Why reset a hydronic system?

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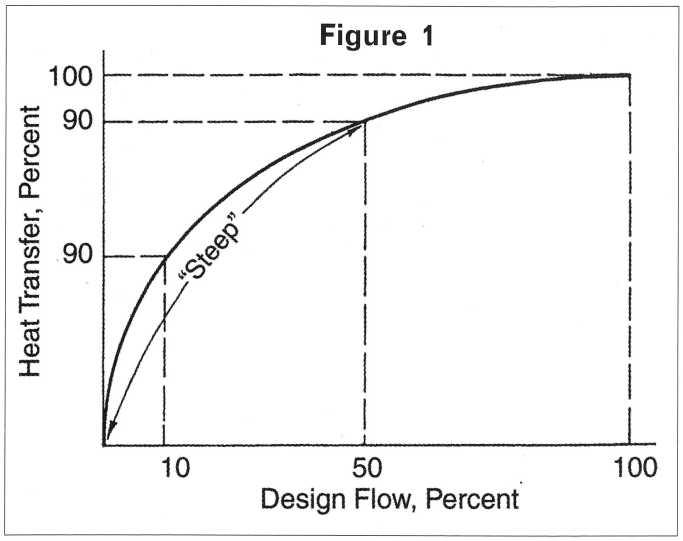
Did you know that in a typical hot water baseboard heating system designed around 190°F water, if the flow rate is cut in half, the Btu/h output would still be around 90%? (see figure 1) This is because of the three factors affecting heat transfer, flow rate has the least impact. The other two factors are the square footage of heat transfer surface (the radiation) and the temperature difference between the heating medium (water) and the air surrounding the heating element (room temperature).

Figure 1



In a typical system, once you install the baseboard, the amount of heat transfer surface is not going to change. In addition, the difference in temperature between the water in the baseboard and the air in the room is usually significant (180°F – 70°F = 110°F). The third factor, flow rate, has to be reduced considerably to cause a substantial drop in the average water temperature in the baseboard, which would reduce the heat output of the baseboard. (see figure 2, opposite page).

For example, if you look at any baseboard manufacturer's literature, the Btu/h output per foot of board is based on 1 gpm and 4 gpm. The difference in Btu output for each flow rate is minimal. This is the reason why most hot water systems work adequately without extensive circulator sizing and/or flow balancing. The design flow rate can be messed up 50% and still the system would get 90% of the Btu/h capacity of the baseboard. The reason is at the reduced velocity (flow rate), the water stays in "contact" with the baseboard for a longer period of time, giving up more of its temperature.

What is the significance of all this? Consider the way we size boilers for our heating systems. We always pick the boiler based on the design conditions, the coldest day of the year! We are trying to keep the customers warm by maintaining 70°F inside their homes while the outside temperature may be as low as zero°F or even colder. However, what happens when the outdoor temperature is not at design conditions? Our boilers and radiation in effect are oversized. Did you know that the design conditions in the Northeast exist for less than 5% of the total heating season? In fact, for most of the heating season, the conditions are 50%-60% of our actual design conditions. So here we are, sizing, selling and installing systems that are oversized for 95% of the season. I think this is where reset provides an opportunity to sell a better job, provide more comfort and cost savings to the customer.

Match the temperature to the load!

Outdoor reset is when you increase or decrease the water temperature going out to the system according to the outdoor temperature. The system incorporates an outdoor sensor to inform the control of the outdoor temperature since this has the greatest impact on the building's heating load.

When you reduce the supply water temperature, you reduce the Btu/h output of the heating terminal unit (baseboard). This is because you are changing the difference between the air temperature surrounding the baseboard and the water temperature inside the baseboard. By lowering the supply water temperature, you can input the right amount of heat, offsetting the heat loss of the building.

A lower water temperature will also create a more comfortable environment for the homeowner because the wide temperature swings that normally occur will be eliminated. A typical heating system uses a thermostat, which is a switch that sends a signal to the boiler and a circulator saying it is cold. The circulator turns on and sends 180°F water out to the baseboard zone. And this happens whether it is 10°F or 50°F.

