• Ideas for Institutional Energy Users •

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PACKAGE BOILERS:

New Directions, New Benefits

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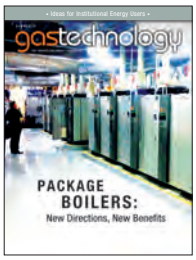

on the cover

Today's package boilers improve plant flexibility and reliability, while taking up minimal floor space. Photo courtesy: Miura America.

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PACKAGE BOILERS FIND NEW FRIENDS

Offer Efficiency, Redundancy, Flexibility

THE NAME "PACKAGE" TELLS PART OF THE STORY. BUT NOT EVERYTHING. Package boilers are meeting the needs of many facilities, both as original equipment and as replacements. Because they are totally factory-assembled, they offer quick installation and startup. They are built under controlled conditions and are tested before shipping. Owners can be confident they will run right from the beginning, and are discovering other advantages to package boilers as well.

Better than Ever

Package boilers have been around for a long time. In years past they were often seen only as the solution for small steam users who couldn't justify a site-built boiler plant. That has changed. Today many larger steam users are selecting package boiler solutions in order to save floor space, add unit redundancy, and maximize plant reliability. Many of today's package boilers offer efficiencies comparable to built-up plants, at a cost that is very competitive.

A clear trend is emerging toward a modular approach to boiler capacity, using multiple package boilers. Doug McMaster is Vice President, U.S. Operations for Miura America Co. Ltd., a major provider of package boilers. He comments on this trend, "Modularity allows systems to expand or downsize if future needs change. Also, modularity can achieve the redundancy requirements of the facility much less expensively."

Reduce Redundant Capacity Needed

As an example, he cites a plant that needs 1,200 boiler horsepower. If it used a single 1,200 horsepower boiler, it would need a second 1,200 horsepower boiler for emergency backup. "Due to the lengthy startup time for these large boilers, the second boiler would need to be idling (in standby mode) just in case it's needed. A big waste of energy."

He notes the benefits of alternatively using smaller, modular boilers for this situation. "We could achieve the required horsepower with five 300 horsepower units – four to handle the load and the fifth as a standby unit. This would probably result in a 30-40% reduction in capital investment." Because of the rapid startup capability of most package boilers, the fifth unit would probably not even need to be kept hot.

Faster Maintenance

McMaster points out that simplified maintenance is another advantage to the modular system approach. "Modular boilers are

Package boilers are growing in popularity because of their flexibility, ease of maintenance, and suitability for modular staging to assure year-round efficiency. Manufacturers offer control packages for coordinated use of many boilers. Photo courtesy: Miura America.

Vertical package boilers are especially attractive because of their minimal floor space requirement. Photo courtesy: Clayton Boilers.

typically easier to maintain due to their smaller size. Annual inspections take a half-day rather than the week needed for traditional boilers." And because the maintenance is done on one boiler at a time, there is no required steam outage during the maintenance period.

He adds that modular boilers are safer due to their low water content. "Some 300 horsepower boilers contain as little as 120 gallons of water, versus approximately 2,000 gallons in older fire-tube boilers. The amount of energy stored in large volumes of high temperature/high pressure water and steam is the primary cause of catastrophic failure of older boilers."

Quick to Ship and Install

A real advantage is their compact size. Most package boilers can be shipped in a closed van and are skid-mounted for rapid installation. Many will fit through the typical double door into a new or remodeled boiler room. Often plant capacity can be increased while reducing the footprint of the system if replacing an older boiler and auxiliaries with package units. Vertical package boilers are especially economical in their use of floor space.

Institutional steam users in particular can benefit from the package boiler solution. They are very attractive when there is great seasonal variation in the demand for steam or hot water, for example with college campuses, hotels and resorts, and other locations where steam or hot water is used for space heat. Such an owner might install four or more package boilers, with most of the capacity being used in the heating season, and a single unit kept hot during the rest of the year. In this way, equipment maintenance is reduced and the single unit can operate in the efficient part of its range.

Second Smaller "Pony" Boiler

Hurst Boiler and Welding Company is another major manufacturer of modular boilers, both horizontal and vertical types. Chad Fletcher from Hurst talks about the role of smaller package boilers in systems such as healthcare centers that have a large single boiler to meet most of the needs during much of the year. He notes that in those situations, it is often advantageous to have a second, smaller package boiler to meet system needs during times of the year when it is not necessary to keep the large boiler hot. "In the summer months, they have no need for space heat, so they do not need the larger boiler." The smaller unit will meet their needs for cooking, water heating and sterilization. He adds, "But it will also allow them to operate, though on a much smaller scale, if the larger boiler goes out."

McMaster and Fletcher both point out the importance of installing the correct control system for single or multiple boiler systems. This is one area where there have been great advances in recent decades. For example, Fletcher explains that Hurst offers control systems for all boilers and related equipment, including the capability for remote monitoring and operation from anywhere with internet access. Alternatively, he points out, some boilers are directly controlled through the central building management system.

You might be a candidate for a package boiler if . . .

- You want to add boiler redundancy for increased reliability
- Your seasonal steam or hot water requirements vary greatly
- You want to have flexibility to add or remove boiler capacity in the future
- Your boiler room doesn't have space for another standard boiler
- You could benefit from separate steam and hot water boilers
- You don't want to keep a large backup boiler hot year round

Control Groups of Boilers as One System

McMaster states, "Miura's master control system, Steam Ops, controls all boilers (up to 36 boilers) as if they are one steam system. It turns boilers on and off and adjusts the flame in order to precisely meet the load requirements of the facility. As steam demand fluctuates, our Steam Link feature raises and lowers the output within seconds, not minutes or hours. This is impossible with large steam boilers."

