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Case history

Seals sustain dryer's vacuum

A chemical producer installs mechanical seals on its horizontal rotary vacuum dryer to maintain vacuum and increase productivity.

A chemical manufacturer produces two chemical compound resins as abrasive pastes that have to be dried to powders. The pastes each contain a different solvent and are dried separately at different temperatures in the same horizontal rotary vacuum dryer. The company was having problems maintaining a tight seal around a shaft that runs through the dryer. Elastomeric shaft seals have components that are incompatible with both solvents, so the company was using packing glands. But these were unable to hold vacuum as the shaft heated and then cooled, resulting in excessively long drying times. In addition, the resins were migrating out of the dryer around the shaft, causing abrasion and product purity concerns. The packing failed frequently and was expensive to replace. The company knew that it needed to find cost-effective seals that would effectively hold the dryer's vacuum, thereby increasing productivity while eliminating abrasion.

A batch of problems

The resins are produced by Huntsman Advanced Materials, McIntosh, Ala.,

The 20-foot-long jacketed horizontal rotary dryer dries the two pastes using steam, which passes through a horizontal, hollow shaft rotating at 4 rpm.

a manufacturer of chemicals and specialty resins for the electronics, aerospace, and other industries. One resin, product A, starts as a mixture of solids, water, and solvent and is dried in the horizontal rotary vacuum dryer at more than 320°F, producing a fluffy powder. The other resin, product B, starts as a different mixture of solids, water, and solvent and is dried in the same dryer at more than 120°F, producing a packable powder.

The jacketed dryer, which the company operates 24 hours a day, 7 days a week, is 5 feet in diameter, 20 feet long, and operates at pressures from 14 psig to 20mm Hg vacuum. Drying temperatures are produced by steam that travels through a horizontal, hollow shaft that extends the length of the dryer and rotates at 4 rpm.

When the shaft is heated from room temperature to operating temperature, the shaft's diameter grows by up to ¼ inch. This compresses the packing. Then, when the shaft cools at the end of each batch cycle, the packing doesn't expand again, so space is left around the shaft, allowing air into the dryer and material to leak out. Maintenance crews were replacing the packing about every 3 months. And each time a packing gland was changed, production was down for at least one-half day. The amount of downtime and lost productivity were mounting concerns for the company.

"But our main concern was that we couldn't pull full vacuum," says Stacey Dunagan, Huntsman maintenance manager. "Because the glands didn't stay tight, the vacuum would suck air in from the outside, making cycle times excessively long. Basically we had to keep the vacuum as low as possible to prevent the packing from failing, and this substantially decreased our productivity."

Another concern was that the packing glands, which were pressurized with nitrogen, were letting nitrogen leak into the dryer, slightly cooling the end plates. This allowed condensation to build up on the end plates, causing material to stick to the condensation and form flakes. It became part of

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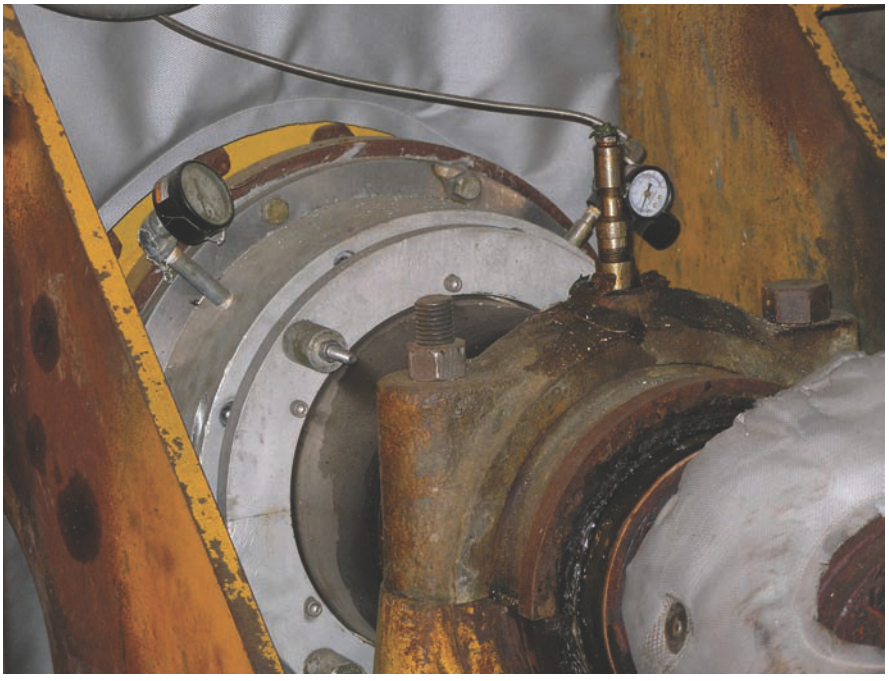

A pressure gauge monitors the seal purge pressure, keeping it at least 2 psi above the dryer's pressure in order to ensure and maintain a perfect seal.

every batch change to scrape this flaky buildup off the end plates inside the dryer, causing more downtime.

"We tried different types of packing, including graphite and PTFE," says Dunagan. "And we did actually find a solution that allowed the dryer to pull vacuum better than the others, but it was abrasive and it started wearing on the dryer shaft. Since it would have cost a fortune to replace the shaft itself, we had to take it out and start over. We kept looking, but we just couldn't find a material that was able to hold vacuum in the dryer without causing secondary concerns."

