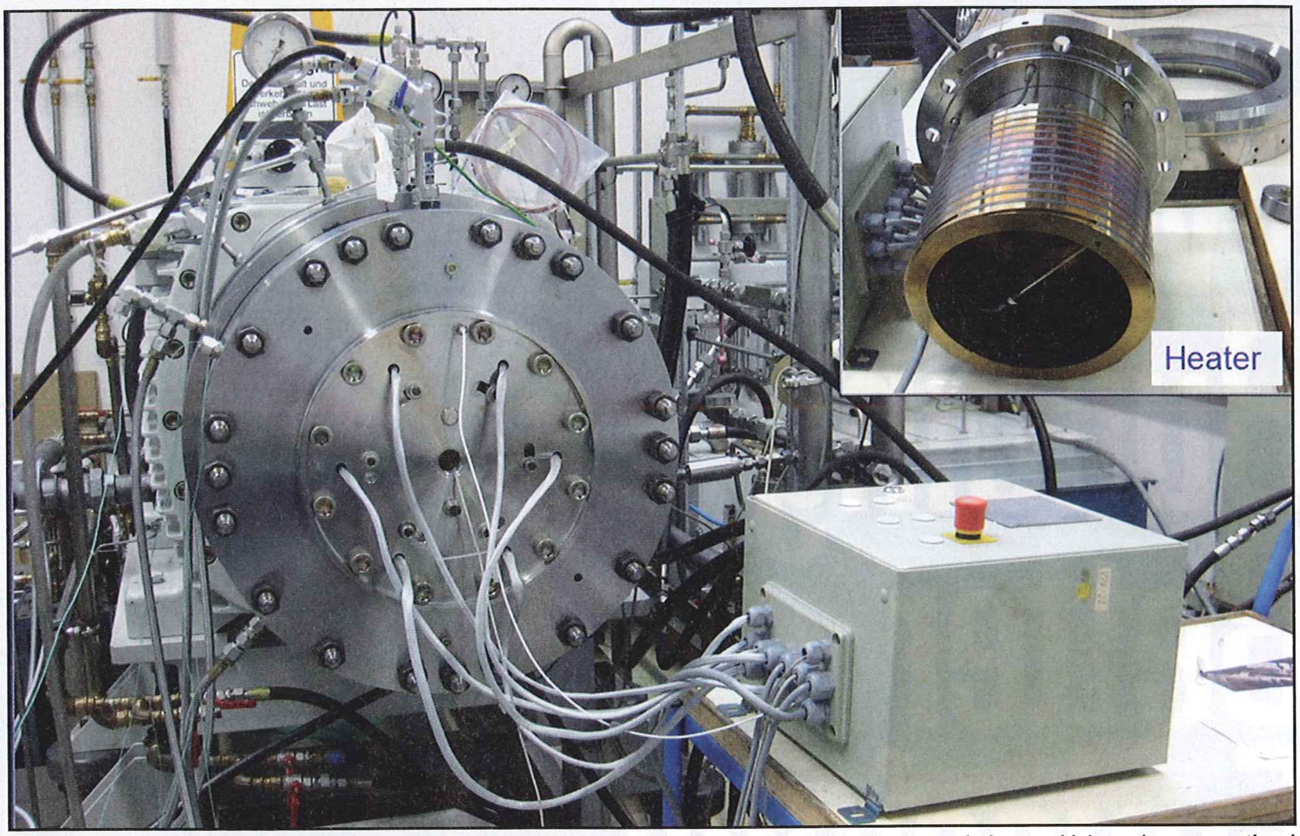

The dry gas seal for the Wuhan project was tested in a special test rig, featuring an electrical heater to reach the very high maximum operational temperature. During the full test the seal ran dynamically from 68° to 482°F (20° to 250°C).

EAGLEBURGMANN DEVELOPS LARGE DIAMETER DRY GAS SEALS FOR EXTREME TEMPERATURES

Can Withstand Temperature of 482°F (250°C) in Chinese Blast Furnace

By Roberta Prandi

Wuhan Iron and Steel Co. Ltd. awarded GE Oil & Gas a contract in 2007 to build a blast furnace gas-fired combined-cycle power plant for its steel production plant in Wuhan, China.

While designing the compressors for the Wuhan project in 2008, GE Oil & Gas decided to use dry gas seals despite temperatures that were expected to reach up to 482°F (250°C) around the seals.

Gas-lubricated seals were chosen over oil-lubricated seals in order to keep the system as simple as possible and to avoid temperature-induced cracking problems.

Because of the very strict project requirements, GE Oil & Gas chose to use products by EagleBurgmann, due to its knowledge of the specific product and its design expertise.

That began the company's process to develop a 15.3 in. (390 mm) gas seal — the PDGS10/390 — that could withstand temperatures of up to 482°F (250°C).

