

A NOVEL WAY TO CONTROL ASH USING ONLINE ANALYSIS

B. Ampil, R. Woodward

Thermo Fisher Scientific

ABSTRACT

Online coal analysers have become commonplace in the US coal industry in the past 15 years, with more than 250 units installed during that period. Many of these are used in conjunction with the coal preparation plant (CPP), generally controlling the plant quality, more specifically ash content. Some have tried to use the rapid feedback characteristic of online analysis to adjust the plant process, either heavy media gravities or in some cases jig settings, but the most elegant and probably most efficient way of capitalising on the analyser's online analysis information is to adjust the fraction of raw coal which bypasses the plant, to keep ash content relatively constant.

In 2000 Alliance Coal procured an online elemental analyser and installed it just downstream of the 5 mt/y Gibson County CPP. By monitoring the minute-by-minute ash levels in the product stream, the plant is able to adjust the fraction of raw coal bypassing the plant, so that when the ash level goes up, the raw fraction is decreased, and vice-versa. This article describes the application and the results.

Gibson County Coal

Gibson County Coal, LLC operates Gibson, an underground mining complex located near the city of Princeton in Gibson County, Indiana (Figure 1).



Figure 1
Gibson County Operations near Princeton, Indiana.

The mine began production in November 2000. The Gibson complex utilises continuous mining units employing room-and-pillar mining techniques. In 2003, Gibson increased mining capacity with the addition of one continuous mining unit.

The preparation plant has a throughput capacity of 700 tonnes of raw coal an hour. Production from Gibson is a low-sulphur coal that historically has been primarily shipped via truck to nearby generating stations. Gibson's production is also trucked to Alliance's Mt. Vernon trans-loading facility for sale to utilities capable of receiving barge deliveries.

Plant Operations

The coal handling system surrounding the Gibson County CPP (Figure 2) includes a diverter on the coal stream entering the plant.

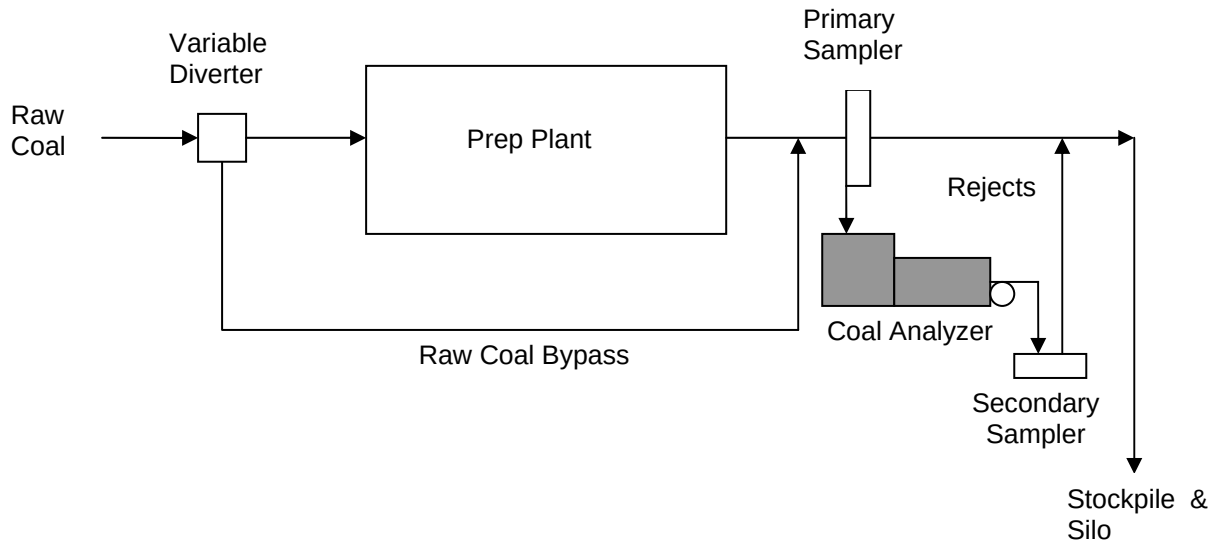


Figure 2
Coal Handling Schematic in the vicinity of the Gibson County Prep Plant

This diverter (Figure 3) is continuously variable, permitting a small fraction of the raw coal to bypass the cleaning process.



