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FLOWSERVE

Face to Face

THE SEALING TECHNOLOGY MAGAZINE

Stand Out
FROM THE CROWD

Flowserve engineered solutions rise above the rest to solve tough challenges.

Stand Out FROM THE CROWD

For the past decade, as oil prices continue to rise around the world, Germany is one of many countries that has been racing to develop cleaner, more environmentally friendly sources of power. One method that is finding favor in Germany is geothermal energy.

Unlike solar and wind, geothermal energy is available around the clock. It uses heat deep within the Earth's crust to heat water to generate power. Pumps deliver the water at a temperature of 150°C (302°F), and the water is transformed to steam that turns a turbine used to generate electricity, creating a renewable and sustainable power source.

When Flowserve was asked to provide a deep-well submersible pump and motor to a Germany-based geothermal power plant, the Flowserve team reviewed the requirements and knew the pump would have to be customized so that it would be robust and reliable enough to handle high temperatures and an installation depth of more than 700 m (2,300 ft).

Overcoming Hurdles

Such a long shaft is bound to shift with movement, and the pump's seals generally can take a one-time axial shift of about 0.381 mm (0.015 in). However, in this geothermal application, Flowserve needed to design a seal that could accommodate +/- 5 mm (0.197 in) of axial movement.

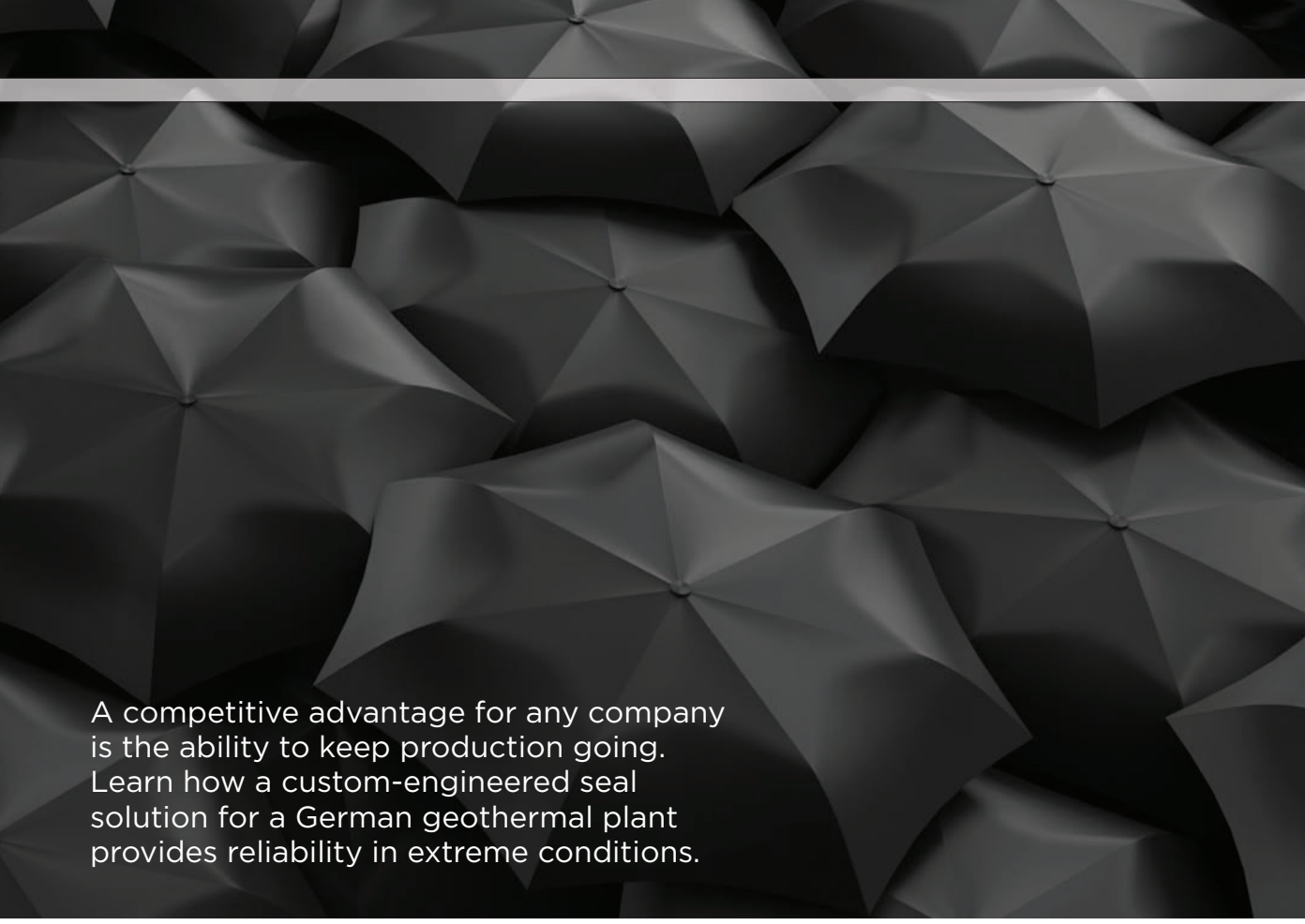
"Thermal expansion causes axial movement of the shaft, as well as motor thrusting during start-up and shutdown," says Ryan Kremer, product development-special projects senior engineer, Flowserve.

