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Cooling the Workplace

Natural Gas Plays a Role

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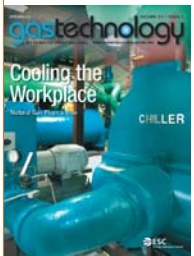

on the cover

Industrial and institutional facilities benefit from cooling the working atmosphere, often using existing energy resources in absorption or engine-driven chilled water plants.

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inside

Cooling the Industrial Workplace

Better Work Environment = Better Production

EXCESSIVE HEAT in a manufacturing or warehouse environment has negative effects on workers, production levels and even the quality of produced or stored goods. This is a growing concern because today's North American industries are being pressed hard to match offshore production options. Fortunately there are plant cooling solutions that can solve this problem.

Growing Concern About the Industrial Environment

In many areas, workplace high temperature problems are more common than before. Average ambient temperatures in the warm seasons are generally higher than have been experienced in the past. Although the differences are only a few degrees, these small differences can change the work environment drastically. Because of heightened attention to employee safety, workers wear more protective gear — helmets, masks or other apparatuses — than they once did. As a result, high workplace temperatures make the same task more difficult and sometimes more exhausting.

Further, many companies have gone to longer shifts, meaning worker fatigue is a greater concern. Finally, many manufacturing plants and warehouse operations have set higher production or product handling goals in order to remain competitive, meaning employees work at a faster physical pace that must be maintained even during the hottest times of year.

Admittedly, there are some jobs where heat exposure is unavoidable — for example, working at a smelting furnace, handling molten metals or other hot products such as cooked foods, paper or glass. Yet even in these cases, it is important for workers to have minimal adverse exposure to heat and to have cooler zones nearby to rotate into.

Excessive heat contributes to worker fatigue, heat cramps, and more serious problems, including heat exhaustion and heat stroke. Even where health problems do not appear, excessive workplace heat can lead to poor memory, loss of concentration, short attention span, carelessness and difficulty following instructions. Certain basic steps can help reduce the incidence of problems, including training on the importance of fluid replacement and having adequate work breaks to cooler areas.

Ventilation May Not Be Enough

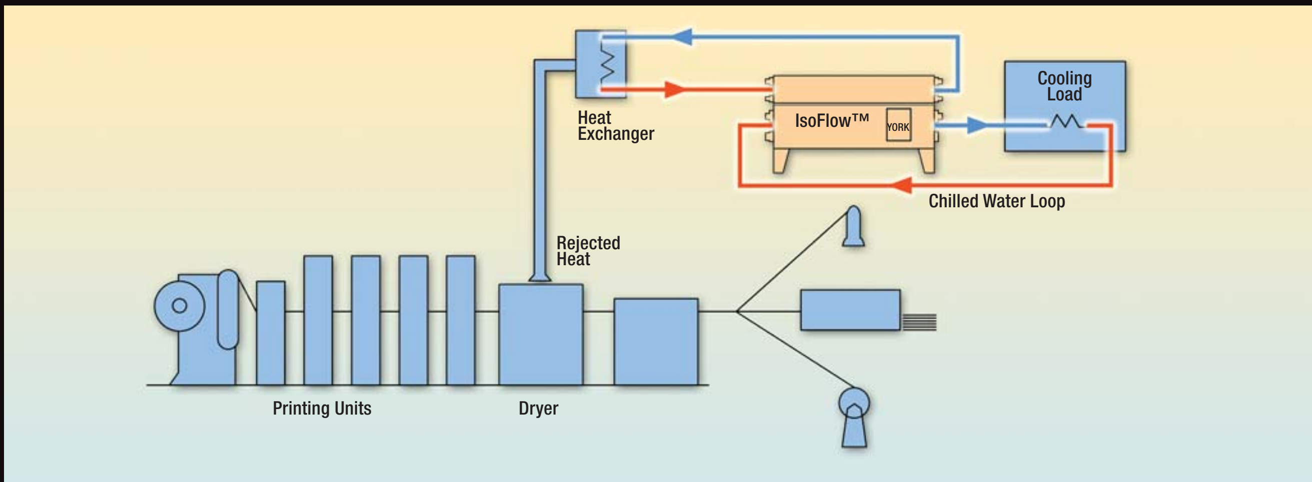
Traditional solutions have been to open doors and windows and use fans to move more air through the workplace. This approach may still be valid in some industries, but there is often concern about precision manufacturing machinery as well as factory products being exposed to the variable quality of outdoor air. Dust, insects, and internal building contaminants can be introduced and blown around the factory with this type of cooling. What's more, if the outdoor air is hot, it may not be an improvement over what's already in the environment.