Figure 3
The variable position diverter is used to determine the percentage of raw coal which will bypass the prep plant.

A large majority of the raw coal enters the plant for cleaning (Figure 4).



Figure 4
The top belt is prep plant feed. The bottom belt is prep plant bypass.

The diverted raw coal rejoins the process downstream of the plant, where it dumps onto the clean coal belt. A two-stage sampling system is installed on the product belt, where it diverts the primary sample stream through a Coal Quality Manager (CQMTM) online analyser from Thermo Fisher Scientific (Figure 5).



Figure 5
Thermo Scientific Coal Quality Manager (CQMTM) is located downstream of the plant, and its ash readings enable the shift operator to vary the prep plant bypass to keep ash consistently on target.

The analyser produces ash and sulphur analyses each minute, and those results are transmitted to the CPP control room for immediate display. The product stream passes through as many as eight transfer points and a silo prior to load out, ensuring thorough mixing of the small raw coal fraction in the product.

The CPP shift operator is responsible for keeping the ash level on target, consistent with the contracts which Alliance has for its production from the Gibson County complex. One of these contracts calls for 10% as received ash, while the other calls for 7% as received ash.

Experience with coal analysers used to control CPP ash levels has shown that the most yield efficient method is not to adjust heavy media gravities to reach the desired quality. Instead, the most yield efficient approach is to choose a heavy media gravity setting which will achieve an ash level comfortably below the lowest ash required by contract, and then divert a small and variable amount of raw coal to bypass the cleaning process and meet up with the cleaned coal on the product side of the plant.

Alliance's Gibson County plant operates the plant with heavy media specific gravity of about 1.45-1.50 to achieve 6 – 6.5% as received ash in the clean coal, while diverting a small percentage of raw coal to mix with the clean. In this case, the raw coal has an average ash of about 25%, so that the fraction of raw coal in the blend will be about 3-7% to meet the 7% as received ash target, and 15-25% to meet the 10% ash target.

Coal Analyser Background

The coal analyser employed by Gibson County Coal at their CPP is an elemental analyser from Thermo Fisher Scientific. It employs the technology known as Prompt Gamma Neutron Activation Analysis (PGNAA). PGNAA uses a neutron source, a minute amount of californium 252 isotope, to irradiate a coal stream on a conveyor. The irradiated coal in turn emits gamma rays. The energy level of the gamma ray is a function of the element whose nucleus has absorbed the incident neutron. A sodium iodide scintillation crystal is used to count gamma rays and determine their energy level, thus forming a composite spectrum. An analysis of the spectrum leads to a determination of elemental composition in the coal each minute.

There are two types of PGNAA analysers: ones which monitor the coal as it is carried on one of the mine's many conveyor belts, and ones which take a representative sample from a process belt and pass it through the analyser. The analyser chosen by Gibson County is a sample stream analyser, the Thermo Scientific (formerly Gamma-Metrics) CQM. The CQM is fed by a sweep-arm primary sampler at a rate of about 3 tonnes/hr. The CQM has its own input hopper, belt conveyor to transport the sample stream through the analyser, and flow control system.

Analysis information is provided remotely on an Operator Console. Although analysis information can be provided each minute, most operators, including Gibson County, choose to monitor a rolling average composition. In the case of Gibson County, they use a 30-minute period for their rolling average. The Operator Console also has trend displays, alarm features, and can be used to track cumulative batch averages, suitable for shift performance assessment. The analyser at Gibson County has an enviable record of availability, in excess of 99%.