"Just like any seal, if the axial movement is greater than the seal's capability, the faces could be overloaded, and a catastrophic failure could occur," he adds.

The geothermal plant also required that the seals for the vertical pump and motor could leak oil no more than 3.79 l/hr (1 gal/hr), and could not leak any water into the system. This was necessary because the motor can only hold so much oil, and it will overheat and fail once that oil is gone. The motor also would fail if any water were to contaminate the oil.

Most seals rely on high-pressure differential to keep the leakage rate low. In this case, a low-pressure differential, ranging from 0 to 1.03 bar (0 to 15 psi), required Flowserve engineers to further customize its solution.

"One way to combat leakage is to increase the spring load. But the higher the spring load, the higher the start-up torque, which can lead to seal face damage," Kremer explains.



A competitive advantage for any company is the ability to keep production going. Learn how a custom-engineered seal solution for a German geothermal plant provides reliability in extreme conditions.

Determined to find a solution, Kremer and the Flowserve engineered solutions team added a diamond coating to the rotating faces to enhance seal face life and reliability in hostile environments. The diamond coating also would eliminate potential damage caused by the increased spring load.

Going Above and Beyond

To increase seal pressure and help prevent water from leaking into the motor, a pumping screw was added near the inner diameter of the product side seal faces. Because motor oil lubricates this seal face, the pumping screw will help direct leakage outward and prevent water from entering the system. A dual-seal configuration provides additional security in the event the inboard seal side were to fail.

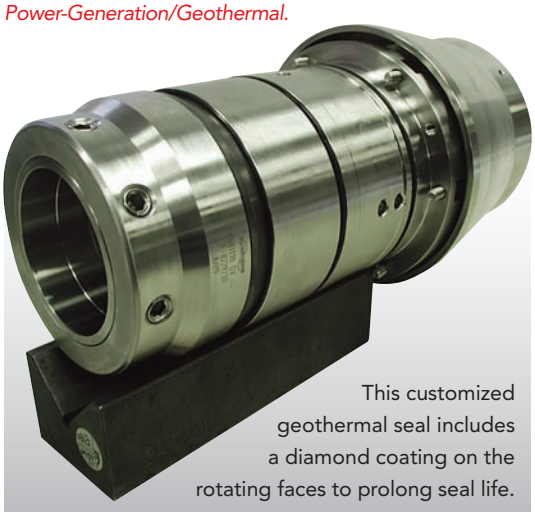
Keeping maintenance in mind, Flowserve engineers designed the seal cartridge to be easy to install, and Kremer says operators who've tested the seal are pleased with its ease of installation.

To make sure the pump and seal work in the most extreme operating conditions, Flowserve runs its designs through extensive testing. If problems arise during testing, the team goes back to the drawing board until the pump and seal pass all requirements. In this case, the seal has met its leakage requirements and is undergoing further validation testing before the user installs it.

No Challenge Too Big

This geothermal plant application is just one example of how Flowserve can fully engineer and design a product to suit any application.

For more information, visit www.flowserve.com/Industries/Power-Generation/Geothermal.

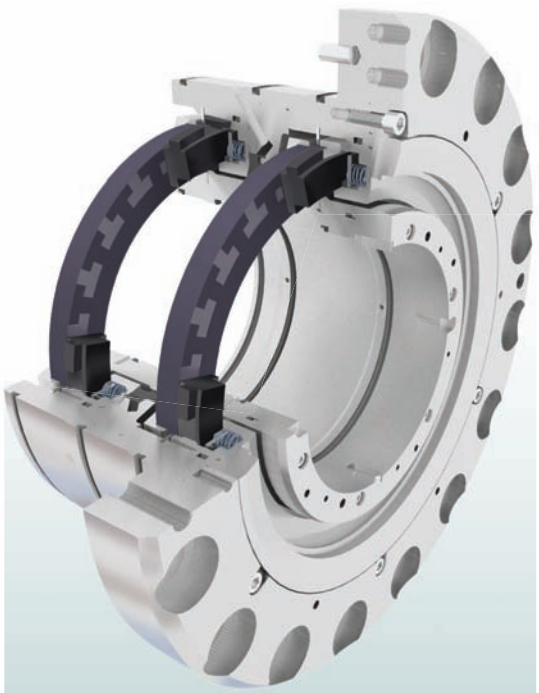


This customized geothermal seal includes a diamond coating on the rotating faces to prolong seal life.

