Consider the Advantages of Modular Condensing Boiler Installations

One of the Energy Cost Recommendation Measures (ECRM) that SEDAC frequently analyzes is the replacement of older inefficient boilers in hydronic systems with high-efficiency condensing boilers. Significant savings can be realized by installing boilers that can, at times, be over 20% more efficient than an existing system. Existing boilers may operate at 75% efficiency or below and a replacement system may achieve efficiencies well above 90%.

Deciding on whether or not to replace a boiler is not a trivial decision. Replacement cost can represent a substantial capital investment. The total costs of operation, including maintenance and fuel usage need to be considered for a comprehensive evaluation. Can the existing boiler be made more efficient and how much will it cost? What are the consequences of a failed boiler? What are the anticipated savings with a new high-efficiency boiler and what are your economic criteria?

With older hot water boilers a significant amount of energy is exhausted out the flue. Due to the possibility of flue gas condensation, boiler flue-gas temperatures are often kept 300°F or higher. Newer condensing boilers achieve a portion of their higher efficiency through much lower stack exhaust temperatures. These boilers also take advantage of the energy in condensed flue gases\(^1\). However, this energy can only be extracted under certain conditions which have to do with return water temperature and firing rates.

Most high efficiency boilers have similar efficiency curves. Figure 1, from Fulton Boilers, clearly shows that there is a direct correlation between return water temperature and boiler efficiency. The warmer the return water is, the lower the thermal efficiency. If the system return water temperature is 80°F, you can achieve very high efficiencies; however, in many systems the return water temperature is considerably higher. If high return water temperatures are a continuing issue, variable speed pumping may be used to ensure a larger temperature differential.

Note also that the firing rate of the boiler can have an effect on thermal efficiency. Lower firing rates for condensing boilers typically have higher efficiencies, particularly at low return water temperatures. This is one reason it

\(^1\)http://www.energysolutionscenter.org/boilerburner/Eff_Improve/Primer/Boiler_Introduction.asp#General_Boiler
is preferable to install modular boilers rather than one large boiler. Control systems will stage boilers such that all boilers will fire at low fire and as more heat is required the control system will keep all the boilers at the lowest firing rate possible to meet system loads to maximize efficiency².

Control systems should also reset loop temperatures based on outdoor temperatures. Ideally, the amount of energy provided to a space should be equal to its rate of heat loss. Outdoor reset controls use outside air temperature as the basis for determining an ideal water temperature to be supplied to the distribution system. As outdoor temperatures increase, the water temperature supplied to the loop decreases. Here is where newer condensing boilers can outperform older non-condensing boilers. Condensing boilers can modulate output temperature down as heating demand decreases to a much lower temperature than non-condensing boilers. Non-condensing systems cannot be modulated as low as condensing systems due to condensation concerns. In addition to improved combustion efficiency, operating at low temperatures has the additional advantage of reduced jacket, distribution system, and cycling losses at part load compared to full-load rated conditions.

Outdoor reset controls have the additional benefits of less fluctuation of indoor temperatures, reduced expansion noises, reduced possibility of thermal shock, and nearly constant water circulation. SEDAC will have more on reset controls in a future newsletter.

If replacing boilers is an unaffordable option, then what? A boiler tune-up should be first on the list. Thereafter, larger boilers can be retrofit with a stack economizer or boiler flue condenser to capture a portion of this waste heat and transfer it to the boiler feed-water, cold makeup water, hot water return, a hot water storage tank, condensate tank, process water, or potable water. The difference between an economizer and condenser is that economizers are primarily used to heat a smaller volume of water to a high temperature for boiler feed water, and condenser units heat a larger volume of water to a lower temperature. Economizers may also be used to preheat combustion air.

Numerous benefits can be accomplished when replacing large antiquated boilers with modern modular condensing units with sophisticated control systems: energy and cost savings, increased occupant comfort, redundancy, reliability, and more. Similar to incentives provided by Ameren Illinois Utilities, ComEd and DCEO for the installation for energy efficient electrical devices, natural gas utility providers are rolling out incentives for the installation of high-efficiency gas equipment – stay tuned.

² http://www.aceee.org/energy/state/durkin_ashrae_journal.pdf