Case history

Seal of approval

A flame-retardant-additive producer replaces its rotary valves' leaky shaft packing with gas-purged solid-metal seals.

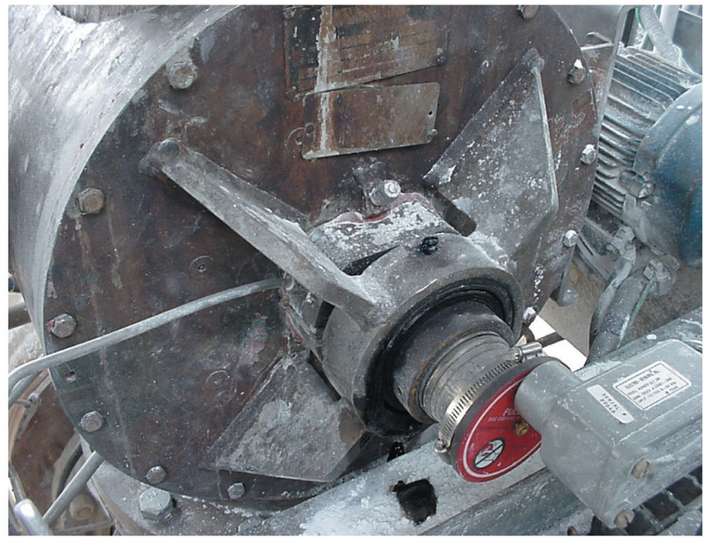
The Albemarle maintenance mechanics glared at the rotary valve metering the fluffy abrasive powder into a flash dryer on the floor below. The seal that had been repacked less than a week ago was leaking again. The mechanics would have to shut down the line and replace the valve with a standby, preventing them from meeting their production goal this day.

Albemarle Corp., Baton Rouge, La., supplies specialty chemicals and chemical intermediates to the plastics, agricultural, pharmaceutical, and other industries. The company's Magnolia, Ark., plant, started in 1969, produces bromine products and is just one of the company's 18 plants around the world. One of the plant's products is Saytex CP-2000, a bromine-based powder that's a flame retardant additive for the plastics industry. It's also the material that leaked from the rotary valves' housing.

Interrupting production

In producing the Saytex CP-2000, the Magnolia plant uses rotary valves to transfer the powder from overhead hoppers to dryers that remove moisture remaining from an earlier production stage. A rotary valve is comprised of a housing that contains a vaned rotor. The vanes form pockets for carrying material from the valve's inlet to its outlet. A shaft that passes through the valve housing turns the rotor. Packing or a seal must be used around the shaft where it enters the valve housing, or material may leak to the outside, wasting material and causing plant contamination problems.

Packing is available in many forms, but typically it's made by twisting fibers of materials such as asbestos, metal, rubber, cotton, and various plastics into coils or rings that are fitted around the shaft. To minimize wear, the packing generally requires some



Albemarle replaced leaky packing with a metal seal (immediately next to the valve housing).

sort of lubricant, which may be impregnated in the fibers or applied. The packing is contained in a stuffing box.

The company was using the standard white Teflon packing rings that came with the valves to seal the area between the shaft and the valve housing. However, the high operating temperatures in the Saytex CP-2000 process softened the Teflon, which ruined the seal and allowed powder to leak to the outside.

Maintenance mechanics would tighten the Teflon packing to stop the leak, but then the packing would extrude to the inside of the rotary valve and sometimes get into the material being processed. The mechanics would replace the packing, but within a week the leaks would begin again.

To replace the packing, the operators would have to shut down the production line for at least 1 hour and sometimes up to 4 hours. The mechanics would take out the rotary valve with the leaking packing and install a spare one with new packing so that production could start up again. Then they would replace the packing in the leaking valve so that it would be ready to use the next time packing gave out on the production line. Since the plant operates 24 hours a day to meet its production goals, the time involved in changing the packing hurt the company's bottom line.

Looking for a reliable seal

The company looked for another type of white packing that wouldn't discolor or contaminate the finished Saytex CP-2000 powder if the packing should extrude into the valve and that would maintain a consistent seal better than the Teflon, but Albemarle couldn't find an effective substitute that met the operating requirements.