Another solution sometimes taken is the use of evaporative coolers to reduce temperatures and increase comfort levels. These systems can be effective in areas where ambient humidity levels are low, but do little good when humidity levels are high, which is the case during the summer in much of the U.S. and Canada. What's the answer?

Plant Cooling Often Best Solution

That answer may be mechanical cooling of the workplace. Once considered impractical for drafty old manufacturing plants, cooling makes sense for today's tighter industrial buildings and warehouses. Further, unlike ventilation alone, mechanical cooling also allows dehumidification. In muggy weather, that's very welcome.

Industrial operators are in an especially good position to take advantage of today's steam, hot water and direct-fired gas cooling technologies. Because industrial plants often already have a steam plant, steam absorption cooling can be an attractive option. Further, the use of plant steam may make the boiler itself operate in a more efficient range at a time of year where it might otherwise be loafing. According to John Szymanski from Trane, double-effect absorption chillers can be used where steam pressures are above 60 psig. Pressures of 125 psig at a temperature of 350°F are ideal for this type of absorber.

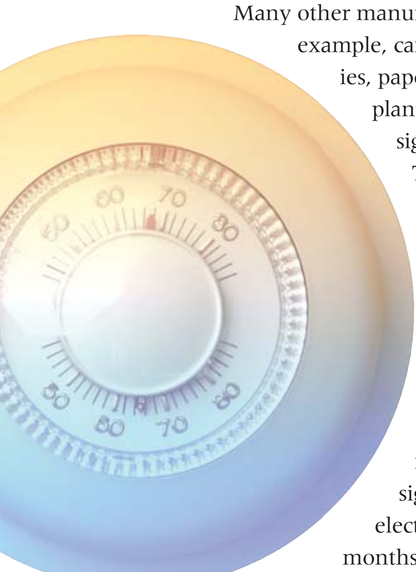


The heat-set printing process produces large levels of exhaust heat which can be used to supply an absorption chiller for plant cooling.

Make Use of Your Hot Water

At lower pressures, a better choice is single-effect hot-water absorbers. According to Ken Kohr from York, a major chiller manufacturer, these can use as an energy input hot water with temperatures as low as 180°F, and can supply cooling using heat energy that might otherwise be wasted. Kohr says, "More often than not, industries will have some type of heat in their process that can be recovered to generate steam or hot water. And quite frequently the heat is simply blown off to the atmosphere while an electric chiller is used to carry the plant's cooling load, with an increase in energy costs."

As an example of the opportunities for plant cooling, Kohr cites the printing industry, which has an excellent source of hot water from print drying units. A single-stage absorber can use this energy for plant cooling. Kohr notes that his company has recently participated in several installations of this type.



Many other manufacturing processes — for example, canneries, dairy plants, breweries, paper and pulp mills, metal treating plants and many others — produce significant quantities of hot water. The chiller uses this hot water to economically produce chilled water, which is piped to central station or remote air handlers and cooling is applied in the plant where it can do the most good.

Whether the choice is a single-effect or double-effect machine, absorption chillers will significantly reduce the plant's electric demand charge during the months of the year when these charges are often the highest. This is a long-proven technology that makes a lot of sense.

Electric Chillers May Have Drawbacks

Thermax Inc is an India-based global supplier of a wide range of absorption cooling products. According to Rajesh Sinha, Business Development Manager with Thermax-USA, there is growing interest on the part of industrial operators in absorption technology. He states, "With rising electrical costs and problems associated with environmental compatibility of synthetic refrigerants, industrial sectors are finding more reasons to consciously shift away from electrically-driven compression type chillers."

Thermax-USA partners with Trane in the U.S. market, and Singh notes that special opportunities can be found in pharmaceuticals and medical technology, where his company has seen a shift away from electric chillers towards absorption. "These companies look at 25 year equipment lifetimes, and for them crystal-gazing into the future is becoming increasingly difficult with the constantly evolving energy matrix and never ending environmental issues. Absorption technology provides the respite."

According to Sinha, Thermax's latest absorption cooling machines provide significant advances in design to extend the life of equipment and improve efficiency of operation. "With our range of capacity from 10 tons to 3500 tons, we can use a wide variety of heat sources." He also points out that Thermax's Multi-Energy Absorbers can simultaneously use multiple heat sources for a single machine. He stresses, "Absorption technology makes sense for industries with an eye on the future."