Reliable Seals Make All the Difference

Discover how a fertilizer plant cut downtime, emissions and financial losses by retrofitting a compressor's oil seals to a more reliable gas seal solution.

Reliability, safety and cost reduction are priorities for any company and its mechanical seal applications. This certainly is true for leaders at a fertilizer plant in Europe, where seal failures were causing costly downtime in its hydrogen recycling operation. Company leaders decided to retrofit the oil seals to gas seals to slash downtime, gas emissions and losses.



Gaspac dry gas seals from Flowserve helped a fertilizer plant cut downtime and oil costs, while boosting reliability and safety.

The company's hydrogen recycling operation uses a one-stage turbocompressor to manufacture ammonia. It was running at high pressure in the loop up to 300 bar (4,351 psig), with its shaft sealed by a Flowserve Turbopac 2100 (http://bit.ly/flowserveturbopac2100) bidirectional, balanced double mechanical seal.

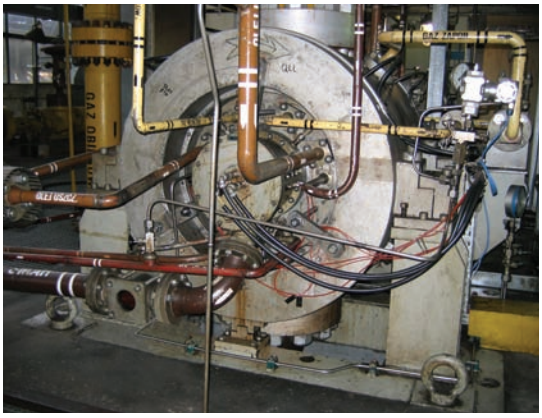
However, frequent, unexpected machine stops created problems with oil system performance, so the compressor shut down often and caused production stops. As a result of this plant downtime, the company lost money, which was simply an unacceptable situation.

Impetus for Productivity

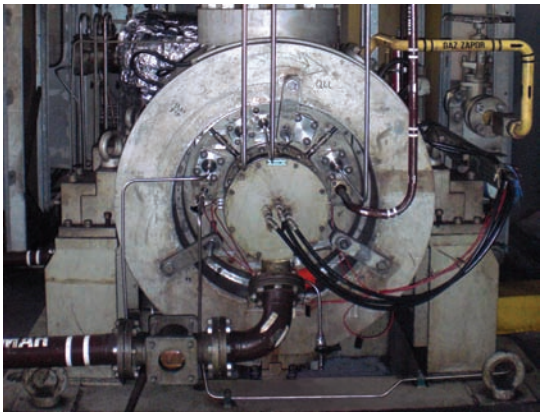
The Flowserve team worked with plant managers and suggested the plant modernize its oil seals by retrofitting to Gaspac dry gas seals (http://bit.ly/flowservegaspac). The team knew the fertilizer plant would benefit from the technology for several reasons:

- The user would not need an oil system to lubricate the seals, which eliminates the need to remove gas contaminants from the oil.
- This approach would not require modifications to the mechanical seal chamber or to the rotodynamic motor.

Before Retrofit



After Retrofit



Upgrading a fertilizer plant's hydrogen recycling operation from wet seals to Gaspac dry gas seals took just 19 weeks, and assembly and start-up of the retrofitted machine took just seven days.

- The gas seals can run in both directions by using T-groove technology, which allows the compressor seal to run in either direction without problems. This is critical if two seals are used, one at each end of the shaft in some cases; the same seal can be used at both ends. If the face pattern were unidirectional (one way), then two different seals would have to be used, doubling inventory and increasing the opportunity to put the wrong seal at the wrong end. That would cause the seals to fail immediately upon start-up.

The fertilizer plant manager realized additional benefits to retrofitting to gas seals.

First, the oil costs are substantial, so the potential **savings** were significant. For example, oil can become contaminated and require expensive degassing. In addition, oil leakage at the plant could run up to 50 liters (13 gallons) per day, costing the company hundreds of thousands of Euros annually for extra oil.

