



Handling Data in Coal Quality Monitoring

Systems for Detecting Ash in Coal Using Natural Gamma Method
White Paper



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Abstract

Parker Bretby Gammatech systems have been in the field providing customers with information since 1994 and seven years prior to this under British Coal. The method of on-line detection has not changed much over two decades. However, the way we handle data most certainly has. This paper will describe the current suite of Parker Bretby Gammatech equipment for detecting the ash in coal using the Natural Gamma method and what we can now do with this enormous amount of data being collected in terms of getting it to the people who need it in the most suitable format, wherever they may be in the world. Any reporting software will have to be compatible with industry standard operating systems and a client's own management systems, which gives our engineers an exciting challenge. We will look at recent installations around the world and how our Matrix Data Delivery is giving customers control of the Coal processing system, when they need it and where they need it.

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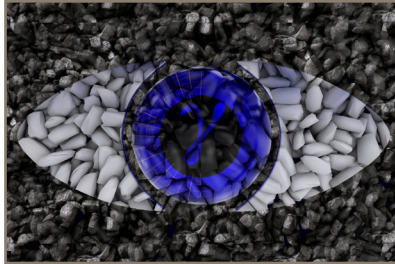
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EyeGraffix logo

Introduction

Parker Bretby Gammatech have been producing coal quality monitoring systems since 1994 when the company was first formed. The founding directors had all previously worked for British Coal, a state owned mining company and had been involved in the first attempts to measure coal quality using natural gamma radiation seven years previously. Parker Bretby Gammatech now provide systems around the globe to customers with widely differing infrastructures. Parker Bretby Gammatech

provide products including both portable monitoring systems, such as the Ash Probe, which can be used with piles of coal at different locations; and online systems, such as the Ash-Eye and Heat-Eye, which are mounted on conveyor belts, providing quality information in real time. The conveyor mounted systems can generate a large amount of real time data which must be processed and passed to the appropriate destinations and it is this transfer of data that this paper is primarily concerned with. In our experience, the nature of some of the information technology infrastructure at sites around the world, can be quite outdated and it can never be assumed that there is any supporting IT system at a customer's site and therefore, the monitoring systems must essentially include all the mechanisms required to handle and move the data without requiring complex servers or communications systems that require constant maintenance and can only be configured by trained professionals.

The solution has been to create a new method of data transport that can be handled entirely by the monitoring computers connected to the Parker Bretby systems, requiring only a network connection to deliver data and no support from a customer's own IT staff, who historically don't often

get involved in external projects.

The main principle of the new data handling systems, termed the Matrix Data Delivery method, is that any computer running the new Parker Bretby EyeGraffix suite of software can physically connect to up to 25 natural gamma monitoring systems via a direct connection such as an RS485 signaling cable but can then mirror the data for any one, or all, of those systems to up to ten other EyeGraffix terminals simultaneously.

These other terminals will see the data as though they themselves are physically connected to the monitored online system(s). They in turn can pass this data onto other EyeGraffix terminals over a local or wide area network connection to additional EyeGraffix terminals, linking together to form a matrix of terminals, or nodes, where data can be passed from any node to any other in order to reach its ultimate destination, which with an internet connection, can be anywhere in the world.

This is currently being used to allow a number of systems throughout the globe to be monitored by Parker Bretby Gammatech engineers in the UK and can be used to make data available to any of a customer's own offices or key stakeholders around the world.

Natural Gamma Detection

Traditionally, coal quality was measured in terms of its ash content which would normally be done by taking coal samples from the conveyor belt and analyzing them in a laboratory. The results would be available some considerable time later, perhaps several days if an external laboratory was used. To alleviate the delays, techniques were developed by several vendors to provide a means of determining the ash content in real time as the coal passed by sensors on the conveyor belt. The most common of these methods was to pass gamma radiation beams through the conveyed coal and then measuring the attenuation of the signals ((IAEA, 1986). This had the distinct disadvantage of requiring radiation sources and therefore all the necessary associated safety

procedures, individual worker dose monitoring and problems with disposing of the radiation generation equipment once the systems were no longer required.

