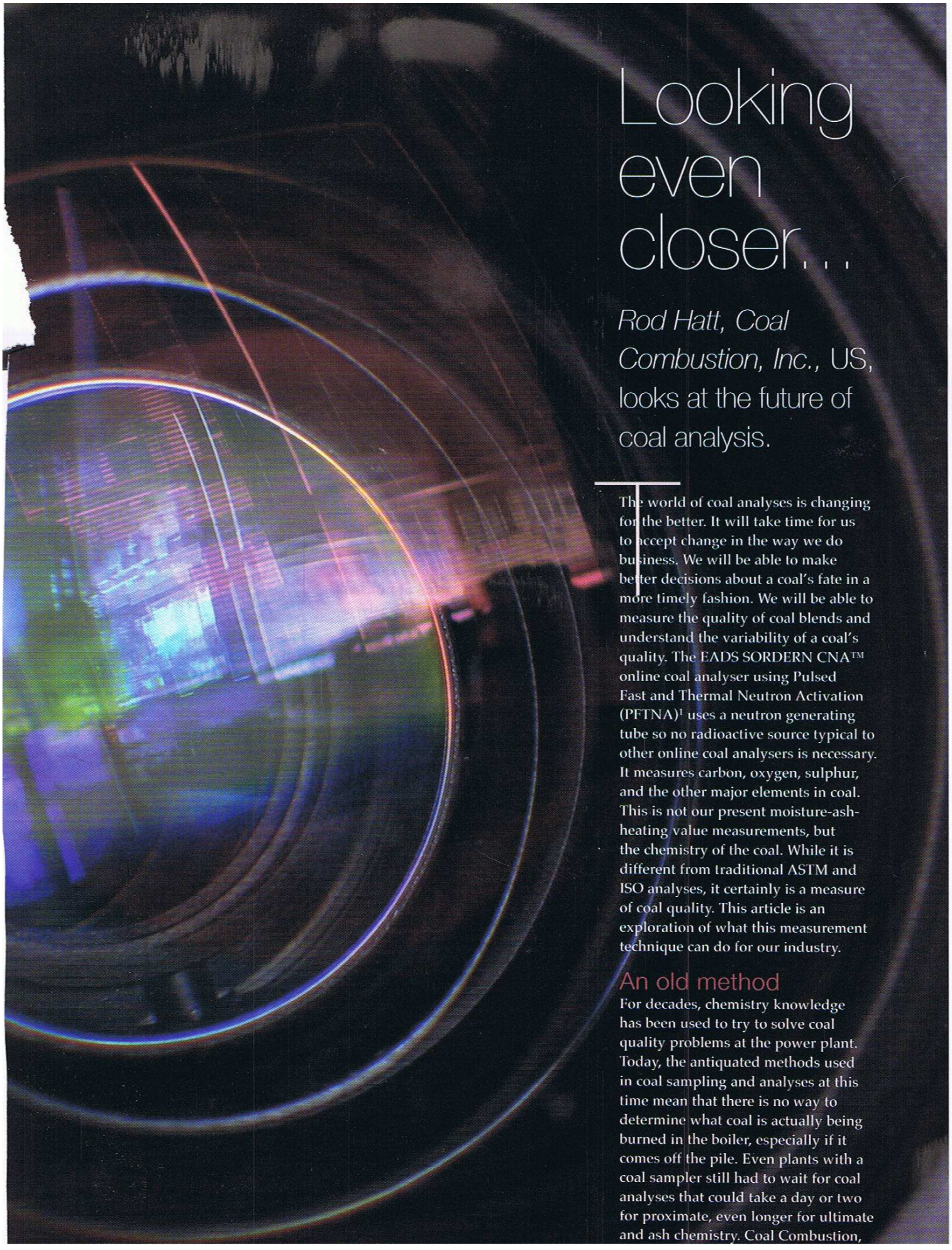


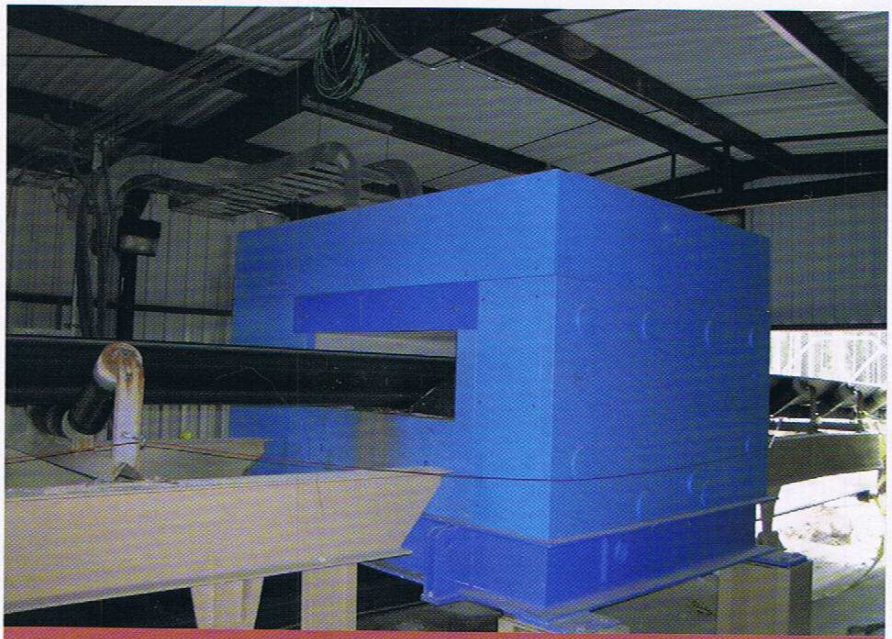
Looking even closer...

