Title: Breakthrough Technology

Author: Larry G. Stolarczyk and
Glenn G. Wattley,
Stolar Horizon, Inc., US

Magazine: World Coal May 2002

Palladian Publications Ltd
15 South Street
Farnham
Surrey GU9 7QU
UK

Tel: +44 1252 718999
Fax: +44 1252 718992

Larry G. Stolarczyk and Glenn G. Wattley, Stolar Horizon, Inc., US, describe how the application of new horizon sensing technology at Monterey coal mine will lead to increases in production yield, clearer ROM coal and reduced disposal costs.

Despite the recent softening of coal prices, the outlook for the coal industry remains bright. Coal provides 23% of the world's energy needs; in the US it generates over 50% of electricity. As a primary fuel, coal will maintain its significant market share for the foreseeable future, and it is likely to increase its share as energy demand grows. But there are challenges to face, driven to a large extent by environmental concerns. Social pressures continue to focus on pollution and waste from coal, and in the face of continuing competition, coal producers will be in a constant battle to control and reduce costs. Advanced technology such as horizon sensing can help the industry improve the quality of ROM coal at a lower net cost.

The outlook for coal

Supply/demand

During the winter of 2000/2001, coal prices increased dramatically - something that has not occurred in almost two decades. Whether in European or North American markets, coal producers enjoyed a new opportunity to garner well-deserved profits. The so-called 'abundant and cheap' competitive fuel, natural gas, was in short supply and extremely expensive. High gas prices drove utilities to back down gas-fired plants and dispatch coal generators at higher rates; coal inventory and coal supply became tight, enabling sellers to take advantage of the supply/demand imbalance.

Unfortunately, the US economic slowdown of 2001, coupled with the mild winter conditions of 2001/2002, caused short-term energy demand to come into balance with supply, and prices to retreat. But most experts agree that, especially for the coal industry, this is a short-term dynamic. Despite an increase in drilling for gas, new

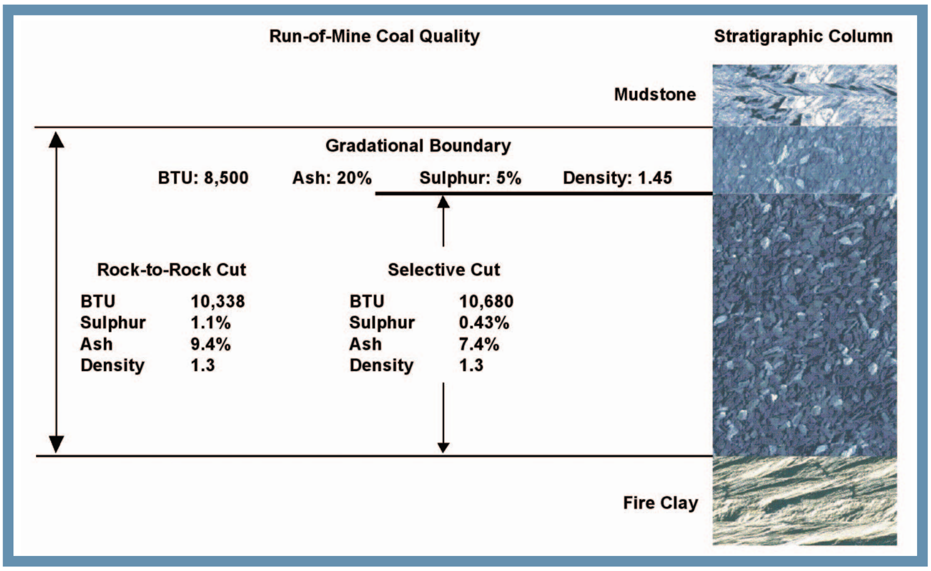

Figure 1. Improving ROM coal quality with selective mining.

supplies have been hard to come by. At this point for the US, forecasters see gas prices settling into a US$ 3 - 3.50/MMBtu trading range. With the cancellations of many gas-turbine units not yet delivered, and with more coal plants being ordered, it appears in the long-term that coal demand will increase.

Environmental issues

However, while coal is abundant (for example, in the US the reserve base is estimated to last for 275 years) and 'cheap', it still has a serious challenge is becoming more environmentally acceptable. With proper controls, the mining and combustion of coal does not have to be a threat to the environment. In this article, three pollution issues will be considered: SO_2 emissions, the cost and impact of coal ash and waste, and the release of heavy metals such as mercury. The debate over greenhouse gases continues, and a carbon tax would have the biggest negative impact on coal vis-à-vis other fossil fuels. But even with a carbon tax, the gap between coal and gas or oil is sufficient that the world will still use its abundant coal resource. Even if one believes we will ultimately live in a 'hydrogen economy', the world will still mine a lot of coal on the way there.

