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Environmentally Friendly Boiler Rooms

By Steve Connor
For *The NEWS*

Every year, health care facilities struggle to hit their operating budget targets. Adding to the challenge are rising energy costs. Boilers are a major contributor to this budget-busting line item, consuming large amounts of gas and/or oil for comfort heating, sterilization, and steam tables.

It doesn't help that eight out of 10 hospital boilers, research has shown, are more than 30 years old. These boilers most likely operate well below today's efficiency standards and are probably less reliable than newer units. Some may even violate federal pollutant emission standards.

With life-saving work performed at hospitals 24 hours a day, seven days a week, these facilities must maintain 100 percent reliability of all operational equipment, including boilers.

One could argue that health care systems across the country are in need of more reliable, efficient, and environmentally friendly boiler rooms. Let's look at several options contractors can recommend to health care system engineers.

IDENTIFY THE PROBLEMS

When looking for energy loss, the entire steam system should be considered. Research has shown that inefficiency in the boiler is most often caused by poor heat transfer and resultant heat loss up the stack. This can be due to fouling of the heat transfer surfaces, poor combustion control, improper furnace matching, and/or all the above.

Research has also shown that the average level of efficiency for industrial boilers is 75-77 percent. This means that roughly one-quarter of the fuel-producing heat through the combustive process is lost.

In the big picture, the type of boiler matters. For years, health care facilities have employed steam boilers for sterilization, kitchen, laundry, and heating needs and used a separate heat exchanger(s) to produce the hydronics for comfort heating and potable water. With today's improved technology, hospitals do not necessarily have to depend on steam boilers alone. There are other options available.

One example is condensing boiler technology for air-handling unit reheat and zone heating. This technology works especially well in spring and fall; when returning water temperatures can be low (<135°F), causing the boiler to at least partially condense combustion products.

The lower the return water temperature, the better with condensing boilers because, in many units on the market, return water temperatures of 100° or lower will result in full condensing of the flue gas and efficiencies in the boiler approaching 99 percent.

With these units, however, it's most important to check with the manufacturer to be sure when full condensing actually occurs and what the minimum flow requirements are. Some designs are more efficient at a higher return temperature and more forgiving with the minimum flow requirement.

NEW BOILER VERSUS MODIFYING

Facilities with old steam boiler equipment can install a smaller steam boiler for process needs and a condensing boiler for building

and potable water heating. These options are designed to maximize the use of boilers' capacity and save considerable amounts of energy.

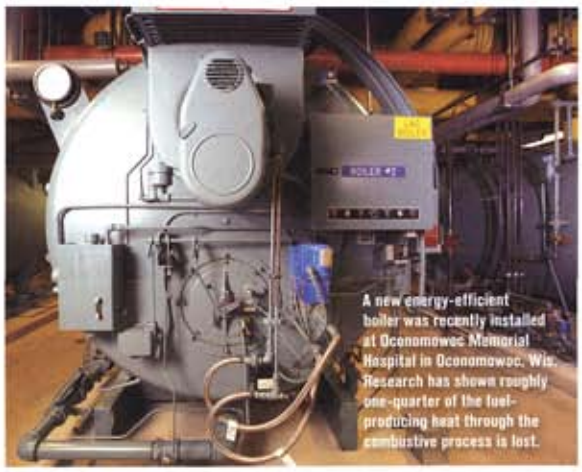
However, if the existing boiler and hydronic heat exchanger are in good shape, then one should consider modifying the system. Supplementing the system with a condensing boiler for heating and potable water is considered an excellent choice, but not the lone choice.

If modifying the existing system is the choice, improvements should begin with the control system. Recent developments in boiler combustion controls have created new opportunities for substantial efficiency gains, especially if the control platform is PLC-based.

For instance, the burner's turndown capability should be increased from 4:1 to 10:1 to compensate for the reduction in load, due to the shedding of the previous hydronic heating requirement.

Next, the boiler's fuel-air ratio control, which may include a single drive and jackshaft, should be considered for replacement with a parallel positioning system, using dedicated actuators for the fuel and air control devices. With this system, air and fuel position curves are programmed into the PLC for each actuator, making setup a breeze — for some, anyway — and repeatability during modulation, for lack of a better description, a sure thing.

Feedwater economizers, such as this, are designed to transfer energy from the boiler exhaust gas to the boiler feed water in the form of "sensible heat." Sensible heat is extracted by the transfer of the heat energy of one body to another, cooler body. This is designed to reduce the boiler exhaust temperature.



A new energy-efficient boiler was recently installed at Oconomowoc Memorial Hospital in Oconomowoc, Wis. Research has shown roughly one-quarter of the fuel-producing heat through the combustive process is lost.

