# ACCURACY IS THE KEY TO SUCCESS

Steve Whitby, Greenbank Group, UK, explains how accurate coal measurement and distribution can help UK power plant operators face upcoming challenges.

Over the past decade, operators of coal-fired power plants in the UK and Europe have come under increasing pressure, as the world faces up to the challenges of global climate change. While much of the focus has been on the reduction of $CO_2$, the reduction of other emissions, such as sulfur dioxide (SOx) and nitrogen oxide (NOx), has put further pressure on coal-fired power plants at a time when they face increasing competition from other power sources.

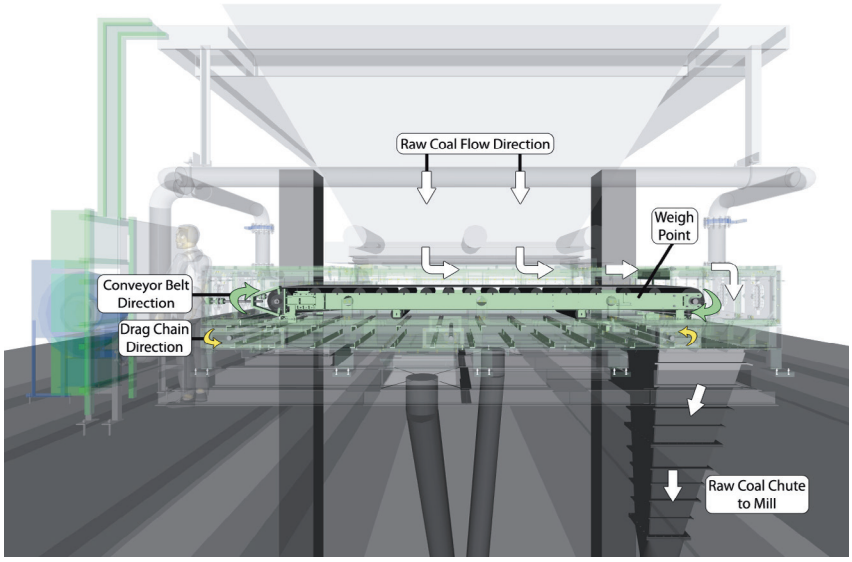


Figure 1. Gravmaster coal feeder.

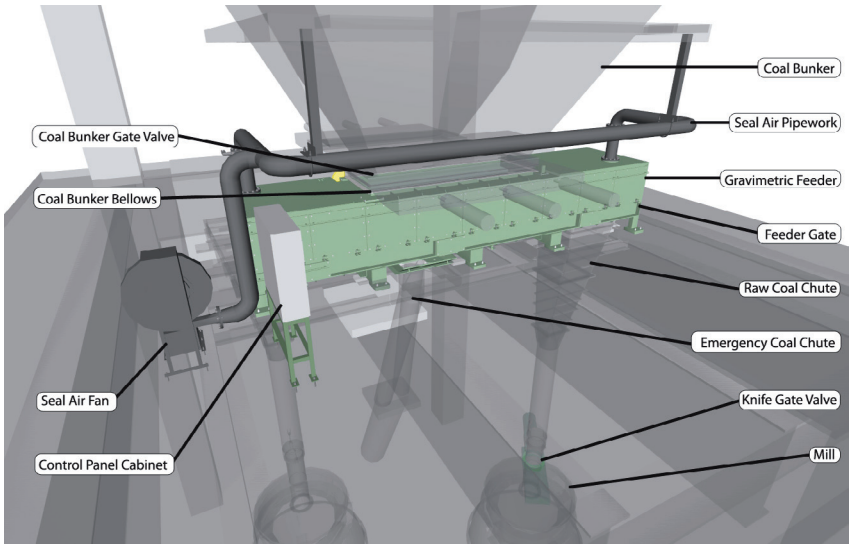


Figure 2. GravMaster details.

In future years, increases in carbon taxes are likely to make gas generation much more attractive, particularly in the UK. This may force coal generators to run only during the winter, with many standing idle during summer months.

This, along with the enforcement of the new Industrial Emissions Directive – which has effectively replaced the Large Combustion Plant Directive – will limit NOx emissions for existing coal plants down to 200 mg/m$^3$ from 2016 – less than half of the current levels.

The impact of these changes will mean that operators will find it increasingly difficult to maintain profits, due to this combination of reduced running, higher taxes and more stringent limits.

The more restrictive legislative framework, combined with shifts in public and political opinion and a more diverse marketplace, has already forced a number of the UK's best-known plants to shut down – something that would have been unheard of just a decade ago.

## Fuel distribution and measurement

To ensure their continued operation in the long term, the remaining plants must take steps to improve the combustion conditions in their boilers and therefore reduce emissions and improve operational efficiency. This can only be realistically achieved through a combination of improved fuel selection and better fuel balancing, distribution and measurement.