Most of the time, the 180°F water heats up the zone quickly and the thermostat, sensing this temperature rise, shuts off the circulator. However, remember the heat loss from the building has not stopped. It continues as long as the outdoor temperature is below the desired indoor temperature. Therefore, the system continues to cycle on and off, becoming too cold and then too warm.

With reset however, when you change the temperature of the water to match the load, the circulators and/or zone valves stay on for longer periods. This keeps the radiation warm all the time instead of cycling on and off. This more constant supply of cooler, comfortable water also eliminates the creaking and groaning noises usually heard in systems that cycle 180°F water into a zone. The room temperature will not override due to the excessive water temperatures. Another benefit of resetting a hydronic system is fuel savings. By lowering the water temperature in the boiler and piping system, the stand-by losses and stack losses are minimized.

The concept of changing the water temperature to match the load of the heating system is very logical and has been around for quite some time. Re-

cently however, control technology has advanced considerably. Which has provided some reasonably priced yet very effective residential and commercial hydronic controls.

METHODS OF RESETTING...

There are two basic methods of resetting the temperature of water going out to the system. One method is known as boiler reset where, by cycling one or more boilers on and off, the reset control delivers the right temperature to match the heat loss of the zone. The other method is mixing reset. This is where you "mix" some hot supply water with the cooler return water to get a blended reset temperature to match the zone's heat loss.

A mixing reset system would normally use a three or 4-way valve or a variable speed injection pump. These devices take a percentage of hot boiler water and mix it with a percentage of cool return water to supply a mixed reset temperature.

Boiler reset is probably the most common method of reset because of its simplicity. The reset control uses an outdoor sensor, a supply water sensor and optionally an indoor sensor and by combining all this feedback, the control calculates the necessary water temperature by cycling the boiler on and off.

One major concern you should be aware of when using boiler reset is flue gas condensation. If the temperature of the boiler water is allowed to operate below the dew point of the flue gases, they will condense back into liquid, possibly corroding the boiler and its breaching and flue pipe.

The boiler will also experience plugged flue gas passageways between its sections. To prevent this problem from occurring, most boiler-reset controls have a minimum supply temperature setting feature. This setting is adjustable and can be set to satisfy any boiler manufacturers minimum water temperature concerns. Unfortunately, the average minimum temperature is around 135°F-140°F which, during the shoulder months (fall and spring) is too hot compared to the building's heat loss.

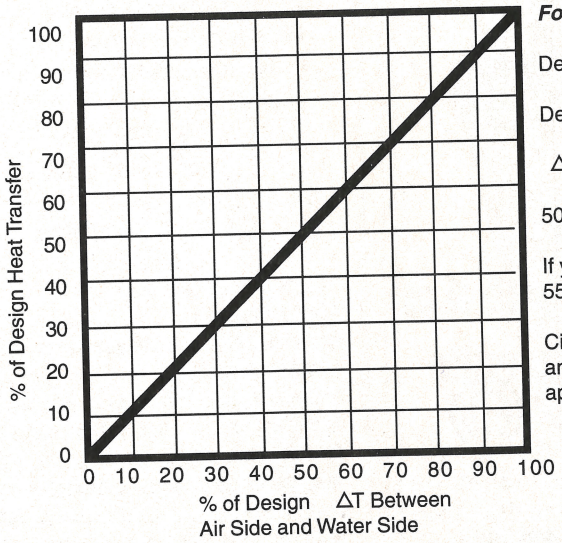
To overcome this problem, it becomes necessary to have some type of thermostat to stop the circulator or close a zone valve when the zone starts to overheat. Even with these temperature limitations, most hydronic systems that install a simple boiler reset control experience fuel savings in the range of 10-15%.

Additionally, the system is more comfortable with less temperature swings and fewer creaking and expansion noises. If you want to provide more energy savings and comfort you should install a mixing system in conjunction with the boiler reset. This will allow the water temperature to drop well below the limitations of the boiler while still satisfying the heat loss of the building.

In a future article, we will discuss the different options available when designing and installing one of these mixing systems.

If you have any questions, please e-mail me at gcarey@fiainc.com *or call 1-800-423-7187.* ❑

Figure 2 Reset Controls



For example:

Design Water = 180°

Design Indoor = 70°

ΔT = 110°

50% of 110 = 55°

If you lower 180° by 55° = 125°

Circulate 125° water and reduce output approximately 50%!