

Can high temperature baseboard co-exist with condensing boilers?



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GRAPHIC: MIKE SANGIOVANNI, ICM

Over the past few years there has been a tremendous amount of Mod/Con boilers installed all over “Hydronics Alley.” These boilers operate with natural or propane gas as their fuel source. They are referred to as high efficiency boilers because they have efficiency ratings in the 90s...some as high as 95%. To attain such high efficiency numbers, they intentionally condense some of the flue products that are formed as the result of combustion. Normally we would make sure that the boiler NEVER condensed its flue products because if allowed to, the condensate would rot out the boiler and vent piping.

When combustion occurs, energy in the form of heat is transferred through a heat exchanger (pinned cast-iron sections, copper-finned tubes, cast-aluminum and stainless steel) to flowing water which is on the other side of the flame. When the flame is produced, combustion gases are formed. These gases contain water in the form of vapor. Generally speaking, we want these vapor gases to vent out of the boiler and up into the venting/chimney system and out to the atmosphere. Mod/Con boilers (modulating and condensing) are designed to allow the flue gases to condense right inside the heat exchanger. They even provide a condensate drain to allow the condensate to escape from the heat exchanger and drip through a neutralization kit into a drain or condensate pump.

The benefit of condensing these combustion gases comes from the fact that they contain heat or energy which we normally lose up the chimney. Just as in a steam system, when the water in the form of vapor (combustion gases) condenses, it gives off a lot of latent heat. How much? Well, for every pound of water vapor that condenses back to liquid, 1000 BTUs of latent heat are released. The heat exchanger “catches” this heat and transfers it over to the system water. And this is how these mod/con boilers achieve their higher efficiency ratings. More of the unit of fuel goes into heating the system water rather than up the flue pipe.

So how are these flue gases condensed? It is achieved in the exact opposite method of how we prevent these same gases from condensing in a NON-condensing boiler. Con-

densing occurs naturally...when the combustion vapors cool below their dewpoint, they will condense back to liquid. Water temperature has the greatest impact on whether the flue gases in a boiler will condense or not. And it's all related to the dewpoint of the combustion gases. Oilfired systems want to keep the water above 140°F to prevent the gases from condensing, while gas systems generally want to be above 130°F to prevent condensing.

With a Mod/Con boiler, the water temperature in the return needs to be 130°F or below for its flue gases to condense. With return water in that temperature range, the flue gases will condense and the boiler will be operating at or near its published efficiency rating. Whenever the return water climbs above 130°F, which is higher than the dewpoint of the combustion vapors, those gases will not condense in the heat exchanger.

So the question comes up often, “Can I use a high efficiency modulating and condensing boiler in a system that incorporates traditional high temperature baseboard?” Some people in the industry say, “No, you can't! The water needs to be hot enough to satisfy the baseboard's requirements, which are too hot to allow any condensing of the flue gases!” And if you aren't condensing the flue gases, why use a condensing boiler?

A large portion of these Mod/Con boilers are sold in retrofit applications for both residential and commercial buildings. The boilers usually are cast-iron oil fired or atmospheric vented gas boilers and they are serving high temperature terminal units such as copper baseboard or cast iron radiators.

When these systems were first installed, the radiation was sized so that on a design cold day, with water circulating through the radiation at 180°F, the room temperature could be maintained at 70°F. Because of those design conditions, that is where the comments are made about compatibility issues between mod/con boilers and baseboard radiation. But how often during the heating season do we actually encounter design conditions? Up here in the Northeast, design conditions make up about 3-5% of the heating—the rest of the year, the conditions

Boiler Facts: Baseboards and condensing boilers

Continued

are somewhere less than design. In fact, through Bin Data collected by the National Weather Bureau, 80% of the heating season requires 50% or less of the BTUs needed for design conditions. In effect, the heating system, including the boiler and the installed radiation, is **OVERSIZED** for most of the heating season.

Reset to the rescue

Outdoor Reset says, "Let's provide the right water temperature to the radiation based upon the load that the house or building is currently experiencing." And what has the greatest impact on a building's load? The outdoor temperature! So by simply incorporating the outdoor reset function that comes with the mod/con boiler's operating control, the boiler can start delivering the appropriate water temperature needed at the given set of outdoor conditions.

And as you look into design conditions, reset curves and Bin Data, you see that for a large majority of the heating season, the boiler can lower the water temperature so the return temperatures coming back to the boiler are below combustion gas dewpoint levels. The boiler flue gases are now condensing; the boiler is operating at or near its rated efficiencies and the apartment building or house is comfortable. When designing around 180°F water, 70°F indoors and a design outdoor temperature of between 0

and 10°F, you will find that until it gets down to 25°F or colder, the reset curve will calculate a water temperature that provides return temperatures down below the dewpoint of the flue gases, ensuring the boiler is operating in a condensing mode.

Another benefit provided by this style of boiler is, in addition to the condensing feature, the burner can also modulate. This means as the load changes, the boiler will only consume the necessary fuel to meet that load. Unlike traditional on/off boilers where, if they are firing, they are consuming 100% capacity, the modulating boiler can fire down to as low as 20% of its capacity and then modulate all the way up to 100%.

In the perfect scenario, when using a Mod/Con boiler, the radiation chosen should be able to provide all the BTUs needed with low temperature water. For that to occur, all of the existing homes and commercial buildings would have to change and/or upgrade their existing radiation. In some rare instances, that actually does happen... but for the majority of the time, it doesn't. But to paint with a broad brush and say that you can't use Mod/Con boilers is inaccurate. Will the boiler condense all the time? No, but it will during the majority of the heating season. And it will also modulate its firing rate to match the load the building is experiencing. All of these features add up to reduced fuel consumption and more comfortable heating systems. [ICM](#)

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