A key stage in this process is the handling of fuel through the coal mills that feed the boilers at the heart of the power plant. There are currently many different types of coal mill in operation, varying from vertical spindle, single or double outlet design – where each outlet splits off into multiple burners – to multi-outlet mills where each outlet feeds its own coal burner. There are also horizontal tube mills and lignite-type Beta mills. All of these coal mills should ideally deliver a balanced fuel supply to the boiler. In practice, however, this is easier said than done.

Feeding each coal mill with an equal tonnage of fuel is often required by the plant operator. The boiler will demand a given amount of fuel from the coal mill in order to provide balanced firing. Delivering this coal to the mills is the job of the coal feeder. Historically, most of these have been simple volumetric designs that estimate the fuel quantity by simple calculation, multiplying the speed of the drag chain by an aperture of known area through which the coal passes.

In recent years, Greenbank Group has worked with a number of operators to develop a more accurate and efficient form of feeder. As a result, the GravMaster system has been designed with the ability to accurately measure the fuel delivered to each coal mill, enabling an equal amount of fuel to be fed into the boiler. This pioneering gravimetric system is capable of measurement to an accuracy of +/-0.5% and also offers operators multiple alarms and control features.

The GravMaster can be designed to handle coal in a continuous production environment at a rate up to 100 tph. The feed speed is determined by the belt speed, which itself is controlled remotely by an

inverter that receives the set-point signal from the plant's distributed control system (DCS).

The casing of the feeder has been designed in acknowledgement of the National Fire Protection Association NFPA 85 code, while the casing is designed to yield at 50 psi. The volume within the feeder meets the ATEX zone 21 and, therefore, all equipment within this space is rated to at least that safety standard, complete with exterior isolation in the local control panel.

With the introduction of ultra-low sulfur coals, the feeders can also handle coal of a wide range of density.

## Fuel balancing

Once the processed coal has left the mill, there are further improvements that can be made to existing systems to improve efficiency and, therefore, emissions. This is particularly important when there are multiple outlets of different lengths running to the boiler. In these circumstances, the problem of balancing the fuel becomes evident.

Traditional methods of balancing have attempted to balance the airflow using orifice valves and measure the airflow in the lines using pitot devices. However, the fuel rarely follows the air, due to its sizing and the effect of the pipework characteristics on the pulverised fuel.

On a recent project in China, Greenbank Group was asked to design a system using their bespoke Coalflo balancing dampers along with a coal flow measurement system to balance the fuel being supplied from six five-outlet mills.

The dampers were designed using detailed computational fluid dynamic (CFD) analysis that took into account the plant design parameters to arrive at the necessary shape and size of the blades.

## Datong power plant

While there are no plans for new coal-fired power plants in the UK, elsewhere in the world, coal is still seen as a primary fuel for power generation. China, in particular, has invested

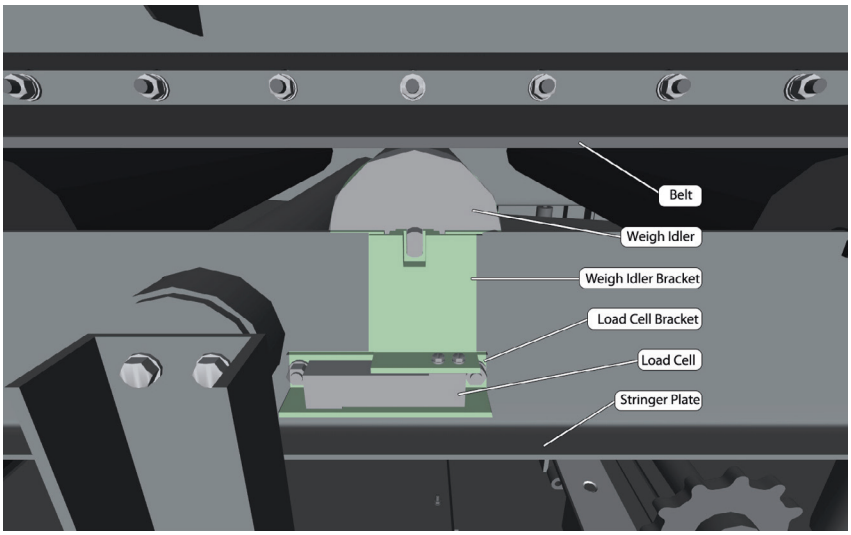


Figure 3. Gravmaster weigh cell.

Figure 4. Coalflo damper positions.

Figure 5. Coalflo damper.

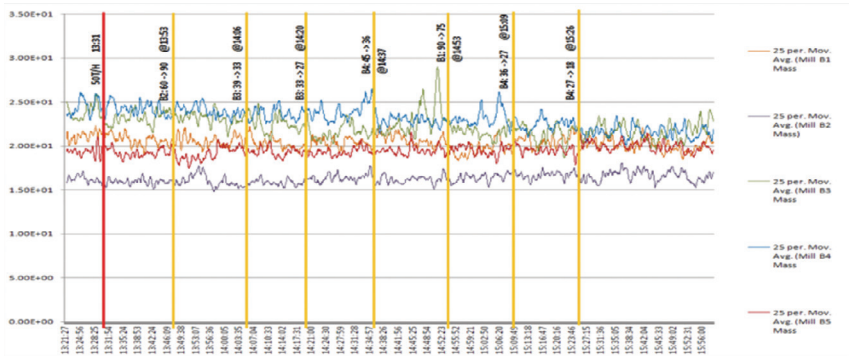


Figure 6. PFMaster showing fuel masses balancing.