EagleBurgmann developed the seal in cooperation with GE Oil & Gas to adapt to the demands of their large MCL split-casing centrifugal compressors. EagleBurgmann noted that support by Paolo Susini and Luca Lombradozzi of GE Oil & Gas was fundamental during the seal development and testing.

"Shaft end seals clearly represent a critical component, greatly affecting the reliability and efficiency of the whole system (compressor and auxiliaries). For this reason, the dry gas seal is a key element in reducing both power and leakage at shaft ends, as well as simplifying the seal control panel and making it more reliable," said Francesco Grillo, who works in the application engineering department of EagleBurgmann Italia and was involved in the Wuhan project.

"The dry gas seal application in MCL frames posed some challenges in design and manufacturing," he explained. "First was the production of a sealing of 390 mm [15.3 in.], still characterized by strict geometrical tolerances to ensure stable gas film properties. Second was the design and validation for operation at extreme temperatures."

The seal was tested for use from -274°F (-170°C), which is the seal design temperature required by liquefied natural gas (LNG) applications, up to 482°F (250°C), the seal design temperature required by the furnace gas compression.

In the Wuhan project, the furnace gas from steel production is used to feed gas turbines for power generation.

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The first compressor train in the steel production plant in Wuhan, China. The combined-cycle power plant is fueled with noncooled furnace gas and features 15.3 in. (390 mm) dry gas seals by EagleBurgmann.

Compression is necessary to increase the gas pressure to the gas turbine combustion chamber pressure. Pre-cooling the gas before compression is generally not recommended in order to keep costs down. Moreover, it would be a contradiction from the thermodynamic efficiency point of view.

For this reason, centrifugal compressors operating in furnace gas applications must be able to withstand a relatively high temperature range.

"Missing certain data on the temperature distribution in the application, a seal design for the estimated worst-case temperature of 250°C [482°F] was necessary to ensure a proper safety margin," Grillo said. "As an additional precaution, this temperature was considered as a design temperature affecting all critical seal components."

"A dry gas seal in tandem arrangement was selected because of the additional safety, in that the secondary seal is capable of operating under the same conditions as the primary seal." He said, "To fulfill the zero leakage requirements, an intermediate labyrinth was installed."

As the seal size was similar to a previously manufactured LNG seal, the same basic design was used for the Wuhan project.

Because the required -58° to 482°F (-50° to 250°C) range exceeded O-ring temperature limits, spring-energized sealing elements were selected.

"The most critical design challenges were heat transfer from the sealing gap and radial gap design. The turbulences on the outer diameter of the rotating ring and friction forces within the sealing gap represented an additional heat source that could bring the seal temperature above the surrounding casing temperature of 250°C (482°F). If the temperature exceeds the design limit, the sealing gap behavior will change and the leakage rate might increase compared with the normal consumption," Grillo said.

"Secondary sealing elements might also be affected if the temperature exceeds their design limits. In order to avoid an overheating effect within the sliding faces, the design requires material which absorbs created heat and conducts the heat away from the sealing gap to the housing and the ring environment," he said.

"Sintered silicon carbide has by far the highest thermal conductivity coefficient and therefore has the highest capacity to remove the created heat from the sealing gap," Grillo said.

For those reasons, the Eagle Burgmann standard hard/hard face combination with a DLC-coated sealing face was found to be the best solution for the high-temperature application.

"For this high-temperature application, the same design has been used for the dynamic secondary sealing element as for the LNG seal previously built. By using a tungsten carbide balancing sleeve and a tungsten carbide supported PTFE element, the effective sealing gap between the seal face and the sleeve will remain stable. With a stable secondary sealing gap, the risk of extrusion or seizing (clamping) is eliminated," Grillo said.

To achieve a 482°F (250°C) working temperature for the dry gas seal, a special test rig was set up, with an electrical heater mounted inside the shaft. EagleBurgmann reported that during the complete test program, the seal operated dynamically from 68° to 482°F (20° to 250°C), maintaining stable leakage behavior.

"After the complete test procedure, including static and dynamic tests under full load, several start/stop cycles, slow roll operation and an extreme temperature test, the sealing faces were inspected and found to be in perfect condition," Grillo said.

Following the in-house test, the seals ran without any problems on the compressor manufacturer's standard mechanical running test.

"The first compressor train at the Wuhan plant was successfully started up in December 2009. At the time, it was the first running application with noncooled furnace gas adopting dry gas seals of this size," Grillo said.

The project opened new opportunities in this market for EagleBurgmann because the seal developed for Wuhan is much the same as the solution for natural gas liquefaction, and many of the challenges encountered in LNG systems (slow roll, vibrations) are similar to those faced in the Wuhan application.