Analyser-based Control

Since the exact as received ash in the clean coal stream will vary somewhat above and below the typical 6%, and since the raw coal ash will also vary about its normal 25%, there is need for real-time monitoring of the blended product ash level and periodic adjustment in the fraction of raw coal which bypasses the plant. The real-time monitoring is accomplished by the Thermo Scientific CQM analyser, while the periodic adjustments in the clean/raw percentages are accomplished by the shift operator. The shift operator monitors the 30-minute rolling average ash from the coal analyser and if ash levels move above the target ash he will increase the clean coal percentage in the blend by adjusting the bypass diverter.

On the analyser Operator Console the shift operator is also able to assign a product name to the two different products the plant produces. With individual product names the Operator Console is then able to track the cumulative average ash % of each product throughout the day. This gives the operator additional critical information for meeting the mine's contractual obligations.

For example, if the plant is producing the 10% as received ash product, and the cumulative ash concentration for the day is 10.2%, whereas the most recent 30-minute rolling average is 9.5%, the operator will probably not

adjust the diverter position. Instead, he will rely on more 9.5% ash coal to take the cumulative ash closer to, or even below the desired 10%.

Analyser Accuracy

Thermo Fisher provides accuracy guarantees with all its analysers. The guarantees are based upon comparisons of 30 to 60 one-hour batch average analysis values from the analyser with representative physical samples of the same batches, subsequently prepared and analysed by a laboratory using ASTM procedures. Guarantees are governed by the ASTM D5 standard guide 6543, usually applying the Grubbs' Estimator method of precision determination. Ash analysis guarantees depend upon the range of values in the ash; the wider the range, the larger (i.e., worse) the guarantee.

The analyser was subjected to guarantee testing in 2001. While it is known that the analyser passed all guarantees, records of those tests could not be located. The most recent performance assessment occurred in August 2006. The scatter plot for 51 shift averages is found in figure X. The RMSD for this data is 0.24. Considering that this statistic encompasses the imprecision found not only in the analyser, but also in the sampling system and in the processes of sample division, sample reduction, and laboratory analysis, the analyser precision for a shift is likely well below 0.2% ash.

Economic Benefit

The benefit associated with this application of an analyser derives from the processing costs associated with coal cleaning averted by being able to bypass a significant percentage of CPP feed. Conservative estimates of the variable costs associated with coal cleaning, especially energy, but also chemical and magnetite costs, are at least \$2/tonne. In the period of 2006-mid year 2008, Gibson County Coal was able to bypass 1.2 million tones, projecting at least \$2.4 million in savings.

Results

Figure 6 shows the variations in total ash along with the clean coal % in the product for one entire day in February 2006.