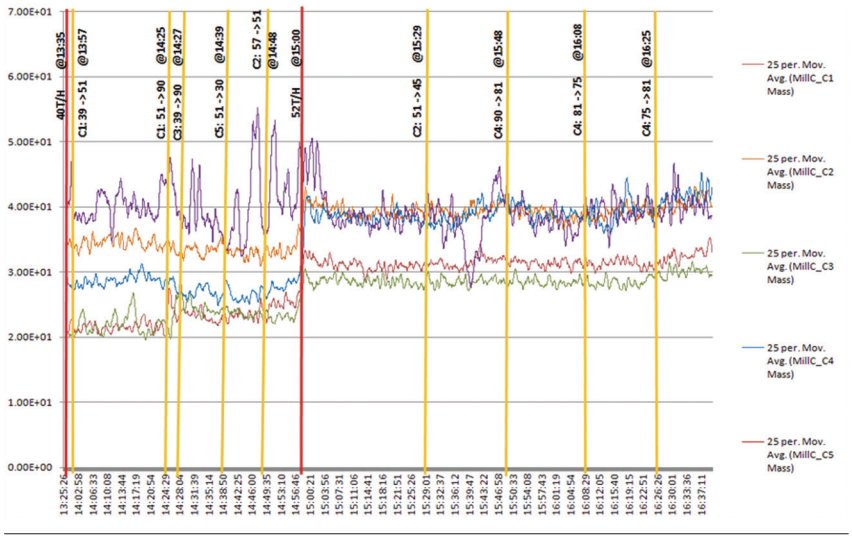


Figure 7. PFMaster showing further balancing.

heavily in coal-fired plants. Greenbank Group has been working with a number of operators to ensure maximum performance and reduced emissions.

In 2012, following design and engineering, Greenbank Group supplied new Coalflo balancing dampers to the power plant at Datong for installation on their Unit 7 coal mills. These were used as part of an integrated control system using advanced monitoring equipment and technology.

Upon evaluation, the Coalflo dampers used in conjunction with a PfMaster measurement system contributed to an improvement in boiler efficiency of 0.3 – 0.8% and reduced NOx emissions by 16 – 25%.

The Coalflo damper blade design was bespoke to the Datong plant and CFD and was used to ensure pressure drops in the pulverised fuel lines could be adjusted and to allow the fuel flow to be balanced. A damper was installed on the 30 outlets from each mill and each mill was trimmed to balance the pulverised fuel flow.

Huadian Tienren, the control systems group, had to demonstrate to its parent company, Guadian Group, that the balancing of fuel from the mills and optimisation of Unit 7 combustion made tangible improvements in NOx performance.

Datong Unit 7 is an opposed-fired boiler, with each of the six vertical spindle mills having five outlets – each of which was fitted with a Coalflo balancing damper. The new dampers were designed to ensure that balancing of the fuel leaving each mill was achieved in line with the guarantees. Greenbank Group's task was to operate the balancing dampers to bring together the fuel masses being delivered to the boiler from each mill. This would then become an essential part of the broader optimisation of the boiler that the Chinese Control Group were undertaking.

By working with the plant operators, each mill was taken and set on steady conditions. A logical procedure was then used to balance the fuel outlets from the mill. The process involved partially closing in the dampers on the legs with the higher masses.

In order to measure the effects of the damper adjustments, PFMaster electrostatic sensors were installed on the vertical sections of pipework nearer to the boiler to allow real-time measurement of the relative mass and velocity. The effects of the changes were monitored by the system and further adjustments were then made as necessary to bring the masses closer together.

Figure 6 shows the effect of closing B3 and B4 valves, which had higher mass loadings. It can be seen clearly from the graph that, as the mass in legs B3 and B4 was reduced, the mass in leg B2 gradually increased.

The mass splits in legs B1, B3, B4 and B5 were brought together and the difference between B2 and B4 was reduced.

Further balancing is shown on C mill, where the highest legs were again adjusted to bring the mass flows together. The PFMaster system displays were configured to show trends. Data was also taken into the station's DCS systems for further analysis.

By using the velocity signals, the effects on fuel distribution by reducing mill airflows can also be advised. Balancing can then be carried out under optimum conditions where the mill fineness and grinding performance is optimised.

## Investment

This latest example of investment by overseas operators demonstrates the advances that have been made to improve both the economic and environmental performance of coal-fired power plants. They also provide a template for the way UK operators can ensure that coal remains a viable and essential part of the strategic mix of energy generation options for many years to come. WC