He adds that the Miura On-Line Maintenance System connects via phone line to Miura's 24/7 monitoring centers. "We can see the condition of the boilers and Miura water softeners in real time in order to ensure proper operation and to prevent damage to the equipment due to changing conditions at the site."

Improved Efficiency Designs

Operating efficiencies of package boilers have seen significant increases in recent years. Improved burner designs allow for a more even flame spread and more precise flame impingement on the tubes. Increasingly, package boilers include an on-board stack-mounted economizer, allowing improved heat recovery and higher feedwater temperatures. Advanced controls manage steam ramp-up and ramp-down for better combustion efficiency and heat transfer. The result of these improvements means efficiencies as high as 85% are being achieved.

Modern package boilers are also compliant with air emission standards. For example, Miura offers models that meet NO_x standards of 9 ppm. According to McMaster, these boilers have also been tested and certified as compliant with the newer NCASI PM2.5 standard. He says, "We believe this stricter regulation will become more widely recognized in the near future."

Package Firetubes Have Advantages

Cleaver Brooks offers a line of package firetube boilers in sizes up to 2,200 HP. Gregg Achtenhagen is the Senior Manager, Package Boiler Systems for Cleaver Brooks. He points out, "Since most institutional users do not need pressures above 250 psi, package firetube boilers can now be used in lieu of industrial watertube boilers." He explains that this approach offers quicker installations, less floor space, higher boiler efficiencies and both standardized and customized control packages to meet user requirements. Achtenhagen adds, "For institutions that do not use steam at all, or have only minimal use for steam, the trend is to use condensing boilers or flexible water tubes in hydronic installations. The driver is mainly high efficiency -- over 92%, depending on operating conditions."

Because of their skid-mounted designs and minimal maintenance requirements, package boilers can often be co-located with other plant operations, as here on the storage floor of a distillery. Photo courtesy: Hurst Boilers.

Trends on Institutional Campuses

Other trends noted by Achtenhagen are skid-mounting of multiple package boilers, decentralization of boiler plants on institutional campuses, and a move to separating steam and hot water production to take advantage of the efficiencies of condensing boilers. He also notes the increasing use of both conventional and condensing economizers in the boiler package.

He points out that with most conventional boilers, efficiencies are reduced 2% to 4% at part load. However, condensing boilers actually have higher efficiencies at part load. He notes that for most boilers, an annual inspection is required by code. On the smaller condensing boilers, only a general inspection of the burner is required. With larger firetube boilers, an annual tuneup is recommended, along with a tube cleaning if the boiler is fired some or all of the time with oil.

Wide Number of Choices

Every situation is different. What is important is that today there is a wide range of package boiler solutions for both industrial and institutional steam and hot water requirements. In evaluating the possibilities, be aware that systems are more efficient and more compact than ever. More package boilers may be in your future. **GT**

MORE info

CLAYTON BOILERS
www.claytonindustries.com

CLEAVER BROOKS
www.cleaver-brooks.com

ENERGY SOLUTIONS CENTER BOILER/BURNER CONSORTIUM
http://cleanboiler.org

HURST BOILERS
www.hurstboiler.com

MIURA AMERICA
www.miuraboiler.com

Natural Gas Infrared Heating

Perfect Solution for Many Spaces

CERTAIN INDOOR AND OUTDOOR SPACES REQUIRE HEAT, and convective heat solutions are not ideal, or perhaps don't work at all. The best solution is often natural gas-powered infrared heaters, either of the heated tube type, or high intensity panels. These systems put the heat on the surfaces and the people that occupy the spaces, without attempting to heat room air directly.

A Good Fit for Many Areas

Whether it's an athletic fieldhouse or an industrial warehouse, a hospital lobby or a manufacturing area, some building locations are just plain difficult to make comfortable for their occupants. Or at least they are difficult if the design is limited to convective heat. But infrared is a different answer, and one that is often the best choice.

For many decades, building comfort experts have understood that gas-fired infrared had this great potential. Today's infrared designs are more efficient and effective than ever. Current designs can convert up to 80% of the input energy into infrared heat that is directed at the space occupants.

Tube and Reflector

One of the types of infrared heat that is used most often is a heated tube system. These have specialized burners that fire into long horizontal tubes. The tubes absorb energy from the long flame and reflect a large amount of it as infrared heat. The tube is typically made in a dark color to maximize heat absorption and re-radiation. The system uses a polished metal reflector behind the tube to direct the infrared energy toward the heated area. Design of the reflector is such as to minimize reflection back onto the tube and maximize the outward pattern.

Eliminates Need for Ductwork

Jim McLellan is Vice President, Sales for Schwank USA, Inc., a major provider of a range of gas infrared heating devices. He emphasizes that infrared is the best solution for areas that are otherwise difficult to heat – high ceilings, open to the outside, or lots of outside air movement. He notes, "These are applications where gas-fired infrared technology really shines. Infrared heat requires no mechanical means or distribution ductwork to move the heat to the floor areas where it is required. Apply the correct infrared heaters in a high ceiling or open air area and you can provide comfort from heaters mounted as high as 180 feet above the surface."

