Burning PRB coal: Problems and solutions

The preceding article discussed the major modifications made to a unit's coal delivery system and pulverizers to reduce its fuel costs and pollutant emissions. But many plants that burn PRB coal have smaller problems with the fuel that can be solved at a lower cost.

Following are three case studies of plants that have found a way either to minimize PRB coal dust or to improve coal blending.

Minimizing PRB coal dust

One of the big challenges to the safe handling of Powder River Basin (PRB) coal is the fuel's high concentration of fine particulates. The presence of these particulates, combined with PRB coal's high (20% to 30%) moisture content, raises the risk of spontaneous combustion. Accordingly, plant operations play a major role in the safe handling of PRB coal.

Particular attention must be paid to cleaning because the buildup of dust on the walls of bunkers and silos and along conveyors and transfer points poses safety problems. However, even fanatical cleaning is no substitute for a well-designed and -operated plant dust collection system.

Dust collection has been a problem at the Wyodak Power Plant (WPP), seven miles east of Gillette, Wyoming (Figure 1), ever since the mine-mouth plant—which burns 6,000 tons of low-sulfur, subbituminous PRB coal daily—was commissioned in 1978. The 335-MW plant is considered environmentally advanced because it has some of the lowest-consumption water systems in the industry and air emissions that are consistently below regulatory standards. PacificCorp, a subsidiary of ScottishPower, owns 80% of the plant and Black Hills Power owns the rest. PacifiCorp oversees plant operations.

Recurring problems. Specifically, Wyodak's operators had experienced chronic problems with the plant's T4 dust collector. They included clogging, bags coming off, and failure of the screw conveyor. Plant managers considered replacing the unit but decided not to because they realized that O&M costs for a new unit—even if worked properly—would likely be just as high. This realization prompted the decision to try another method of passive dust control—one that would eliminate the need for collectors and ultimately reduce O&M costs.

In 2003, Wyodak issued a request for proposals to provide dust control systems for four conveyor passages, for the one dust collector at the "G" end of the conveyor system, and for the station service dust collector at the "J" end. After a competitive bidding process, PacifiCorp chose Air Control Science Inc. (ACS) of Boulder, Colo., to perform the work.

ACS proposed modifying WPP's existing loading chutes, replacing and upgrading existing transfer point chutes and skirting systems, replacing and upgrading existing belt support systems, and sealing up head chutes as needed to reduce induced airflows. The objective of the last step was to maintain existing material flow while minimizing load zone material spillage.

To optimize the design of the chutes and transfer points, ACS engineers verified the chutes' airflow calculations using a proprietary program called Dust Analyst. They then used discrete element modeling to create a three-dimensional wireframe representation of existing chute conditions, including coal flow. After the 3-D simulation was verified against observed plant conditions and modified to improve the flow of coal, the wireframe model was converted to fabrication drawings. The same process was used to produce drawings for the skirt enclosures, tail box, and belt support systems.

It was hoped that the new conveyor transfer points would contain coal dust by reducing air movement within enclosures, eliminating spillage, and minimizing coal "carryback." And it also was hoped that by centering the loads on the existing belts operating near their design speed,

1. Now, the only dusting is of snow. A view from Wyodak's coal silo facing northeast. The large horizontal structure at left in the foreground is the plant's air-cooled condenser. Wyodak's main coal supply belts (H1 and H2) run up from the bottom through the center of the photo. *Courtesy: Wyodak Power Plant* the modern chute design would help to reduce wear and tear on the belts and chute components (Figures 2 and 3).

Results speak volumes. ACS' modifications and installations at Wyodak began in November 2003 and finished on schedule in March 2004. Today, Wyodak is working with the Wyoming Department of Environmental Quality to achieve a Best Available Control Technology (BACT) designation for the system and approval to decommission the remaining two troublesome dust collectors. Both are expected soon.

Meanwhile, fugitive PRB coal dust in and around WPP has been greatly reduced. That is clear not only from the cleaner appearance of equipment but also from the fact that the plant now requires half as many washdowns as before, and they are usually smaller in scope. The amount of maintenance required for plant equipment has declined as well. Finally, post-project readings show significant reductions in dust levels (Table 1).

An unexpected benefit of the work has been the reduction of noise. For example, where operation of the plant's Reddler Deck belts at the "J" end of the system used

2. One of the new pieces. The upgrades to Wyodak's fuel handling system included new liners, skirtwalls, supports, covers, and risers for the G1 to H1 transfer and tail section. *Courtesy: Wyodak Power Plant*

to generate an average 114 dB, now the belts put out only 102 dB, on average.