Clean coal technology

Many industry analysts agree that coal still has a bright future. With the world price of oil slowly firming, the energy industry is once again attracting more attention. The US Congress is considering an energy policy; drilling in Alaska's Arctic National Wildlife Refuge (ANWR) is being debated. To address coal's future, President George W. Bush is again focusing on his campaign promise to spend up to US$ 2 billion on clean coal technology (CCT). Since coming to office, several CCT projects are now underway, funded by the first US$ 95 million program. Recently, the US government announced a call for more proposals, and the industry can expect another US$ 330 million this year. Proposals are due by August 2002, with awards to be made by the end of the year.

The focus to date for CCT has been on cleaning coal to improve quality (reducing sulphur and ash), cleaner combustion, and/or scrubbing of coal to reduce emissions. However, 'waste' is still an issue, and the thinking is changing to include mining equipment that also produces cleaner ROM coal. As the US Congress has debated and proposed changes in legislation, investment tax credits for CCT will include qualifying mining equipment and technology. Producing a cleaner ROM coal is part of the CCT initiative.

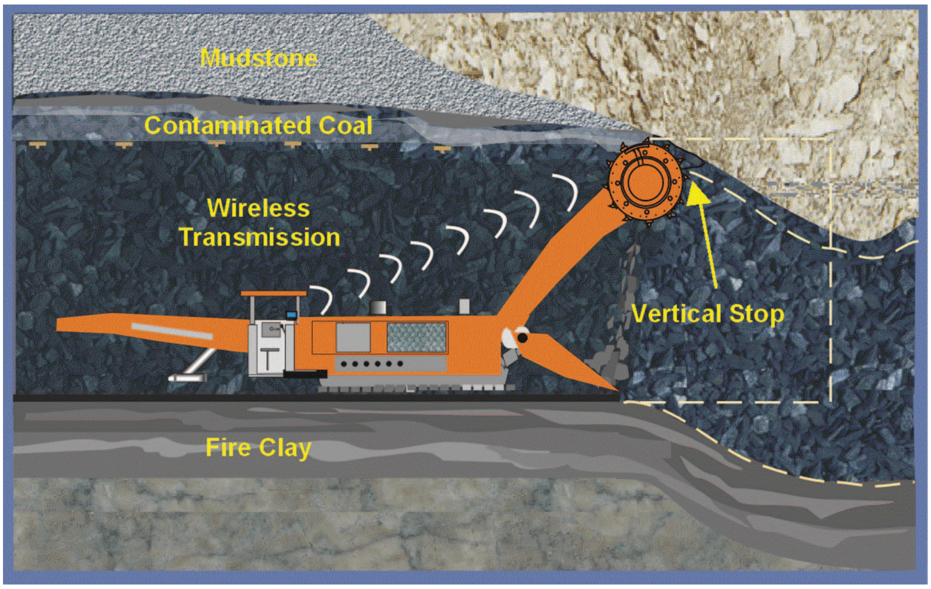

Figure 2. Selective mining with drum-mounted horizon sensing.

Additionally, in an effort to support their local coal industries, US states with higher-sulphur coal reserves have set aside significant funding for CCT programs. Illinois and Ohio are two states allocating over US$ 2 billion for CCT programs.

The Illinois program is of particular interest for coal mining and equipment companies. Administered by Southern Illinois University (SIU), this state program recognises that CCT can and should include mining equipment. A specific program is being funded to demonstrate the value of selective mining to increase the quality of ROM coal.

CCT for selective mining

The process of selective mining is not new to the industry; there is general agreement that the practice exists, and there should be more of it. Selective mining starts with a good understanding of geology and the need for horizon sensing.

Geology

It is a universal truth that the quality of a product is a direct function of the quality of its ingredients; a five-star restaurant seeks the highest quality food.

In mining, the basic ingredient is the coal from the seam, and as the mining industry knows, coal seams are not consistent and homogeneous. Along with the coal or carbon we get moisture, ash, volatile matter, sulphur and heavy metals. Figure 1 illustrates how the quality of coal can vary within the seam. In the US, many seams have higher concentrations of sulphur and ash in bands closest to the roof. Other seams have a contaminated layer on the floor boundary. The analysis shows that mining 'rock-to-rock' and extracting the entire seam produces the ROM quality illustrated in the figure. If this seam were to be cut selectively by leaving behind the upper band of coal, the ROM quality improves dramatically, with sulphur cut in half and ash reduced by 2%.