Widely Used in School and Government Facilities

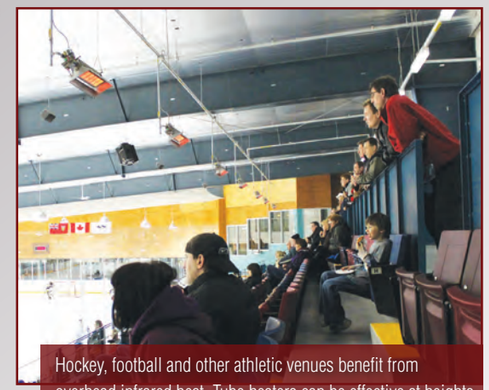
In educational facilities, infrared heaters are widely used to improve comfort in school gymnasiums and similar open spaces. In technical schools, they are used in areas for hands-on training in plumbing, air conditioning and auto mechanics. McLellan says, "Military and government facilities are using infrared to meet mandated energy reduction targets and this has proven very successful. Examples include aircraft hangars, large warehouse and distribution facilities, transportation maintenance buildings, airport baggage handling areas, and many more."

McLellan explains that gas-fired infrared heaters sold in the U.S. and Canada are required to produce a minimum of 35% of their input energy as radiant energy – the portion that will heat surfaces and floor space. He says, "Although 35% does not sound like a very good energy conversion, it is more effective than other technologies such as warm air." This efficiency might be typical of an "entry level" infrared system, and Schwank also offers the ultraSchwank tube heaters that are 60+% radiant efficient with fully insulated reflectors and a very efficient combustion technology.

Popular for Athletic Facilities

McLellan explains that Schwank heaters are widely used in stadiums and practice facilities at the college and professional level for soccer, football and hockey, and for outdoor venues for concerts, bars, restaurants and beer gardens. Infrared heat can extend the usable season for many of these facilities in cold climate areas. The U.S. Army Corps of Engineers recently approved the use of ultraSchwank technology for a large heating upgrade project for the Defense Logistics Agency at Tinker Air Force Base in Oklahoma.

Distribution centers and warehouses with high ceilings and doors that frequently open to the outside are ideal applications for infrared heat. Advantages include improved comfort, rapid recovery and avoidance of drafts and dust. Photo courtesy: Schwank USA.



Hockey, football and other athletic venues benefit from overhead infrared heat. Tube heaters can be effective at heights up to 180 feet. Photo courtesy: Schwank USA.

Hangars and transportation terminals are often great locations for infrared heat. Photo courtesy: Superior Radiant.

Pamela Davis from Schwank USA was recently a presenter at a Technology and Market Assessment Forum sponsored by the Energy Solutions Center. She pointed out that another advantage of infrared as compared with convective systems is that there are no dust swirls or drafts, such as may happen with blown hot air. She also explained that with infrared, the recovery times after doors are opened is very short, and the system helps maintain warm floors, which is a great advantage for workers such as mechanics and for spectators in sports facilities.

Recent Improvements in Efficiency

Tim Seel is the North American Sales Manager for Superior Radiant Products, another major provider of a range of gas-fired infrared heating products. He remarks on the progress that has been made in recent decades in infrared heating design. He points out that early infrared tube heaters used burners that were simply adapted from boiler burners. "Flame shapes were not ideal for small diameter tubes. In more modern times, manufacturers have applied technology in burner designs to create more ideal flame shapes for tubing." Flame shape is important to achieve maximum radiance for the entire length of the tube.

Seel notes that a European test method, EN419, is commonly used to measure direct infrared outputs. However, he also mentions that IR efficiency by itself does not make an installation successful. "Consideration of IR efficiency, thermal efficiency, distribution, and the application itself contribute to successful installations and large fuel savings." He emphasizes that the maintenance of infrared systems is moderate, but should include periodically removing dust in blowers, monitoring tube condition, and maintaining design installation conditions.

In the Industrial World

In industrial applications, infrared tube heaters are widely used in warehouses, distribution centers, loading docks, and in open industrial areas that require high levels of ventilation. Often they are installed in zoned systems so they can be operated only when spaces are occupied, thus conserving energy.

The gas-fired tube infrared heaters are the most widely used type, but there are also high-intensity infrared panels which provide a concentrated source of infrared heat for certain locations. According to Seel, high intensity units must be vented per NFPA 54. He says, "Because they have a concentrated pattern of energy output (think of them as 'spotlights'), they are most effective when high energy density is needed. Most high intensity units do not do well in outdoors where wind and rain can affect flame stability, hence they are usually shielded by overhangs, etc. However, some models have provisions built in to provide stability in an outdoor environment."

Consulting Services from Manufacturers

Schwank USA, Superior Radiant, and other manufacturers offer consulting services to assist in sizing, selection and placement of infrared tubes and panels to maximize comfort and efficiency. If your facility has problem areas for convective heating, gas-fired infrared may be the ideal solution. GT

Dining areas that are open to the outdoors or have high ceilings can increase customer comfort by applying infrared tube heaters. Photo courtesy: Schwank USA.

