
Steam System Best Practices

Document No. 4

Combustion Efficiency/Fuel Air Ratio

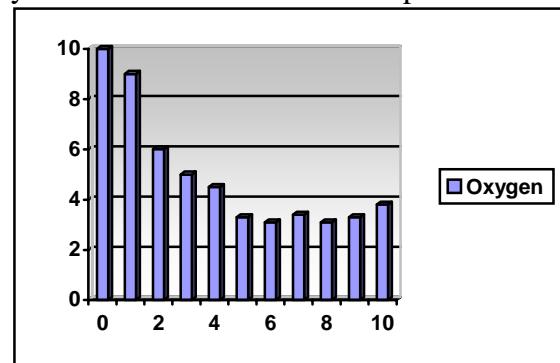
Fuel Cost Savings (2% and higher)

Combustion efficiency is over looked or taken for granted. There is no certification or formal training requirements for some one to make adjustments to the fuel/air ratio curves. This is very unfortunate and our Boiler Plant Audits have concluded a high percentage of boilers are operating with low combustion efficiency.

Reducing excess air increases flame temperatures in the combustion chamber; reduces stack temperature; thus increases combustion efficiency and boiler efficiency. A widely used rule of thumb for estimating energy savings is that for every 4.4°C reduction in stack temperature there will be a corresponding increase in boiler efficiency of 1%.

What is Combustion Efficiency or Fuel/Air Ratio

The fuel/air ratio curve is the lowest excess air level (measure in percent of oxygen O₂) in the flue gas; at a set firing rate without the carbon monoxide (CO) being produced. At lower firing rates; the burner design requires more excess air to ensure the air mixes with the fuel. At higher firing rates there is enough differential pressure drop (burner wind box to combustion chamber area) for air to mix with the fuel.



All boilers have a fuel/air ratio curve and it is extremely important that the plant has this documented information.

Periodic testing and adjustments (minimum twice a year) to the boiler burners are recommended to increase boiler efficiency. A common and undesirable practice is to test and adjust at two points only, a high- and low-firing rate, but this usually results in inefficient combustion at intermediate rates. The "Best Practice" is to adjust the burner at ten (10) or more different points along the air/fuel ratio curve.

What are the parameters? The flue gas analysis should include Oxygen in percentages and Carbon Monoxide in PPM (not percentages). The intent is to have the lowest percentage of oxygen, with a carbon monoxide (CO) reading of less than 250 PPM.

How to Measure

Combustion analyzers are available that can determine the amount of excess air in combustion by measuring the contents of flue gases. US Department of Energy and PSE, Inc recommends such an investment for boiler systems with annual fuel costs above Bht 1,750,000. Equipment that measures oxygen is more precise than carbon dioxide measuring devices. The other crucial measurement is carbon monoxide (CO) measured in PPM (parts per million). Information from the combustion analysis equipment is used to calibrate the settings on the air and fuel supply systems for the combustion process.

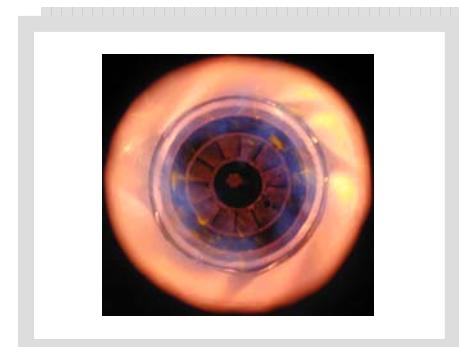
In modern boilers, excess air should be target to achieve approximately 10% (2.2% oxygen). This will vary from boiler/burner to boiler/burner and from application to application; always consult the burner manufacturer's manual.



Who can set this Fuel/Air Ratio Curve?

Contact the burner manufacturer for safety procedures and instructions before doing adjustments, and always adhere to applicable codes. If the plant has qualified personnel, it is usually done In-house. If not, plants will have an outside vendor supply these services. If you are using an outside source, you must make sure the vendor is qualified. 62% of our audits have found that the outside vendor are not doing the combustion testing correctly or is unqualified to work on the burner.

We have found on the average, that a qualified combustion vendor will save a plant more than 2.2 % in fuel cost.



How to find a qualified combustion testing vendor?

A vendor must have experience with the boiler/burner combination that the plant has in operation. Some vendors do a great job with the fire tube boiler/burner design systems, but have no clue how to work on the water tube boiler/burner combination system.

FAQ Question:

If I have a vendor perform combustion testing of the boilers, how do I know if they are doing it correctly?

Answer: This is usually easy to find out. The original startup boiler/burner manual or book will have all startup data and the combustion curve. It will be in a printed form typically called the combustion testing report. If the report is not in the manual, call the boiler/burner manufacturer to obtain the data.

Best Practices:

- 1.) Benchmark the proper fuel air ratio curve
- 2.) Check combustion every three months