Solutions Driven by Service & Technology

Flowserve solves difficult problems quickly by using leading-edge technology, innovation and outstanding service.
On a Thursday in 2014, one of the largest refineries on the U.S. West Coast had to pull a key effluent water pump out of service because of a leaking seal. Operations personnel had noticed that some stripped water was leaking underneath the seal sleeve. The seal previously had been repaired in September 2013. The refinery, which processes crude oil into gasoline and several other fuel types, is a major producer of clean fuels. It operates at more than 360,000 barrels per day at full capacity. The business impact of this pump’s downtime was tens of thousands of U.S. dollars per day.

Consequently, the failure mode needed to be determined quickly and the competitor’s seal either repaired or replaced in time to bring the pump back online over the weekend.

Miguel Gonzalez, onsite Applications Engineer for Flowserve at the refinery, worked closely with the Flowserve Quick Response Center (QRC) in Rancho Dominguez, California, and the Seal Operations in Kalamazoo, Michigan, to orchestrate a remarkably quick turnaround of a new, tailor-made Flowserve mechanical seal that still is operating successfully.

**Creative Approach to an Aggressive Timeline**

The refinery’s Worthington D1011 effluent water pump, size 6 x 4 x 13, is designed to operate in temperatures from 27°C to 49°C (80°F to 120°F). The pump’s competitive dual unpressurized mechanical seal had adaptive hardware made of 316 stainless steel. The inner seal faces consisted of silicon carbide versus...
carbon, and the outer seal faces consisted of silicon carbide versus carbon. Upon disassembly, refinery personnel noticed the existing pump shaft was heavily corroded and showed excessive pitting.

Gonzalez ascertained quickly only two options could resolve the situation. He could seek assistance from the seal competitor; however, that would be too expensive if the provider assembled a seal on the weekend, or too slow if the company worked normal business hours. The other option was to work diligently to engineer a Flowserve solution and have the customer’s pump back up and running on Saturday. That was the logical choice, although it wouldn’t be easy.

He consulted with the refinery and suggested replacing the failed seal with a Flowserve ISC2 double bellows seal (ISC2-BB) that would be delivered for installation on the following Saturday. Permission was promptly granted.

It was an aggressive goal. Because the pump required a unique sleeve for the seal, the effort required tight coordination by Flowserve personnel on the West Coast and Upper Midwest. “A standard ISC2 sleeve would not work in this situation,” explains Mike Kralick, Senior Planner at Flowserve Kalamazoo. “Our engineers designed a new sleeve and sent a marked-up drawing. It would be manufactured at the Kalamazoo operation due to a welding procedure associated with the sleeve.”

“The sleeve was unique because it consisted of a larger radial cross section than the standard ISC2 sleeve,” says Gonzalez. “It was also designed and manufactured this way because the sister pump was using an identical seal design, and we wanted to ensure that both mechanical seals were interchangeable.”

Within 24 hours, the team designed, made, and shipped the sleeve assembly overnight to the Rancho Dominguez QRC, where it was received early on Saturday morning. By then, the basic mechanical seal parts already had been identified and acquired by Nichole Paelaez, Flowserve Inventory Control specialist at the QRC. The ISC2-BB dual seal quickly was assembled, air tested, and boxed for hand-delivery by Gonzalez to the refinery.

The refinery installed the new Flowserve seal on Saturday afternoon, and the effluent water pump was returned to operation quickly.

**Positive Impact**
The new seal, installed in August 2014, continues to operate successfully. “The performance of the new Flowserve seal has been great, and as of today no issues have been noted by Operations,” remarks Gonzalez.

In addition to the reliable performance of the ISC2-BB seal, the customer is pleased with the fast response and service of the Flowserve team. “The refinery did not have to wait up to 10 days to have a repair completed on the competitive seal since Flowserve was able to provide a brand new seal in less than 72 hours,” says Gonzalez.

Financial benefits were gained as a result. The rapid turnaround for the seal allowed the refinery to minimize its downtime costs. In addition, the customer reported it actually saved money in the process. With the two sister pumps now using identical mechanical seal designs, maintenance efficiencies also were achieved.