Then, in mid-2001, Jason Bitting, senior mechanical excellence engineer at the Magnolia plant, talked with James McKinney, a sales rep for Sealing Devices Inc., Hot Springs, Ark., a company that distributes packing and seals for various industrial applications. McKinney had worked with many companies requiring various kinds of seals, and one of his best products was a bearing isolator for retaining oil or grease in pumps, steam turbines, and motors. The bearing isolator was manufactured by Inpro/Seal, Rock Island, Ill.

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McKinney was also familiar with the bearing isolator supplier's Air-Mizer powder containment seal, which is based on the same mechanical principles as the bearing isolator. The seal was originally designed for the machine-tool spindle industry for use on metal lathes, but McKinney had seen it adapted successfully for screw conveyors. He believed the seal would solve Albemarle's problem.

McKinney, Bitting, and others on Albemarle's maintenance engineering staff experimented with the seal. "We had to do quite a bit of modification to the seal and minor modifications to the rotary valve," says McKinney. The dimensions weren't compatible at first, so the engineers had to slightly modify the pieces to fit. The engineers also added a backplate, or flange, to completely surround the exposed part of the seal.

Additionally, the seal has a gas purge, and some experimentation was needed to get the purge pressure and the gas flowrate right. But once the modifications were made, the seal was easily applied to the rotary valves, "And they've been working great ever since," says McKinney.

Applying the seal

The seal used at Albemarle is made of hardened, corrosion-resistant electroless nickel plated bronze. It's also available in bronze and stainless steel. The seal itself is made primarily of metal, although there are some O-rings that seal against potential leak paths.

Because the seal is made from metal, there is no chance for the seal to extrude into the valve and contaminate the material passing through the rotary valve. Paul Bender, sales and marketing director for Inpro/Seal, states that "Teflon can cold-flow. If you put a two-inch cube of Teflon under load and then go back and measure it, it will no longer measure two inches. This effect is more pronounced at higher temperatures. The metal seal, on the other hand, is much more dimensionally stable."

The gas pressure prevents material from bridging across the labyrinth and either escaping or damaging the seal.

From the outside, the metal seal in its flange looks something like a weight on a barbell, like a flat disc mounted on the rotary valve's shaft. Inside, the seal has two parts — a stator, which is stationary, and a rotor, which fits inside the stator and turns with the rotary valve's shaft. There's a very small gap between the stator and the rotor. The gap is a labyrinth, a complex series of grooves in the adjacent edges of the stator and rotor that don't quite meet, creating a torturous path that inhibits powder from escaping.

However, because there *is* a gap, material could escape through the labyrinth if something didn't prevent it. This seal uses a positive gas purge to ensure that no contaminants and none of the material traveling through the rotary valve gets into the gap. A stainless steel tube running from the plant's nitrogen gas supply to the purge inlet directs the gas toward the rotary valve housing. The gas pressure prevents material from bridging across the labyrinth and either escaping or damaging the seal.

Some gas-purge seals use quite a bit of gas, which "is an expensive commodity," says Paul Bender. "However, this seal uses less than most similar products."

Sealing the deal

Albemarle maintenance mechanics installed the Air-Mizer seals, with Jim McKinney's help. After 6 months of continual use, no leaking has occurred. However, should a seal ever need replacing, the Albemarle mechanics can do it themselves. "It's easy," says Bender. "You just remove the old seal, bolt the new one in place, and hook up the gas hose."

The seals require no lubrication or routine maintenance, and they're expected to last indefinitely. "They're a noncontacting seal with no wearing parts. They should get years of service, unless, in an unlikely event, the company loses purge pressure. Then powder could migrate into a seal," says McKinney.

Albemarle is happy with the metal seals. "The new seals allow us to perform as needed at our required operating conditions," says Bitting. "They've saved us repair costs and reduced plant downtime. We no longer have to spend up to 4 hours several times a month changing rotary valves and replacing packing." He adds, "These seals should be a standard installation on all our rotary valves in the future to help meet cost and reliability standards, especially in our critical and tough powder environments."

PBE

Charlie Covington, Albemarle's complex maintenance coordinator (left), and Jason Bitting, senior mechanical excellence engineer, check the seal for leakage and find none.

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