MORE info

CAMBRIDGE ENGINEERING
www.cambridge-eng.com/products/ith-series-gas-fired-infrared-heaters

ROBERTS GORDON
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Buried Thermal Treasure

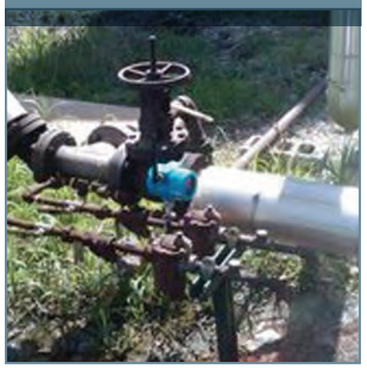
Recovering Energy for Improved Plant Efficiency

WHEN WE CONSIDER THE FUEL MILEAGE OF OUR AUTOMOBILE, we tend to focus on the efficiency of the engine and sometimes forget to consider how much weight we have on board, which direction the wind is blowing, and whether the tires are at the proper inflation. So it is with our boiler plant: We tend to focus on burner efficiency and the condition of the boiler tubes. But many other opportunities exist for making the plant more efficient. One is capturing heat that is otherwise wasted and using it to improve overall plant efficiency.

Maximize Condensate Return

The first opportunity is to collect as much hot returning condensate as possible. Condensate return lines should extend as far into the system as possible, minimizing any hot condensate going down the floor drain. Another key to maximizing condensate return is regular, comprehensive monitoring of steam traps, finding and correcting any that have failed or are out of adjustment. If all the steam traps are in open accessible areas, a daily inspection routine may be enough. For many facilities, the best solution is to install a steam trap monitoring system, with alarms for traps that are malfunctioning.

By installing monitoring at steam traps, correct trap operation and condensate return can be verified. This is especially important in institutional campuses with remote trap locations and potential high condensate losses. Photo courtesy: Armstrong International.



According to Tom Hiatt, Armstrong International's Director of Higher Education Markets, there is considerable variability in the attention paid to condensate recovery and steam traps in institutional markets. "Some obtain a percentage of return – 80% to 90%. Others much less. It all depends on the managerial commitment to allocate funds for this type of initiative."

Nevena Iordanova from Armstrong International was recently a presenter at a Technology and Market Assessment Forum sponsored by the Energy Solutions Center. She emphasized the value of recovered hot condensate, pointing out that recovery of 2000 lbs. per hour of condensate has a total value of $11,800 per year to an owner. This value is based on both the thermal value of higher temperature feedwater, and the reduction in the cost of paying for and treating makeup water rather than capturing condensate.

Steam Trap Monitoring

Iordanova also stressed the importance of selecting the right type of steam trap, and installing monitoring and maintenance programs for steam traps and the condensate recovery system. She pointed out that steam trap monitoring is especially important where traps are located in places with difficult access, such as below floor level or at heights where they need to be reached by ladders or the use of harnesses. She explained that in many campus situations, such as in universities and at military bases, steam and condensate lines and traps are in tunnels and are difficult and time-consuming to check regularly. These areas especially benefit from continuous automatic remote monitoring.

Also important is insulation of steam traps and condensate return lines to assure that collected condensate retains as much heat as possible. Today, companies offer custom-fitted insulation for steam traps that is removable and replaceable in minutes. Unlike industrial applications, in institutional settings most of the steam is converted to condensate and can be returned to the boiler. It is highly advantageous for that condensate to return at as high of a temperature as possible.

Heat shields reduce energy loss at stream traps and can quickly be removed and reinstalled. Photo courtesy: Insultech.

This condensing economizer system at Indiana State University recovers 4,760,000 Btus from several boilers which raises the temperature of condensate return water from 142°F to 175°F at peak load times. This provides annual savings of $509,200 and a reduction of annual CO_2 emissions of 2907 tons. Photo courtesy: Condex.

Recover Heat from the Stack

In addition to condensate return, another important source for heat recovery is exhaust stack heat recovery. Many newer industrial and institutional boilers are equipped with economizers to do just that. If your boilers are not so equipped, an economizer can be installed. ConDex Energy Systems offers a condensing economizer that can be used to heat boiler makeup water, or many other streams.

Cameron Veitch from ConDex explains that in industrial boiler applications, where a large portion of the steam is consumed in the plant, the system can provide a significant amount of heat to the makeup water. Often the makeup water temperature can be brought up well above 200 degrees.

Where to Use the Heat

Veitch says, "One of the key considerations in every installation is whether or not we have enough of a heat sink to put the recovered energy into, in order to have a viable payback. Most institutional boilers do not have a high enough flow rate of makeup water alone to justify a condensing economizer project, so we must look for other places to put the available heat. Often we use several "stages" of heat recovery. We will use separate exchangers (all inside one box) to heat separate streams to maximize heat recovery. In many cases we will heat three or more streams of water, such as: condensate return; district heating water return; domestic water; and makeup water."

He suggests that the first stage, where the temperature is highest, can be used to add heat to returning condensate. "The next stage of heat recovery is domestic water or building heating loop water, and the last stage, the coldest, would be boiler makeup water. We have done this at quite a few places, but one of the largest was at the University of California, Davis campus. We used a ConDex system to heat condensate return water, dormitory heating water and boiler makeup water. This increased the fuel utilization efficiency of the boiler plant substantially."

Boiler Blowdown Heat Recovery

In addition to maximizing hot condensate return and capturing exhaust heat with an economizer, another opportunity is boiler blowdown streams. Nearly all boilers use the blowdown process to periodically or regularly remove contaminants from the feedwater stream. In newer boilers the blowdown is often initiated when dissolved solids in the feedwater reach a pre-determined level as indicated by conductivity monitoring. The hot blowdown water carries away a significant amount of thermal energy, and often goes to municipal waste water systems.

