New Barrier Seal Improves U.K. Compressor Reliability

> EagleBurgmann's CobaSeal targets leakage problems

■ The compressor shaft prior to new seal installation.

EagleBurgmann and Siemens have reported the successful application of the former's CobaSeal, a rotating ring made of ductile material and a spring-loaded stationary face made of silicon carbide.

The companies noted that centrifugal compressor performance and availability is closely related to the effectiveness of shaft sealing technology.

The shaft seal creates an impermeable barrier between the pressurized gas supply and unpressurized ambient environment, preventing pressure loss and contamination of the former and protecting the integrity of the compressor. If the seal performance degrades, compressor functionality is compromised.

EagleBurgmann, a specialist in industrial seal technology, developed CobaSeal and initially installed it in collaboration with U.K. gas network operator National Grid and compressor manufacturer Siemens Energy.

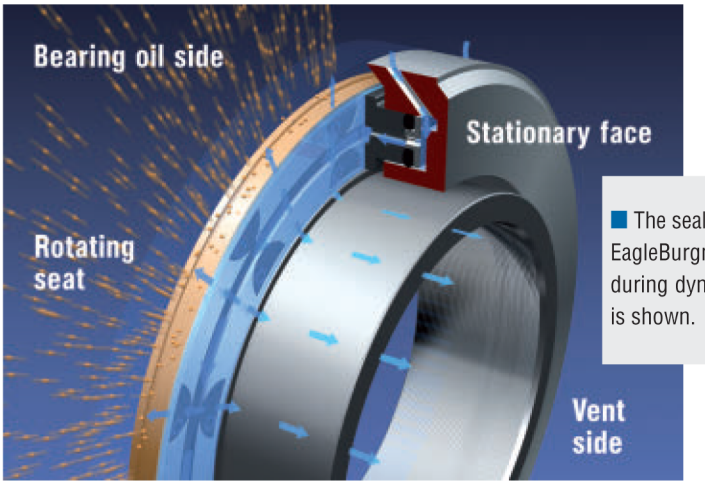
EagleBurgmann said conventional sealing solutions have served gas producers and distributors well enough, but its new coaxial barrier seal can improve compressor availability in gas liquefaction, gas transmission or any gas compressor application.

It said that several months of field operations have confirmed that the CobaSeal is more robust than older seal types, is consistently reliable under all operating conditions and provides cost savings in the form of reduced nitrogen gas consumption.

Oil leakage

National Grid's Nether Kellet booster station near Manchester uses dual gas-turbine driven Siemens STC-CP centrifugal compressors with the overhung impeller design widely used in gas transmission.

The shaft sealing technology, a dry gas seal in tandem arrangement with



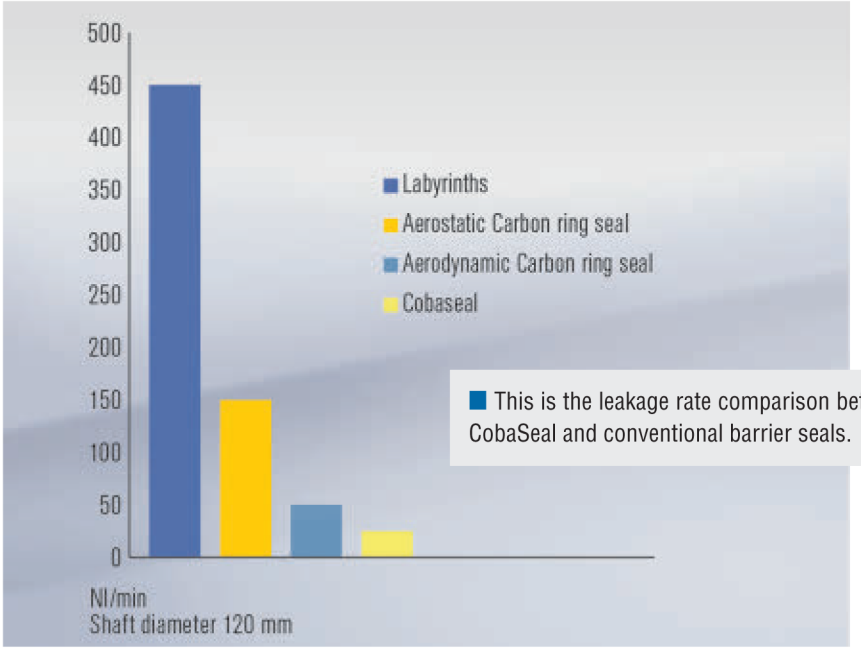
■ The seal function of the EagleBurgmann CobaSeal during dynamic operation is shown.

