

# Reliable Solutions

Technical and economical improvements



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Focused on economical efficiency, reliability and safety



Usually, compressor modifications are carried out because of adaptations to new operating parameters. However, in cases of ongoing operational difficulties or problems in procuring components of auxiliary systems, modernizations are playing an important role to keep plant reliability as high as possible.

With the focus on technical and economical efficiency, as well as reliability and safety, MAN PrimeServ was able to supply a customer in a petrochemical application with a modernization of the obsolete oil-lubricated shaft sealing system to a state-of-the-art dry gas sealing system.

## **Project goals**

Two compressor trains in a hydrogen-recycle and a carbon monoxide gas application had to be modernized. The original oil-lubricated shaft sealing system from the early 70s had to be replaced. Due to increased maintenance expenditure and difficulties in procuring spare parts for the existing instrumentation and components such as pumps, valves, filters and seals, MAN PrimeServ was entrusted to supply a new

and reliable solution. Other important considerations included the environment and the customer's technical and economic expectations.

## **The MAN PrimeServ solution**

The compressor trains consist of two compressor casings each (a total of three horizontally split compressors and one barrel-type compressor). MAN PrimeServ's recommendation to the customer was to



*Typical dry gas seal cartridge*



*Old oil-lubricated shaft sealing instrumentation and monitoring rack*



*New dry gas seal instrumentation and monitoring rack*

convert the compressors from the old wet shaft sealing system to state-of-the-art dry gas seals (DGS) due to reliability and health, safety & environmental (HSE) considerations.

The complete scope of supply included the tandem dry gas seal (DGS) cartridges with accessories and one DGS instrumentation and monitoring panel per compressor train.

Furthermore, complete detail engineering, all necessary modifications of the casing and the compressor rotor including inspection and high-speed balancing, were provided. The modifications of the compressor rotors were carried out on the spare rotors just before the plant shutdown to minimize the risk of plant shutdown without spare part coverage. The available time frame to convert the four compressors from wet seals to dry gas seals was a 4-week plant shutdown. Within this time frame, the casing modifications were carried out, redundant piping and parts of the shaft sealing systems had to be removed and the new dry gas seal instrumentation and monitoring rack had to

be installed. Additionally, a general overhaul of the compressors and the plant was performed.

#### **Project results and customer benefit**

The benefits of this modernization project are improved plant reliability and environmental considerations:

- very low process gas leakage to a designated area
- energy savings due to lower power consumption compared to the oil-lubricated shaft sealing system
- no more difficulties in procuring spare parts
- simple and almost maintenance free instrumentation and monitoring panel
- disposal of contaminated seal oil no longer necessary

#### **Dry gas seal technology**

For compressors equipped with dry gas seals (DGS), the correct operation of the sealing system is mandatory. The whole system for the distribution and control of the seal gas, the buffer and the separation gas is arranged in the dry gas seal control rack, containing the piping, filters, valves, manifolds and local instru-

ments. The control and safety functions as well as the monitoring and alarming of the various measured parameters are performed by a control/monitoring system (PLC or DCS) located in a remote panel (preferably in a safe area).

### **Seal gas supply**

The seal gas which is used for feeding the inner DGS is tapped from a source with higher pressure than the compressor suction in order to always have a positive seal gas flow across the inner gas seals and the labyrinths (back to the compressor suction). By means of an orifice, the gas is throttled from source pressure to slightly above compressor suction pressure. The gas is filtered in the seal gas filter (double change-over type). If possible, the seal gas is tapped after the 1st or 2nd impeller on the compressor casing. This enables the use of superheated (dry) seal gas. Alternatively, the seal gas may be taken from the compressor discharge at higher pressures and temperatures.

During a compressor standstill and pressurised (i.e. settle out) conditions, the temperature in the DGS cartridge close to the inner DGS on the suction side is monitored. This is to avoid cooling down of the seal cartridge (Joule-Thompson effect) followed by the possible formation of liquids, hydrates or ice. A restart of the compressor under these conditions could damage or destroy the DGS.

### **Inner leakage**

The inner leakage to the flare (out of chamber "C") is a mixture of seal gas coming from the inner DGS and buffer gas (i.e. nitrogen) from the outer DGS chamber "D". The pressure in the inner leakage line is kept constant by the backpressure control. It is controlled at about 1 bar (15 psi) above the maximum flare backpressure.

Each of the inner leakage/buffer gas lines is equipped with pressure rupture discs in order to route large

process gas leakage flows to a safe location in case of an inner seal failure or a total seal failure. An uncontrolled process gas flow to the vent or, even worse, via the separation seal to the oil system is prevented.

### **Buffer gas supply**

The buffer gas (nitrogen) must be dry and clean and is supplied from an external source. A buffer gas filter will be required if the supplied nitrogen contains particles bigger than 5 microns. The buffer gas injection in between the seals prevents process gas from leaking to the outside (i.e. via outer leakage to the vent). It also keeps the outer seal in a dry and clean environment. This prevents the build-up of deposits (fouling) and reduces the risk of a sticky outer seal. In the case of a high(er) leakage across the outer DGS, the pressure upstream from the flow restriction (segmented carbon ring) will rise. The backpressure created by the inner carbon ring can be measured and the system integrity can be verified.

### **Overhead vent**

The buffer gas and a part of the bearing separation gas is collected in chamber "F" and fed via a common pipe to the overhead vent. During normal operation of the intact DGS, the gas flows to the vent will be pure nitrogen.

### **Bearing separation gas supply**

The bearing separation gas of the separation seal segregates the DGS cartridge from the bearing housing and therefore prevents oil from penetrating into the gas seals. Additionally it keeps the whole oil system under a continuous nitrogen blanket. According to MAN PrimeServ's safety strategy, the use of nitrogen as separation gas is vital. It prevents the build-up of an explosive gas mixture in the case of a seal malfunction or failure. Due to the specific design of the separation seals the use of nitrogen is minimized.

# Technical Data

Seal type	Max. pressure rating per seal cartridge operation/test		Notes
	Static (bar)	Dynamic (bar)	
Double	25/30	20/25	1
Tandem	60/82	60/82	1
Tandem	300/350	240/300	2, 3

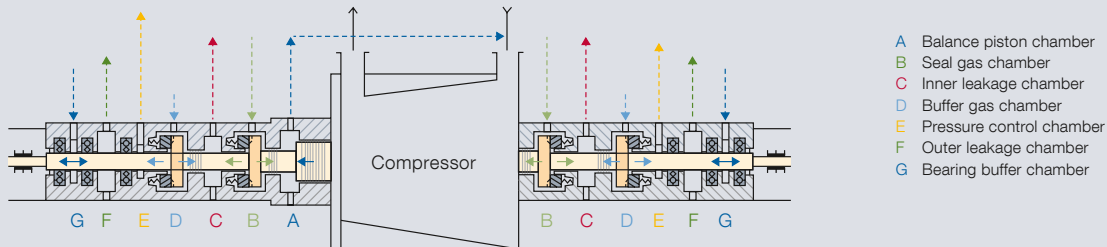
Notes

1\_Seal cartridge with elastomer seals

2\_Seal cartridge with elastomer-free seals

3\_Given pressure ratings may differ depending on gas compositions (dew point, MW, density, water content etc.) and technical development

## Dry gas shaft sealing system (tandem seal nitrogen buffered)



## Standard P&I diagram of a dry gas shaft sealing system (tandem seal nitrogen buffered)