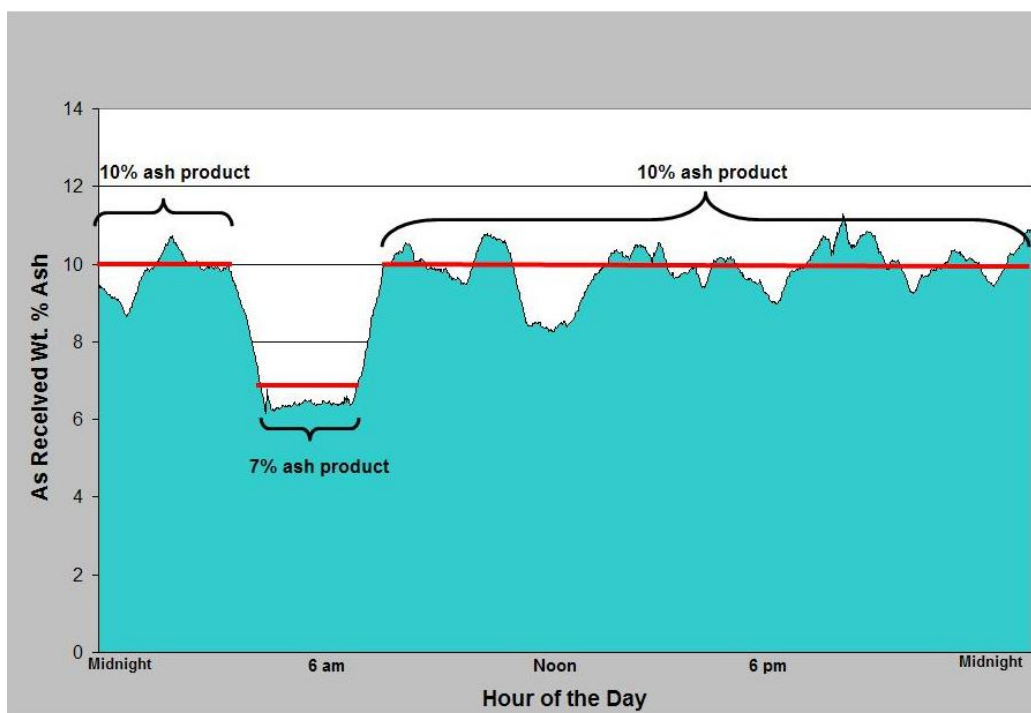


Figure 6
Gibson County prep plant ash from one day in February 2006

It is clear that the plant is able to minimise significant excursions from the target ash. Apart from a brief, 2-hour stretch the plant was producing the 10% ash product on this day. Figure 7 shows variations in the % of raw coal which bypassed the prep plant in a four-hour period from the same day. The % of clean coal in the product varies from 78% to 85%.

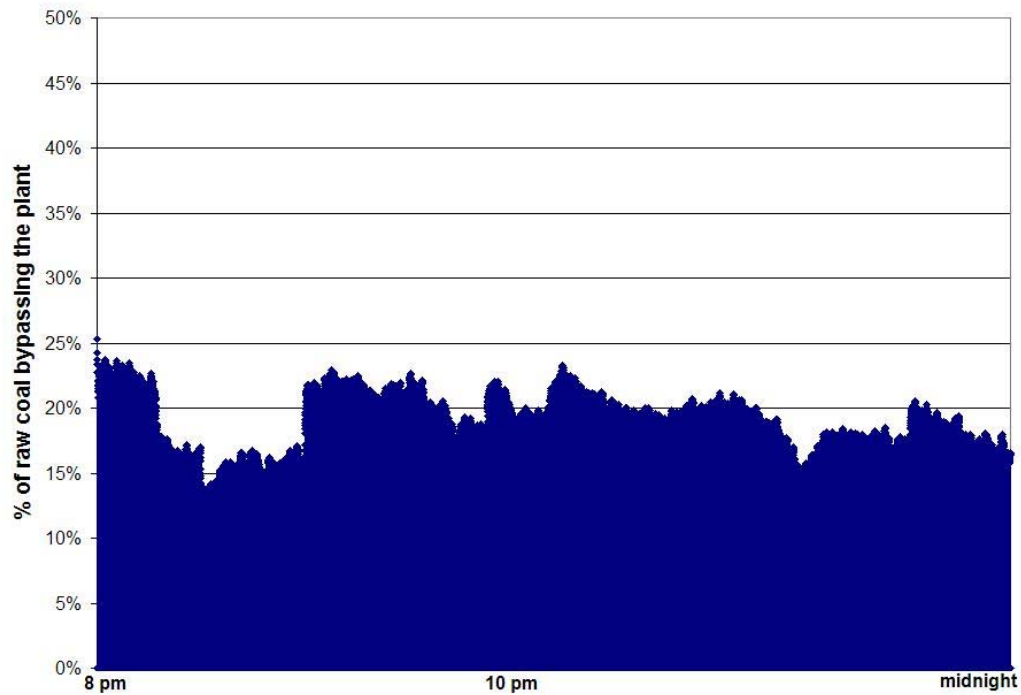


Figure 7
Percentage of raw coal bypassing the Gibson County plant over a four hour period

Summary

Alliance Coal built a new CPP in 2000. In facing the decision of how to control product ash to satisfy contract requirements, it elected to procure an online analyser to facilitate the process. But unlike many others, it chose not to adjust the CPP process itself, electing instead to achieve its target ash levels by making real-time changes to the small percentage of raw coal diverted around the plant to mix with the clean coal. The plant has found this approach quite successful in meeting market place requirements.