a nitrogen-buffered carbon ring barrier seal, has been the industry standard.

The dry gas seal performs the principal sealing function, while the carbon ring seal protects the dry gas seal against bearing oil contamination and guards against compressor gas contamination of the bearing brackets.

"At Nether Kellet, bearing oil leakage over the existing barrier seal was contaminating the dry gas seal, causing an undesirable level of unplanned compressor down time as well as a loss of nitrogen pressure during pressurized standstill periods," said Ferdinand Werdecker, head of compressor seals engineering at EagleBurgmann.

"The loss of pressure resulting from the distortion of the carbon ring segments of the seals is linked to low pressure cycling in the pipeline. Low pressure cycling is part of normal pipeline operations and is unavoidable."



This is the leakage rate comparison between CobaSeal and conventional barrier seals.

CobaSeal solution

In 2010, National Grid and Siemens Energy asked EagleBurgmann to help develop a better solution. The customers envisioned a barrier seal design that would tolerate vibrations from high gas film stiffness and assure contact-free operations in all operating modes.

They also wanted the design to be sufficiently robust to eliminate the issue of broken sealing rings. There would be no oil leakage during standstill or low roll operations, gas leakage prevention would be assured, and the new design would boast very low nitrogen purge gas consumption and fluctuation, thereby reducing operating costs.

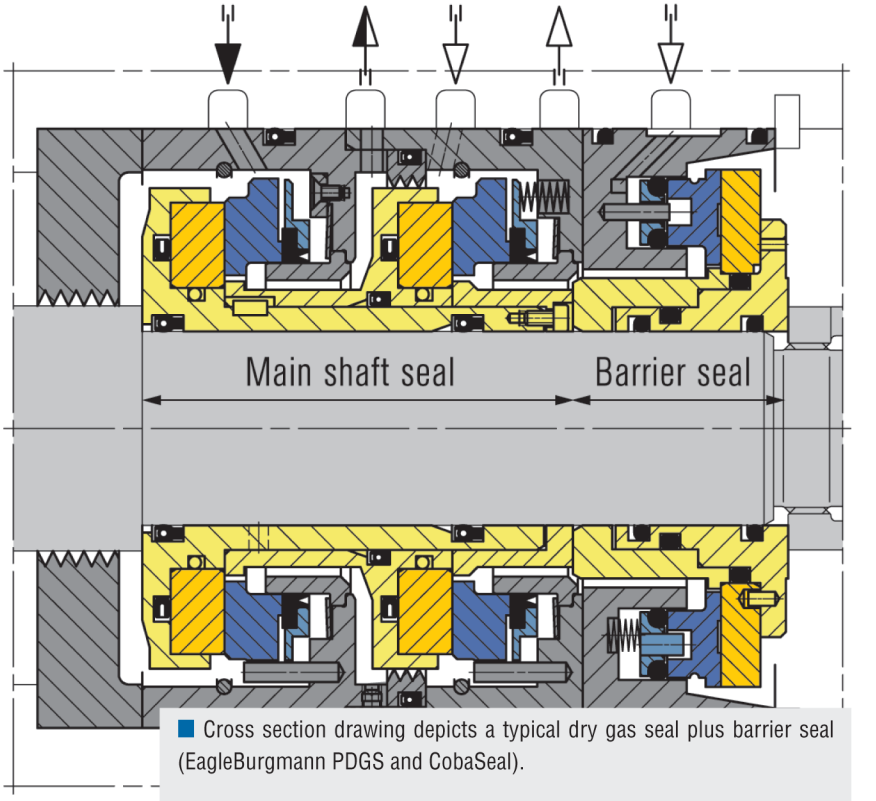
Nitrogen is used at a minimum temperature of -122°F (-50°C) to ensure the carbon rings have sufficient sliding capability for the aerostatic barrier

seal to achieve liftoff from the compressor shaft after stoppages.