In the 1980s, the possibility of measuring the gamma radiation naturally emitted by the main coal impurities was being investigated (Wykes et al, 1989) and the founders of Bretby Gammatech were significantly involved in this.

The theory is that principal contributing isotopes in the ash are potassium K40 and members of the uranium and thorium radioactive series. The level of natural gamma radiation emitted from a given weight of mined material increases monotonically with ash content and a system calibrated to particular coal

sources by means of comparing a range of samples measured with the on belt system against laboratory results for the same samples, allows the system to determine the ash content with a relatively high degree of accuracy (around $\pm 1.5\%$ for run of mine coal) (Wykes et al, 1989).

Whilst the instantaneous measurement of gamma radiation is not consistent due to the very nature of the radiation source, averaging the measurements over periods of time produces a more representative measurement. This was eventually put into practice with the development of the Natural Gamma Coal Quality Monitor (NGCQM) system by Bretby Gammatech (Taylor, 2000)

Ash-Eye/Heat-Eye and EyeGraffix

Over the years the original NGCQM system has been developed into the Ash-Eye on belt monitoring system, which utilises the same principles as the original designs, adding enhanced data processing and functionality. The Ash-Eye system, as the name implies, is designed principally to determine the ash content of conveyed coal in near real-time.

link, typically RS485 running a proprietary protocol. The monitoring computer collates all the data and calculates average ash content over periods of time ranging from a few seconds to an entire shift, allowing the customer to get the data they need in the required resolution.

The latest EyeGraffix software suite

takes this further by providing a much more modern user interface, the ability to generate a number of user configured reports automatically and email these to multiple recipients. Each terminal can monitor up to 25 Ash-Eye or Heat-Eye systems and larger systems can be accommodated by linking together EyeGraffix terminals.

The Heat-Eye system is an extension of the Ash-Eye, which uses the addition of a microwave over-belt moisture analyser, to allow calculation of the Calorific Value of the conveyed coal. Whilst the Ash-Eye and Heat-Eye systems are stand-alone and can present their data by the local display on the main processor cabinet, most customers prefer to present the data on a monitoring computer connected via an appropriate communications

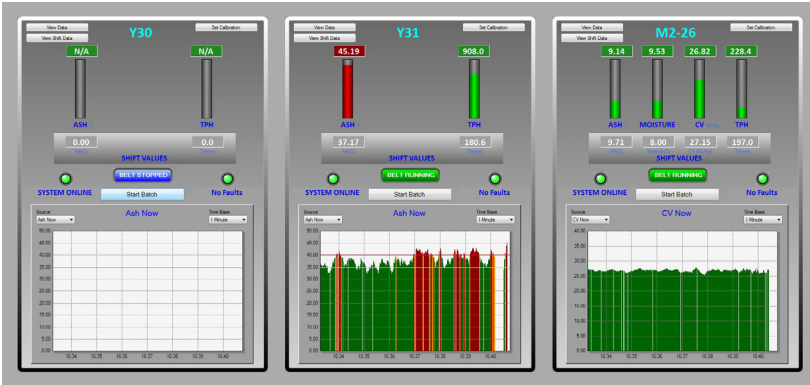


Figure 1: Multiple EyeGraffix system information display screen

Matrix Data Delivery (MDD)

Most customers want the data to be analysed and then reported in terms of average figures for each work shift or the averages on an hour by hour basis (or some other appropriate resolution), which can be provided as a spreadsheet, sent automatically or on demand via email from any of the directly connected EyeGraffix host terminals. However, there are occasions when a customer wants the ability to drill down into the data from a remote location and in order to achieve this, the large amounts of raw data needs to be passed to their local EyeGraffix terminal. Similarly, Parker Bretby Gammatech can also offer to receive the data from a customer's on site equipment at their UK base in order to track system performance and make adjustments remotely. In such cases, the large volumes of raw data generated by the system each second need to be passed in their entirety to all remote EyeGraffix

terminals rather than just the processed data. To achieve this, the Matrix Data Delivery (MDD) system was developed. This is essentially a method of providing large volumes of data across, and via, a number of terminals/nodes using the most basic of infrastructure and therefore minimising the amount of support required from the customer. A network connection is all that's required in most cases.