Improved blending of western coals

Because coals are solids, blending them uniformly is more difficult than blending liquids. In September 2000, that became evident at Colorado Springs Utilities' downtown Martin Drake Power Plant when it switched from "Colowyo" coal (with a

3. Space-age design. Discrete element modeling was used to modify the J3 and J4 recirculation chamber of the Wyodak Power Plant. Because it can more accurately predict material behavior and facilitate center loading of belts, the technique leads to longer chute life and reductions in dust, belt wear, and noise. *Courtesy: Wyodak Power Plant*

heating value of 10,450 Btu) to coal from the Foidel Creek mine (with a heating value of 11,250 Btu). The plant—which has three units rated at 51 MW, 80 MW, and 141 MW—burns about one million tons of blended coal annually.

In November 1999 the Drake plant began experimenting with mixing PRB coal and Foidel Creek coal in all three units. The mixing was done right on the coal piles; for each load of PRB coal they pushed into the hopper, rubber-tired bulldozers pushed in three loads of Foidel Creek coal.

However, the mixing of the coals produced load swings on all three generating units due to stratification in the coal bunkers. Because the bunkers are not "mass flow," the coals would "rathole" as they fed into the pulverizers. The result was a very uneven flow of nonblended fuel, in pockets. Even worse, the heat content of the pockets differed, making control of the three units difficult.

Having experienced enough of these problems, in July 2000, Colorado Springs Utilities (CSU) hired Denver-based Merrick & Company to conduct an engineering study to determine the best way to achieve a consistent blend of the two coals. It was hoped that better blending would not only eliminate the load swings but also lower the plant's fuel costs (by maximizing the amount of PRB coal burned) and reduce its ash production and air emissions. A reduction in ash production was an important goal; Martin Drake's managers determined that the plant could not burn PRB coal exclusively because ash has to be transported more than 20 miles to a landfill, after being watered to minimize the formation and escape of dust during the trip.

Table 1. Dust levels between Wyodak Power Plant's G and H conveyors with the No. 2 belt running. All data represent samples over 10-second average intervals. *Source: Wyodak Power Plant*

	Plant location	Pre-modification (mg/cubic meter)	Post-modification (mg/cubic meter)
Tail pulley	North	1.12 (average)	0.457 (average)
	North	0.903 (min)	0.182 (min)
	North	1.36 (max)	0.882 (max)
End of load zone	South	0.953 (average)	0.526 (average)
	South	0.725 (min)	0.225 (min)

The Merrick study presented CSU with four options:

- Add a new at-grade hopper, a weigh belt feeder, and a blending conveyor that would discharge into the crusher house chutework.
- Add a new at-grade hopper and a blending conveyor that would discharge onto the existing, 30-inch reclaim conveyor.
- Add a PRB coal storage silo and a live-bottom belt feeder that would discharge to the PRB blending conveyor of option 1 or 2.
- Tap the existing, 72-inch stackout conveyor and add a conveyor to a dedicated PRB stackout area above the new hopper of option 1 or 2.

After reviewing the options and their costs and impacts, the Drake plant's managers decided to go with Option 2: building a 30-inch blending conveyor and having it discharge onto the existing reclaim conveyor. The new conveyor—a "Stealth" air-supported unit from Martin Engineering (Neponset, Ill.)—would be fed by a drag-chain feeder from McLanahan Corp. (Hollidaysburg, Pa.). The design, engineering, and construction management parts of the project were awarded to Roberts and Schaefer Co. of Salt Lake City, Utah. Construction began in 2002.

Meanwhile, CSU decided to replace the crushers and crusher house chutework at Martin Drake while the blending conveyor was being built. A temporary conveyor and crusher were used so that the reclaim conveyor equipment could be taken out of service during the construction work. The original crushers were replaced by new, 120% capacity units from Pennsylvania Crusher Corp. (Broomall, Pa.), and the existing chutework was replaced with new material using one-half-inch-thick overlay plate. A new coal-sampling system from Thermo Ramsey (a subsidiary of Thermo Electron Corp., based in Gormley, Ont.) replaced the original system. After Merrick added new belt scales to the existing 30-inch reclaim conveyor and the blending belt, the new equipment went into service in December 2002. The entire reclaim system is controlled by an Allen-Bradley programmable logic controller (PLC) with a PanelView 1000 screen.

Now, the Foidel Creek and PRB coals are segregated into two coal piles. The former is fed through the existing 30-inch reclaim conveyor, while the PRB coal is fed through the drag-chain feeder and onto the new blending conveyor. The blending conveyor discharges the PRB coal onto the Foidel Creek coal about halfway up the reclaim conveyor. The reclaim belt then discharges both coals into either one of the crushers. From there, the coal is conveyed into Martin Drake's coal bunkers.

The blending percentages are controlled by the PLC. Two of the three generating units typically burn 40% PRB coal and 60% Foidel Creek coal, while the other fires a 20/80 blend. If a change in the blend as small as 1% is needed, an operator can use the PLC screen to make it. The PLC, which gets coal feed rate information from the belt scales, adjusts feeder speeds automatically to maintain the selected blend percentage. Blends are normally within 1% of the setpoint on the PanelView screen. The belt scales are calibrated on a monthly basis to ensure their accuracy. Daily coal burn tonnages are fed via a process instrumentation system to the plant's control room.