Make the Most of On-site Generation

Another increasingly widespread application is the use of absorption chillers to use byproduct heat from a cogeneration facility. To increase energy supply security and to help lower electric demand charges, many industries are installing either natural

“With rising electrical costs and problems associated with environmental compatibility of synthetic refrigerants, industrial sectors are finding more reasons to consciously shift away from electrically-driven compression type chillers.”

— Rajesh Sinha,
Business Development Manager, Thermax-USA

In this installation, a single-stage absorption chiller is located next to a plant boiler in a manufacturing facility. Photo courtesy The Trane Company.

gas-fired reciprocating engines or natural gas-fired combustion turbines to generate on-site power. These units become even more energy-efficient if their byproduct heat is used in plant processes or applications.

Typically the gas turbine is fitted with a waste heat boiler to capture heat from the turbine exhaust to create steam. Reciprocating engines produce heat both in the form of engine jacket cooling water and engine exhaust. Whether this heat is steam or hot water, it can quite effectively be used to drive an absorption chiller to provide plant cooling, as well as chilled water for other process purposes.

A Sweet Solution

An example of this application is at Ghirardelli Chocolate Company in San Leandro, California. Here a 145-ton York absorption chiller uses byproduct heat from four 350 kW Cummins natural gas-fired reciprocating engines that generate 60% of the plant’s required electric power. Kohr from York says, “This is an excellent example of extracting all the energy possible from natural gas.” The hot water from the engines enters the York chiller at 200°F and leaves it at 185°F.

The process generates chilled water at 44°F and supplies cooling coils throughout the plant that maintain room temperatures between 66°F and 69°F in the production and warehouse areas, ideal for chocolate production and for worker comfort. Cooled areas total 35,000 square feet. Ghirardelli Engineering Manager Ty Tia says, “It’s like free electricity. We make use of the waste heat from our cogeneration and use it to make hot water that drives the chiller.”

Put an Engine to Work

Another practical approach to plant cooling is the use of a natural gas-fired engine-driven chiller. Again, this does not contribute to plant electrical demand and can take full advantage of lower industrial natural gas rates, normally during the season when gas usage is down. TECOGEN, a U.S. manufacturer, offers its natural gas-fired V-8 engine-driven TECOCHILL chillers in sizes from 150 to 400 tons for water-cooled models, and 25 to 65 tons for air-cooled models.

According to TECOGEN, the advantages of engine-driven chillers are that they have a footprint no larger than an electric chiller, they avoid electric demand charges, and they free up site electric capacity for other purposes. They use natural gas, which is already available on the site. In many cases they are eligible for rebates from local electric utilities and they can be arranged for engine heat recovery if desired.

Is This the Year for Plant Comfort?

Given the growing need for in-plant cooling systems, operators are fortunate that a wide range of cost-effective systems is available. Plant efficiency means more than cutting costs: it often means creating an atmosphere for effective work. Putting in an efficient plant cooling system powered by natural gas may be an important step. **GT**

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NEW WAY TO CAPTURE WASTE HEAT

Organic Rankine Cycle Gives New Options

IN AN ENERGY-HUNGRY WORLD, industry looks for new methods of optimizing energy use. A few decades ago, many processes wasted energy and no one got very excited. With rising energy costs and a growing need to reduce carbon dioxide and other emissions, it's different today. So when an entirely new technology for heat recovery becomes available to industry, smart operators pay attention.

Using an Organic Working Fluid

Such a process is the Organic Rankine Cycle (ORC). Industrial and mechanical engineers are familiar with the Rankine Cycle. It's the thermodynamic process described by 19th century Scottish physicist William Rankine for extracting work from steam. It is the familiar process used in combined-cycle generators. The steam-based Rankine cycle is great for extracting waste heat from high temperature sources, such as gas turbine exhausts. This energy can then be used to spin a steam turbine to generate additional electric power. However, for heat sources less than perhaps 500°F it's not as practical.

That's where the ORC comes in. By using as a working fluid an organic fluid that vaporizes at a temperature far lower than water, the Rankine cycle can be used in the same way to extract otherwise wasted energy from fluids with temperatures as low as 150°F. Heat is extracted from the fluid in a heat exchanger, vaporizing the organic working fluid. The organic fluid in its gas form can then spin a turbine and generate useful electric energy. The produced power can be used on site or sold. The turbine exhaust returns the fluid to the heat exchanger for another shot of energy. A whole new world of heat recovery options opens up.