Each host terminal can connect to up to 25 online monitoring systems by direct physical connection (i.e. an RS485 serial interface). Any of these sites can then optionally be made available to the MDD system, such that all data from the individual systems is passed out to any of the other terminals connected by MDD. Therefore remote host terminals can connect to any such site via MDD, either through a Local Area Network connection, or through

an internet connection if available. In turn, any sites monitored in such a way can also be made available to other host terminals using the MDD system.

For a customer's satellite office, there could be a single EyeGraffix terminal which links over the internet to other local host terminals connected to actual Ash-Eye/Heat-Eye systems at different sites but any other interested parties within the office can then link to the single terminal so only one internet connected terminal is required to establish communications, minimising the effect on bandwidth of connecting lots of terminals over the slower internet connection rather than a high speed office local area network.

Should the route be lost through one particular terminal or link, then the MDD network can be quickly reconfigured so that the data takes a different route, using

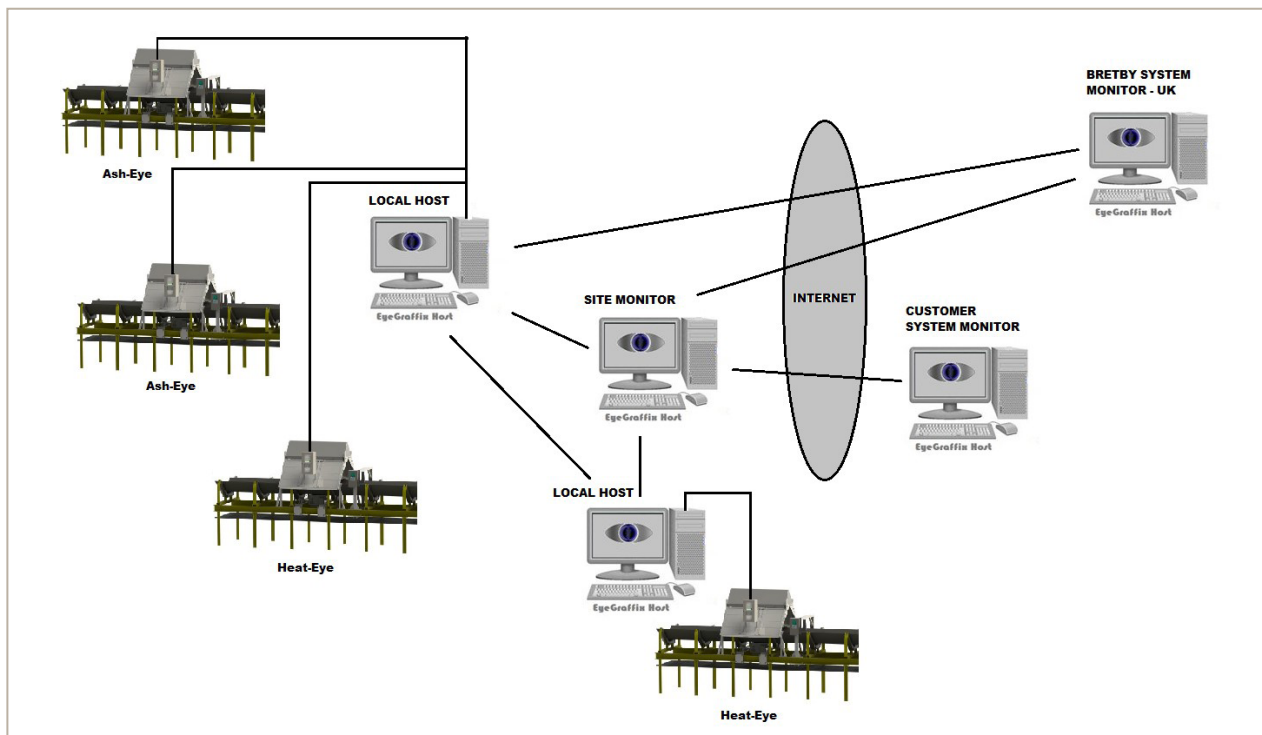


Figure 2: Overview of MDD system

as many terminal nodes it takes to get to the source data. Each EyeGraffix terminal is usually configured in such a way as to make available any received site data to any other EyeGraffix terminal that connects to it. This means that complex reconfiguration is not required in the event of a loss of link. Usually the terminal affected needs only one simple parameter change