So far, the reliability of the new system has been excellent. Gone are the load swings caused by an inconsistent fuel supply. Now, the plant controls the blend—rather than the other way around.

Minimizing the risks of burning coal

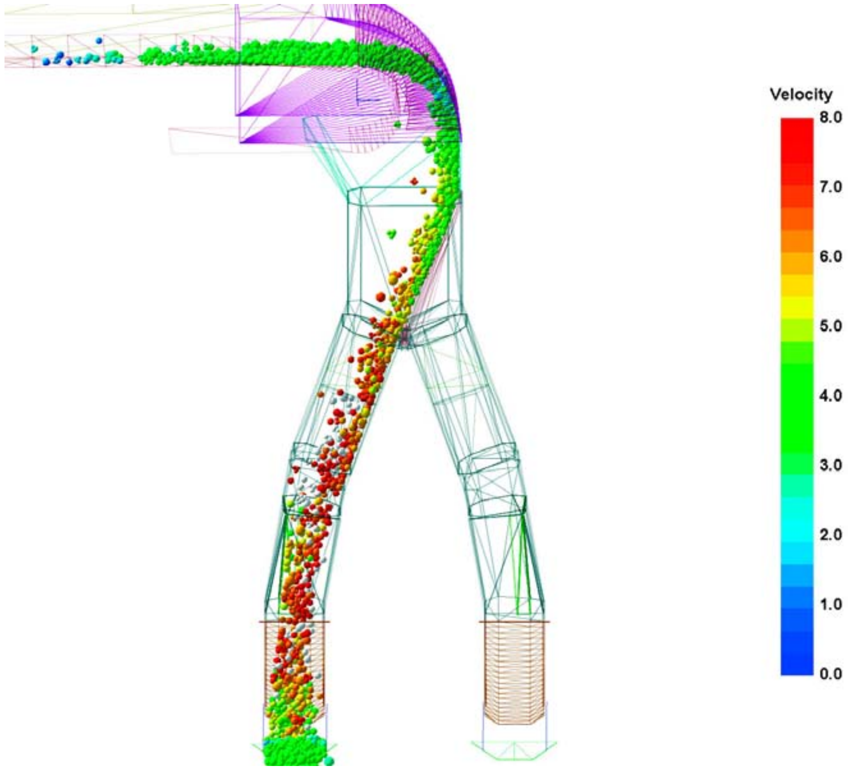
Keeping PRB coal and fugitive dust from it under control is difficult even at small power stations. As you might imagine, over the past 30 years that task has consumed an inordinate amount of resources at Ontario Power Generation's generating facility in the city of Nanticoke; with eight 500-MW coal-fired units, it is the largest power plant in North America.

In recent years, the Nanticoke Generating Station has relied on a comprehensive and integrated program designed by Benetech Inc. (Montgomery, Ill.) to successfully reduce the plant's operating risks. Among the objectives of the program are:

- Increased system reliability.
- Reduced PRB dust emissions and coal spillage.
- Improved safety.
- Reduced O&M costs.

4. Advanced transfer chute hood. According to Benetech, its "Reach" transfer chute is less costly to maintain. *Courtesy: Benetech Inc.*

5. Super model. The Reach transfer chute was designed using discrete element modeling to simulate its flow properties. *Courtesy: Benetech Inc.*



A key part of the program is Benetech's "Total Dust Management" approach, which combines technology deployment, sound engineering, consulting, and maintenance. According to David Liu, Nanticoke's material handling maintenance manager, "Benetech has worked closely with [us] for a number of years to support our needs. We have tried other companies and are pleased with both the level and diversity of support and service provided by Benetech."

Technologies deployed at Nanticoke by Benetech include chemical dust suppression systems, advanced transfer chutes, and washdown systems. Benetech's residual dust suppression systems provide dust control during stackout and long-term control of coal pile dust. Foam suppression technology is used ahead of crushers and at crusher outlets to effectively control dust and to minimize the need to add moisture during reclaim.

Benetech's "Reach" transfer chutes (Figures 4 and 5) have improved the Nanticoke station's coal flow and greatly reduced coal spillage and dust emissions. During the chutes' design and engineering, animated discrete element modeling (DEM) was used to simulate their flow properties so their performance could be compared with that of existing chutes prior to fabrication and installation. Two other benefits of the Reach chutes' design are improved maintenance access and reduced overall maintenance costs. Based on the success of the first chutes installed at Nanticoke, Benetech is currently installing five additional and even more advanced chutes at the plant. They too were designed using DEM and uniquely feature three-position curved surface elements that enable each chute to smoothly handle three different scenarios of coal flowing from two belts.

At Nanticoke, Benetech also has provided new washdown systems at both stacker units to remove dust and minor spillage. In addition, a Benetech-designed portable washdown system cart is being used at various locations throughout the station to introduce surfactant into the hose station water supply. The cart has reduced dust kickup during washdown and significantly reduced the consumption of washdown water. ■

—Edited by ***John Javetski***