In many mines there are minimum mining heights, which require the operation to mine both roof and bottom rock or clays. In such operations, the yields are low, affecting mining economics as well as creating considerable waste in the ROM coal, which must be processed. Even in rock-to-rock operations, using technology to ensure the minimum height is achieved and held contributes to quality improvement. Minimising waste to improve yield improves ROM coal quality.

Horizon sensing

For many years, horizon sensing has been a technical capability for which industry leaders have been searching. With the advent of remote-control mining and automation, where the operators are removed from the face and cannot see the horizon, a search for detection technology began. A recent technology roadmapping event conducted by the National Mining Association and the US Department of Energy Office of Industrial Technologies identified the technology needs of the mine of the future. It was identified that horizon sensing is one of the top critical

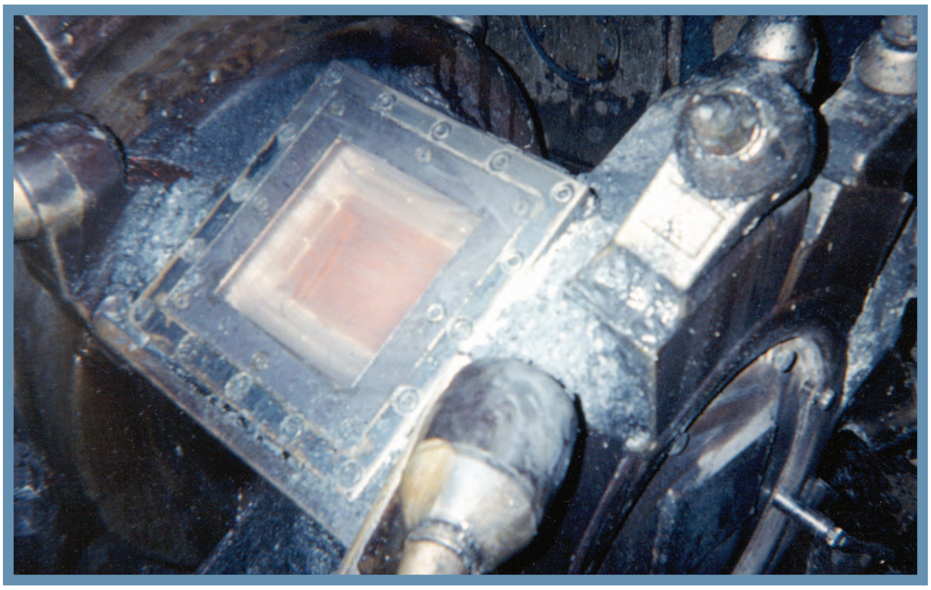

Figure 3. Horizon-sensor electronics mounted on cutting drum.

technologies needed for agile mining machines that will operate in deeper, thinner and more geologically complex reserves.

In South Africa and Australia, there has long been recognition that horizon sensing is a crucial technology. Industry groups in both countries have supported R&D projects to develop horizon-sensing technology. The basic concept of mounting and using a horizon sensor on a continuous miner or longwall shearer is shown in Figure 2.

Mounted on the cutter head, the sensor enables the operator to remotely (and accurately) detect the coal seam horizons and head position. This capability will enable selective mining to follow the coal seam as it undulates, and to avoid cutting excess rock or coal zones, which have lower quality coal.

Horizon sensing has moved from the concept stage to commercial operation, and in January of this year, the first commercial horizon-sensing unit (the HS-3) was mounted on a Joy 12CM at the Monterey Mine 1# in Illinois, US (Figure 3).

The HS-3, which has a resonant patch antenna mounted directly on the cutter drum, instantaneously measures bottom/floor coal thickness. The electronic measuring package is also mounted on the drum surface and contains a digital signal processor (DSP). A wireless RF modem transmits the detection data to a remote graphical user interface (GUI) that is mounted on the mining machine. The HS-3 also has an electric generator mounted within the cutter drum to produce the required electric power for the horizon sensor. An inclinometer is mounted on the cutter drum to identify the cutter-head position at all times. This enables the total mining height to be determined when the machine is mining out-of-seam.

Watching a display on the GUI, the CM operator's primary objective is to use the HS-3 to selectively mine the seam to reduce mine waste and improve production yield. The coal in Illinois is known for low yields (65 - 70%) and higher sulphur content (< 2%). Recognising these factors, the State of Illinois is funding an innovative CCT mining project to support the mounting of two HS-3s on the longwall shearer at Monterey. Stolar Horizon, the manufacturer of the HS-3, and Monterey Coal are partnering under the SIU direction to confirm that the HS-3 is an enabling technology for selective mining, which can contribute to cleaner ROM coal in the Illinois Basin.

The focus of this CCT effort will be the reduction of ash and sulphur found in the upper bands and possibly bottom coal. As is known, the pyretic but not organic sulphurs can be washed out of coal. In the bands of the coal seam where the organic sulphur is found, the mine operation can leave this pollutant behind.

