Technical Bulletin

High Turndown Part 1

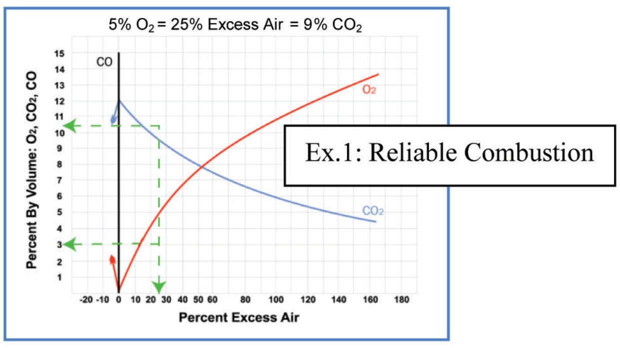
For more than 16 years, manufacturers have been trying to sell the Mechanical Engineering Community on the concept of extremely high combustion turndown. This pertains to the range of modulation as it corresponds to a burners output. This concept sounds fantastic when selecting equipment as it theoretically would be an insurance policy; enabling the boiler to turndown to satisfy a micro load or allowing for the oversizing of equipment without the risk of short cycling. While this sounds like a solution for multiple applications, it is simply not realistic. This is the first bulletin of a series detailing the reality of high turndown boiler claims. To follow we will illustrate the impact high turndown has on efficiency when operating in a 20:1 or 5% modulation rate.

This passage was taken from the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Office standards for Commercial Packaged Boilers, RIN 1904-AD01

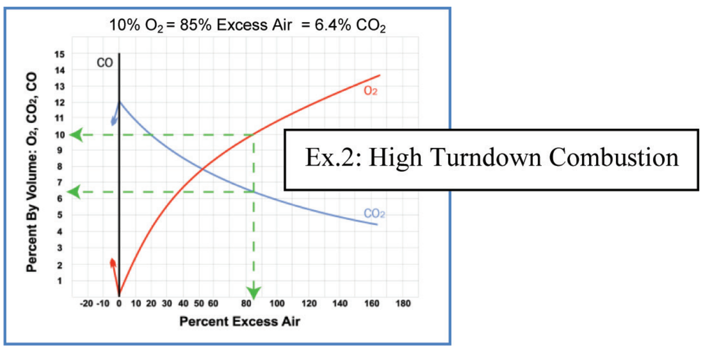
> ***Modulating Burners***
>
> Two-stage and modulating burners can decrease losses caused by burner cycling at partial loads. However, modulating burners may not accomplish net energy gains if excess combustion air levels must be increased at low firing rates (in order to maintain combustion performance) or if electrical power requirements for the burner do not decrease in linear proportion to the firing rate. In condensing boiler applications, an increase in excess combustion air ratio can result in reduced latent heat recovery due to decreased flue gas dew point temperatures. This can result in an energy loss that outweighs the benefit of reduced burner cycling.

The explanation of their message is outlined below.

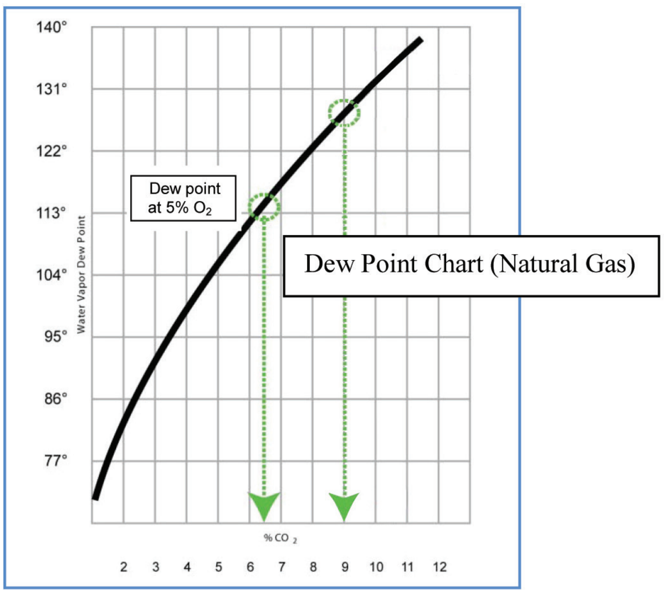
DOE is warning against the effect of increased excess air that is used in boilers that boast high turndown. Please see the below graph showing industry standard combustion (5:1). Please note that we will see roughly 25% excess air in the equation giving us an O_2 reading of roughly 5% and a CO_2 reading of 9%. This equates to very stable and reliable combustion which will be discussed in part 2 of our High Turndown series.



Look at the relationship of O_2 and CO_2 when the combustion is operating at a 20:1 turndown. *The amount of air needed to correctly operate and vent the flue gas in an individual pressure vessel has a limitation on turndown much lower than that of the fuel. We typically see a maximum of 18% modulation on a blower where as the gas valve is expected to track to 20:1 or 5%.* This leads to very lean combustion, roughly 85% excess air, which equates to 10% O_2 and 6.25% CO_2. Lean combustion is unrealiable but we will address this in a future discussion as I don't want to get off point.



This illustrates the point the DOE warned about on the first page and that is the effect CO_2 has on the dew point, or in laymens terms, the efficiency of the boiler. Please see the following chart.



Conclusion:
As you can see in the chart above, the excess air needed to operate at 20:1 (6.25 % CO_2), drastically reduces the dew point, which is the point at which we condense and start to see high efficiencies. There is roughly a 20 degree decrease in return water temperature needed to see the same efficiencies you would experience at a 5:1 combustion turndown. If your customer is paying a premium for high efficiency, they won't be seeing the return on investment that was advertised on the brochure.