The solution design is suited to the refinery’s operating requirements. “They were satisfied that the mechanical seal was able to fit into a small envelope and did not require a lot of axial space, and that the mechanical seal parts were readily available. Overall, the customer is very satisfied with Flowserve,” explains Gonzalez.

For more information on Flowserve seals and systems, visit www.flowserve.com/Products/Seals.

**Refinery Pump Failure Quickly**

The user reports that Flowserve ISC2 double bellows seal (ISC2-BB) has been performing reliably since being installed in August 2014.
Process optimization and cost reduction initiatives are helping BIOX Corp., a biodiesel production facility in Hamilton, Ontario, to meet its production targets for its markets in Canada and the United States. The renewable energy company produces biodegradable and renewable fuel that is used as a replacement of, or an additive to, petroleum diesel fuel from pure seed oils, animal fats, and recycled cooking oils.

One recent initiative improved equipment reliability in the plant’s continuous product distillation processes. The company previously struggled with failing horizontal evaporator seals and process contamination within the seal itself, resulting in unscheduled downtime and associated maintenance costs.

Several failure factors were at play. “The seal diameter is over 12.7 centimeters [5 inches] and the length of the shaft is about 6.1 meters [20 feet]. The result is you get about 1.9 centimeter [3/4-inch] axial shaft expansion due to thermal growth on the tail-end seal,” explains Hany Aboushaka, Project Designer at BIOX. “Other issues are temperature, which is nearly 204°C (400°F); deep vacuum; excessive shaft run-out; and having the proper seal and cooling system on the seal that can deal with these conditions. Finally, the amount of salt and solids in our material impacts the seal significantly,” adds Aboushaka. A unique seal design from Flowserve helped to resolve the issues.

Causes and Costs of Failure
Premature seal failure was a recurring problem with severe consequences. “BIOX’s horizontal evaporator machines are at the core of their operations, and when they go down, the whole plant pretty much comes to a halt,” says Bassem Gabra, Senior Applied Technical Solutions (ATS) Engineer at Flowserve. “The tail-end seal failed continuously and erratically, usually within a three-month period, as it didn’t sufficiently accommodate excessive shaft axial growth and run-out.”

To maintain a properly sealed vessel, shaft run-out as well as the axial growth from cold start-up to operational temperatures must be taken into consideration in the mechanical seal design. The original design failed to accommodate excessive run-out and to compensate sufficiently for thermally induced axial growth. Major failure modes included the following:

- Solids from the process hung up the inboard stationary seal face.
- Shaft run-out exceeding the operational limits of the original seal design caused the inboard and sometimes the outboard dynamic O-rings to hang up and fail.
- The seal drive mechanism wore out and failed frequently because of excessive shaft motion.
- Shaft run-out sometimes caused excessive relative motion between the sleeve and shaft, causing sleeve O-rings to fret.

The financial and operational costs of machine downtime are tremendous. “Production loss is the biggest cost, as we have to shut the plant down to allow repair work to take place. It takes about 12 hours to do a seal and bearing replacement,” says Aboushaka.

“It costs tens of thousands of U.S. dollars for a seal and bearing repair, plus labor hours,” he adds. “Installing new components costs about three to five times more as the parts are so expensive. Additionally, our materials can’t take cold temperatures very well, so stopping in the middle of the winter is particularly detrimental.”

Aggressive Goal Leads to Innovative Solution
BIOX established a goal of one-year mean time between failure (MTBF) for the tail-end seal. By comparison, the original seals received with the machine in 2004 almost never made it to the one-year mark, and usually failed within months.
To prevent premature failures, the seal had to be completely redesigned to better accommodate the solids from the process as well as the excessive shaft run-out. “Flowserve worked with the evaporator OEM and came up with a couple possible designs, and we worked with them to pick the one best-suited to our application,” says Aboushaka.

The redesigned seal failed initially within seven months because of a seal bearing failure, but the failure analysis showed the seals themselves were clean and continued to seal properly. The Flowserve Bridgeport, New Jersey, Quick Response Center (QRC) engineering team redesigned the seal drive mechanism and way the bearing was mounted improving the lubrication. The seal’s latest iteration now has been running since March 2014 with no failures, already surpassing the one-year MTBF that BIOX was seeking. BIOX now has moved the bar to a two-year MTBF.

