Situation

Wet coal is sticky coal. Surface moisture binds coal together, agglomerating it into masses large enough to plug chutes, feeders and silos. These obstructions must be cleared to maintain production. Failure to address wet coal problems can lead to extended downtime, equipment degradation or even injuries.

The severity of a wet coal problem dictates the methods used to keep coal flowing. Some facilities can maintain flow using bulldozers to blend wet with dry coal. Some derate the plant, producing less power, but preventing complete shutdown by moving coal at a lower rate. Others resort to brute force, sending operators into the coal transfer systems to manually clear obstructions as they form.

Problem

Surface moisture causes wet coal problems. Rain is the most obvious source of surface moisture, but plants must also deal with moisture from other sources, like rail cars that have traveled through storms on their journey from the Powder River Basin (PRB) to the plant or barges that have taken on water before unloading. Regardless of how the moisture gets on the coal, its presence limits the amount of dry coal available for loading into the silos to fuel the facility.

Wet coal events are costly. A prolonged rain event coupled with wet coal in rail cars or barges can create a situation where neither the coal on site nor the coal being delivered is usable. Demurrage on the railcars, additional maintenance cleanup and manpower costs, and de-rates on the unit combine to increase unit operational costs.

Clearing obstructions in coal handling equipment is hot, dirty, hazardous, time-consuming, manual work. No one wants to be down in a coal bunker or chute with a pick axe or a shovel, trying to clear out wet coal.

The physical properties of coal make it a particularly difficult material to work with. Wet coal creates the conditions necessary for spontaneous combustion, a serious safety hazard if it occurs within the coal handling system.

<table>
<thead>
<tr>
<th>Customer Impact</th>
<th>eROI</th>
<th>Economic Results</th>
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<tbody>
<tr>
<td>Reduced Labor</td>
<td></td>
<td>512 manhours per day</td>
</tr>
<tr>
<td>Reduced clean-up costs</td>
<td></td>
<td>$100,000/year</td>
</tr>
<tr>
<td>Equipment Repair</td>
<td></td>
<td>$1,000,000 per event</td>
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<tr>
<td>Increased Generation (reliability)</td>
<td></td>
<td>1,800 MW in regained generation capacity</td>
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Spontaneous combustion occurs because coal can self-heat. The rate of reaction increases if the heat generated by oxidation cannot dissipate. For every 10°C in temperature rise, the rate of reaction doubles.

This explains why spontaneous combustion occurs inside coal piles rather than on the surface. Coal on the surface is exposed to the atmosphere, which means heat generated by oxidation dissipates. Heat generated by oxidation within the coal pile can’t dissipate as readily and, as the coal self-heats, the oxidation reaction speeds up, increasing the potential for combustion. Coal combustion in a pulverizer or other areas of the coal transfer system creates a very hazardous situation.

At this large, coal-fired plant, wet coal presented a major impediment to reliable, full-load operation. Coal started to stick and obstructions form at about 8% moisture. Often, coal arrived at the plant with high surface moisture content and, during a rain event, efforts to blend wet with dry coal to were effective for only limited amounts of time. Eventually, the plant would derate to maintain as much production as possible for as long as possible.

Solution

RAMSorb is a patented, dry, granular super-absorbent polymer reagent (SAP) designed to absorb surface moisture from wet coal. The product interacts with surface moisture, forming a lubricating gel that allows the coal to flow readily. The material, applied at a single source in the coal handling process, has the capacity to absorb up to 200 times its weight in water.

Super absorbent technology has been used for over fifteen years in power generation and industrial applications to prevent wet coal problems. This field evaluation was conducted on one of the plant’s four units during the coal reclaim process. The goal: assess its performance under the most difficult of operational conditions.

Field Evaluation

For most power plants, wet coal flow problems are intermittent and occur for short — and unpredictable — periods of time. Most facilities experience about two weeks of wet coal handling problems annually. Rather than wait for a rain event, the plant engineering staff agreed to intentionally create the worst conditions possible for coal handling. Using bulldozers to mix the coal and the plant’s water trucks and dust suppression system to add moisture, they created a serious rain event by adding a tremendous amount of water to the active storage piles. At the time of the trial, the moisture content of the coal reached 42%, higher than the plant had ever experienced during an actual rain event and the highest moisture content at which the coal handling system could move material. Wetter coal would simply slide down the belts. The plant could not move coal at higher than 10% moisture content, so these conditions were truly a worst-case scenario.