Second, when fitted with wet seals, the application has potential to release gas emissions into the atmosphere, so company leaders chose gas seals to ensure increased **sustainability** and regulations compliance.

Third, gas seals would help increase **safety** by virtually eliminating wet seal contamination, thereby decreasing the likelihood that maintenance personnel would have to service the seal support system.

Fourth, **reliability** would improve because seal oil support systems can fail even if stand-by equipment might be installed for that contingency.

Benefits of retrofitting to dry gas seals included cost savings, safety and reliability.

Reliable and Safe Operation

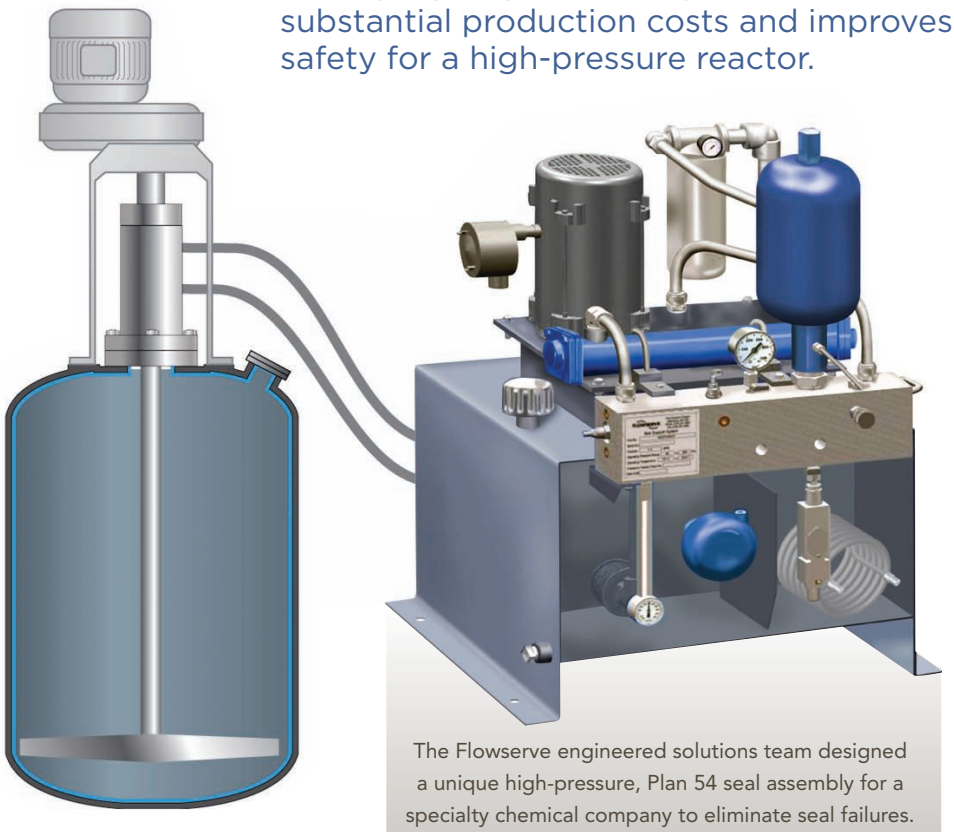
Flowserve performed the upgrades in an exceptionally short time of just 19 weeks from receiving the order to getting the compressor running again, and assembly and restart of the machine took just seven days.

The Gaspac dry gas seal solution engineered for the fertilizer plant's specific application has provided the user with reliable, safe, cost-effective long-term operation. With no seal contamination and safe maintenance conditions, the customer has seen considerable savings, personnel and production advantages.

Visit www.flowserve.com/Products/Seals/Compressor for more information about Flowserve compressor seal technology.

When a Seal *Has* to Work

A uniquely engineered triple seal saves substantial production costs and improves safety for a high-pressure reactor.



The Flowserve engineered solutions team designed a unique high-pressure, Plan 54 seal assembly for a specialty chemical company to eliminate seal failures. It has three individual seals that create two redundant sealing chambers, so if the primary chamber fails, the other maintains the integrity of the seal.

When the consequences of a failed seal include a lost production batch worth USD $150,000 to USD $200,000, additional lost production time, tens of thousands of dollars to replace equipment and a possible explosion, the seal needs to work.

A specialty chemical company was experiencing failing seals on a large reactor in its U.S. plant, with that level of production and repair costs.

An acrylonitrile reactor proprietary to the company converts nitrile rubber to acrylonitrile rubber through a batch hydrogenation process. The seal must isolate the vessel from atmosphere and the motor driving the shaft of the mixer inside it.