The successful arrangement is a Flowserve SL-5200W/BRO dual seal assembly that can tolerate process solids acting on the inboard seal faces, excessive shaft run-out, and axial shaft growth. This new design is a “floating” assembly unaffected by axial shaft travel and excessive run-out. A floating assembly configuration allows the shaft to grow beneath the seal sleeve as the evaporator heats up slowly to operational temperatures. With this arrangement, all the seal components remain in proper position and operate to specifications.

“This solution is very unusual in that it turns the seal into its own stable platform all the while completely shielding it from shaft motion,” says Gabra, who worked closely with Flowserve Mechanical Designer Bill Merichko on the new concepts. Almost 18 months after being installed, the new seal still is in operation. “That’s the longest run ever for a tail-end seal in that application. It is performing better than expected, to tell you the truth,” remarks Gabra.

**Lasting Impact**

With the Flowserve seal design, BIOX is avoiding unplanned downtime and costly seal rebuilds and replacements. “We proved that we can dramatically increase BIOX’s MTBF through this innovative technical solution,” says Gabra. “When the new two-year run time goal is achieved, BIOX will switch the rest of the evaporator seals to the new design.”

“Uptime is the main advantage. We are no longer doing expensive repairs on the machine every four months. If we have a seal that can last for more than two years, then we can plan to change the seal after two years rather than waiting for it to fail,” explains Aboushaka.

“Working with Flowserve has been wonderful and cooperative,” praises Aboushaka. “Flowserve has a big facility here in Scarborough, and Bassem Gabra, the main ATS engineer of that seal, was able to travel here and work with us on the new solution. All of that got us where we are today. We have high hopes.”

For more information on Flowserve seals and systems, visit www.flowserve.com/Products/Seals.
Fossil Fuel Power Plant Boosts Emission Control Performance

Coal-fired power plant operators have active strategies to comply with stringent environmental regulations. One major U.S. electric power company has spent a fortune on emission controls at its fossil fuel plants to support a clean power supply. Key maintenance goals include maximizing the mean time between failure (MTBF) of emission control equipment and minimizing downtime should there be a failure.

Sulfur dioxide (SO$_2$), for example, is a colorless pollutant gas that also is a respiratory irritant and a primary cause of acid rain. Because the largest source of SO$_2$ emissions is fossil fuel combustion at power plants, the process is regulated closely by the U.S. Environmental Protection Agency (EPA).

Mechanical seal performance is a critical success factor in curbing SO$_2$ emissions. In one application, the fossil plant was using Flowserve scrubber circulation pump seals that were performing reliably, but there was an opportunity to improve maintenance efficiency by switching to a split seal design.

Flowserve engineered a unique seal solution that outperformed competitive models tested by the plant. The simple-to-install, large-frame seal delivered improvements in downtime, maintenance costs, MTBF and water usage, leading Flowserve to become the sole seal provider for that application.

Scrubbers Cut Emissions

One of the compliance strategies used by the electric power company was the installation of wet limestone “scrubbers” that removed an estimated 95% of SO$_2$ from this fossil plant’s emissions.

Scrubbers, also known as flue gas desulfurization (FGD) systems, refer to equipment used to remove sulfur oxides from the combustion gases of a boiler plant before discharge to the atmosphere, according to the U.S. Energy Information Administration (EIA). Chemicals such as lime are used as scrubbing media.

The fossil plant, which has two coal-fired generating units with a summer net capability of more than 2,000 megawatts, uses slurry circulation tank pumps at the FGD scrubbers for environmental preservation. Without the pumps supporting this function, the plants can’t operate, reducing the company’s ability to supply power to its customers.

Mechanical seals are on the lime slurry circulation pumps for six slurry tanks at the plant. Each tank requires 10 pumps to circulate the lime slurry up to the top of the scrubbers, where it is sprayed into the flue gasses generated by the burned coal fuel driving the boilers in the power plant. The lime extracts SO$_2$ from the flue gas. This is the process of “scrubbing” the emissions.