Blowdown Rate, % Boiler Feedwater	Heat Recovered, Million Btu per hour (MMBtu/hr)				
	Steam Pressure, psig				
	50	100	150	250	300
2	0.45	0.5	0.55	0.65	0.65
4	0.9	1.0	1.1	1.3	1.3
6	1.3	1.5	1.7	1.9	2.0
8	1.7	2.0	2.2	2.6	2.7
10	2.2	2.5	2.8	3.2	3.3
20	4.4	5.0	5.6	6.4	6.6

Avoid Excessive Blowdown

As Gregg Achtenhagen from Cleaver Brooks points out, "The first rule in reducing energy use is to minimize waste. It is much more cost effective to minimize blowdown than to recover energy from too much blowdown." It

may be appropriate to upgrade or install a feedwater conductivity monitoring system to assure that you are not doing blowdown more than necessary.

Yet some blowdown is essential. Cleaver Brooks offers a flash blowdown heat recovery system that captures both sensible and latent heat from the surface blowdown system. He describes this system, "It is a flash tank which is used to first flash the blowdown to steam to offset low pressure steam use (typically in a deaerator). Then the condensate is cooled with either a helical coil in the flash tank or an external shell-and-tube heat exchanger, depending on size."

Dual Benefits of Blowdown Cooling

According to Achtenhagen, the captured waste blowdown heat usually goes to preheating the makeup water stream, thus reducing boiler energy requirements. In addition to the energy savings, the process of lowering the temperature of the blowdown can reduce municipal fees for thermal discharges. He notes, "Most codes require discharges to be cooled to at least 140°F." By using the blowdown to heat makeup water, you eliminate the need to otherwise cool the water with city water, thus avoiding water charges."

Achtenhagen indicates that in a new system, paybacks are typically 12 to 18 months. "In a retrofit, it will depend on the amount of modification required, however it is typically under three years." These short paybacks should be attractive to most boiler operators. Several manufacturers offer various types of blowdown thermal recovery.

Tom Hiatt from Armstrong International notes, "The return on investment on a blowdown heat recovery system must be in line with the cost to generate steam. Some steam systems are using the excess from electric generation, and look at that as 'byproduct' or 'free steam.' Clients need to weigh the cost and benefits to make that decision."

A boiler blowdown heat recovery unit can be installed on many industrial or institutional boilers. Illustration courtesy: Cleaver Brooks.

Sweetening the Absorption Option

Especially in institutional applications, it may also make sense to use recovered heat, perhaps from a boiler economizer, to supply energy for a single-stage absorption chiller. This unit could supplement an existing chiller plant to provide chilled water at an operating cost much lower than an electric chiller in the warm months, or even year-round. Today's single-stage absorbers can generate chilled water from hot water as low in temperature as 190°F.

Even if the temperature of the recovered heat stream is not this high, it could very effectively reduce the cost of the heat input to either a hot water or steam absorption chiller. Again, it's important to balance the cost of adding absorption chiller capacity versus the reduction in operating costs. If you already operate a hot-water chiller, the payback from streaming hot water with recovered heat could be very attractive.

Multiple Benefits

By capturing the available thermal energy from all of these sources – boiler blowdown, stack economizers and improved condensate return, you are not only reducing the operating cost for your system, but you are also significantly reducing your greenhouse gas discharges. This is increasingly important for many owners. Consider asking your system engineer to look into all of these possibilities. **GT**

MORE info

ARMSTRONG INTERNATIONAL
www.armstronginternational.com

CLEAVER BROOKS
www.cleaver-brooks.com

CONDEX ENERGY SYSTEM
www.condexenergy.com

INSULTECH (SHANNON INDUSTRIES)
www.blanket-insulation.com

Single stage absorption chillers are available in sizes from 50 tons to several thousand, and can be designed to generate chilled water from relatively low inlet temperatures. Photo courtesy: Broad U.S.A

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STANDBY GENERATION AS A PROFIT CENTER

Natural Gas-Powered Reliability

For healthcare centers, universities, and government facilities, it has been typical to install diesel engine-generator sets as standby generation. They are able to pick up critical elements of the facility electrical load if the utility power goes down. Diesel engines start quickly and, if properly maintained and periodically tested, provide reliable backup power. But what if another approach could supply reliable power not just to cover short-term outages, but could carry a major part of the site load in demand-response service, supplementing central-station power at peak times? Such a solution exists.

Natural Gas Engine-Generators

In a recent presentation at a Technology and Market Assessment Forum conducted by the Energy Solutions Center, Aaron Trexler, Waukesha Senior Product Line Manager from GE Power discussed this alternative route. He noted the traditional approach for facilities that require standby power was diesel-fuel powered engine-generator sets. These are often sized between 500 kW and 3 MW. If properly maintained, they operate reliably for the relatively short hours needed in standby service.

However, Trexler noted, diesel units have their limitations. "They require on-site fuel storage for two or more days of operation, and that fuel has to be kept in good condition. Because of emission restrictions, unless they have significant upgrades for pollution control, they cannot be operated other than in emergency service."