Flowserve already had a maintenance contract with the company, including maintaining a seal made by a European seal company. "Over the past two years the seal had begun to fail," says Lynn Gilmore, principal sales engineer at Flowserve.

Analysis showed that the existing seal was failing in a number of ways in response to high temperatures and slightly varying axial thrust.

For example, some o-rings showed evidence of explosive decompression and were not accommodating the drop in hydrogen pressure of more than 10 bar (150 psig) per minute. This could have allowed bubbles of hydrogen to leak past the seal and into the atmosphere. Seal faces were binding because anti-extrusion devices behind them exerted too much pressure. There was a large metal block behind one seal face. This block retained heat, which thermally distorted the seal faces adding stress and degrading the seal face and surrounding gaskets.

Triple Seal Design

In approaching Flowserve's design, Gilmore says, "We asked how we could keep the machine running to complete the production run even if the seal experienced problems."

Starting with a high-pressure Plan 54 design, Flowserve engineers created a unique seal assembly for this application. The design has three individual seals that create two sealing chambers; if the primary chamber fails, the other maintains the integrity of the seal.

In this triple-seal design, the first seal is exposed to 88 bar (1,280 psig) at 43°C to 49°C (110°F to 120°F) from the reactor vessel. The middle or second seal, which forms the second wall of the first chamber, is maintained at 10 bar (150 psig). If the first chamber fails, the second, walled by the second and third seals, can alone provide a complete barrier to hydrogen that is within the vessel at 88 bar (1,280 psig).

The seal assembly also has to be able to sustain a sudden reversal of pressure, so that the second and third seals as well as the first must be able to tolerate 88 bar (1,280 psig).

Unique Features

A number of new features within the seal prevent loss of hydrogen.

"We optimized the surroundings and contact points of each seal face to improve heat transfer effects, drive and loading," explains Rick Doornbos, manager of engineering at Flowserve. "We also designed the seal to carefully control the closing force on the seal faces. Additionally, a series of laser-machined shallow waves on the surface of the seal faces provide lubrication and load support during operation."

Overall, the seal faces are engineered more tightly, with tolerances that are more precise. In addition, Doornbos says, "Flowserve added stainless steel bands to the faces and lapped the reaction surfaces behind the faces. The combination ensures that the faces have been optimized for performance and reliability."

Laser-machined waves provide lubrication and load support.

The Flowserve team positioned the seal faces so they were always covered by the seal's lubricating fluid. Next, they improved the flow rate characteristics of the lubricating fluid, effectively doubling the flow rate in the seal chambers to 7.6 liter/min (2 gpm). To enhance fluid circulation further, the team added a sinusoidal groove in the sleeve so that when the shaft and seal rotate, fluid is moved around and under the seal faces for maximum cooling.

No Failures

To correct the o-ring problems, Flowserve used high-quality perfluoroelastomer o-rings that deliver higher chemical resistance and less degradation in high-pressure areas. The new o-rings are protected by spring-energized polytetrafluoroethylene (PTFE) seals. With these provisions, the o-rings have experienced no explosive decompression.

The company installed the Flowserve triple seal on one of two reactors at the plant in May 2011, and a second in October 2011. There have been no failures. Spare parts are available locally, so, in the event of a seal failure, Flowserve can have a new seal at the plant within 24 hours.

The Flowserve triple seal has improved performance in every aspect, according to Gilmore.

The chemical company concurs that this has been a very successful project and that they are impressed with the rigorous design, pretesting and skills of the Flowserve engineering group in Kalamazoo, Mich., USA.

"This is a major step for Flowserve in high-pressure agitator seals," Gilmore adds.

Visit www.flowserve.com for more information.

FLOWSERVE

Increase production reliability in continuous flow and batch process sealing for critical containment mixing vessels

Flowserve has the products and expertise to keep you safely up and running

We know that keeping your chemical process equipment operating while maintaining containment integrity is your utmost concern. At Flowserve, we have a complete range of sealing products that have been accomplishing this in chemical processing plants worldwide.

We offer a range of mixer seals for dry or wet running applications as well as dry nitrogen barrier gas seals, both contacting and non-contacting. Based on years of research, development, lab testing and satisfied customer experience, our products are designed for your production criteria, including features that reduce process equipment downtime and maintain strict quality and safety standards such as:

- Seals designed for mixers, centrifuges, dryers, fermenters and stills
- Batch processing clean in place (CIP) and steam in place (SIP) seals
- Special electro-polishing for complex cross contamination avoidance between campaigns
- Sanitary designs to maintain critical product integrity
- Sterile designs meet contamination-free criteria