Section IV- Boilers

Summary:

- Types:
  - Fire-tube
  - Water-tube
  - Cast-iron
  - Modular
- Standard boilers have poor efficiency at low load (70-85%).
- Condensing boilers have poor efficiency at high load (83-98%).
- Modular units provide good capacity control.
- Hybrid standard/condensing systems are possible.
Condensing Hot Water Boilers:

Non-condensing hot water boilers are built and operated to avoid condensation from occurring in the heat exchanger. To do so, temperatures within the heat exchanger need to be kept above approximately 140°F. This requirement causes flue gases to be quite hot which are then vented to the exterior. Stand-by (jacket) losses from these boilers can also be considerable since minimum temperatures need to be maintained. Conversely, condensing boilers are built from materials that can withstand the corrosive effects of condensation, capture the heat that non-condensing boilers exhaust out the flue, and have much lower stand-by losses since they can operate at temperatures well below a non-condensing boiler, and capture heat off the heat exchanger.

SEDAC recommends replacing the existing non-condensing hot water boilers with high-efficiency condensing boilers. Current condensing boiler technology with high turn down ratio can achieve efficiencies between 85-97%, with peak efficiency at low-fire rates and low-return water temperature. With proper system design and operation, this characteristic allows condensing boiler technology to be particularly efficient at partial loads as opposed to non-condensing boilers which operate below their rated maximum efficiency under part-load conditions.

Because boilers are typically sized to satisfy heating loads during the coldest anticipated weather, which occurs infrequently, they usually operate at part-load. Therefore, condensing technology can substantially increase the overall operating efficiency of the space-heating hot water system.

An alternative to full boiler replacement may be utilization of a smaller condensing boiler that serves as the lead boiler in conjunction with the existing boilers, also referred to as a hybrid system. This setup allows the smaller boilers to handle the heating load during low-load conditions. This strategy will save gas during swing seasons and can make it a more economical retrofit. SEDAC recommends discussing this possibility with a mechanical engineer or HVAC contractor.

SEDAC recommends replacing the existing boilers with new high efficiency boilers, or adding a high efficiency lead boiler to create a hybrid system with existing boilers.
**Examples:**

Water-tube boilers have a flame of gas inside, along with a tube of water, which circulates through and warms up. These are generally 70-85 percent efficient, or around 80 percent at a low load. Standard boilers are low efficiency at low load. Condensing boilers have poor efficiency at high load, so these actually work better at part load, which is easier for extracting heat across the heat exchanger.

It’s typical for buildings to have several modular or condensing boilers that can be turned on or off as needed, which is a more efficient method for smaller spaces. It is also possible to optimize efficiency by running all units at low load.

Hybrid standard condensing systems are also possible, because of this fact that the standard boiler is going to run 80 percent efficient at full fire, and whereas the condensing boilers are going to run at low efficiency at full fire. Sometimes it’s not a bad idea to leave a standard efficiency boiler in and run it just for the coldest time of the year.

For example, you need 300 MBH to heat the building, but you only need that on the coldest day, or a few days, or a week in January. Whereas the rest of the year you might run at 200 MBH, so you could leave the rest of your boilers in and put in a series of modular boilers. But instead of putting in all condensing boilers, you can have these work together, and basically the old boiler only comes on a few days a year, or a couple weeks a year. So we’ve seen some interesting scenarios that lower the initial cost and still get most of the advantage of gas savings from the condensing system.
Small Boilers:

Some examples of old boilers:

Kewanee boilers are relatively small.

To the left are some very large steam boilers. A high school installed three of these boilers with new controls. The units themselves are old pieces of metal, but they do maintenance on the tubes. All of the technology is in the burner and the controls. They have updated the controls, they have oxygen sensors, and they can optimize the flame burn. There is likely a 2 percent increase in efficiency by performing those measures.

Large Boilers:

This 1960 steam unit has a new burner with an O2 sensor and separate gas and air controls to optimize burner efficiency. +2%