Emission Restrictions on Non-Emergency Diesel

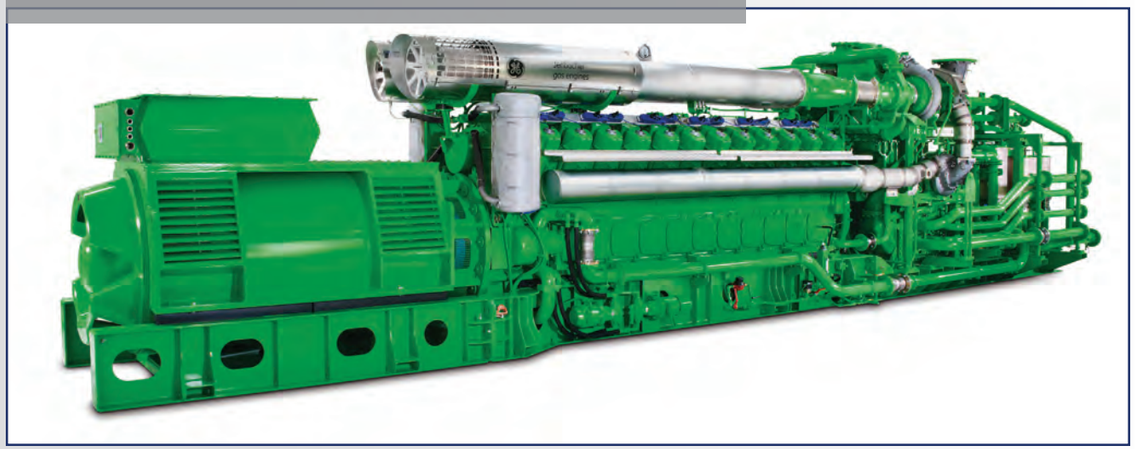
He explained that recent court decisions have confirmed emission restrictions for standby engines used on demand-response applications. "According to the U.S. Court of Appeals for the District of Columbia Circuit, beginning May 2, 2016, engines used for any demand response activity must meet emissions requirements for non-emergency engines. They must be fully compliant. Older engines are not grandfathered – they must be updated. Demand response with diesel just got more expensive, and fast-start natural gas units are a viable alternative."

Trexler suggests as an alternative that institutional and industrial owners should consider these natural gas-fired engine-generator sets such as the Jenbacher and Waukesha models offered by General Electric. "These units not only provide reliable standby power, but can also be used in a demand-response mode, reducing utility demand charges and providing economical site energy for 1,000 hours a year, or more. They are no longer a 'stranded asset,' but in effect become a profit center.

Rapid Start Now a Feature

Trexler indicates that at one time natural gas engines couldn't meet the requirement to carry full load within 15 seconds. This has been overcome. This criterion for rapid startup in emergency situations can now be achieved by many Waukesha and Jenbacher natural gas engines, matching the performance of diesel engines. Qualifying Waukesha sets are available in sizes from 200 kW to 3.6 MW, and Jenbacher sets range from 200 kW to 10.0 MW. "These units are well proven, with over 36,000 units operating in over 170 countries."

Large gas-fired engine-generator sets such as this Jenbacher unit are in widespread use around the world for demand-response or full-time power supply as well as serving as a reliable backup unit with a 15 second start time. Photo courtesy: General Electric.



This Waukesha mobile standby generator set could also be used in a demand-response role to reduce utility demand and energy charges at times of peak use. Photo courtesy: General Electric.

Trexler noted the high efficiencies available with today's natural gas-fired engines, with proven performance levels ranging from 35% to 50%, depending on size and type. "Application of gas-fired engine-generators in combined standby and demand-response service can show a payback as short as two and a half years. If yours is also a potential cogeneration application, it could be even sweeter."

Alternative Gaseous Fuel Options

Several of the GE lines of engine-generator sets are designed to use alternate gaseous fuels such as propane, CNG and LNG. This makes them practical alternatives even when there are no pipeline gas sources. This also fulfills the need when it is a critical standby classification that requires on-site fuel storage.

He noted that conversion of existing diesel engines to dual fuel (diesel+gas) service has some significant limitations. "You're still using diesel fuel, so there are emission restrictions. Unlike engines designed for natural gas, these conversions do not have pistons, cylinder liners, crevice volumes or bowl configurations designed for gas. Their efficiency and reliability suffers. Our gas engines are designed to combust air/fuel in such a way to extract the maximum amount of power. The same cannot be said of today's dual fuel engines."

Striking Fuel Cost Comparison

Additionally, Trexler pointed out the fuel economies with natural gas as compared with diesel. He indicated that with diesel at $1.88/gallon, the fuel cost would be $14.56/MMBtu, compared with natural gas at $2/MMBtu. "This would result in a diesel-only fuel cost for electricity of $131/MWHr versus $24/MWHr with pipeline natural gas."

He states that the cost of a natural gas-fired unit would typically be about 50% more expensive than a standby-only diesel. However, if the gas unit operates for 2,500 hours per year in demand-response mode, the project payoff is 2.5 years. This assumes no cogeneration application. There is no payoff for the diesel unit, because it can only operate in standby situations.

Quieter and Cleaner

Other advantages of gas engines include the fact that they are significantly quieter than diesel units. According to Trexler, the difference can be as high as 20 dB. Gas units on pipeline have no limitation on operating hours, and require relatively inexpensive emission controls as compared with diesel. He indicates the diesel unit will require five to ten times more expensive emission controls.

