When passing stones is a good thing

A gypsum wallboard plant discovers severe-duty rotary valves that allow proper discharge of gypsum rocks and powder from its storage silos.

As some of us know from personal experience, passing stones can be a painful ordeal. The plant engineer at National Gypsum's Burlington, N.J., plant found that this was true not for anyone on his staff, but for the plant's storage silos. The plant had installed new heavy-duty rotary valves to discharge gypsum rocks and powder from the silos, but the valves would only operate for about 15 minutes before the rocks jammed and broke the valves. After that experience, the plant tried vibrating tube conveyors to discharge the gypsum, but in this case, it was the powder that was the problem. It flooded the conveyors, causing the line to shut down. By this time, the plant was discouraged by its two costly and vain efforts and wasn't sure it was going to find a solution to its stone-passing problem.

The gypsum's path

National Gypsum is a major manufacturer and supplier of building and construction products worldwide. Its Burlington plant manufactures wall-

The approximately 2-inch-diameter gypsum rocks and fine powder were destroying the plant's heavy-duty rotary valves.

board, used in commercial and residential construction. To make wallboard, the plant receives gypsum (technically known as calcium sulfate dihydrate) that's transported by ship from National Gypsum's Nova Scotia gypsum mines. Gypsum is a relatively lightweight white or gray mineral that's brittle and chalky. It consists of a network of needlelike crystals that provides strength when the material is made into wallboard.

The plant unloads the gypsum from the ship and conveys it into a crusher to break it down to a manageable size. The crushed rock is classified, and rocks approximately 2 inches in diameter and smaller — all the way down to fine powder — pass on to a rock-drying system. After leaving the dryer, the still-hot rock goes to one of two destinations: It can go directly to a mill where it's crushed to a powder before going to the wallboard-making process, or it can go into one of two 300-ton-capacity storage silos to be gravity-discharged as needed onto a belt conveyor that carries the material to the mill and then to the wallboard-making process. The plant installed the silos to keep the wallboard process going continuously, even when the dryer and other equipment are shut down for routine maintenance. When the silos aren't in use, the wallboard process must be shut down when the drying system is shut down.

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The new severe-duty rotary valves feed the gypsum from a storage silo to a belt conveyor.

The discharge problems

In 2004 and 2005, the US housing construction boom made a heavy demand on the gypsum wallboard industry, so it was important that the Burlington plant keep the wallboard-making process in continuous operation. Unfortunately, the rotary valves the plant was using to control the gypsum discharge from the silos were old and worn down. Replacement parts were no longer available, so the plant needed to replace the valves with new ones that could each discharge 50,000 pounds of gypsum per hour. The plant requested bids from several rotary valve manufacturers and selected heavy-duty 22-inch valves (with a 22-inch square inlet) with a conventional cast-iron body and end covers and a fabricated, open-bladed rotor with adjustable abrasion-resistant tips. The valves' cost was reasonable, and, the plant believed, the adjustable tips would ensure long wear. The plant installed the valves, two on each silo.

Unfortunately, when the plant put the valves online, it was immediately apparent that they weren't going to do the trick. When the gypsum rocks entered a valve, they filled the rotor pockets and jammed the valve. The valve's motor would continue to try to turn the rotor, which it couldn't do and would hit high amp and trip out.

The fine powder flooded the process, leading to more maintenance problems and downtime.

Operators increased both the horsepower in the rotary valve's drive motor and the drive sprocket size, but this only twisted the drive shaft, again causing shutdown. They adjusted the rotor tips to increase the clearance between the rotor and the housing, but now the finer powders would pass freely around the rotor tips, flooding the valve housing and the feeding process.

After many efforts to repair and modify the valves and many hours of downtime and attempts to make the valves operate properly, the plant realized that these valves couldn't do the job.

Still wanting to be able to run the wallboard production process continuously, the plant looked for another silo-discharge solution and came up with a vibratory tube conveyor. They knew the rocks wouldn't jam this conveyor. When they put this solution online, the rocks passed successfully, but the fine powder flooded the process, leading to more maintenance problems and downtime. Frustrated, the plant stopped using the silos and resorted to running the dryer and other upstream equipment continuously, ignoring the need for preventive maintenance.

A new solution

Then the plant hired a new plant manager. This fellow had come from a company that produces charcoal briquets, and that company used a severe-duty rotary valve that was very successful in passing various-sized charcoal stones and powder. The new manager thought that perhaps that valve would work at the Burlington plant.

