Sealing the deal

A lignite-fired power plant in Germany upgraded the performance of its boiler feed and FGD slurry pump seals, in turn eliminating unplanned pump shutdowns and improving mean time between repair from 20 to 40 months, writes Jim McMahon

The lignite-fired power plant is one of the largest coal-fired power plants in operation for power generation in Germany. The power plant has different pumps installed, which are sealed with mechanical seals that keep the pumps in operation.

Mechanical seals are found, for example, in the main heat cycle – pumping raw feed water, boiler feed water, condensate and the cooling water that supports the condensate system. They are also found in secondary pumps, fire suppression systems, and service and wastewater applications. Mechanical seals are also in limestone slurry for the flue gas desulphurization (FGD) scrubber system.

A mechanical seal comprises a stationary primary element which is fixed within the pump housing, and a rotating mating element fixed to the shaft. Precisely machined, these two components are pressed together, meeting at a wear face, while the extreme tolerances between the two elements minimizes leakage. The seals, however, rely on a certain amount of leakage to lubricate the moving surfaces. The rotating element is supported on an extremely thin lubricating film, typically 0.25 microns in thickness.

Mechanical seals are influenced by a number of factors, including temperature, pressure, vibration from pump shaft misalignment and quality of the pumped fluids. Coal-fired plants have many processes that contain abrasives and solids within the fluids being pumped. These insoluble liquids are hard on mechanical seals because they create added abrasion and erosion of the components. The particles can get into the mechanical seals' O-rings and springs and cause them to go rigid, where the seal is no longer able to move with the shaft movements and pressure deflections.

As with all rotating equipment, seal wear is a constant factor requiring continual monitoring, maintenance, repair and replacement to keep the equipment operating as required. This lignite-fired power plant, however, experienced premature pump seal wear and excessive seal corrosion, as a result of adverse reactions to feed water treatments and inadequate maintenance coupled with part stocking issues.

The plant's boiler feed circuit pump seals and FGD slurry pump seals were negatively impacted, experiencing a significant reduction in mean time between repair (MTBR), ultimately resulting in unplanned pump shutdowns.

To remedy the condition, John Crane, whose seals were originally installed in the plant's boiler feed water pumps, implemented a comprehensive programme to isolate the cause of the premature pump seal degradation; engineer a mechanical solution to extend longevity for the seals; implement a system to monitor the ongoing condition of the feed water; and establish a structured maintenance, repair and part stocking regimen.

Boiler feed circuit pump seals

The boiler feed circuits, being the core of a thermal power generating plant, rely on high-speed, high-performance pumps to keep the water moving through the systems. Each boiler feed circuit has two high-speed, high-performance pumps feeding the boiler, and approximately 100 secondary pumps along the feed circuit.

Plant-wide, the boiler circuits, combined, have 12 high-performance pumps and approximately 600 secondary pumps. Each of these pumps has mechanical seals, and the high-performance boiler pumps have two mechanical seals for each pump.

In this plant, as in many power stations using high-purity boiler feed water/COT processes, with high-speed, heavy-duty pump applications in boiler feed circuits, minute electrical potentials develop which cause electrostatic corrosion on the mechanical seals. The material of the mechanical seal itself becomes degraded, resulting in a shortened lifespan. This condition is due to chemical reactions from combined oxygen treatment procedures of the feed water initiated to reduce corrosion in the boiler, resulting in the creation of electrical voltage.

"Failure of the mechanical seal is the primary cause of pump failure," said Wolfram Enders, Senior Application Engineer with John Crane. "The high-performance boiler feed circuit pumps are integral to the operation of any thermal power generating plant. If just one of these pumps fails, that boiler feed circuit would be running on 50 per cent operation, or could be potentially shut down."

This is just what occurred at this plant, where boiler feed seal integrity was lacking, causing unplanned pump shutdowns. John Crane thoroughly investigated the condition of the pump seals, and developed a strategy to mitigate the problem. This included: a) specifying and installing specific components for the boiler feed seals of this plant; b) implementing an ammonia dosing system which feeds an ammonia solution around the mechanical seal to increase electrical conductivity of the feed water; and c) putting into place a control system to monitor the electrical conductivity of the feed water, integrated into the pump PLCs.

"We are changing the conductivity of the water around the seals, and changing seal face materials," continued Enders. "This is giving them more reliability and longevity. It has been a project underway for some time, and we are seeing the results in 100 per cent longer life of the seals."