The competitive seal leaked profusely and was covered with slurry.
New Scrubber Seal Design Sought

With a goal of lower costs and cleaner energy in mind, the coal-fired power plant wanted to upgrade the mechanical seals on its slurry circulation tank pumps to a more efficient solution. “The previous seals were Flowserve RIS seals that actually provided very good reliability and high MTBF [mean time between failure],” says Sam Layne, District Sales Manager at Flowserve. “The challenge was in the time, manpower and equipment required to replace a RIS seal when there was a failure.”

The existing seal’s RIS component ensures a nonclogging design and long MTBF, but the company wanted to try split seals as an alternative to improve turnaround times in seal replacement and to improve the pump run time.

Three suppliers were selected to provide split mechanical seals for these pumps. “The intent was to use all three versions and evaluate each manufacturer’s benefits and capabilities before moving forward with the design that performs the best,” explains Layne.

Initially the non-Flowserve providers showed more promise, with limited leakage at start-up. Then, Flowserve Applied Technical Solutions (ATS) engineers developed an innovative design. They engineered a large PSS III seal that incorporated a number of features that made it easy to install and that would be immediately reliable upon installation.

“These were among the largest split seals made by Flowserve to that point,” says Flowserve Sales Engineer Bob Dodson. “Much of the redesign work was done on-site by the local Flowserve team and ATS engineer during early trial installations of the prototype seals. It involved long days, unexpected overnight stays, and after-hours support from a local machine shop to fine-tune the components.”

The PSS III has only two major components, and it installs around the shaft, outside the seal chamber, eliminating the need for equipment tear-down. Installation tools are included with the seal, and only one wrench for the gland bolts is required. Integral setting tabs on the seal components reduce installation errors and avoid measurements and markings at the point of installation.

“The Flowserve PSS III seal design allows the plant to replace a seal without disassembling the pump, which results in a significant savings in equipment downtime and maintenance costs,” says Layne. “This is a very large split seal with a unique design of the throttle bushing. This allows them to minimize flush water usage while maintaining adequate stuffing box pressure.”

Carter Guyse from Repair Services, Flowserve’s authorized distributor responsible for the account, worked with the customer on installation issues and trained its employees on how to install and operate the seals, according to Layne.

Solution Exceeds Expectations

The original PSS III seal installed in 2011 was removed at 32 months only because the pump required non-seal-related maintenance. Another PSS III was installed in 2011, and about a dozen more have been installed since then. These seals all are still operating at peak performance, and the company plans to install several more. By comparison, the competition’s seals either failed after a short time or suffered installation issues when a local representative wasn’t available when needed.

Because the Flowserve seals thrived and performed beyond expectation, the fossil plant is a very satisfied customer. “Since there have been no failures and no replacements, there is not a calculable MTBF,” says Layne. “The plant is very satisfied with the ease of installation, low water usage, and reliability of the Flowserve PSS III seals as compared to the other manufacturers they tried. They have stated that they will purchase only Flowserve seals for this application moving forward.”

For more information on Flowserve seals and systems, visit www.flowserve.com/Products/Seals.
Providing Service and Solutions to Global Infrastructure Markets

Flowserve focuses on providing customers with uncompromising technical service and engineering support to meet the customer's immediate need. Dedicated to delivering the highest quality support, Flowserve integrates mechanical and materials engineering knowledge to create sealing and support system solutions.

Highly skilled engineers and technicians are available around the clock, seven days a week to respond to customer situations by evaluating and troubleshooting problems and to provide reliable solutions.

Typically, approximately 90% of the total life cycle cost (LCC) of a flow management system is accumulated after the equipment is purchased and installed. Flowserve offers services and solutions to provide customers with value and cost savings throughout the life span of the equipment.

End User Service and Support
- Local Quick Response Center (QRC) operational excellence
- Repair and maintenance
- Genuine Flowserve parts and service

Engineering and Technical Solutions
- Engineering support
- Technical assessments
- Equipment performance improvements

Local Engineered Application Support
- Troubleshooting problems
- Developing reliable solutions
- Providing operational support

To learn more, visit www.flowserve.com