Additionally, the selective mining process, coupled with an accurate fixed mining height when required, should reduce mine waste and ash content of ROM coal. When the sensor is mounted on the shearer drum, the sensor will enable the accurate cutting of roof coal to minimise the potential for rock fall (guttering) prior to the advance of the roof supports. This will have an immediate impact on mining by reducing out-of-seam dilution and improving yield.

Finally, and while not fully confirmed, in some instances, leaving rock and ash behind could allow coal companies to reduce heavy metals production such as mercury. With pending regulation, if selective mining could reduce this pollutant, this would add considerable value. The Illinois CCT program will address the validity of such a benefit.

The economic benefits

The good news here is that this new approach to addressing environmental issues should not be a net cost to operations, as is usually the case. Environmentalists argue that society pays for not addressing pollution in the form of health costs. However, deploying horizon-sensor technology appears to be one of those rare situations where there is a net economic benefit for everyone concerned.

At this year's Society for Mining, Metallurgy and Exploration (SME) Annual Meeting held in February in Arizona, US, Stolar Horizon presented a technical paper addressing the concept of selective mining and its economic benefits. There are three areas of cost reduction with improvement in ROM quality: in the mine, at the preparation plant and at the power plant or coke oven.

Lower mining costs

A key factor in the strategy of achieving improved coal quality is selective mining. Two key elements of selective mining are:

- Cutting less roof and bottom rock to reduce waste.
- Leaving behind the sections of the coal seams near the roof or bottom that have higher concentrations of ash (and sulphur).

Cutting less rock will have the immediate cost benefit of improving ROM quality and yield. This can be achieved on the CM sections as well as the longwalls. Case studies show that in the US, yield improvement will reduce mining costs by up to US$ 1/t. It stands to reason that if a mine maintains its tonnage output, and if more of the output is saleable coal, there is more coal to amortise the fixed cost over reducing unit cost.

Other areas of potential cost savings include longer bit life with less cutting of rock, and better bottom and roof conditions, enabling increased productivity. Many mines have clay or mudstone bottoms. Leaving a thin layer of bottom coal will isolate the mud bottom, and better roof conditions can potentially improve safety. On addition, remote mining aids in keeping operators away from dust and noise.

Lower preparation costs

The economic benefit of receiving cleaner ROM coal at the coal washing plant falls into three categories. Firstly, having less waste in the ROM coal can effectively increase the preparation plant's capacity. Since plants have a fixed throughput, ROM with less waste means that a higher percentage of coal will be processed, lowering the fixed cost component of the cost.

Secondly, with less rock and waste, variable costs should fall because usually a lower amount of chemicals will be needed. For example, the specific gravity is higher in the coal bands which have higher ash content. ROM coal with a lower specific gravity will require fewer supplies for floating and separation. Additionally, long-term maintenance costs should be lower with less rock entering the plant.

Last, but not necessarily least, is the fact that the waste disposal problem is reduced. The settling pond will have an extended life. Waste and ash disposal is a cost that has been increasing and can represent a serious liability. It can also present a hidden liability long-term if not properly addressed.

Case studies, as presented at the SME meeting, show a benefit of US$ 0.25 - 0.50/t. With increasing concern regarding water impoundments, Stolar Horizon notes that the cost of disposal might increase in the future, thus making the benefit of leaving waste behind all the more valuable.

Lower cost of generation

In cases where ROM coal is not washed and shipped directly to a coal-fired power plant, improving quality will have direct economic benefits. A cleaner coal that has an improved heat content in most cases enables the plant to improve its heat rate, and if the coal's quality is more consistent, plant operators are able to better control the plant for efficient operations.

At the power plant, coal with lower ash content can be a benefit. In some situations coal companies are taking fly ash back from the plant because of disposal costs. It should be noted, however, that some plants sell fly ash as an economical byproduct, so these plants will not value an ash reduction. But generally, the cost of dealing with ash is something plant operators want to avoid.

An obvious benefit of selective mining at the plant is the reduction of sulphur, and if it is confirmed in the CCT Illinois program, the reduction of mercury. For sulphur, the economic benefit can be quantified in large part through the SO_2 credit system. Whether the power plant or the coal company captures this value, the point is that there is value. On a cost-of-coal basis, analysis indicates a potential of US$ 0.50 - 1/t of additional benefit to power plants.

Conclusion

Increasing ROM coal quality and lowering costs are realistic objectives of the coal industry. Horizon sensing is a technical reality and a tool that can contribute to both objectives. While still in the early stages of adoption, considerable interest is being shown for deploying this technology to aid in automation and selective mining.