The ORC is already widely used for energy recovery from gas pipeline compressors and in geothermal power plant applications, and is increasingly being applied in solar collector applications. In all of these situations, waste heat energy generates electric power to supplement electric requirements for the site, or is sent to the electric utility grid. ORC can also be used to generate electricity in industrial applications.

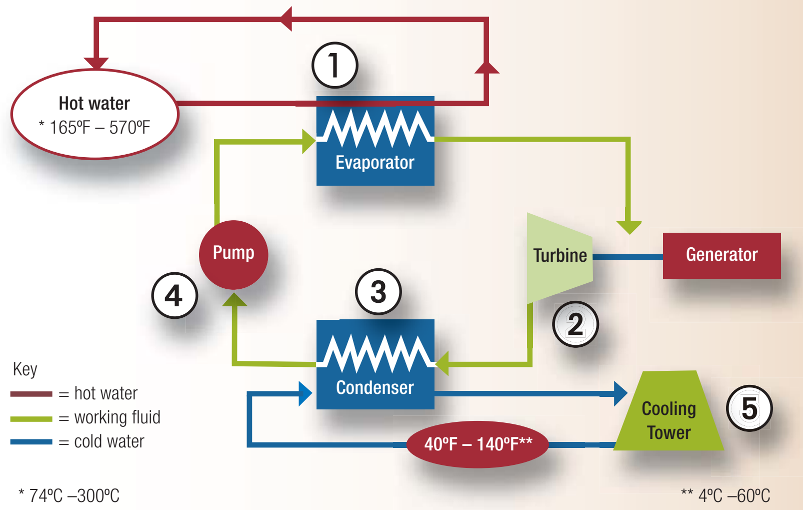
According to Gordon Foster from Calnetix, a manufacturer of ORC systems, "The early adopters in the U.S. tend to be in states that have investment credit or production credit programs for recovering waste heat to produce electricity. Companies in states without incentives but with high electricity rates are also candidates." According to Foster, paybacks for industrial customers tend to be from three to five years.

Finding the Right Application

If your industrial plant has the right characteristics, the ORC may be a great tool for increasing energy efficiency. Possible sources of waste heat for an application include oven or furnace exhausts, cement kilns, petrochemical processing exhausts, incinerators or other flue gas discharges, and process water or other fluids in the food processing, plastics, or metal treating industries.

Foster indicates that in assessing suitability of a process for ORC, it is important to gather information on temperature and flow rate of the heat source, and also information on ambient wet bulb and dry bulb temperatures. He notes, "Even if the heat source is adequate, high temperature and humidity locations do not tend to pencil out."

Ormat Technologies, Inc. is a vertically integrated provider and operator of large ORC systems. The company provides



This diagram illustrates the process used for energy recovery using the ORC. Illustration courtesy Pratt & Whitney.

The Calnetix waste heat generator uses the Organic Rankine Cycle to generate up to 125 kW of electric power from waste heat streams. Photo courtesy Calnetix.

support to utilities and industry, as well operating its own geothermal ORC plants. Paul Thomsen, Director of Public Policy and Business Development from Ormat, indicates that right now the firm is also seeing large energy potential in the cement industry, as well as in lower temperature gas turbine heat exhausts, and pipeline compressor stations. According to Roni Omessi, Ormat's Senior Director of Recovered Energy, industrial energy users should look for waste heat streams between 200°F and 350°F for the greatest opportunities in energy recovery.

Omessi says, "Look for sources with temperatures above 200°F not being utilized by other heat recovery methods." It is true that at the lower end of the range, the necessary size of the heat exchanger increases, conversion efficiency is lower and capital costs increase. However, if this is a heat source that would otherwise be wasted, conversion efficiency may not be critical.

Designed for Specific Application

According to Omessi, ORC providers such as his firm can work with industrial customers in assessing their waste heat stream, then design a system and choose an organic working fluid to maximize heat recovery. He notes that with the company's experience in these applications, they can make available simple and reliable designs. One of the newer features of commercial ORC systems is their potential for remote operation. Omessi says, "This is especially attractive for remote sites or for large industrial facilities. The system controls can be located at a convenient central location."