Now that the rapid-start issue has been overcome, for most institutional owners the choice of natural gas engines for combined standby and demand-response service is obvious. It's the way for your standby system to pay its way. When you are installing standby power, keep this option in front of you. GT

MORE info

ENERGY SOLUTIONS CENTER INFO ON ENGINE GENERATION
http://www.energysolutionscenter.org/gas_solutions/engines.aspx

DOE INFORMATION ON DISTRIBUTED ENERGY
http://energy.gov/oe/technology-development/smart-grid/distributed-energy

GENERAL ELECTRIC POWER GENERATION
https://powergen.gepower.com/products/reciprocating-engines.html

Vintage Factory Converted to Healthcare Offices

Energy Improvements Key to Success

THE *PROVIDENCE CENTER*, A NON-PROFIT, BEHAVIORAL HEALTH-CARE ORGANIZATION now occupies the 72,000 square-foot brick building that was once part of the Eagle Screw Company. After the building was renovated to provide offices and meeting rooms, Providence Center purchased it in 1996. But it wasn't until 2013 that a mechanical system retrofit brought all facets of the 1875 building into the 21st Century. Operating costs fell while indoor air quality and comfort levels rose.

Gary Tsacoyianis, controls and startup technician for Victory, checks the Modine controls during commissioning. Photo courtesy: Emerson Swan.

Major Renovation

"These old brick buildings are solid and beautiful, but they sure don't win any energy awards," said Bob Pritchard, director of facilities and projects at The Providence Center. "We couldn't keep the facility at a comfortable temperature in the winter, and spent huge dollars attempting to."

"Also, there are two full levels of the building below grade," continued Pritchard. "The entire east side of the building has a 40-foot tall flagstone foundation, which inherently means moisture within the envelope. Air quality was a concern year-round. The building was just damp and musty."

Victory Mechanical was hired to design and install components to provide a solution. Don Fleck, PE, systems engineer at Victory, brought in manufacturers' representative firm Emerson Swan during the design.

"The work was split into two phases; a hydronic retrofit in late 2011, and a more invasive air-side upgrade in early 2013," said Tim Eaton, at Emerson Swan.

The Providence Center. An 1875 industrial building has a complete renovation of its mechanical plant and air distribution system to create a comfortable and energy-efficient office space. Photo courtesy: Emerson Swan.

Hydronic Makeover

The first challenge was the basement mechanical room. Four existing 1 MBtu boilers consumed nearly 18,000 gallons of fuel oil each year. The Victory crew removed the oil boilers and installed four, HTP Mod Con 850 gas-fired boilers. The new condensing boilers offer 96% efficiency, a vast improvement over the roughly 65% efficiency the facility had before the retrofit.

The building's existing fin-tube radiation was serviceable, as were a handful of fan-coil units in stairwells. "With four modulating boilers, each with a 5:1 turndown, this system literally has 20 stages of heat input," said Fleck. "It's like having 20 tiny boilers, and each one only turns on if it's needed. So you're never using more fuel than the building really needs."

Taco pumps on the boilers and the building's primary loop provide efficient, maintenance-free circulation. For further space and initial cost savings, Victory installed Taco Plus Two multi-purpose valves with each secondary pump. The compact valve is effectively five valves in one, combining all the functions that are normally required on the discharge side of a centrifugal pump in a single body; a shut-off valve, a non-slam check valve, a balancing valve and a flow metering valve. It's easily field-converted from a straight pattern to a 90-degree pattern for easy use in nearly any application.

The Providence Center didn't have to wait long to see savings from the boiler retrofit. Once connected to the natural gas utility line -- fuel expenses were $66,000 below the prior winter, meaning the estimated 4.8-year ROI is tracking nicely.

Airside Needs

Next, says Pritchard, the company tackled the problems with humidity and indoor air quality. "We knew we were using way too much electricity for air conditioning," he added, "and temperatures varied as much as 15°F from room to room." The building's 37 independent HVAC systems couldn't maintain desired conditions.

In 2013, work on the airside project started. Fleck and Eaton had designed a dedicated outdoor air system around a new product.

The solution to all ailments would come in the form of a packaged rooftop unit. The 20-ton Modine Atherion unit now installed at Providence Center is used for dedicated outdoor air supply. It features condensing gas heating technology and an optional ERV module with an energy recovery wheel, the effectiveness of which typically exceeds 60%.

Ductwork a Challenge

Gary Tsacoyianis was the controls and startup technician from Victory for the Atherion unit. "My job was easy," he says, "But I'm told the ductwork was another story." The most challenging part of the project came when Victory technicians installed 5,100 lineal feet of duct in the building. The old brick and large timbers slowed progress, but when finished, there was neutral-temperature, fresh air delivery to the farthest reaches of the facility.

With the Atherion's ERV module, a portion of the cooling load has been lifted from the existing independent systems, allowing the system to easily meet demand. And with up to 94% efficiency, the unit is able to condition outdoor air in the winter without adding heating load for the modulating boilers downstairs.

The Atherion's gas heating capability is provided by Modine's Conservicore technology; a dual heat exchanger that provides condensing efficiency and up to 100°F temperature rise. Paired with the Energy Recovery Module, the unit provided everything needed at Providence Place.

Four condensing boilers operating at 96% efficiency replaced older oil-fired boilers that operated at 65% efficiency at best. Between the improved efficiency and the lower price of natural gas fuel, building heating costs were slashed. Photo courtesy: Emerson Swan.

Pressure Balance Problems

"Before the retrofit, we had major issues with negative pressure in the building," said Pritchard. "You had to heave on the door to get in the building. Once open, it'd literally suck you in."