Rod Hatt, Coal Combustion, Inc., US, looks at the future of coal analysis.

The world of coal analyses is changing for the better. It will take time for us to accept change in the way we do business. We will be able to make better decisions about a coal's fate in a more timely fashion. We will be able to measure the quality of coal blends and understand the variability of a coal's quality. The EADS SORDERN CNA™ online coal analyser using Pulsed Fast and Thermal Neutron Activation (PFTNA)[1] uses a neutron generating tube so no radioactive source typical to other online coal analysers is necessary. It measures carbon, oxygen, sulphur, and the other major elements in coal. This is not our present moisture-ash-heating value measurements, but the chemistry of the coal. While it is different from traditional ASTM and ISO analyses, it certainly is a measure of coal quality. This article is an exploration of what this measurement technique can do for our industry.

An old method

For decades, chemistry knowledge has been used to try to solve coal quality problems at the power plant. Today, the antiquated methods used in coal sampling and analyses at this time mean that there is no way to determine what coal is actually being burned in the boiler, especially if it comes off the pile. Even plants with a coal sampler still had to wait for coal analyses that could take a day or two for proximate, even longer for ultimate and ash chemistry. Coal Combustion,



Coal CNA for a blending application.

Inc. works weekly with boilers with slag problems where no knowledge exists of coal ash chemistry, especially prior to the slagging where actions might have been taken. The company specialises in training power and coal industry people about coal quality and combustion. It is very frustrating to try to work in the real world and rely on coal quality data that is tardy at best and non-existent if no good sample was taken.

The modern coal trader needs to know the quality of a shipment as it is loaded. Time is money, and the wait of a day or two for coal analyses is uneconomical. We only live with this because we always have done it this way. More financial concerns arise if the quality is 'off spec'. This is where instantaneous online CNA coal analysis addresses these issues.

Room for improvement

When you work on coal quality issues with hundreds of coal industry and power plant personnel, you find that there is a lot more to coal quality than what is represented on a sheet of paper from a lab. The inability of the coal industry to precisely and continuously analyse coal hampers both the commercial and the utilisation aspects. The following two large areas of coal utilisation have not been addressed:

- Coal traders need to know the weight and quality of a shipment as soon as possible. The present sample and laboratory analyses require a day or two to obtain average shipment quality. Limited information is provided about the ranges of quality within a shipment. When the coal is resold or utilised in quantities less than the analyses shipment size, the range of quality variations are important.
- The power plant operator has little to no indication of the coal quality prior to consumption. Very few power plants have continuous monitoring of coal quality as the units are loaded with alarms set for specific quality concerns. Low cost coal plants utilise fuel flexibility as a way to lower costs by promoting competition between suppliers and transportation routes. As a result, most power plants have less margin available to handle excursions in coal quality. Yet most control room and boiler operators have no prior knowledge of coal quality and have not been trained to utilise this type of data if provided. Thorough coal quality and combustion training will make the coal quality data meaningful. Continuous monitoring of coal quality will allow the plant to mitigate quality concerns using blending and/or corrective measures.

If the medical industry were limited to techniques developed over 100 years ago, we would all be very frustrated patients. It is time to bring the world of coal analyses from the 1880s to today's technology. It is not that classical sampling and laboratory methodology promoted by the standard organisations is bad, it just does not operate in our modern timeframe. What we would like to have for each coal shipment or bunkering is a continuous monitoring of the coal quality on the belt as it is loaded.

The professionals that work in the coal industry are greatly influenced by the quality of coal. Business and engineering people don't like fuzzy numbers.[2] These professionals work with money and measurements. Money is easy, it adds up precisely. Engineering is less precise, but a 1.99 m desk will always fit through a 2 m doorway. Coal chemists live in a different world. A 1.99 % sulphur coal has only about half its sulphur less than 2% and how high above 2% does the sulphur actually range? It is hard to determine without constant analyses being performed. Coal professionals already know how coal quality impacts price, and power plant workers definitely know how coal quality impacts plant operations.