Another important provider of ORC equipment is Pratt & Whitney, a United Technologies company. According to Jeff Jurgensmier, Engineering Communications Manager for the firm, Pratt & Whitney Power Systems offers a 280 kW machine, and also a family of larger ORC equipment from Italian partner, Turboden. The Turboden product line ranges from 400 kW to 4MW, and above. The two companies combined now have 160 ORC power generating systems in 14 countries.

Jurgensmier indicates that the company's primary interest in North America to date has been natural geothermal resources. However, he adds, "There are many waste heat opportunities, including biomass burners, reciprocating engine and turbine exhausts, gas compression stations, etc." He adds, "Other heat or power intensive industries such as glass, refineries, steel, thermal oxidizers and cement all have great potential. We continue to find new applications for ORC technology." He adds that until quite recently, smaller energy sources — less than one megawatt — generally could not take advantage of the merits of ORC technology. With smaller systems such as Pratt & Whitney's PureCycle 280 (280 kW), that has changed. ORC is now practical for smaller heat sources.

Attractive for Renewable Characteristics

According to Paul Thomsen from Ormat, heat recovery systems using ORC technology may qualify for federal tax credits of from 10% to 30%. Also important is the fact that electric generation using ORC equipment for heat recovery may qualify for renewable portfolio credits in many states. Companies that are attempting to reduce carbon emissions can increase their on-site energy potential without increasing emissions.

Is It Right for You?

Not every industry can take advantage of ORC technology. But if you have a continuous stream of hot water or other fluids – typically between 200°F and 500°F – on which you are not already doing heat recovery, this may be both a solution and an opportunity. If you are facing high electric rates or growing demand charges, it's definitely worth looking into. GT

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LARGER MICROTURBINES MAKE INROADS IN INDUSTRIAL COGENERATION

MATURING TECHNOLOGY FOR HEAT AND POWER

MICROTURBINES HAVE COME a long way. These distant descendants of aviation auxiliary power supply turbines and automotive turbochargers were first developed in the 1990s. From the beginning, they have been recognized as an important technology for on-site electric generation. Beneficial use of the turbine waste heat has always been the key to successful installations. The first cogeneration microturbines were in the 25–30 kW size range, followed by later developments of the 60–65 kW size class. In recent years, manufacturers have introduced larger 200-250 kW microturbines, which makes this technology more attractive for commercial and industrial users.

Making Full Use of the Energy

The larger microturbine generators have fuel-to-electricity efficiencies of 25 to 30% — slightly lower than larger utility class gas turbines. However, this doesn't take into account the fact that virtually all microturbine installations are designed to also use the high-temperature turbine exhaust in a wide range of useful applications. This can bring the overall thermal efficiency of the installation up to 75 to 80%, and makes the on-site generation package an attractive energy solution.

Capstone Turbine Corporation is a major supplier of microturbines, offering units in the 30kW, 60kW and 100kW classes, as well as the C200, a new 200kW product that is especially attractive to industrial and large commercial customers. According to Kyra Bonavida, a spokesperson for Capstone, "Companies that have various thermal needs that can be satisfied or assisted by the microturbine waste heat are often interested in microturbine power systems." She notes, "Mid-sized microturbines are a good source of energy for industrial facilities because they are

This application in Italy uses the Capstone C200 at a wastewater treatment plant. Photo courtesy Capstone.

efficient, clean, low maintenance, and can be easily connected to the utility grid."

Many Ways to Use Byproduct Heat

Bonavida cites as examples of byproduct heat utilization the production of hot water for food processing and for drying tasks in the furniture industry. Other Capstone installations include process heat in the plastics and plating industries, generation of steam for sterilization and drying operations, and preheating air for use in industrial burners such as found in the metals industry.

Bonavida also points out that hot water or steam can be used for cooling needs. "The waste heat can be run through absorption chillers to provide cooling for facilities such as data centers or other facilities that have refrigeration requirements." The recently introduced Capstone C200, because of its larger scale, triples the amount of byproduct heat energy from a single unit, making it more attractive for the industrial market. Capstone also offers an engineered package of five C200 units that has an electric capacity of 1MWe, and a proportionately larger heat output.

Can Use Methane Generated On Site

Another way in which microturbines are a good fit for industrial applications is that they can use byproducts from other manufacturing operations to fuel the turbine. As an example, digesters or other processes that produce methane can feed that fuel into the microturbine as a stand-alone fuel or as a supplement to natural gas. Bonavida notes, "For example, wastewater treatment facilities can use the methane byproduct to fuel the microturbine." This application is already being used by several municipalities.