Three vertical utility shafts in the building – plus the elevator shaft - acted as big chimneys, providing a perfect conduit for warm air to leave the building. This – and the building's inoperable windows – created a vacuum.

As annoying as the pressure issue was, it also created a huge waste of energy as conditioned air was pulled out of the building, especially in the winter. During the retrofit, the shafts were used to run ductwork between the floors, and were then sealed off. But Victory took the pressure solution a step further. Aside from providing cost-effective make-up air, the Atherion is also tasked with maintaining positive pressure within the building.

A barometric pressure sensor in the building corresponds with the Atherion's VFD-powered fan in order to maintain the .02" H_2O setpoint – similar to that of a typical pharmaceutical clean room. "On average, the Atherion is exhausting 3,800 CFM and supplying 4,000," said Tsacoyianis.

Home Run

"We're absolutely, 100 percent satisfied with the retrofit," said Pritchard. "The energy savings are staggering and the indoor environment is now infinitely better." But the project also resulted in a few less-tangible benefits.

The new control system installed by Victory allows domestic water to be shut off within the building during unoccupied hours – another big benefit because the facility had suffered a few overnight leaks in the past.

This project in Providence is an excellent example of giving new and energy-efficient life to a very old building using 21st century boilers, airside systems, and control technologies. Many other buildings out there are candidates for such renovations. **GT**

Atherion rooftop unit conditions ventilation air, preheating it in the winter to maintain building comfort levels. Photo courtesy: Emerson Swan.

MORE info

HTP MOD CON BOILERS
www.htproducts.com/modconboiler.html

MODINE ATHERION VENTILATION UNIT
www.modinehvac.com/web/products/commercial-ventilation-system

Natural Gas Supports Green Efforts

IT'S TRUE THAT NATURAL GAS IS A FOSSIL FUEL, AND AS A FOSSIL FUEL ITS COMBUSTION INVOLVES THE RELEASE OF CARBON DIOXIDE, a "greenhouse gas" which is believed by most scientists to contribute to global climate change. Yet natural gas also can play a major role in the reduction of global greenhouse gas emissions. How is this possible?

Replacement for Heavier Emitters

Natural gas is increasingly being chosen to replace other fossil fuels which produce much higher levels of greenhouse gas emissions. It is generally estimated that combustion of natural gas reduces these emissions by 25% to 50%, depending on the previous fuel characteristics and the combustion technology used. There's no dispute that replacing a coal-fired boiler with a natural gas equivalent amount of generation will reduce not only carbon emissions, but will virtually eliminate sulfur dioxide and particulate emissions and greatly reduce nitrogen oxides.

Supporting Renewables

Renewable energy sources for electric generation are important tools for reducing greenhouse gases. But for them to be practical, they need a backup that will operate when they can't. Solar and wind are just two examples of promising renewable technologies that can't be relied upon 24 hours a day, 365 days a year. Natural gas can. In its backup role, it makes it practical to use the renewable approaches for electric generation.

Enabling New Technologies

Many newer technologies use natural gas more efficiently than ever. Examples include condensing boilers or furnaces that wring that last amount of energy from the fuel. Another example is combined-cycle generating plants. These use natural gas-fired turbines to spin generators, then use the turbine exhaust to generate steam to spin an additional steam turbine-generator, boosting the plant efficiency to well over 50%.

Natural gas is the natural choice also for combined heat and power (CHP) systems for industry, which supply both site electric energy and steam or hot water for plant processes, or even to supply absorption cooling. A CHP plant can achieve a total energy utilization of over 75%, compared with 50% or less with separate electric and thermal systems. Thus they work to extract more energy from fuel combustion and help reduce emissions.

Another area where natural gas can reduce greenhouse gas emissions is in replacing combustion of gasoline or diesel fuel in motor vehicles. Millions of vehicles around the world have moved to using natural gas as a primary motor fuel. This also has the effect of reducing total greenhouse gas emissions.

Today's highly efficient natural gas-fired engines can replace coal and oil fired electric generation, reducing total emissions of greenhouse gases and other air pollutants. Photo courtesy: General Electric.

Existing Pathway for Renewable Gas Fuels

The existing natural gas distribution network is also the logical mechanism for gas fuels produced in renewable forms. Example might be fuels developed from biogas from municipal landfill gas or digester gas products from wastewater treatment plants, agricultural wastes, or wastes from food processing industries. All of these streams can be upgraded to be interchangeable with pipeline natural gas, thus can be efficiently transported from the point of production to the end user. Therefore, not only does natural gas support other renewable technologies, but the industry collection and distribution structure simplifies getting green fuels to market. Many U.S. and Canadian utilities are studying this possibility.

A Strong and Steady Bridge

The time may come when most of our energy comes from renewable sources. It is obvious we're not there yet. Clean and abundant natural gas, wisely used, can be depended upon until that full-renewable future is here. **GT**

MORE info

AMERICAN GAS ASSOCIATION ON ENVIRONMENTAL BENEFITS OF NATURAL GAS
www.aga.org/environmental-benefits-natural-gas

INTERNATIONAL GAS UNION REPORT: IS GAS GREEN ENOUGH?
www.igu.org/sites/default/files/Is%20Natural%20Gas%20Green%20Enough%20TF3%20IGU%20Final%20May%202015.pdf

NATIONAL FUEL GAS COMPANY EMISSIONS COMPARISON
www.natfuel.com/natural_gas_environment.aspx