Spectrolaser Application: Brown Coal – Lignite

Industry Background

Low-rank coals such as lignite/brown coal and peat are used commercially in power production in at least 16 countries worldwide. Increased use of lignite in power production is forecast as it is used extensively in those countries experiencing the strongest growth in electricity demand (such as India, China and South-East Asia) in addition to it replacing depleting fuel sources in developed nations.

The coal industry is an example of a capital-intensive, high-volume industry where process control is critical to the efficiency of operations and profitability. Elemental analysis of coals within this industry is a key measure in the quality classification of various coal types and impurities. A range of analytical techniques is applied within the industry, whether it is at the mine, at transport links, in commercial service laboratories, or at the point of utilization. Owing to the wide range of chemical and physical tests required, there is no single solution to all the analytical needs of the industry. New solutions are required to enable rapid characterization of coal and hence optimization of its efficient delivery and utilization.

Material Characteristics and Utilization

Elements in Coal

The major elemental components of lignite/brown coal are C,H, O, N and S in addition to inorganic elements such as Na, Mg, Ca, Fe, Al, Si and Ti. There is also a range of trace components present in the fuel whose occurrence depends strongly on its geographical origin. The inorganic components present in the material occur as soluble salts, discrete minerals, or exchangeable cations associated with the carboxyl groups that form part of the organic lignite matter.

Analysis Requirements

As the material varies in chemical composition depending on its geographic source, the analysis requirements in each application can differ widely as well. The total ash and moisture component of the coal is a key measure of its quality and are invariably measured regularly at each site. In addition, the ash composition is also determined by many users to gauge the fouling and slagging propensity of the fuel.

The Utilization Problem

Fouling and slagging deposits occur when the residual ash component of the fuel forms deposits on heat-exchanging surfaces and other regions of power station boilers. These ash residues can reduce the efficiency of power stations and produce operational problems in process control. Fusing of the deposits by reactive components such as sodium and iron in the ash adds to the problem. Delivery contracts between mines and power stations often specify key ash components be kept within specific limits otherwise heavy penalties may result.

How the Spectrolaser Helps

- Reduce analysis time per coal sample from several hours using traditional techniques to just 20 seconds.
- Include a wider range of elements that can be analyzed in each measurement.

Spectrolaser – A Financial Advantage

Spectrolaser technology has been used effectively by operators of lignite power stations and mines in Australia and Indonesia to lower the cost of laboratory services and to improve the efficiency of their operations. The usefulness of Spectrolaser technology, and the fast payback period that can be achieved, have clearly been demonstrated. In the case of coal producers, the technology assists coal deliveries to be made within contract specifications thus avoiding financial penalties and enabling goodwill to be maintained with customers. At the point of utilization, large savings can be achieved as the rapid assessment allows early identification of problems with the fuel enabling corrective action to be undertaken before process problems occur.

Loy Yang Power Australia – An Example

Loy Yang Power is an example of a large mine-mouth power station development using brown coal as the fuel source. The mine provides sufficient coal to power four 500MW generators in addition to providing coal under contract to another nearby power station. Although the coal is very low-ash (typically 2%) the power station can experience problems with fouling if the coal composition varies greatly from certain specifications. Mixing of the coal obtained from two different locations in the mine is used to maintain the delivered coal within these specifications.

Before the Spectrolaser

Prior to installing a Spectrolaser the power station's chemical laboratory used acid-extraction AAS (atomic absorption spectroscopy) to provide daily point measurements of the coal composition being delivered to the boilers. The chemical testing was limited to 3 key elements linked to the fouling mechanism – Na, Al, and Ca. Only 4 coal samples were characterized per shift using this labor intensive method, as the analysis procedure can take up to three hours for a small batch of samples. In addition to the daily samples a weekly composite is collected and submitted to an external laboratory for a detailed analysis.

After the Spectrolaser

Loy Yang Power has been using a Spectrolaser 1000M since 2002 in the daily operations of its chemical testing laboratory. The implementation of the Spectrolaser at Loy Yang Power enabled the analysis time per coal sample to be reduced from several hours to just 20 seconds. Furthermore, a wider range of elements is analyzed in each measurement. In addition to the required Na, Ca and Al measurement: Mg, Si, Fe, K, and C are typically monitored as well. Forecast savings in analytical services alone are in the vicinity of $100,000 US per year. Far greater savings are expected as the rapid assessment allows early identification of problems with the fuel enabling corrective action to be undertaken before process problems occur.

PT Bukit Baiduri Enterprises (BBE) Indonesia

Before the Spectrolaser

BBE operates an open-cut mine in East Kalimantan, Indonesia that supplies thermal coal to various power stations in South East Asia. The coal product is sold under contract with detailed specifications on coal quality – in particular the Na in coal ash having a defined upper limit. Punitive financial penalties apply when the specifications are not met. Prior to a 2003 Spectrolaser 1000M installation BBE used an external laboratory to provide analysis services. Frequent delays were encountered in obtaining analysis results using this external services laboratory resulting in shipment delays and substantial extra costs to BBE. From time-to-time disputes also arose regarding analysis results necessitating extra testing to be carried out.

After the Spectrolaser

The installation of the Spectrolaser 1000M has resulted in BBE being able to operate independently of external laboratory services providers, enabling them to undertake rapid and effortless characterization of their coal product. This in turn has assisted them to deliver coal within specification and to avoid the financial penalties associated with shipping coal of inferior quality.

In the words of Robert Scheeres, Technical Manager BBE Indonesia “this project has been a massive success” exhibiting the early pay back that can be achieved on the investment in a Spectrolaser system.

Estimated Detection Limits of Key Elements on Lignite / Brown Coal

Spectrolaser 1000M	
Element	Estimated Detection Limit (% in coal)
Al	0.008
Ba	0.001
Ca	0.008
Fe	0.02
K	0.004
Mn	0.004
Mg	0.01
Na	0.008
Si	0.02
Sr	0.001
Ti	0.005
C	0.1

Accuracy and reproducibility study of Indonesian sub-bituminous coal

	Na	Mg	Al	Si	K	Ca	Fe
measurement number	818.482nm	280.27nm	394.4nm	288.157nm	769.897nm	643.907nm	373.5nm (C)
1	0.20	0.09	0.43	0.40	0.033	0.25	0.40
2	0.19	0.10	0.44	0.38	0.032	0.25	0.39
3	0.17	0.08	0.41	0.36	0.030	0.24	0.36
4	0.20	0.09	0.41	0.37	0.032	0.26	0.39
5	0.17	0.08	0.40	0.37	0.029	0.24	0.35
6	0.19	0.09	0.43	0.39	0.030	0.25	0.39
7	0.19	0.09	0.39	0.35	0.028	0.25	0.37
8	0.19	0.08	0.41	0.35	0.030	0.27	0.37
Average	0.19	0.09	0.42	0.37	0.031	0.25	0.38
SD	0.01	0.01	0.02	0.02	0.002	0.01	0.02
%RSD	6	7	4	5	6	4	5
Reference Value	0.18	0.09	0.42	0.34	0.032	0.26	0.38

Photon Machines, Inc.
15030 NE 95th Street
Redmond, WA 98052

Web: www.photon-machines.com
Email: info@photon-machines.com
Tel: +1.425.296.6400