For industries that have concerns about emissions, the larger microturbines are also attractive. According to Bonavida, the Capstone C200 is CARB certified for emissions. "This makes it extremely easy to get the equipment and site approved and it often does not even require an air permit. The C200 is also UL certified, which makes it easy to get building permits for installing the equipment. The UL certification also makes connecting to the grid a simpler procedure."

Ingersoll Rand Mid-sized Offering

Another major provider of microturbines in the 200–250 size class is Ingersoll Rand. This global firm offers its Model MT250, a 250 kW machine that is well adapted to industrial applications. Andy Freeman from this company provided information on this product at a Technology Marketing Assessment Forum (TMAF) sponsored by the Energy Solutions Center in Pasadena in spring, 2009. In his presentation he noted, "This technology makes sense for companies that have a 24/7 electrical load greater than 250 kW, and a 24/7 need for hot water."

Freeman pointed out that these units are especially attractive in areas where there are high electric rates. He adds, "In some cases there are also incentives available from the utility for an industrial microturbine installation." Freeman points out that the maximum use of the byproduct heat is essential for a good microturbine application.

Compact Design Saves Space

The MT250 includes a patented recuperator and an integrated heat recovery system to minimize the amount of floor space needed for the installation. The package is CARB-2007 certified for use in California and features NO_x emissions of less than 9 ppm. The unit requires only one planned annual shutdown and the overhaul interval is 40,000 hours, or nearly five years of operation.

Chocolate Plant Chooses Microturbines

An example of a successful industrial installation of microturbines with heat recovery is an installation at Astor Chocolate in Lakewood, New Jersey. In 2006, Astor was looking for an energy solution that would offer high power supply reliability as well as effective heating and cooling. The installation features five Capstone C60 microturbines with integrated heat recovery. The hot water supplements the plant's hot water and space heating requirements, and also feeds a 100-ton absorption chiller for building cooling, including cooling for the finished chocolate products in the warehouse.

According to Astor Chocolate's Plant Engineering Manager, Joe Verschleisser, "We installed these Capstone turbines to enhance our already developed cogeneration design and to go further green with the latest technology." He explains that the turbines are operated in a load-following capability due to New Jersey's lack of net metering functionality. The company has been pleased with the results of the installation. Verschleisser says, "The Capstone microturbines have paid for themselves and proven to be dependable and reliable."

Microturbine Cogeneration Makes Sense

If your plant needs reliable cogeneration and has use for the considerable heat output of a mid-sized microturbine, this may be a solution worth investigating. The obvious attraction is the high-efficiency use of natural gas for electric generation, heating and cooling in an installation that makes full use of the energy. GT

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Is Your Boiler the Best It Can Be?

Your Old Boiler Demands Your Attention

FEW ENERGY DEVICES are as universally used in industrial plants as are boilers. Because they are seen as a mature technology, boilers often don't receive the regular attention given other industrial equipment. Yet because it is the largest single energy consuming device in the plant, the industrial boiler should be at the center of interest in most energy efficiency improvement plans. At a minimum, you should bring your existing boiler plant up to date with today's technology. It may be that a boiler replacement will pay for itself in short order.

A Major Energy User

The U.S. Department of Energy (DOE) suggests that plant owners begin by determining the efficiency of the steam generation system, based on steam energy output to fuel input. DOE says, "Steam generation needs to be measured with accurate, well maintained and calibrated flow measurement devices and reconciled with a rigorous steam balance."

DOE also recommends that owners optimize excess combustion air to improve steam generation efficiency. An oft-stated rule of thumb is that boiler efficiency can be increased 1% for each 15% reduction in excess air or 40°F reduction in stack gas temperature. To achieve these improvements, better boiler controls are often needed. Older boilers typically have mechanical linkages that easily drift out of calibration, and are, under the best conditions, imprecise. Modern controls use digital sensing and direct-drive mechanisms to allow burners to meet tight performance standards and remain accurate, even with changing fuel, air and furnace conditions.

Keeping Boiler Surfaces Clean

Another critical aspect to boiler efficiency is maintaining clean fire-side and water-side boiler heat transfer surfaces. A good deposit control program is necessary to do this. It is important to perform boiler blowdowns regularly to reduce dissolved solids in the system. Follow boiler manufacturer and feedwater additives provider recommendations to optimize these blowdowns.

