Ensuring quality

Richard Woodward, Thermo Electron, US, looks at how the use of an online coal analyser can reduce fuel costs.

Coal analysers have been in use for more than 20 years, and during that time almost every conceivable application has been attempted. At least that was the belief until Luoyang Longyu Yidian Co. Ltd (Longyu) of China decided to use an online coal analyser to keep its coal suppliers were providing the coal quality and quantity agreed upon. Longyu decided to invest in an auger sampler to feed an online coal analyser so that the coal quality of each truck coming into the power plant could be checked against the contract requirements. The use of auger samplers to verify incoming coal quality is not new, but to know immediately who the offenders were and to warn them before they could even dump the coal on the coalyard stockpile was unique.

Plant details

China is experiencing unprecedented growth in its installed electrical generation capacity, with almost 80% coming from coal. One of the plants recently added to the electrical network was the 265 MW Longyu plant near the city of Luoyang in Henan Province (Figure 1). Completed in 2004, the plant consists of five pulverised coal units. Coal comes from more than 15 nearby mines, with all deliveries by trucks ranging in capacity from 11 tons to 36 tons. Coal is dumped into four separate stockpiles where bulldozers load bins, beneath which are conveyor belts that take the coal on toward the bunkers.

Figure 1. Luoyang Longyu Yidian power plant, near Luoyang, China.

Problem discussion

The coal-fired utility industry throughout the world has long faced the challenge posed by some unscrupulous coal suppliers who attempt to add rock or water to their shipments, realising that they are paid by tons delivered and

Figure 2. The incoming truck inspection system, consisting of weigh scale, auger sampler and Gamma-Metrics CQM coal analysers.

Figure 3. Trucks can be sampled and analysed in a matter of minutes. Up to 400 trucks per day deliver coal to the plant.

Figure 4. A Gamma-Metrics CQM coal analyser, configured for auger sample analysis.

hoping their practices will go undetected. Coal sampling systems, particularly auger samplers, have been used to try to check this practice in coal delivered by truck, and for the most part have been successful. However, there are limitations to the use of auger samplers. The auger sample system has to have a means of creating a physical sample that corresponds to each truck, which requires two stages of sampling with crushing required. But the costs associated with sample preparation and laboratory analysis render impossible the analysis of each truck. The compromise which evolved decades ago was to capture the physical samples from each truck in different sample containers, one for each coal supplier. This requires some mechanical complexity (for example, sample containers on a carrousel platform), but with simple programming and operator intervention the system can provide unbiased estimates of each supplier's average coal quality, over a day or a recent shift. This includes a time delay of approximately 24 hours.

Longyu faced a coal supply challenge greater than that undertaken by most power plants. Firstly, the range of coal quality delivered was considerable, with ash ranging from 20% to 50%, and sulphur from 0.5% to 3%. In fact, the plant had intended to have contracts with its coal suppliers such that there would be a price penalty, should the heating value ever dip below 4000 kcal/kg. Secondly, it had more than 15 coal suppliers, and it was not practical to engineer a sampling system that could segregate and accumulate 15 different coal gross samples.

Instead, Longyu decided to let a coal analyser fed by an auger sampler assess the coal quality not just of each supplier, but of each truck. This concept was fulfiled with the selection of an auger sampler from Jiangsu Ramsey in China, coupled with a Gamma-Metrics Coal Quality Manager (CQM) from Thermo Electron in the US. Jiangsu Ramsey was also responsible for the site engineering which included truck scales, an operator's control room and connecting conveyors, a bucket elevator, and a sample reject bin. The system was ordered in 2004 and commissioned in the first quarter of 2005 (Figure 2).

System detail

Jiangsu Ramsey designed and delivered an auger sampler with a fixed boom, with variable radius and able to swing over a broad arc, to enable sampling from different parts of the truck bed. The auger has a 30 cm inner diameter and has a design capacity of 0.18 m^3 of coal per increment. The auger increment is taken, deposited into a bin on the auger boom, crushed, and then it falls into the analyser input hopper (Figure 3).