to then connect to another node through which it can get its data without needing to know how the data is getting to this new node. A further development under consideration, is automating this process so the entire MDD network becomes self-configuring under fault conditions. The MDD system was first installed at a number of locations in Kazakhstan operated

by ArcelorMittal. There are currently five on-belt systems at two separate locations being monitored by three local EyeGraffix terminals on site, with data available to ArcelorMittal management at locations outside of Kazakhstan as well as directly to Parker Bretby Gammatech in the UK, who are able to diagnose any reported issues immediately.

Why not build a web site?

Perhaps the most obvious way of making data available to multiple users over large areas is to establish a web site, a solution which has the added advantages of allowing any user with the appropriate access level to get the data from any location using any browser enabled device.

Whilst this method has many clear advantages, the principle disadvantage is the need for a web server to be setup and maintained at the customers premises or externally on behalf of the customer. Once again, the problem we have encountered with this solution is the lack of an interface between a customer's IT department and the engineers who control and use the system. Whilst we can arrange to get network and internet access as this is a common task within the plant, setting up the necessary database and website servers and linking them to our installed systems proves to be a step too far. Therefore our solution has had to have minimal involvement from other departments and as such, the MDD method restricts the configuration and maintenance of the system to the individual computers installed, which more often than not, are supplied by Parker Bretby Gammatech, meaning the link can be set up quickly and efficiently.

Security Concerns

With direct connections to computers over the internet, there will always be a level of concern of the security of the system, not just in protecting a customer's potentially commercially sensitive data but also in the risk of providing some form of back-door onto the computer and the local network to which it is attached.

There are a number of ways in which this concern has been addressed. First is the use of a unique encrypted PassKey which both ends of a connection must be provided with in order to communicate but secondly, the protocol used for the connection is not a standard IT protocol but a proprietary one designed specifically to meet the needs of passing the relevant data packets around but without providing any other facilities, such as connecting to elements of the operating system on the connected computers.

Such a protocol leaves no possibility of any other system utilising the link to gain access to any part of the computer or network.



Future Developments



PLC in a cabinet

Currently, the next generation of Ash-Eye/Heat-Eye systems are under development utilising a Programmable Logic Controller (PLC) as the processing heart of the system. Apart from improvements in scalability, standardisation and production, this also allows far easier

integration into a customer's other control and monitoring systems, by using standard protocols such as Modbus. It can also give us the possibility of linking the actual systems directly into the data matrix. Whilst using an industry standard protocol has advantages, the protocol is converted to the Parker Bretby Gammatech proprietary one when connect to the MDD matrix to maintain the security of our system.

A further development, concerns the use of Parker Bretby host website and web applications. Whilst the idea of using a web site or web application to access the data worldwide has many difficulties as described previously, we are currently investigating hosting a secure dedicated web server that each customer's systems can optionally link to, to provide a web based

user interface – but without requiring customer involvement in the installation and maintenance of the system. There would, of course, be sufficient partitioning to ensure that each customer's data will be distinct and securely separated from any other customer's data. The data would be held on a Microsoft SQL Server database back-end with links to the on-site equipment through the MDD system, or in the case of the new PLC based equipment, by secure Modbus connection directly to the processor (when the facilities provided by MDD are not required and a secure enough link to the site can be established). Such a system will, in turn, allow us to produce mobile apps on Android and Apple iOS as well as Microsoft platforms on all devices to make the data available to our customers through a much faster user interface when on the move.

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