Application of the Super Absorbent Polymer

Controlled application of the dry, super-absorbent material relied on two pieces of equipment: the surface moisture monitor from NDC and pneumatic conveying feed equipment from Nol-Tec Systems.

The surface moisture monitor allowed accurate metering of
the material onto the belt based on the surface moisture of the coal. As surface moisture varied, the application rate varied directly, continuously optimizing dosage.

Pneumatic conveyance is the most reliable and consistent way to keep a material like this dry and transport it from the storage vessel to the application point and tightly control the application rate. Its accuracy and precision can reduce product usage by 10-15% over mechanical conveying systems. The conveying system used in this trial — a trailer-mounted unit — was designed and built by Nol-Tec Systems, Inc.

**Results**

The results of the trial were very positive. Coal flowed normally throughout the period of the trial and those who would have detected a problem — the operators in the control room — detected no change in operation, even at 42% surface moisture content.

Safety: Manually clearing plugged chutes, crushers and transfer points presents risk of eye injuries, pinch points, back strains and injuries from trips and slips. Eliminating the wet coal flow problems eliminated the need to send people into the coal handling equipment to clear obstructions, eliminating the risk of injury and potential for near misses.

Eliminating wet coal sticking issues in storage silos reduces the potential for spontaneous combustion and TPE (temporary pressure exceedance) incidents, both of which present risk to people and equipment.

**Manpower:** Keeping a power plant at full load during a wet coal event is time-consuming. At this facility, to take 45-90 minutes to clear one transfer area, crusher or chute. It takes about three hours for the problem to recur after clearance.

4 units x 7 transfer points x 8 times/day = 224 manhours/day to clear transfer areas/crushers/chutes.

Wet coal continues to cause problems even after it’s passed through the transfer system. Wet coal in a silo or pulverizer/feeder can plug and must be cleared.

4 units x 9 silos per unit x 8 times/day = 288 manhours/day to clear feeders and silos

**Cleanup Costs:** Vacuum trucks, extra contractors, and the cost of wasted coal represent additional costs. At this plant, those costs were estimated between $20,000 and $200,000 based on the length and severity of the rain event.

Equipment repair/replacement: As noted above, wet coal plugging and packing creates the conditions necessary for spontaneous combustion, fires and explosions. Although less common than the other problems associated with wet coal, the costs are higher. At this facility, the cost to repair ductwork and feeders could range from $1 million to $10 million per event.

**Derates:** Derates generally represent the highest direct costs associated with wet coal flow problems. To allow time to clear plugged chutes, the plant would have had to have slowed production, transferring fuel using only the cleared chutes. This plant estimated each unit would have to derates over half of its output during a serious rain event.

4 units x 900 MW each = 3600MW

3600MW/2 = 1800 MW loss due to wet coal

Not every wet coal event results in a MW loss of this magnitude, but every derate prevented protects revenue generated by the plant and costs avoided.

**Accountability/Reliability/Consistency:** Reliability and availability are key power plant metrics. Plant management commented
after the trial that high reliability while dealing with severe weather is very positive for customers and good for community relations.

During the trial, Generation did not see any change in their operating parameters. The amperage on the pulverizers did not change. The louvers on the hot air vents to the blowers on the feeders did not change.

**Conclusion**

Every power company wants to be a good corporate citizen of the community in which it operates and a safe place for employees to work. They also want to provide low-cost, reliable power under even the most challenging conditions. Nalco RAMsorb 9922 helps power plants safely maintain peak production during severe weather events and under very difficult operating conditions. Before this program was adopted, plant production would slow to allow operators to enter confined spaces and clear chutes and transfer points obstructed with masses of wet coal. Today, the plant can operate at full load under those conditions, maximizing revenue, meeting power generation commitments and minimizing the risk of injury.

¹The plant's nameplate capacity is 3,600 MW. Each unit is 900 MW.

²Moisture content was verified by weighing samples sent to the on-site lab and use of a near-infrared surface moisture analyzer from NDC.