The coal flows through the analyser (Figure 4), where it takes approximately three minutes to analyse the sample increment. Coal exits the CQM analyser and drops onto a short, angled conveyor where a secondary sampler is located. This sampler can be used to take physical samples to be prepared and analysed in the onsite laboratory for the purpose of calibration and analyser performance evaluation. The secondary sampler has a four-sample-can carrousel to allow the gathering of more than one sample. After leaving this short conveyor, the coal is elevated by a bucket elevator to the top of a large bin, which collects a few hours' worth of increment samples. At this same interval, trucks receive the output of this bin and transport it to the coalyard stockpile.

Analyser modifications required

CQM's most common application consists of a continuous sampler. This feeds either primary save or secondary reject sample streams to the input hopper of the CQM and has its flow control system transport the sample continuously through the horizontal tunnel of the analyser. Coal quality analyses occur each minute that the sample stream flows through the CQM, usually at rates of 3 to 15 tons per hour.

The Longyu application was different in its requirement to conduct a discrete analysis for each auger increment, rather than giving the periodic trends found in a continuously flowing stream. In addition it was necessary to minimise the time delay from the entrance of the sample into the input hopper to its arrival in the analysis zone within the horizontal tunnel. These two challenges were addressed by making the input hopper smaller and by changing the flow control logic. The smaller hopper reduced the time lag for the coal to reach the analysis zone. Furthermore, by putting a level sensor at the bottom of the hopper and by running the analyser belt at a fixed speed, the exact start and stop time for the increment is known. In this way, each auger increment is analysed separately and in its entirety. The analysis is reported immediately after the discharge of coal from the CQM.

Results

The most important benefit of having the coal analyser monitor each incoming truck for coal quality was to put an end to occasional bad practice on the part of some coal suppliers. The heating value of each truck was examined to ensure that it met the contract requirement of 4000 kcal/kg. Figures 5 to 7 show the considerable variations in coal quality, taken from a three-hour period on a randomly selected day in November 2005.

In the first six months following the commissioning of the Gamma-Metrics CQM analyser, the power plant was able to save US$ 375,000 in fuel costs. Furthermore, by knowing the quality associated with each truck, the plant was able to segregate the coal into four different piles, according to heat content. The reclaim which went on to the bunkers was, as a result, significantly more consistent, leading to much improved boiler efficiency. The final economic benefit from having the analyser monitor the trucks was to reduce the amount of rock 'hidden' in the trucks. As a result, the life of the hammers used in the crusher increased by a factor of four. ■

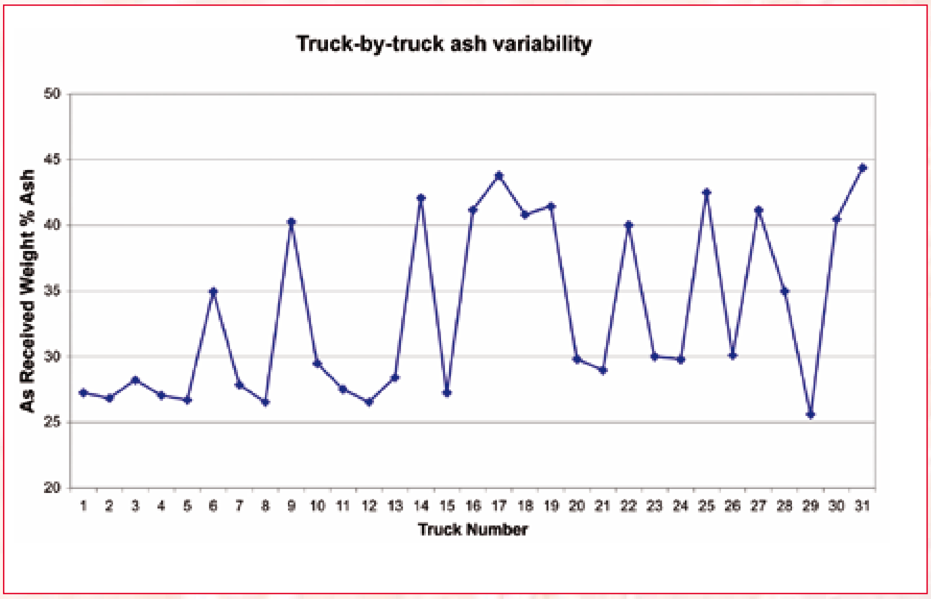

Figure 5. In this three hour period, most trucks met the 4000 KJ/KG target heating value.

