TECH TALK

Turndowns on Condensing Units

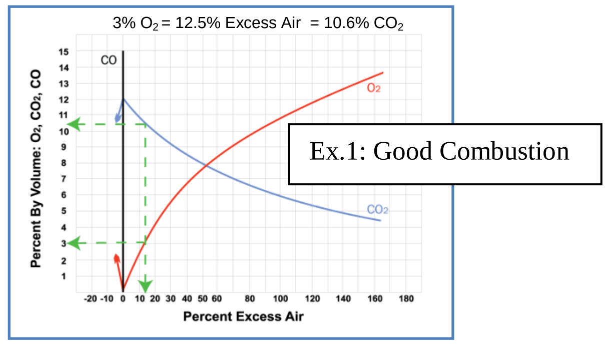
Objectivity (or lack thereof):

The first critical point is that most equipment manufacturers are good marketers, therefore some are less than totally objective. Specifiers should look beyond the claims being made and ask the tough questions about how this equipment will actually perform in the environment the equipment is going to live and operate in.

Like most hot topics, there is usually a good explanation for things, if one would only take the time to look for them.

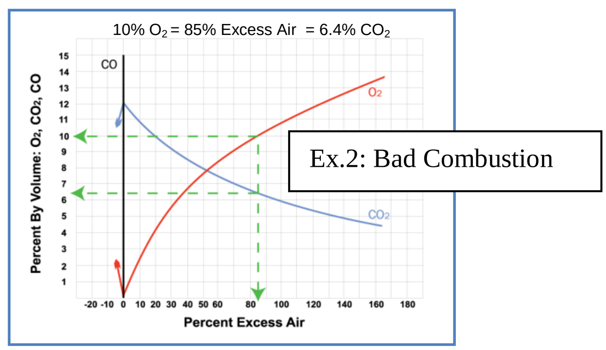
High Turndowns and Condensing Boilers

Most manufacturers make (sometimes extravagant) claims about the advantages of their proprietary turndown capabilities. Perhaps it is appropriate to discuss high turndowns and condensing boilers in terms of plain old chemistry and physics. We'll include relevant charts here to help you see how combustion efficiency directly impacts the game when it comes to condensing boilers and their ability to maintain a high efficiency level. We need to be sure to include Water Vapor Dew Points in this discussion, because that is the *"elephant-in-the-room"*, as they say.



Our setup

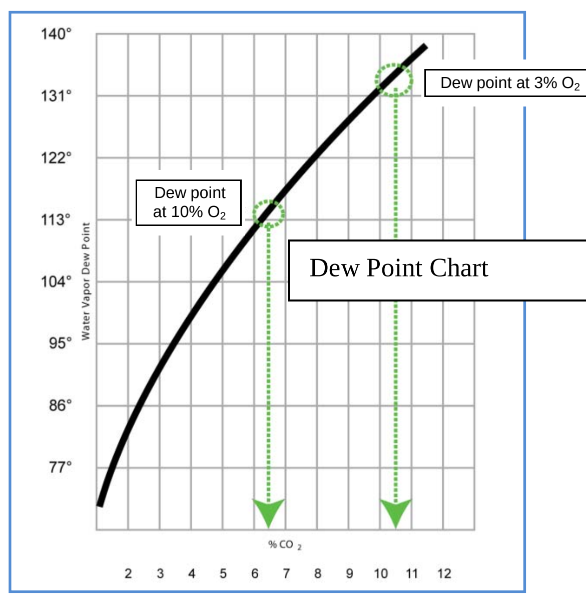
Example 1: You have really good combustion when you have a 3% Oxygen level. Looking at the Good Combustion graph, you can see that the Volume Percent of O_2, CO_2, and CO levels are measured on the y-axis, and the Percent of Excess Air is measured on the x-axis. Following the green dotted lines, we see that with a 3% O_2 level we have approximately 12.5% Excess Air, and approximately 10.6% CO_2.



Example 2: Here you have inefficient or bad combustion that has 10% Oxygen. Using the same methodology as above, we look at the Bad Combustion graph where we have redrawn our green lines to correlate with the 10% O_2, and we find that we have ~ 85% Excess Air and ~ 6.4% CO_2.

Dew point - the crux of it all

Looking at the Dew Point Chart for example 1 (good combustion), we see that 10.6% CO_2 has a dew point of ~133°. That is the temperature we *begin* to condense water vapor out of the flue gas. In example 2, with the bad combustion, we saw combustion with 6.4% CO_2, and looking at the Dew Point Chart, we see this has its dew point at ~114° before condensation can begin. I am willing to bet that your building's water comes in below 133° more often than it comes in below 114°, so your opportunity to condense is much greater with the *higher* combustion efficiencies.



Turndowns on Condensing Units

It's important to remember that commercial boiler manufacturers achieve high turndown by adding lots and lots of excess air as you modulate to low fire. As the charts show us, the more excess air, the lower the dew point. It's the amount of excess air they have to add to get to the really low firing rates that creates the problem.

Caveats

The units we are discussing here, condensing type boilers, have high turndowns that don't come about by magic. They add excess air -- and lots of it -- to get the burner down that low. And that's the heart of the problem. *High excess air equals low dew point* and that equals less condensing hours in a heating season.

Now if you get the water cold enough, it doesn't matter how bad your combustion is. But most of the time, the heating system won't have water in it that's cool enough to cause condensation when the excess air levels are so high at lower firing rates.

Don't get us wrong, we do know reasonable turndowns are desirable to avoid excessive cycling (which will also reduce your efficiencies). For most of these units, a turndown in the range of 5:1 is more than adequate yet attainable without sacrificing for higher excess oxygen levels. This is the "sweet spot" range for peak performance.

Industrial sized boilers have industrial burners that manage the higher turndowns without the high levels of excess oxygen – but those industrial units are beyond this scope of discussion. Here, our focus is on the smaller (0.5 – 6M BTUs) condensing units built for commercial applications.

Extremely High Turndowns

Now that we have established the correlation between dew points and combustion efficiencies, let's wrap this up by seeing what happens with extremely high turndowns. Generally speaking, at high turndowns, the low fire combustion efficiency is poor, so *the dew point will be* lower than the water temperature. Extremely high turndowns will ***<u>not</u>*** let your condensing boiler condense, simply because <u>the dew point will be too low</u>. *Operating a condensing boiler at high turndowns causes you to lose your opportunities to condense.*

How to win when specifying or buying a condensing boiler

You maximize efficiency by getting the *highest dew points* for the greatest *percentage of condensing <u>hours</u>* possible. The dew point chart for natural gas is your reality check - there is a direct relationship between dew point and combustion efficiency: the higher the dew point, the higher the number of hours you will have in any given season where your boiler can condense. Ask your sales representative about combustion efficiencies (your O_2 levels) at specific turndown rates, and see where your dew point will be.

Most manufacturers list their efficiency levels at a specified turndown ratio. This information is normally listed in their Operations Manual, not in their sales brochure. We suggest you ask for it before you decide which manufacturer you should specify. This simple question will get you the answer you need to make an intelligent choice: *"What is the efficiency of your condensing boiler at an "X" to 1 turndown"?*

An effective condensing boiler application will include excellent heat transfer, with good combustion performance throughout the firing range and an achievable turndown ratio of 5:1 or greater. Any good manufacturer sales rep will provide you with the documentation you require. From there, you can determine the best course of action for your condensing applications.