A search for sanity

Because of these problems, the company decided to look for a change. Since it had already tried so many standard alternatives, the company realized it would have to find a customized solution. In late 2001, Huntsman's production manager, Alan Curtis, saw an ad for customized seals in *Powder and Bulk Engineering* and contacted the seal supplier, Woodex Bearing Co., Georgetown, Maine, a manufacturer of custom seals and bearings. The supplier sent one of its reps, Jerry Chevalier of Mid South Mechanical Sealing, Chattanooga, Tenn., to meet with the company and determine a solution to the sealing problems.

"I visited the plant and, along with the maintenance crew, filled out a seal application data sheet," says Chevalier. "We measured the dryer and shaft and gathered other necessary data, including the material type and size, operating temperatures, and pressure amounts. This information allowed the MECO engineers to build a custom-engineered solution with the best possible likelihood of success." From the data, the engineers put together a proposal for two custom-designed seals that required no modification to the company's existing dryer.

The company purchased the seals and installed them in June 2002. Chevalier worked directly with the company's maintenance crew and supervised the installation. Because the seals were built split and no shaft bearings had to be removed, installation took only 1 day.

A customized sealing solution

The fully split MECO EX-PAC seals are suitable for applications with aggressive chemistries, abrasive materials, high temperatures, and pressure fluctuations. The seals are elastomer-free and use the company's MECO-DR mechanical drive system.

One custom-designed, 10.5-inch-diameter seal is installed on each end of the dryer and fits tightly on the dryer's 10.5-inch-diameter hollow shaft. Each seal has an aluminum housing similar to a stuffing box. Each seal also has two stainless steel stators and two MECO-3000 polymer rotors arranged stator-rotor-rotor-stator, with a purge chamber between the two rotors. Since no elastomer is compatible with both solvents, a piece of braided Teflon packing is used as the driving mechanism. The packing wraps around the shaft, protecting it from abrasion damage and blocking materials from migrating along the shaft.

Changes in process pressure and temperature during the drying cycle don't affect the seals, allowing the vacuum to be effectively maintained.

The seals are spring-loaded, and the combined pressure from the springs, which hold the seal faces closed, and the purge gas pressure, which presses the rotors against the stators, maintains a perfect seal. The seals are purged with less than ¼ cfm of nitrogen, which is monitored by a pressure gauge that allows operators to easily detect pressure drops. The seal purge pressure must be 2 psi above the dryer pressure. When the pressure drops below this level, it means that the rotors have worn beyond the point where the springs can maintain adequate seal face pressure.

The seals can accommodate thermal shaft growth without affecting the seal's integrity. "The company's process has fairly high temperatures, about three hundred degrees Fahrenheit" says Chevalier. "That's one reason the elastomer wouldn't work for them. Once higher temperatures are reached during a process, the shaft actually grows. These seals allow the shaft to grow axially while the dryer still pulls full vacuum. The seals can take about a one-quarter-inch axial movement in both directions."

The batch cycle time for product A has been reduced from 60 to 48 hours and the cycle time for product B has been reduced from 12 to 9.5 hours.

The seals also accommodate shaft runout and misalignment, with a standard runout tolerance of 6 millimeters (¼ inch) total indicated runout (TIR). Changes in process pressure and temperature during the drying cycle don't affect the seals, allowing the vacuum to be effectively maintained.

A batchful of benefits

Since being installed, the seals have been trouble-free and the company has noticed significant benefits. For instance, because the seals easily handle thermal growth, material is no longer able to migrate out. This has eliminated any chance of product contamination and has protected the shaft against abrasion damage. The company also added an adapter plate to extend the seal from the shaft and further protect the shaft from wear. In addition, the problem with flaky material buildup on the end plates is all but

gone. Now operators scrape off the end plates about once every 16 batches.

"The biggest benefit for us has been increased productivity," says Dunagan. "Because the seals can hold full vacuum, we've shortened drying times significantly. And since the seals are spring-loaded and don't require adjustments or maintenance, we have minimal downtime." The batch cycle time for product A has been reduced from 60 to 48 hours and the cycle time for product B has been reduced from 12 to 9.5 hours.

The seals have been rebuilt twice since installation because of normal wear and tear. Rebuilding the seals consists of replacing the two rotors, which are sacrificial wear parts, when a certain amount of axial wear occurs. The seals' split design allows quick and inexpensive rebuilds.

In the past, the maintenance crew had to clean the dryer after every batch. With the new seals, cleanout is only required every 16 to 20 batches or when product changeovers occur. Cleanout consists of taking all the equipment apart, including the seals, and water-blasting everything. This eliminates any product buildup on the end plates and any chance of product contamination.

The company has been more than satisfied with the custom seals. "We've been extremely happy with the seals' reliability," says Dunagan. "And not only have all our sealing problems been solved, but Woodex has been easy to work with. Any time we need spare parts or have a question, they're ready and willing to help. And the best part is that the seals do exactly what Jerry said they would do, plus more! We can pull more vacuum than ever before, and we avoided the costly prospect of reshafting the dryer. That's time and money in our pocket." **PBE**

Note: To find other articles on this topic, look under "Valves" and "Drying" in *Powder and Bulk Engineering*'s Article Index at www.powderbulk.com or in the December 2007 issue.

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