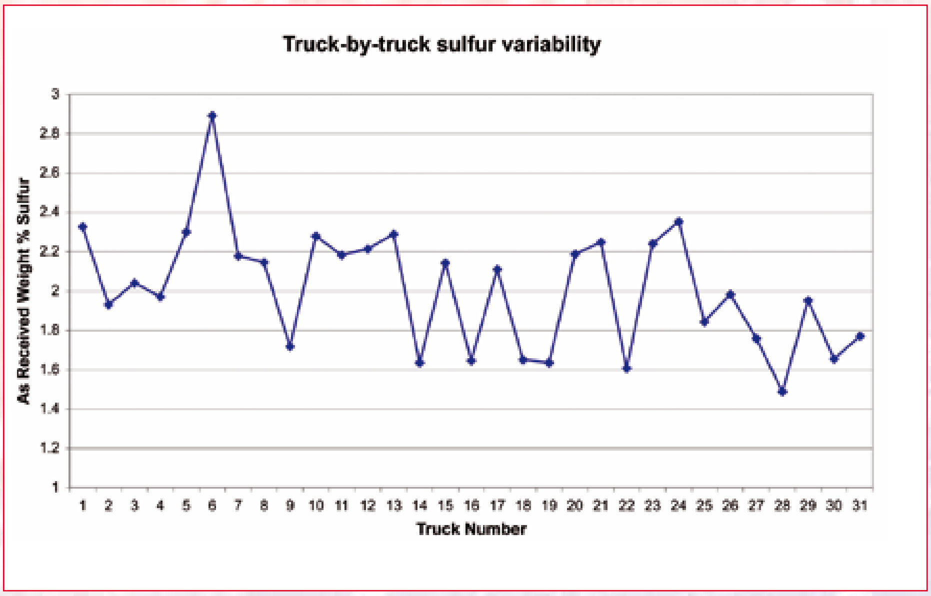

Figure 6. Sulphur variability ranged from 1.4% to 2.9% in this three hour interval.

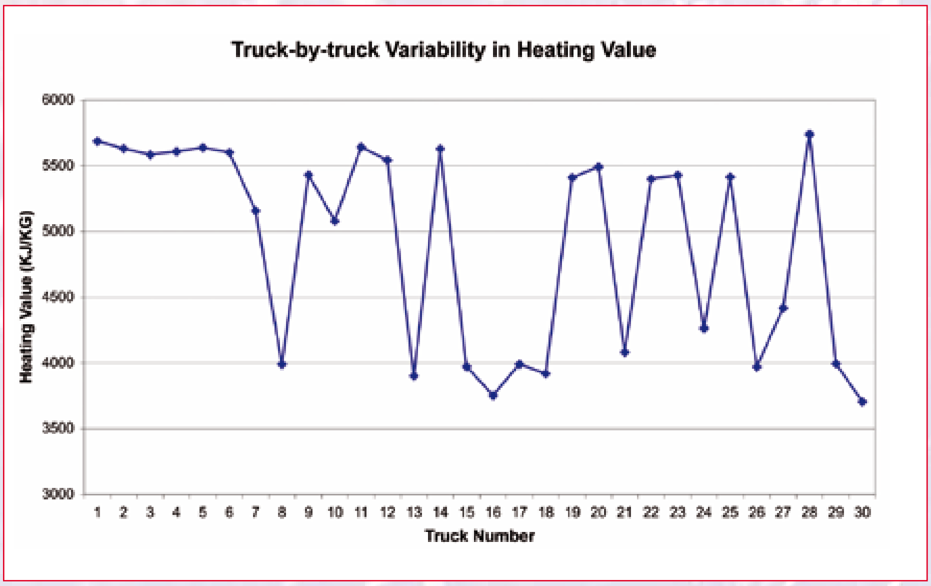

Figure 7. Ash variability ranged from 25% to 45% in this three hour interval.