EagleBurgmann
a member of EKK and FREUDENBERG

RELY ON EXCELLENCE

Ultra-high-pressure PDGS compressor seal for CO_2 gas reinjection on FPSO

Proven reliablity in CCUS application (EOR) for ten years

The Lula oil field off the coast of Brazil is one of the largest oil discoveries in recent years. The oil is extracted using FPSO (Floating Production Storage and Offloading) platforms. EagleBurgmann set a new standard on the Tupi 4 production platform with its PDGS seal. The gas-lubricated mechanical seal was designed for the highest static pressure which had ever been certified for ultra-high-pressure gas reinjection in its time.

The operator, a world leader in the field of CO_2 gas reinjection, posed a new challenge for the engineers at EagleBurgmann in 2013. The operating point of the compressors had to reach the unprecedented peak value of 428 bar(g) (6,206 PSIG).

Discovered in 2006, the Lula oil field is located in the Santos Basin, off the coast of Rio de Janeiro, Brazil, about 250 kilometers to the southwest. The ocean is roughly 2,000 meters deep at this point. The oil and gas-bearing strata lie 4,000-5,000 meters below a layer of rock and salt, called the "pre-salt". The recoverable oil and gas deposits are estimated at a volume of 5.5 billion barrels. Lula has been tapped into on a large scale since 2008 with FPSO vessels like the Tupi 4.

The deeper below the seabed the drilling is done, the stricter the requirements on rig operators for process pressure to maintain the strong and constant flow of crude oil needed to justify the immense costs of development and license fees. So in this project, every extra bar counts.

Advance into a new range of pressure

The operating pressure exceeded the limits of all seals used in all ultra-high-pressure applications of this kind to date.

The pressure is reached when the system starts up, shuts down, and whenever there is a balance between inlet and outlet pressure at standstill pressure (settle-out pressure). The aim was to create an effective mixing zone needed to bring the crude oil to the production well. The seal also had to be designed for a maximum speed of 13,844 rpm.

CO_2 reinjection on Tupi 4

On the Tupi 4 oil platform, supercritical carbon dioxide (sCO_2) is accumulated as an unusable by-product. Since environmental concerns prevent it from being vented to the atmosphere, the operator decided to use the gas as an injection medium. It is therefore injected into the ground instead – and it also poses a more economical alternative to water as an injection medium. This approach, that is, carbon capture, utilization and storage (CCUS), is considered worldwide to be a major component of a solution for achieving net zero by 2050. This makes CCUS ever more important to reduce the impact of greenhouse gas emissions (GHG).

CASE STUDY

- **Reference:** CO_2 gas reinjection, Brazil
- **Client:** Major exploration & production company
- **Industry:** Oil & gas (upstream)
- **Challenge:** Extreme mechanical load on the compressor seal due to process pressures of up to 428 bar(g) (6,206 PSIG)
- **EagleBurgmann services:** Engineering, implementation and local support
- **Technical solution:** PDGS high-pressure compressor seal

The solution: Proven tandem PDGS with intermediate labyrinth as application-specific design adaptation.

Seal with new peak performance

In developing the seal concept, the engineers at EagleBurgmann opted for the PDGS compressor seal, which was designed for such applications, placing it here in a tandem arrangement with intermediate labyrinth. This arrangement represents the best technical concept for ultra-high process pressures in gas reinjection.

However, several different goals needed to be reconciled when designing the seal to achieve the best possible result. The leakage rate had to be kept as low as possible while keeping the torque stable during start-up. The engineers had three main points to work on to achieve this:

- The functional gap between the balance sleeve and the support ring of the dynamic secondary seal was minimized as much as possible while still retaining free movement under all operating conditions.
- The shaft sleeve was designed to be divided so as to ensure maximum stability, even at high axial loads.
- Finally, a material suitable for the extraordinary mechanical loads was selected for rotating and stationary seal face. Specially sintered silicon carbide provides maximum strength and boasts optimal heat conductivity. In conjunction with the soft torque of the transmission technology, this makes the sealing surfaces resistant to contamination and high pressure.

Advantages of the PDGS

The PDGS is a time-tested series of seals for applications at high pressures as well as extremely low and high temperatures, like those in gas reinjection. Innovative design features make it possible to handle even the highest pressures. The use of U-cups and special dynamic sealing elements opens up a broad spectrum of applications.

- Ready-to-fit cartridge unit
- Any application-specific seal arrangement possible
- Wear-free and contact-free operation
- Self-cleaning 3D gas grooves
- High gas film stiffness
- Secure cupped retainer for seat
- Available in various materials for optimized chemical resistance

Result

The performance of the EagleBurgmann PDGS mechanical seal was so convincing that two main and two backup compressors on Tupi 4 have now been equipped with two seals each since the initial installation 10 years ago. The seals were last inspected in 2016. All of them still exhibit top performance values.

The latest qualification of the PDGS series now leads to pressures of up to 650 bar (9427 PSI). The operator is now planning to use the PDGS on further FPSO platforms.

Extensive tests at both the EagleBurgmann R&D center and the compressor manufacturer showed that the seal is extremely reliable during both system start-up and shutdown as well as in continuous operation under full load. The high availability of the compressors is guaranteed alongside minimal leakage in spite of the ultra-high pressure.

The outstanding results are also proven in operation.

Further information on PDGS

EagleBurgmann – at the leading edge of industrial sealing technology

Our products are used wherever safety and reliability count: in the industries of oil & gas, refineries, petrochemicals, chemicals, pharmaceuticals, food, energy, water and many more. About 6,000 employees contribute their ideas, solutions and dedication every day to ensure that customers around the globe can rely on our seals. With our modular TotalSealCare Service, we emphasize our strong customer orientation and offer custom-tailored services for every need. **Rely on excellence.**

eagleburgmann.com
info@eagleburgmann.com