The significance of boiler water-side scale was emphasized in a presentation at a recent Energy Solutions Center's Technology Marketing Assessment Forum by Jason Smith from Miura Boiler, one of the world's largest boiler manufacturers. Smith noted that just a 1/32" inch deposit of scale on boiler tubes causes a 10% reduction in boiler efficiency. He further pointed out that such an increased level of scale on all U.S. boilers would cause a waste of $81 billion in fuel costs, and an additional 405 million excess tons of carbon dioxide emissions. The case for appropriate feedwater treatment and adequate blowdowns is obvious.

Modern firetube boilers offer enhanced efficiency from digital burner controls and advanced metallurgy. Newer boilers often have far greater turndown capability than older units. Photo courtesy Cleaver Brooks.

Newer boilers are designed to minimize fire-side deposits. One of the main advantages of natural gas is that the potential for these deposits is minimal to begin with. Optimizing fuel-air ratios further reduces fire-side problems.

Heat Recovery Essential Today

As fuel prices have increased, it has become increasingly important to recover energy that would otherwise be wasted. Economizers can be added in the boiler's exhaust gas stream to recover heat that would otherwise be lost to the atmosphere.

This heat can be used to preheat boiler makeup water or feedwater. Heat recovery from boiler blowdown equipment is also a practical way of recovering heat that would otherwise go down the drain. Downstream of the boiler, more energy can be conserved by adjusting or replacing steam traps, and by improving condensate return systems.

Condition of Existing Boiler Critical

According to Steve Connor, Marketing Services Director at Cleaver-Brooks, the decision whether to retrofit or replace a boiler can be complex. He points out, "The most important consideration is the condition of the existing boiler, especially the pressure vessel – shell, furnace and tubes." He explains, "If during the annual inspection wherein the waterside and fireside surfaces are revealed, it doesn't show signs of heavy scaling, pitting, cracking or stress, the pressure vessel is most probably in good shape and in a position to deliver many more years of dependable life."

Summertime Presents a Challenge

Connor points out that often even if a boiler performs well through the efficiency analysis, there still may be losses due to improper sizing. He indicates that this often results from a boiler being oversized in summer months of the year, or at times when some process steam is needed but major industrial processes are shut down. "During these times, the boiler 'loafs' along in low-fire most of the time, cycling several times an hour. This is extremely inefficient operation and drives up radiation and convection losses as a percent of input while increasing excess air levels, reducing combustion efficiency." In cases like this, the best solution may be the addition of a small "summertime" boiler, sized for these reduced load conditions.

Smith from Miura explains that the penalties from part-load operation can be significant, especially with older boilers with inadequate designs for high-turndown operation. Even the most modern boilers decline in efficiency in high-turndown situations. The solution may be multiple boilers. Smith notes that a group of smaller high-efficiency boilers with modern controls can operate as a single boiler with no turndown penalty, with boilers being quickly brought online as needed.

Boiler Cost Dwarfed by Fuel Cost

Where the existing boiler has reached the end of its useful life with poor pressure vessel conditions and overall poor performance, replacement is the logical step. Connor points out that boilers on average consume four times their cost in fuel every year, so selection of the replacement boiler needs to be well thought out. Industrial users must consider operational requirements, physical conditions of the facility, and financial values.

Hospitals, though actually institutional energy users rather than industrial users, face many of the same decisions as industry because their need for steam is continuous but variable throughout the day and throughout the year. Thus, their decision process is instructive. Rockville General Hospital in Connecticut is a 233,000 square foot facility that had recently gone through a consolidation process and was looking to improve its competitive position without adversely affecting patients. The hospital's engineering director, John Lombardi, and HVAC engineer, Scott Roman, looked at improving the efficiency of the facility's steam generation.

Changing Facility Requirements

Overall steam requirements had declined due to outsourcing of some of the facility's laundry and sterilization needs. They chose to retain one of the hospital's existing firetube boilers as a standby unit, and they supplemented this unit with a new Optimized Cleaver-Brooks firetube boiler with a high-turndown modulating burner with electronic controls and parallel positioning actuators for precise air and fuel metering.

The new unit also included an advanced stack economizer for heating feedwater and a second condensing stage for preheating cold makeup water. Because this second stage captures the latent energy in the flue gas, it helps the boiler offer up to 90% fuel-to-steam efficiency. In addition to boosting boiler efficiency from 75% or less to more than 90%, the new system delivers NO_x emissions of less than 9 ppm and an annual reduction in CO_2 emissions of approximately 600,000 lbs.

