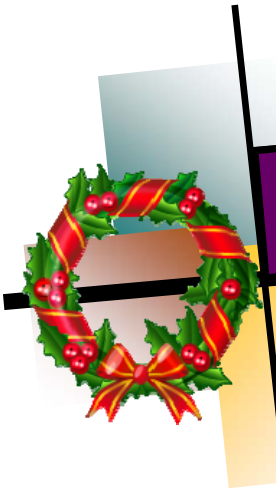
BY TINA L. TOBUREN P.E.



Efficiency Extra Edition

Happy Holidays!

T2E3 Newsletter
December 2008

Calculating Heat Rate: Q&A

Even with today's fuel prices dropping the way they are, calculating and monitoring your heat rate is important. **Changes in heat rate can indicate problems with your unit** – problems may include instrument calibration drift, gas path fouling or foreign object damage (FOD). Although, in most cases, performance losses due to FOD are noticeable without getting out the calculator.

There are only three numbers that go into the heat rate calculation, so it should be simple, right? But, when you look at those three numbers a little closer, several questions can come up.

First, the calculation:

$$\text{Heat Rate} = \frac{\text{Fuel Flow} * \text{Fuel Heating Value}}{\text{Power Output}}$$

The first question is: **What are the engineering units on these values?**

In the US, Heat Rate is most often shown in Btu/kWh. Fuel Flow can be in a number of different units, the most common being KPPH (thousands of pounds per hour), PPS (pounds per second) or SCFM (standard cubic feet per minute). Fuel Heating Value might be provided in Btu/SCF or Btu/lb. Power Output is nearly always in either kW or MW.

For places outside the US, Heat Rate is most often shown in kJ/kWh. Fuel Flow might be reported in m3/hr (standard cubic meters per hour) or kg/hr. Fuel Heating Value may be in GJ/kg, or GJ/m3. Power Output is still in either kW or MW.

As long as your fuel flow rate and fuel heating value are in compatible units (both mass basis or both volume basis), your units should cancel out. If not, you will need to know the density of your fuel (kg/m3) in order to convert them to a common basis. To calculated the density of the fuel, you'll need to know the constituent analysis: for natural gas, this would mean the volume percent of Methane, Ethane, Propane, Hexane, etc. Note: Industry standards, such as ASME PTC-22, provide guidance on converting the constituent analysis to a density (as well as calculating the heating value).

The next question is: **Where does the fuel heating value come from?** The best answer for this question is to have your own gas chromatograph or heating value lab on site. A more common source of fuel heating value and constituent analysis is your fuel supplier. If the supplier cannot provide you the detail you need for the time frame you need, or if there are mixing stations between their reporting station and your unit, you may need to take your own fuel samples and send them to a laboratory for analysis. You'll need to determine the source of your fuel heating value prior to calculating heat rate, just in case you do need to take your own samples. Samples need to be taken at an approved location (free from moisture or other 'heavy' particles that are filtered out prior to combustion in the unit), and must be transported in an approved container (an approved pressurized cylinder for natural gas) to an appropriate lab.

Once you have your fuel heating value source, the sources for the other two values must be found as well, but luckily, these two are normally easier to identify. **There are normally two choices for fuel and power output:** At the unit, or at the plant boundary (i.e. the billing meters). The heat rate you need to determine will define which meters to use.

For a **gas turbine unit heat rate**, you'll want to record the fuel flow to the gas turbine at the meter closest to the unit and the power output from the power meter on the gas turbine generator – again, at the meter closest to the unit

Announcements

- **Read & Comment at Tina's Blog:** www.t2e3.com/blog
- **Next LM6000 Seminar** to be held in Palm Springs on March 12 & 13, 2009

Products & Services

Analysis Tools

Excel Workbooks, Macros and Add-Ins:

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For an **overall plant or facility heat rate**, you'll probably want to use the billing meters for both gas and electricity – and this should therefore be a net heat rate for the facility (after all auxiliary and house loads have been accounted for).

There is still the question of uncertainty, or: **How accurate do I know my calculated heat rate?** For an ASME PTC level test, facility heat rate should be known with an error band of less than 1.5% (including corrections to reference conditions). When doing spot checks for heat rate using permanently installed instrumentation and a fuel suppler reported heating value, the uncertainty may be much higher – it all depends on the sources of your information.

I hope this helps you on the way to calculating – and trending – your own heat rates. **Please contact me if you need any help in determining the best data sources to use or in setting up worksheets for unit conversions and fuel density calculations.** I also have add-ins for Excel which can automate a lot of the calculations for you (see below for more information).

T2E3 Add-ins for MS Excel

Streamline your analysis spreadsheets by using functions from the T2E3 Automation Add-ins. Available functions include ASME steam tables, ASHRAE air properties, orifice flow meter calculations and select performance functions, including: compressor efficiency and evaporative cooler effectiveness.

For a complete function listing, available options or a trial version of an add-in contact T2E3 at 425-821-6036

T2E3 Performance Analysis Services for Power Plants

Including:

Analysis Tools & Software – from customized spreadsheets to add-ins for Excel or complete compiled programs, T2E3 can develop software tools and analyses to support all your performance monitoring needs, including integrating your existing tools with available site data systems, to create online systems providing data and results in real-time.

Training – both public seminars and customized options are available. Highly interactive sessions increase attendees' knowledge and understanding of the thermodynamic cycles, instrumentation and analyses needed to improve equipment performance and reliability.

Performance Test Support – if your site is required to perform annual capacity or PPA performance tests, having Tina Toburen from T2E3 on site to direct the testing can lead to a smoother test execution with more consistent performance results. Professional reports can also be produced to communicate the results to all required parties.

Site Marketing and Dispatch Support – Do your marketers and/or dispatchers understand the operation of your facility? Do they constantly dispatch the plant at loads which are difficult or impossible to maintain? T2E3 can help you build tools and training programs to help all parties understand the expected changes in performance due to ambient conditions and operating constraints. These tools can also lead to a greater understanding of the long-term economic outlook for your facility.

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