Ironically, that valve had been in contention when the plant chose the heavy-duty valves that didn't work. The plant hadn't selected it because it didn't fit into the desired budget. And by now, the plant was convinced that no rotary valve would work in this application.

However, the plant manager contacted the valve supplier, who was certain the valve would work with the gypsum. The plant manager sent the supplier 500 pounds of gypsum in the form of rocks as big as 2 inches by 4 inches and 200-mesh fine powder. The supplier tested the gypsum in the severe-duty valve and experimented with different valve inlet configurations to make sure all sizes of the gypsum would pass through the valve with no problem. Once the supplier was satisfied with the customization, it contacted the Burlington plant manager and made an

The chain and sprocket that drive the valve's rotor are protected by an OSHA-yellow cover.

offer: "You let us put one of these valves in for sixty days, and if it doesn't work, you don't pay for it." The plant manager eagerly took up the offer.

The severe-duty valves

The 18-inch PERMA/flo Severe Duty "18 XL" rotary valve is supplied by Delta/Ducon, Malvern, Pa., a pneumatic conveying company and engineering firm that focuses mainly on abrasive products. The 400-pound valve has a cast-iron housing with a closed-end rotor cast of Ni-Hard, an extremely hard iron alloy (550 Brinnell hardness) with small percentages of nickel and chromium. Because the rotor is made of such hard material, no coatings are used, so the abrasion resistance never wears off.

In other rotary valves, the rotor typically is open on each end, allowing fine material to filter between the rotor ends and the housing, potentially causing jamming and abrasive wear. Also, the rotor vane tips are set with a fine clearance between them and the housing. This acts as a seal of sorts to prevent larger material from getting caught between the rotor tips and housing, but if the clearance isn't tight enough, it doesn't prevent powder from getting through. The supplier's severe-duty valve is set up differently. The rotor ends are closed, preventing the flooding possibility, and the inlet has an adjustable wear shoe that covers a pocket on each side of the rotor. This acts as a seal, allowing material to enter only the pockets that are exposed directly under the valve inlet.

In addition, the rotor has no contact with the valve housing; the only contact is with the adjustable shoe. As wear eventually occurs, the rotor and shoe can be adjusted to bring the clearance back to factory settings. This can be done in minutes from external set points.

"You should never have to buy another valve," says Ron Tempesta, the supplier's vice president. "It's just the shoe that will wear out after thousands of hours of use, so you might have to replace the shoe."

The valve's rotor is driven by a chain and sprocket, which are, in turn, driven by a variable-speed motor. This allows the plant to change the gypsum's discharge rate from the silos. "We want to control how fast the gypsum comes out of the silos," says Wayne Vetter, the Burlington plant engineer. "Instead of just an on-off option, when the stuff just sits in there if it's off, we want to try to match the use of our mills so that we have continuous material flow."

In addition, the drive has an automatic reversing sequence that activates if the system senses a jam or amperage spike.

The variable-speed drive is controlled by a PLC with an easy-to-operate control panel. The PLC collects usage data, which helps the plant maintain accurate inventory records of the material that passes through the silos.

The supplier customized the valve inlet to suit the gypsum application. After experimentation, it found that a V-shaped AR-steel breaker bar installed in the inlet would ensure passage of all stones of approximately 2 inches in diameter and somewhat larger. The breaker bar prevents rocks from jamming between the rotor and the wear shoe. "It's like a plow," says Tempesta. "Any rocks that hit dead-on center are sheared left or right by the breaker bar. It also helps break up bigger rocks as they impact the point of the V and the rocks above bear down pressure."

Success at last

The Burlington plant installed its first severe-duty rotary valve in early 2005. From the moment it was put online, it worked as planned. Larger rocks and fine powder discharged evenly with no jamming or flooding.

"We were really pleased," says Vetter. "The supplier was good to work with. This wasn't a standard application."

"We were happy with the severe-duty valves, and I know we're going to be even happier when we have both silos up and running and passing stones again."

The plant purchased three more of the severe-duty valves, so it has two for each silo. Two are currently installed, and the others will be installed when the plant is ready for them. After using the initial valve for a few weeks with no problems, the plant found that it needed to install a heated dust collection system on each silo to handle the hot dust from the dryer-heated rocks, so the silos are currently offline, waiting for that installation to take place.

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Note: To find other articles on this topic, look under "Valves" in *Powder and Bulk Engineering*'s comprehensive article index at www.powderbulk.com and in the December 2005 issue.

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