Pumps in Power Generation

Top: Freighter Unloading to Coal Pile
Bottom: Transfer Belt Area Sump

New Solutions for Solving Coal Handling Pumping Problems

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Positive displacement technology helps solve maintenance headaches at a power plant.

A large amount of fuel is needed to generate 2,100 megawatts of power. A boiler's appetite for coal is as relentless as a customer's demand for power. In the case of the power plant discussed in this article (corporate policy prevents name disclosure), the generating station provides enough electricity to serve 1.3 million people.

Those familiar coal piles (black mini-mountains) are the result of a constant, supply-and-consume process that requires substantial conveyor belt systems including dumping stations, transfer points, sloped belts and outside bulldozers.

Coal Pile Unloading

Millions of tons of coal arrive each year at the Midwestern plant, either by rail car or freighter, and must be unloaded. Rail cars are dumped, and the dumper infrastructure and belt systems are located about 80 feet below ground. This coal is conveyed over and up onto the coal piles via underground and sloped belts. Eventually, it is fed to the boilers again through a conveyor belt system. Coal from freighters is offloaded to the coal pile and fed to the plants using the same conveyor systems.

Coal Handling Pump Problems

Two key factors cause problems when handling coal. First, coal sinks in water. Second, water collects in low spots. Combine this with a conveyor system, which operates below ground and has dust, fine particles and chunks falling from the belt. With nowhere to drain, water collects, and whatever is with it must be pumped up and out together. The conditions cause difficult pumping situations.

However, coal handling applications have ever-changing variables. Under upset conditions, solids can be dumped so quickly that they literally bury the pumps. Water flow is generally low and intermittent with variable sources such as rain, snow melt, groundwater seepage, automatic flush and dust suppression systems. In addition, operators manually wash down these areas to control dust and build-up. The sumps are often small and sized for lower flows. This dirty, dusty environment is, in most cases, rated as Class II, requiring explosion-proof motors and controls.

The net result is a variable, medium-to-low flow slurry application that is critical to plant operation. Flooding the conveyor equipment and stopping the flow of fuel are not options.

Typical Solutions and Limitations

The common approach is to use vertical and submersible slurry pumps, but this is often a poor matchup for the flow rates, solids concentrations and solids sizes involved in this type application.

One example is a 30-inch square sump with fines draining in at a normal rate of 10 gallons per minute. This is followed by 2-inch chunks pushed in with a pile of solids as an operator washes the area down with a 70-gallons-per-minute hose. The 10-gallons-per-minute inflow, which carries the quick-settling fines, can easily silt-in a typical centrifugal pump as it waits for a sump high-level indicator to activate it.

DI Area Test Sump

In addition, the 3-inch solids capacity (needed to pass the chunks) requires a much larger pump and higher flows to function properly. The small sump is drained in seconds, bumping the pump on and off too quickly, assuming that it was not silted-in during the low-flow conditions.

The final problem can come from the slug of solids pushed in all at once during the wash-down process, creating slurry too thick to be pumped.

All these factors can create excess maintenance, pump failure and expense. The financial costs involve:

- The labor to pull the pumps, clear the area and unplug the piping
- The erosive damage from abrasive solids
- Motor and seal failures from running dry

Coal Sump Issues Addressed

At the power plant, the maintenance supervisor for fuel handling is responsible for keeping the coal handling equipment up and running to feed the plant. Downtime is critical, and eliminating problems, as well as the maintenance that accompanies them, is essential to keeping the plant running at capacity.

The coal handling sumps at this plant were a continuous source of problems and expense for the supervisor's maintenance team.

Submersible and vertical centrifugal slurry pumps with grinders were used to handle the coal slurries. The average time between rebuilds and/or replacements was about six months. In addition, downtime due to plugging, silt-in issues, unintentional debris and float controls hanging up was substantial, requiring considerable labor.

"It was nothing to spend a whole shift just to get a pump to work," the supervisor noted.