We have all been taught that traditional coal analyses measure the average moisture, ash, and calorific values and many other parameters of coal shipment or lot. These values are then reported very accurately, sometimes using four or five significant figures, like 11.13% ash. This accurate looking number gives us a false sense of security as it is really only 95% of the time between 10 - 12 if sampling error is considered.[3]

The present approach

Let us explore what our present sampling and analyses methods actually do for us. Labs don't measure moisture, they weigh the coal, cook it mildly, reweigh it, and then say that whatever boiled off is moisture. Coal labs do not measure the minerals in coal. They burn the coal and whatever is left over is called ash. For calorific value coal labs take 1/12,700,000,000 (one 12.7 billionth) of a 14,000 t rail shipment, cook some water with it, and measure how hot the water gets, usually just a few degrees. This then is the higher or gross calorific value reported. For example the NYMEX[4] coal futures contract lists 12,000 Btu/lb with a lab tolerance of 250. This means that a shipment with an average heating content of 11,751 Btu/lb meets the 12,000 spec. This is over 2% error placed in a contract in recognition of the errors associated with sampling and analyses. The coal industry is truly challenged by coal quality.

Twin Coal CNA in a Chinese power plant for boiler combustion optimisation.

Since the 1980s the coal industry has had the radioactive isotope analysers that work best if provided with prior knowledge of the coal and regular calibration. This mode of operation works well at coal mines where each shipment has a standard coal analyses performed and the coal characteristics are well understood.

The vast majority of these elemental coal analysers employ a technology known as prompt gamma neutron activation, and the term PGNAA is well known. Unlike the dual-gamma ash gauges, which must infer ash, these analysers directly measure the major ash constituents (Si, Al, Fe, Ca, K, Ti, and sometimes Na) and sum them to determine total ash. Moreover, they measure sulphur, an element critical to the US coal industry for reasons associated with environmental regulations. Most applications of PGNAA technology use a californium neutron source to irradiate the coal and a sodium iodide scintillation crystal to detect the gamma rays given off in the process of neutron absorption.[5]

Some authorities on coal quality have been reluctant to endorse the previous analysers that have to be calibrated regularly due to the decaying radioactive isotope, and their inability to measure the combustible quality (carbon) of an unknown coal. One power engineer said about his PGNAA "it was a machine that if you told it what coal it is measuring it could tell you what coal it was measuring." Not the best feature for a power plant bringing in a variety of coals, particularly if the plant blends coals.

Neutrons

Unlike the nuclear isotope-based analysers developed in the 1980s, the SODERN CNA uses an electrical neutron source or tube. Turn it on = neutrons, off = no neutrons. This new generation of analyser offers operational and analytical advantages.

More powerful neutrons allow the direct measurement of carbon and oxygen. Carbon has calorific value, oxygen does not. This is valuable information, even if it is different than the moisture-calorific value data from the labs. The CNA also measures sulphur and the elements in the minerals in the coal. This is different to ash and ash elements reported as oxides.

Safety and liability have significantly been improved with the CNA. Fires and radioactive isotopes that could not be deactivated have been a concern. One way radioactive isotope analyser manufacturers can save you money is to minimise the shielding. The CNA's on/off capability minimises neutron and gamma shielding requirements without compromising personnel safety. It can be equipped with the Automatic Radiation Protection (ARP) system, a safe system that automatically shuts off the source whenever a person is in the vicinity, reducing the requirement for heavy and voluminous solid shielding. Reduced size and weight simplify installation and lower cost, while supporting an easy relocation at a later date.

Further, the CNA has the ability to control the rate of neutron output reliably at a fixed level to ensure that analytical performance is stable and the calibration is long lasting. Neutron stability over time makes periodic and laborious onsite recalibration unnecessary. This has always been a concern where power plants don't even have a coal sampler to use to calibrate the machine. In addition, if we send the coal calibration samples to a second or third laboratory, the inconsistency of the lab data biases the calibration.

Thanks to PFTNA abilities, combined with a comprehensive in-factory calibration process, the CNA is non-material specific and highly robust in applications where highly variable chemistry with widely varying mineralogy exists. Its analytical performance is unaffected by varying belt loading, material origin and changing blend ratios from multiple sources with varying compositions.

With this analyser the operator interface is also an information gateway that can communicate with plant DCS and PLC networks. Powerful automation software can be combined with the elemental data stream to provide the highest process control benefit.

The future is here. We will have instantaneous and accurate coal analyses for both commercial and production operations. Gone will be the day when you have to wait a day or two to find out the quality of a shipment. An on-line analysis of coal that measures the elements that coal is composed of is just what the industry needs. By measuring carbon and oxygen in addition to the sulphur and ash chemistry we can characterise coal quality. This will not only ensure that shipments meet quality, but that power plant personnel can measure and control the quality of coal into the plant.

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