Paul Wronkowski, a facility boiler room operator, works on a new boiler system at Oconomowoc Memorial Hospital in Oconomowoc, Wis. With life-saving work performed at hospitals 24 hours a day, seven days a week, hospitals must maintain 100 percent reliability of all operational equipment, including boilers.

Boilers that incorporate parallel positioning have proven to hold closer tolerances on the oxygen levels in the stack. This means this type of setup should ensure complete combustion and higher overall efficiencies.

Another option is to incorporate an oxygen sensor-transmitter in the exhaust gas. The sensor-transmitter is designed to continuously sense oxygen content and provide a signal to the controller.

In turn, the controller is designed to "trim" the air damper or gas valve, depending on varying conditions, such as ambient temperature, relative humidity, and barometric pressure. This is designed to minimize fuel-rich or lean conditions and improve safety. At the same time, the setup is designed to further optimize the air-to-fuel ratio control as affected by the parallel positioning system.

HEAT RECOVERY

The following are two "post-combustion" retrofit devices designed to recover heat loss.

1. Feedwater economizers: These are designed to transfer energy from the boiler exhaust gas to the boiler feed water in the form of sensible heat. Sensible heat is extracted by the transfer of the heat energy of one body (in this case, exhaust gas) to another, cooler body (in this case, the boiler feed water). This is designed to reduce the boiler exhaust temperature, while preheating the boiler feed water. As a result, overall efficiency can be increased in the range of 5-10 percent.

Another development involves the use of specialized membranes in the stack, designed to recover both latent and sensible heat from the boiler exhaust and, at the same time, to recoup the exhaust condensate for the boiler feed water stream. (At a recent beta site, combining this technology with another standard economizer and controls resulted in boiler efficiencies greater than 90 percent, far surpassing the typical 75-77 percent mentioned earlier.)

2. Air preheaters: These are designed to transfer sensible heat from the boiler exhaust gas to the combustion air required by the burner. This is designed to reduce the boiler exhaust temperature while preheating the combustion air. The end result should be, again, increased system efficiency.

There are also small, effective retrofitting options for hospitals. Smaller savings can be achieved by insulating steam piping; including main supply headers and condensate return lines. Research has shown that a 4-inch-diameter, 100-foot pipeline at 150 psig loses 850 million Btu/year, which can cost almost $13,000. Research has also shown that approximately 90 percent of this loss can be saved through insulation.

Another option is blowdown heat recovery. All boilers must remove dissolved solids from the boiler water to maintain water purity. This process also is designed to ensure a longer boiler life because of scale formation control. The frequency and duration of each blowdown cycle, therefore, equates to a substantial efficiency loss over an annual basis.

A blowdown heat recovery system is designed to transfer the blowdown effluent energy to the boiler feed water. As much as 90 percent of this energy was recuperated in some projects. Savings over the year can total 5 percent — possibly more — of the boiler's fuel bill if the boiler's cycles of concentration is low, requiring more frequent blowdowns. ■

green is hot

Contractors working on upgrading hospital boiler systems should also consider green options. Many, if not most, boiler systems in health care facilities are at least 30 years old, if not older. They emit far more NOx and greenhouse gases than newer models, simply because of new improvements and developments with newer models.

Here are three key green options contractors should consider while retrofitting or modifying hospital boiler rooms:

1. Burner: The most effective way to reduce emissions is by upgrading or adding options to the burner. The option considered by many to offer the largest emissions improvement is flue gas recirculation (FGR), which is available as a retrofit option or as part of a new burner. FGR is designed to reduce peak flame temperatures where thermal NOx is formed. As a result, it is designed to reduce harmful smog-producing emissions.

2. Turndown: Another burner option to consider is to increase the turndown rate. Many small burners have only two positions: off and on. As the boiler water reaches the desired setpoint, these burners turn off. As water or steam is used, the level drops below the setpoint, and the burner is turned back on.

For each of these cycles a pre- and post-purge is dictated by code. During these purges, research has shown that large volumes of air can be passed through the boiler, resulting in large amounts of heat simply blown out the stack. A high-turndown burner is designed to minimize the number of cycles, hence saving significant amounts of energy.

3. Condensing boiler: It's safe to say that many boilers in hospitals today were oversized originally for "fudge" reasons, including the possibility of expansion. Back then, energy was relatively cheap. Today, however, we're concerned about high-energy cost and the carbon footprint left by an energy user consuming large volumes of fuel while emitting tons of carbon dioxide to the atmosphere during the course of a year. As a result, many condensing boilers are being installed to replace steam-to-water heat exchangers.

When condensing boilers are properly applied to a hydronic heating system, this setup is designed to allow the boilers to condense most of the time and can greatly reduce fuel bills. At the same time, this design can positively impact the environment. The key is in applying these boilers using state-of-the-art control systems for temperature regulation against outside load conditions, intelligent hydronic coupling between the supply and return piping, and proper air elimination. ■

ABOUT THE AUTHOR...

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