000 MBH firetube condensing boilers.

St. Vincent Fishers installed three dual-fuel Fulton Vantage high-efficiency condensing hydronic heating boilers designed to run full-time on No. 2 fuel oil without strict cleaning requirements.

Condensing Boilers used in Health Care

St. Vincent Fishers Hospital in Fishers, Indiana is part of the largest Catholic, not-for-profit health care system in the U.S. It was the first hospital in Indiana to obtaining U.S. Green Building Council LEED certification under the Health care rating system.

When it came to its heating, humidification, and sterilization needs, St. Vincent Fishers chose to install Fulton boiler equipment. St. Vincent Fishers installed three dual-fuel Fulton Vantage (VTG-2000 DF) high-efficiency condensing hydronic heating boilers. The three installed Fulton Vantage hydronic boilers, as fully condensing boilers, achieve high thermal efficiencies—up to 99%—by recovering the latent heat of condensation from their own exhaust gases. They are dual-fuel optimized for both natural gas and No. 2 fuel oil. The Vantage condensing hydronic heating boilers also were installed with a Fulton ModSync controller for outdoor reset and BACnet communication to maximize system efficiencies based on seasonal temperatures and integration with building software systems, respectively.

Tips for End Users

Bottorff offers advice for users interested in acquiring a hydronic system: "Don't overcomplicate it. By keeping the system simple using variable primary piping arrangements, you can eliminate blending, boiler pumps, controls complexity, and ancillary devices," he said. "Variable primary piping is where the system uses a single loop for the boilers and heating coils, therefore all of the return water from the system goes directly through the boilers instead of being blended in a primary-secondary header, buffer tank, or hydraulic separator. Not only does this save the owner on installation and operation costs, but it also makes diagnosing concerns and routine maintenance much simpler.

Worth Investigating

Not all boiler replacement projects will result in high levels of savings, but for the right application, a condensing boiler system can yield significant energy savings, reduced plant emissions, and rapid response to changing heating load conditions. If your hydronic operation fits the temperature regimes for condensing boilers, it is certainly worth making that investigation. **GT**

MORE info

ENERGY SOLUTIONS CENTER
www.energysolutionscenter.org

FULTON HEATING SOLUTIONS INC.
www.fulton.com

Vantage hydronic boilers and VMP steam boilers complement each other in this hospital application. The Vantage boilers are piped variable primary flow to reduce installation costs and optimize operating efficiency.

Hatteras Yachts Receives Partnership Award

HATTERAS YACHTS, NEW BERN, N.C., RECEIVED THE ENERGY SOLUTIONS CENTER PARTNERSHIP AWARD ON FEB. 28, 2018 at the Technology and Market Assessment Forum (TMAF) in Charlotte, N.C. The Partnership Award is given three times a year during the Center's TMAF. Hatteras Yachts was nominated by Piedmont Natural Gas, Wilmington, N.C., the hosting utility, because of the partnership formed during a recent project.

Project Description

As part of its commitment to safety, in 2016, Hatteras Yachts, a manufacturer in New Bern, N. C., hired Piedmont Natural Gas, a business unit of Duke Energy, to conduct a leak survey of the natural gas fuel lines throughout its facility.

Piedmont offers these leak surveys as a value-added service to its customers using a remote methane leak detector (RMLD) tool from Heath Consultants Inc. in Houston. RMLD units use laser technology, and can detect leaks up to 100 feet away, allowing a technician to conduct the survey at a safe distance, providing easy detection in hard-to-reach areas. When a leak is identified, the light from the laser is refracted back to the unit and converted to an electrical signal used to determine the concentration of the leak.

At the completion of the survey for Hatteras Yachts, Piedmont was able to provide the customer with a detailed assessment of any leaks identified, as well as a detailed proposal and estimate for recommended remediation activities. The customer accepted the proposal resulting in a safer work environment for the plant employees, a great customer experience for the customer, and a margin generating project for Piedmont.

Piedmont continues to offer these leak detection services along with integrity assessments for its residential, commercial, institutional, and industrial customers. **GT**

Energy Solutions Center chair, Jim Hearing (left), and vice chair, Bob Stoyko (right), flank two Energy Solutions Center Partnership Award ceremony winners, David Kennedy (center-left) of Piedmont Natural Gas and Shawn Baumgardner (center-right) of Heath Consultants, supplier of the remote methane leak detector (RMLD) tool.

Partnership Award at a Glance

Award:
Energy Solutions Center Partnership Award

Category:
State-of-the-art natural gas leak detection

Award recipient:
Hatteras Yachts
New Bern, N.C.

Nominating (host) utility:
Piedmont Natural Gas
Wilmington, N.C.

Leak detector supplier:
Heath Consultants Inc.
Houston