Condensing Boilers for Existing Buildings

Opportunities and Pitfalls

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With maximum efficiency ratings in the range of 96 per cent, condensing boilers are becoming a popular choice for building owners looking for improved energy efficiency, reduced operating cost and lower GHG emissions. However, many owners are not aware of the technology behind condensing boilers and the conditions required for achieving their rated efficiency. Mismatching the boiler with the heating system requirements can result in operating conditions that do not achieve the potential of condensing boilers.

The high efficiency rating for condensing boilers is primarily achieved by capturing latent heat from water vapour in the flue gas. This is done by condensing, or changing the phase of water vapour from a gas to a liquid. As the water vapour in the flue gas condenses, it releases heat that is then captured in a heat exchanger and transferred to the boiler return water flowing through the other side of the heat exchanger. For this process to occur, the return water temperature has to be below the dew point of the water vapour.

The dew point for natural gas combustion products is typically around 55°C (130°F) under Stoichiometric conditions. To obtain complete condensing and achieve the maximum rated efficiency of the boiler, return water temperature needs to be approximately 20°C (68°F), which is extremely low and unachievable for most applications. Between return water temperatures of 20 to 55°C, condensing will partially occur but the boiler does not reach the maximum rated efficiency.

For condensing boilers to achieve maximum efficiency, the overall heating system, including distribution and end uses, should operate as an integrated unit. When recommending condensing boilers for existing facilities, the end use systems already exist and it is not usually practical to modify them to obtain lower supply and return water temperatures. There can still be improved boiler energy use, but the performance will be limited according to the return water temperature.

To evaluate whether an existing building heating system is suited for condensing boilers, categorize the end use systems served by the boiler plant according to high/mid/low temperature return water. **Domestic Hot Water** is a high temperature load as it requires a high output temperature. This usually results in the boiler return water temperature being higher than what is needed for condensing. Other examples are hot water coils in air handling units, unit heaters and perimeter radiation systems. **Medium Temperature** loads need boiler supply water in the range of 40°C to 65°C (100 – 150°F). Low mass radiant heating is an example. **Low temperature** loads, such as radiant slab heating, require supply water temperature in the range of 27°C to 50°C (80 – 120°F).

Low temperature loads are the best match for condensing boiler systems as their return water temperature is low and provides the most opportunity for obtaining high boiler efficiency. A building that has mostly high temperature loads is not an ideal candidate for condensing boilers unless operating practices include strategies such as hot water reset schedules that result in low temperature return water whenever possible. In these cases the most benefit from condensing boilers will be gained in the shoulder seasons when lower supply water temperatures, and hence lower return water temperatures, can be realized.

Here are strategies that can be used in existing facilities to decrease the supply and return water temperature requirements, and therefore improve condensing efficiencies:

1. Decoupling DHW. Consider heating the DHW and other non-weather related high temperature loads with a separate boiler rather than from the main boiler plant. This will allow the supply water temperature of the boiler to be lowered according to actual load requirements during shoulder season and non-peak periods. This also allows the boiler plant to be shut down during summer months when no space heating is required.

2. Demand Control for Supply Water Temperature (**SWT**). Control the boiler supply water temperature according to the demand from the building systems. If all heating valves are partially closed it indicates that the supply water temperature could be lowered without impacting comfort in the space.

3. Variable Flow. If the boiler can accept variable flow, another method of demand control is to adjust the flow according to the load requirement. A variable speed drive would reduce the flow during non-peak periods, resulting in a lower return water temperature and more condensing.

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4. Cascade load types. Supply the highest temperature load requirements first, with loads with the lowest water temperature requirement near the return end of the loop. As an example, preheating DHW makeup water with a heat exchanger located next to the boiler return can be an effective strategy to lower the temperature of return water prior to it entering the boiler.

5. Burner Operation. If too much excess air is brought into the burner, the dew point for the flue gas will reduce, making it even harder to reach condensing conditions. Setting burners for lower excess air while still maintaining safety levels will improve efficiency of the boiler.

6. Operator Training. Ensure the operators know the requirements for optimum condensing boiler operation so they can operate the system as efficiently as possible.

Condensing boilers are an important product for the market, but they are not necessarily the best choice for all existing facilities. Incorporating considerations of the overall heating system can help make their installation successful, but it takes a bit more work and some training to make it happen. PM

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