EagleBurgmann said its solution was an industry first: a conventional dry gas seal in tandem with the newly designed coaxial barrier-type seal, which substitutes for the existing carbon ring seal.

Similar to a dry gas seal, the CobaSeal has a rotating ring made of ductile material and a spring-loaded stationary face made of silicon carbide, both covered with a high-performance coating.

The nitrogen separation gas is routed into the seal by using axial bores through the stationary face into the middle of the rotating seat. The purge gas then separates into two leakage flows: one to the inner diameter towards the secondary vent; the other to the outer diameter of the seal face towards the bearing chamber.



■ Cross section drawing depicts a typical dry gas seal plus barrier seal (EagleBurgmann PDGS and CobaSeal).

Contact eliminated

The aerostatic liftoff design separates the rotating and stationary seal faces as soon as the CobaSeal is pressurized and leads to a wear-free operation.

The stiff gas film eliminates the risk of contact between the rotating ring and stationary seal face during irregular operations such as axial vibrations or micromovements of the compressor shaft.

The CobaSeal has no restrictions with regard to “slow roll,” “turning gear”

and "coast down" operations of the compressor that are integral to the demand-driven requirements of a major gas delivery network.

EagleBurgmann said the design allows operating pressure of up to 145 psig (10 barg) in the vent line combined with differential pressure control, which is an additional safeguard against a total failure of the tandem seal arrangement. Also, the risk of process gas leakage towards the bearing brackets is eliminated.

The design underwent extensive shop testing, including the simulation of upset conditions as well as operations at maximum design specification.

The seal was tested first for EagleBurgmann's specifications and then subjected to a witness and acceptance test created for field conditions at National Grid.

Werdecker said all tests were successful, including the simulation of a total failure of the dry gas seal in combination with the pressure-controlled supply of the coaxial seal barrier.

"After all testing, the seat and faces of the tested coaxial seal were in like-new condition," Werdecker said. "There were no contact marks, demonstrating that the maintenance of separation, essential for extended safe, continuous operations, worked as intended."

Field results

That has continued to be the case at the Nether Kellet station since the August 2011 installation of a CobaSeal on a compressor with a 4 in. (102 mm) shaft circumference.

"The unit has been subjected to a wide range of operational conditions including surge trials, and normal starts and stops, both running and starting trips, and has clocked in excess of 1300 operating hours," said Huub de Bruijn, head compressor service product manager at Siemens Energy.

"From an operational standpoint, the coaxial barrier seal has done exactly what National Grid hoped to achieve: most notably achieving improved compressor availability with extended maintenance intervals. Since installation, unplanned compressor downtime has basically been zero," he said.

Mike Marcinko, National Grid's responsible asset engineer, agreed. "In general, the operation of the CobaSeal is already proving to be a success," he said. "There has been a lot of start-stop operating including emergency shutdown trips and it has endured the harshest of tests: performance testing of the compressor during which time the actual surge line was plotted. There has not been one issue with its operation since installation."

EagleBurgmann said nitrogen consumption is less than half of the rate for a carbon ring seal, in line with results from predelivery testing. And there has been no evidence of lube oil in the secondary vent line of the compressor. All of this suggests National Grid can expect wear-free seal operation with maintenance intervals extended up to 10 years.

The company said its CobaSeal design can be adapted to all standard seal cavities. Siemens Energy has certified the design for use with its compressors and EagleBurgmann plans to have it certified by other compressor manufacturers for applications throughout the industry. CT2