THE ENERGY OBSERVER

Energy Efficiency Information for the Facility Manager

Quarterly Issue – March 2009

Upgrade that Boiler!

The Energy Observer summarizes published material on proven energy technologies and practices, and encourages users to share experiences with generic energy products and services. This quarterly bulletin also identifies informational sources and energy training for facility managers and staff. ***The Energy Observer*** is a service of the **Bureau of Energy Systems, Michigan Department of Energy, Labor & Economic Growth.**

This issue of the Energy Observer focuses on improving the energy efficiency of your boiler through replacement or retrofits that can save your facility energy and money. A boiler is equipment designed to provide heat throughout a building by circulating hot water or steam through a network of pipes to radiators, radiant floor systems, and/or a heating coil. In industrial facilities, boilers are also used to supply hot water or steam for manufacturing processes and for operating pieces of equipment.

AFUE

The AFUE, or Annual Fuel Utilization Efficiency, is the measure of a central furnace or boiler's energy efficiency. AFUE is the ratio of heat output of the furnace or boiler compared to the total energy consumed (or input). For example, an AFUE of 80% means that 80% of the energy in the fuel becomes heat for the building and the remaining 20% exits through the exhaust vent to the outside as a waste byproduct. The minimum allowed AFUE rating for a fossil-fueled boiler is 80%; the minimum allowed rating for a gas-fueled steam boiler is 75%. The AFUE rating does not take into account the heat loss that occurs through duct systems or piping. Adding insulation to ductwork and piping can reduce these other energy losses.

An all-electric boiler has no flue loss through an exhaust or chimney, so its AFUE rating is usually close to 100%. However, the higher cost of electricity usually makes electric boilers and furnaces a cost-prohibitive choice for facility managers and consumers. For that reason, the remainder of this issue applies only to gas-fired boilers.

Replacing your Boiler

While older boiler systems had AFUE ratings in the range of 56%-70%, the newer systems can have efficiencies as high as 97%. A high-efficiency boiler operates with reduced fuel consumption, lower flue-gas temperatures and emissions, which in turn produces a higher AFUE. High-efficiency boilers operate at efficiencies of 90% or higher, and can typically heat water to temperatures of 120 to 140^{o}F. High-efficiency boilers are called "condensing" boilers because during the process of recovering heat from burned fuel, the temperature of the flue gas is reduced to a point that the water vapor produced during combustion is "condensed out."

A condensing boiler reduces flue-stack temperatures and heat loss, which saves money and energy in the long-run. High-efficiency boilers rely on larger heat exchangers to operate in a condensing mode. However, while such systems are most efficient when operating in the condensing mode, they will also operate in a non-condensing mode, with efficiencies a bit higher than a conventional boiler due to the larger heat exchanger.

While there are many benefits to installing a high-efficiency boiler, they are generally more expensive to install than a conventional boiler. The added cost is largely due to the use of stainless steel and other materials needed to resist the corrosive condensate found in wet flue gases generated by the combustion process. The condensate is acidic and must be piped away to a drain or soakaway. However, despite this higher initial cost, high-efficiency boilers are very economical to operate, and repay the added upfront cost in fuel savings. (See table on next page.)

In replacing a boiler, consider your actual boiler use, the water temperature requirements needed to supply enough heat throughout the facility and to any additional processes connected to the heating system..

Table 1. Annual Estimated Savings for Every $100 of Fuel Costs by Increasing Your Heating Equipment Efficiency*

Existing System AFUE	New/Upgraded System AFUE								
	55%	60%	65%	70%	75%	80%	85%	90%	95%
50%	$9.09	$16.76	$23.07	$28.57	$33.33	$37.50	$41.24	$44.24	$47.36
55%	----	$8.33	$15.38	$21.42	$26.66	$31.20	$35.29	$38.88	$42.10
60%	----	----	$7.69	$14.28	$20.00	$25.00	$29.41	$33.33	$37.80
65%	----	----	----	$7.14	$13.33	$18.75	$23.52	$27.77	$31.57
70%	----	----	----	----	$6.66	$12.50	$17.64	$22.22	$26.32
75%	----	----	----	----	----	$6.50	$11.76	$16.66	$21.10
80%	----	----	----	----	----	----	$5.88	$11.11	$15.80
85%	----	----	----	----	----	----	----	$5.55	$10.50
90%	----	----	----	----	----	----	----	----	$5.30

Source: U.S, Department of Energy

Industrial facilities using several individual unit heaters will most likely require water temperatures ranging from 150 to 180°F in order to provide sufficient heat for the building. If the heating system requires the water to be 140°F or higher, then a traditional or non-condensing boiler is the only replacement option. This is because the dew point of flue gas is approximately 140°F. If the heating system does not allow flue gases to condense, then purchasing a condensing boiler would not be economic since the system wouldn't run at peak efficiency.

Retrofitting an Inefficient Boiler

If replacing your boiler is not cost-effective or financially feasible, a number of retrofits are possible.

Adding a vent damper prevents chimney losses by closing off a boiler's vent when the boiler isn't firing. It is the most common boiler retrofit, and is usually most beneficial for large steam boilers. They may not be cost effective with properly sized newer models.

Intermittent ignition devices are connected to a boiler's furnace and light the pilot when needed, as opposed to having the pilot light burning continuously. They can be installed on older boilers that use a continuous pilot light. These devices should only be installed by a professional, cost about $250 and usually have a payback period of less than 10 years.

Derating gas burners. Many boilers in homes and commercial buildings today are oversized, especially if the energy efficiency of the building has been improved. It is sometimes possible to reduce the heating capacity of your gas boiler to make it operate more efficiently by reducing the size of the gas burner orifice, and possibly also the baffles. This process should only be performed by a qualified technician. Also, make sure it will not violate local building codes and/or void manufacturers' warranties. If it does not, however, the modifications should cost less than $100 and save up to 15% of your fuel costs.

Steam boilers should only be derated if the steam system is also modified to remove excess radiators.

Modulating aquastats. An aquastat controls the temperature of the hot water in a boiler, typically keeping it around 180°F. But when heating loads are lighter in the spring and fall, this temperature setting is usually far too high and wastes energy. A modulating aquastat, (or *outdoor reset*), measures the outdoor temperature and adjusts the hot water setting accordingly. These units typically cost up to several hundred dollars, but can save up to 10% of fuel costs.

A Time-Delay Relay circulates hot water through the system without turning on the boiler for a set time after the thermostat clicks on. After the set time expires, the boiler will turn on. A time delay relay costs around $100 and can cut your fuel costs by up to 10%.

For more information:

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