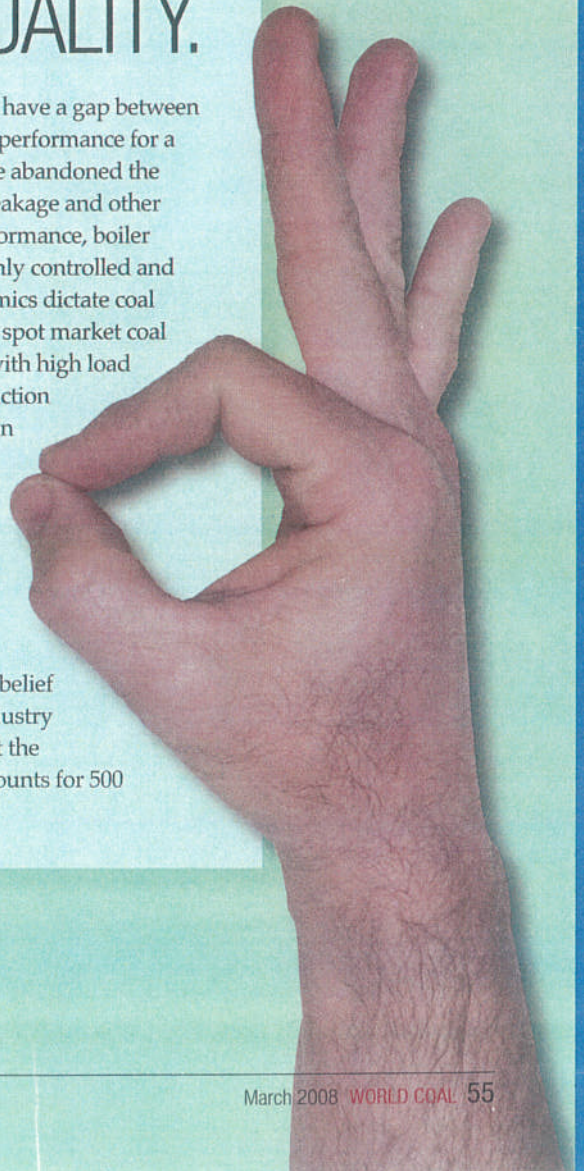


QUALITY COUNTS

STEPHEN K. STORM, STORM TECHNOLOGIES, INC., US, CONSIDERS DIFFERENT WAYS OF MEASURING COAL QUALITY.

Operators of large utility power plants throughout the industry have a gap between understanding the plants' coal quality and the steam generator performance for a number of reasons. First and foremost is the fact that many have abandoned the 'old-fashioned results engineering' tests of coal fineness, air in-leakage and other manual performance monitoring of boiler and combustion performance, boiler efficiency and heat rate. Secondly, coal quality just isn't commonly controlled and managed to the extent possible with today's technology. Economics dictate coal purchases, not coal qualities. Thirdly, the combination of varied spot market coal purchases for economic production considerations, combined with high load factor operation of coal units due to comparatively lower production costs when competing with natural gas and other fuels, results in less 'natural de-slagging' of boilers. Considering the age and condition of many of the coal-fired power plants in the US, as well as the installation of environmental control equipment, the industry heat rates have escalated such that the difference between the industry's best and average plant heat rates is well over 1000 Btu/kWh. Much of this is related to the challenges with low NOx firing systems and increased auxiliary horsepower consumption. However, it is the author's belief that accounting for the heat losses is necessary to reduce the industry averages. Upon completion of performance surveys throughout the industry, Storm Technologies, Inc. routinely and commonly accounts for 500 - 600 Btu that is controllable at the boiler.



How can it be overlooked that 500 - 1000 Btu is equivalent to 5% - 10% in fuel savings? That's not to mention the inter-relationship with a reduction in CO₂ emissions and forced outage rates that could be reduced with improved plant performance. Before discussing the role of coal analysers in our industry, let's first review the methods of boiler efficiency measurement for a large steam generator. Simply, heat rate (Btu/kWh) and/or efficiency are measured by the ratio of energy output to the energy that is input into a system.

Methods of measurement

- The input-output method. This is a simple procedure, but it requires extreme accuracy of the measurement of the fuel flow rate, fuel quality, steam flow leaving the steam generator, feed water flow into the boiler, steam pressure and temperatures, steam quality and the pressure and temperature of the feed water to the boiler.
- Heat loss method. This method



Figure 1. Test personnel coal sampling at the discharge of multiple gravimetric coal feeders during a boiler efficiency test.

measures the various heat quantities that are lost to the steam generator. Again, the procedure is fairly simple. However, ASME code procedures must be taken into account for measurement of the flue gas chemistry leaving the boiler as well as the air side and fuel quality measurements. Major losses include:

- Loss due to heat in dry flue gas.
- Loss due to moisture in fuel.
- Loss due to moisture from combustion of hydrogen.
- Loss due to combustion in refuse.
- Unmeasured losses (usually determined with a manufacturer's margin).

As with any performance programme, if you can measure it, you can manage it. So, with that said, now let's review the bare minimum of inputs required to determine efficiency of a steam generator.

Required measurement variables

- Raw coal ultimate analysis and HHV.
- Fuel flow measurement.
- Air inlet temperature.
- Feed water flow.
- Steam flow, pressures and temperatures.
- Steam quality.
- Boiler exit flue gas measurements (multiple locations, including the actual furnace exit).
- Air heater outlet flue gas measurement.
- Carbon in the refuse (bottom ash and fly ash).

In summary of the test variables required for efficiency and heat rate measurement, it should be noted that there is the capability to measure all of these variables online. Most of the methods of measurement are simple and proven. However, many are overlooked. The one that

is overlooked most often when determining performance is coal quality.

Coal analyses

Today, most coal-fired power plants obtain coal analyses by either trusting the coal supplier with mine analyses data or taking physical samples onsite at plant itself. If samples are collected onsite, they are typically sent off to a commercial laboratory and the results are available in weeks. Because of this, on-line analyses of coal with proven coal analysers that provide real-time data have substantial merit.

This technology has advanced over the past couple of decades, and it seems obvious to the author as to why these are needed by the end users involved with power generation. However, let's just take a minute and review the benefits again. These are as follows.

Benefits

- You can determine coal quality in real-time, which gives operations time to react and prepare for a poor coal quality. For example, close monitoring of slag via local checks or with in-furnace cameras, furnace exit gas temperature (FEGT) monitors, CO measurements and draft checks.
- It assists with quality control of fuels purchased.
- It assists with sorting or blending for environmental compliance.
- Control of SO₂ emissions to the atmosphere.
- It can assist with reducing fouling and slagging if you know the quality of the fuels and the ash fusion temperatures with the same fuel source or blended coals.

In December last year an article was written by Rod Hatt of Coal Combustion, Inc., US, in World Coal entitled 'Looking even closer,' and he expanded on the variations of nuclear coal analysers available and even provided updates on the EADS Sodern CNA analyser. As the author understands it, this is the only analyser that directly measures all major elements (up to 12) including carbon, oxygen and sodium, and which determinates a reliable calorific value without prior knowledge of coal type.

Real-time coal analysis

Integration of on-line fuel quality measurements in real-time is essential



Figure 2. Multi-point flue gas sampling probes for boiler efficiency testing.