Making the Right Decision

Using this hospital as an example, Cleaver-Brooks' Connor stresses, "Looking at a boiler's in-service efficiency potential and coupling it with basic engineering knowledge will lead to the best solution for any process or heating application. It's a matter of putting the right shoe on the right foot or, in Rockville's case, putting the right boiler type, properly sized and configured, in the proper place to do the job." **GT**

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Flexible watertube boilers are excellent replacements for failing boilers because of their resistance to cold water shock and compact size. Photo courtesy Cleaver Brooks.

Natural Gas Supply Estimates *Growing*

NOT TOO MANY YEARS AGO, many North American energy planners saw the supply of natural gas as rapidly dwindling. As recently as a few years ago, some felt natural gas was a useful "bridge" to renewable energy resources in the future, but believed our known reserves were quite limited so we'd best plan on other energy sources for beyond 2050. That estimate has proven unduly pessimistic. Recent years have seen major additions made both to proven reserves and to broader estimates of the total gas resource.

Increasing Estimates

A recent Energy Analysis by the American Gas Association (AGA) explains that estimates of supplies of natural gas in the U.S. have dramatically increased in the last five years. The report notes that since 1990, 17 to 20 trillion cubic feet (tcf) of natural gas have been produced from U.S. known reserves each year. Yet proven reserves in the last 20 years have actually grown by 45%. The report cites information from organizations such as the well-known Potential Natural Gas Committee at the Colorado School of Mines.

New Technologies

What are the causes of this dramatic increase? One important contribution is the development of horizontal drilling and advanced fracturing technologies, which are tapping into the currently estimated 600 tcf of natural gas found in multiple shale formations in the U.S. and Western Canada. These were for the most part unrecoverable in the 1990s but are now coming into production.

Secondly, the report notes that new discoveries, extensions and revisions of prior reserves data have outgained the pace of production. The report further quotes the Potential Natural Gas Committee and similar groups' estimates that yet undiscovered natural gas resources in the U.S. alone, added to known reserves, point to a total resource of over 2,000 tcf.

Role of Underground Storage

The report adds that growth in the underground storage capacity has increased in recent years. Current storage capacity may account for 30% of all gas supplied during the peak winter months. The report notes, "This flexibility is crucial to meeting heating load peak demands for local gas utility customers, and all customers for that matter."

The report also indicates that long-range planning has started for development of Alaskan gas reserves and pipeline transmission to Canada and the U.S. Although these projects are not yet completed, the report notes, "Many analysts believe that a pipeline connecting North Slope gas reserves to the lower 48 states is closer than ever, and that by 2020 or soon after, as much as 4 billion cubic feet (bcf)/day may be flowing."

U.S.–Canadian Partnership

Canada has long played a role in providing natural gas to the U.S. About half of current Canadian natural gas production of 13 bcf/day is exported to the U.S. This is a decline from a peak of about 16 bcf/day a few years ago. Canadian resources continue to play a role in providing natural gas supplies to U.S. customers.

LNG Still a Small Player

Additional evidence of our abundant supply is that imported liquid natural gas (LNG) currently plays a minor role in the U.S. supply picture, providing less than 2% of daily usage. The report notes that the current 14 bcf/day of LNG import capacity has never been fully utilized. There are vast resources of natural gas in many locations around the world and they can potentially supplement domestic and Canadian production. However, as domestic reserve estimates have increased in recent years, the enthusiasm for offshore resourcing of LNG has declined.

The potential for economical extraction of gas from shale has increased. Dark red areas indicate potential resource areas in the U.S. and Canada.

Resource Diversity Critical

Summarizing many of these issues, the report indicates that the strength of gas supply in the U.S. is based not only on the abundance of gas resources, but also on the diversity of those resources. The report emphasizes that the future of natural gas supplies will also depend on adequate infrastructure growth, such a pipelines and storage, and on "effective regulatory and policy measures that protect all interests in securing a stronger domestic energy future." **GT**

MORE info

AMERICAN GAS ASSOCIATION
www.aga.org

DOE INFORMATION ON OIL AND NATURAL GAS RESERVES
www.eia.doe.gov/emeu/international/reserves.html

COLORADO SCHOOL OF MINES POTENTIAL NATURAL GAS COMMITTEE
www.mines.edu