Technical Article
Boiler Efficiencies

The efficiency of a boiler should be an important part of a purchase evaluation since the annual cost of fuel can easily be 2 to 3 times the installed cost of the equipment. Therefore, a difference in efficiency and the resultant difference in fuel cost can easily offset a difference in installed cost. In many cases, the fuel savings in the first year alone can exceed a difference in installed cost and, of course, fuel savings are on-going – year after year, after year.

While it is important to consider efficiency in an equipment purchase, it is equally important to understand efficiency to the point that the purchaser can be assured that values are being compared on an apples-to-apples basis. The subject of efficiency for a boiler is rather complex when all of the elements that effect efficiency are considered and a complete thermodynamic analysis is performed. Fortunately, it is not necessary to understand the process, in detail, but a basic understanding of the terms can help ensure a good apples-to-apples efficiency evaluation. These factors are discussed in the context of the discussion on efficiency terms.

There are several terms used to qualify efficiency when used in the context of a boiler. These include, simply efficiency, boiler efficiency, thermal efficiency, combustion efficiency and fuel-to-steam efficiency.

The terms, Efficiency and Boiler Efficiency, by themselves are, essentially, meaningless since they must be qualified in order to understand their significance.

In general, the term, Thermal Efficiency refers to the efficiency of a thermal process. This is as opposed to Mechanical Efficiency – the efficiency of a mechanical process. When used in conjunction with boilers, Thermal Efficiency sometimes refers to the efficiency of the heat exchanger. In any event, this term is not significant for purposes of comparing one boiler, or steam generator, to another. While the thermal efficiency of the heat exchanger is an important factor, its importance lies in its contribution to the Fuel-to-Steam Efficiency.

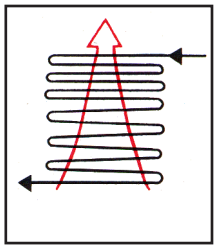
While the terms Efficiency and Thermal Efficiency are not meaningful for comparing one boiler to another, the terms Combustion Efficiency and Fuel-to-Steam Efficiency are. Of these, Fuel-to-Steam Efficiency is the most significant but is difficult to measure or calculate in real world situations. Therefore, Combustion Efficiency that can be easily computed using a combustion gas analyzer is, frequently, used for performance comparison purposes.

Combustion Efficiency equals the total heat released in combustion, minus the heat lost in the stack gases, divided by the total heat released. For example, if 1000 BTU/Hr are released in combustion and 180 BTU/Hr are lost in the stack, then the combustion efficiency is 82%: (1000 – 180)/1000 = 0.82 or 82%.

Fuel-to-Steam efficiency is the most important because it is a measure of the energy that is converted to steam and that is, after all, the reason a user installs a steam boiler – to produce steam. Fuel-to-Steam efficiency is equal to combustion efficiency less the percent of heat lost through radiation and convection. As in the example above, if 20 BTU/Hr are lost to convection and radiation then the convection and radiation losses are 2%: 20/1000 = .02 or 2%. If the combustion efficiency for this same case is 82% then the Fuel-to-Steam efficiency is 80%: 82% - 2% = 80%.

Each of the terms discussed above refer to the efficiency of a boiler when operating at a fixed condition, such as 100% load, with specified air and feedwater temperatures, etc. These efficiencies are, unquestionably, important but there are operational factors that affect the annual fuel bill and can have an affect that may be greater than the difference of a point or two in the efficiency of the equipment when, for instance, operating at 100%.

The article Boiler Blowdown provides further information on the topic of blowdown and how it can affect operating efficiency.



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