A New Solution Using Different Technology

Tired of fighting the same problems with the same technology, about four years ago,

Non-Impeller Submersible Slurry Pumps

The Pitbull® pump design eliminates seals, impellers, diaphragms and internal components to reduce pump maintenance. Two check valves route large solids/liquids through full pipe-diameter passages at low velocities. CIPC manufactures a full line of these unique, air-operated pumps in flows from 5 to 1,500 gallons per minute. Submersible, transfer, self-priming and filterpress feed configurations/models are available in stainless, steel and FRP construction.

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Conveyor Upgrade Sumps

the supervisor looked for new solutions.

A local area pump and sealing specialist, Todd Sherwood of Dubric Packing and Seals, was aware of the supervisor's maintenance issues and suggested going in a new direction. He proposed using a different type of pump to address these maintenance issues. The supervisor took the risk of trying a new approach and selected a 3-inch submersible pump for one of the problem sumps. This test sump handled primarily coal fines, grit and ground run-off as is called the de-ionized (DI) water treatment equipment area pit.

This positive displacement (PD), air-operated pump used two check valves as the only wetted, moving parts. It is similar conceptually to a diaphragm or piston pump but without the diaphragm, piston or any sort of membrane. The design employed full pipe diameter passages and check valve ports to route fluid into and out of the pumping chamber.

Compressed air was used to directly push the surface of the fluid, eliminating the need for dynamic seals while allowing for a large stroke-to-volume ratio. This design kept cycles to a minimum for a given flow rate and the internal velocities low, reducing wear in abrasive slurries and difficult fluids.

When used in an application such as a coal handling sump, this PD pump is filled by vacuum. This allows the pump to operate in just a few inches of liquid, minimizing both the volume and the amount of time that solids have to settle out because the sump does not have to reach a high level for this pump to function.

Probably the most important difference under these conditions is that the PD pumping technology does not require the relationship of solids diameter to flow capacity and discharge head that centrifugal pumps need. This allows large diameter solids to pass through the pump at both low- and high-flow rates.

At this plant, the 2-inch chunks would be able to pass through the pump under the 10-gallons-per-minute, low-flow condition. Consistent with other air-operated pumps such as single and double diaphragm pumps, this PD pump had an extensive tolerance to solids concentrations. It also had the option of increasing discharge pressure to handle different slurry densities and discharge heads.

The Results

The results have been successful. "The original pump is still in service in the DI area sump and has been untouched these last four years," says the supervisor.

Given the prior six-month replacement/rebuild intervals the return on investment has been dramatic on the purchase costs alone. The eight-fold (and still growing) service life also reduces the overhead of spare parts inventory, purchasing and the substantial labor to switch out pumps.

Most beneficial for this supervisor has been the savings in manpower, allowing him to apply his personnel to other pressing problems.

Three years ago, after the initial success, he installed a second 3-inch PD pump in his transfer conveyor sump. This sump is next to the belt and receives solids, chunks and fines along with welding rods and other materials that find their way into the sump during wash-downs.

The transfer conveyor sump is considered a difficult application at the plant and required high maintenance. A long, convoluted discharge run further complicated problems and plugging. Again, the PD pumping technology was able to greatly reduce maintenance with the original pump still in place without rebuilding.

In the meantime, the crews have learned to take advantage of the new ability to handle solids and now stir the sump bottom after wash-downs to eliminate solids build up.

"Downtime was the issue," says the supervisor, "and that has been greatly reduced."

Based on the successes and savings in both manpower and repairs, this PD pumping technology was specified for an upgrade project on the plant's longest underground conveyors. The project included new dust suppression and wash-down systems resulting in higher flow requirements, and this time, larger 6-inch inlet by 4-inch discharge pumps were selected. These have been installed during 2010 and are performing up to expectations.

The supervisor stated that based on the field experiences at his plant, he would consider this pump technology first as the way to solve future difficult sump applications.

P&S

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