The feed pump seals in place are heavy-duty John Crane Type 270F O-ring pusher cartridge seals, for boiler feed circuit applications. They are designed for critical high-pressure, high-temperature and high-shaft speed applications. The face and seat are computer-engineered for optimum distortion control leading to high reliability and long operating life.

The seals can handle temperature limits from -40°F to 500°F (-40°C to 260°C); pressure limits up to 1000 psi(g) (69 bar)(g); and speed limits up to 4000 fps (60 m/s). Advanced computer-designed faces maintain optimum performance under all temperatures and pressures.

FGD slurry pump seals

Flue-gas desulphurization, a set of wet-scrubber technologies used to remove sulfur dioxide (SO_2) from exhaust flue gases of fossil-fuel power plants, typically uses a wet limestone ($CaSO_3$, calcium sulfite) slurry through which flue gas containing SO_2 is passed in absorber spray towers. The abrasive and corrosive wet limestone slurry puts high corrosive demands on both pumps and seals.

"Flue gas desulphurization feed pump seals at the plant failed due to metal erosion and corrosion issues, resulting in a lack of seal component flexibility," added Enders. "The corrosion came from the calcium sulfite, and the erosion from the fluid velocity in close to the mechanical seals."

The plant has 60 main feed pumps in the FGD circuit, and an additional 250 – 300 secondary pumps, for a total of 310 – 360 pumps involved in plant-wide flue-gas desulphurization.

"Together with the local pump service companies of the pump OEMs, we conducted considerable testing, then engineered a mechanical seal solution that mitigated both the erosion and corrosion problems," said Enders.

"The net result is: we were able to measurably extend the running life of the seals."

The corrosion/erosion problem, which concerned the 60 main FGD feed pumps, was solved by installing heavy-duty John Crane Type 5860 cartridge slurry seals. These seals are specially designed to operate in the harshest abrasive slurry environments, including exposure to process fluids such as limestone. These seals can handle slurries with solids contents up to 50 per cent by weight, without the need for water flush support.

The seals can handle temperature limits up to 180°F (80°C); pressure limits up to 360 psi(g), (25 bar)(g); and speed limits up to 65 fps (20 m/s). The seal face provides maximum stability and minimum heat generation under adverse conditions, optimizing performance with maximum seal face life and lubrication.

Reliability programmes

A critical component necessary to restoring and maintaining the integrity of the plant's pump seals was the establishment of a programme for ongoing seal inspection, maintenance, repair and part stock management. It was insufficient management of these areas which premediated the premature degradation of the plant's pump seals, and resultant pump failures.

The plant required a reliable way to manage and repair seals to improve MTBR. Stocking problems and tracking difficulties created confusion and frustration among operations technicians as well as procurement. And it needed a 24/7 stocking programme that would integrate with its existing enterprise resource planning (ERP) system.

To facilitate organization and structure into this area, John Crane implemented its Performance Plus Reliability Programme, called Interface, for management of the plant's mechanical seals.

Programme development for reliability support began with a comprehensive feasibility study to establish the full scope of the plant's needs. It measured equipment performance, calculated total cost of ownership and identified opportunities for improvement and cost savings.

Once the data was collected, John Crane used the Interface reliability management software to benchmark asset performance against industry averages and perform a cost/benefit analysis. "The program initially inspected the existing seal installments and stocking procedures," continued Enders.

"Then it made recommendations to bring order to existing repair and stocking systems, so to deliver high pump reliability. The stock standardization program ensures correct quotes and orders ultimately find their way to the right equipment. It is linked to the plant's ERP system, streamlining seal repair, stocking and tracking."

All failures from existing seals are now immediately sent to a nearby John Crane Service Centre for 24/7 repair. Dedicated spare parts are available 24/7 as part of the product/stock standardization program.

The mechanical seal service delivers new John Crane seals and seal components to the plant, eliminating delays and inefficient and faulty repairs.

And, importantly, training is provided to field engineer and operations personnel to reduce the risk of unplanned downtime and recurring issues in the future.

"The Performance Plus Reliability Programme ensures high pump reliability and reduced maintenance costs for the plant's rotating pump mechanical seals," added Enders. "MTBR, a key driver for the industry, was increased 100 percent, from 20 months to more than 40 months, because of improved seal maintenance, repair and stocking initiatives, including replacing existing seals with new John Crane components."

Jim McMahon writes on industrial technology for John Crane, a global leader in rotating equipment solutions

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