SEPARATION SEAL UPGRADE TO O vercome Repetitive Failures

Author: Rasgas

Pradip B Sonavane
(Senior Engineer - Rotating Equipment)

AbdelKhalek, Mohamed H
(Advisor - Rotating Equipment)

Quraisy Shatri
(Head of Maintenance - Machinery & Reliability)
Objectives

- Trouble shooting of Separation seal failures.
- Reference for DGS design selection at Project stage.
- Share experience with audience for improved DGS performance (in certain applications).
Separation Seal Upgrade to overcome Repetitive Failures
Problem

- Repetitive failures of Separation Seal (Contacting Design type).
- Flooding of main gas seal with lube oil.
- Excessive leakage of lube oil from DGS cavity drains.
- Lube oil accumulation at Primary & Secondary vent lines.
- Lube oil & vapors mixture seepage to buffer gas skid filters.
Events’ Summary

- **Cracked mating ring – in to 7 pieces (Sept 2000).**

- First modification made on 18/28-K001/2 FG Compressor Gas Seal Cartridges (Year 2000) was:
  1. Adding O-ring at locking-sleeve / collar between items 11 & 13; to prevent oil migration.
  2. Increase annulus area --- around outboard retainer between O-rings 33 and 34 --- to reduce flow restriction thus preventing possible reversed pressure.

- **This has reduced failure frequencies due to oil migration but still at a level of unacceptable MTBF.**

Separation Seal Upgrade to overcome Repetitive Failures
Events’ Summary

- Frequent seal failures in Fuel Gas Compressors, experienced over 12 years of operation.
- 9 sets of DGS were replaced on 4 units in last 4 years.
- Lube oil migration is monitored for quantity, color, and debris.
- Separation Seal Gas supply Nitrogen pressure was increased gradually from 0.45 (design) to 0.9 barg.
- About 50 to 150 ml/day accumulated lube oil being drained on daily basis from seal cavity.

Separation Seal Upgrade to overcome Repetitive Failures
Equipment Details

Compressor

- **Service**: Fuel Gas Compressors
- **Type**: LP (MCL) & HP (BCL)
- **Model**: MCL 9H-7C (LP Compressor)
  
  BCL 5V-8B (HP Compressor)
- **Max working pressure**: 7 barg (LP) & 29 barg (HP)

Dry Gas Seal

- **Gas seal**: Tandem 28AT Model
- **Separation seal**: Contacting type, (T82)
- **Size**: 7.625” (for LP), 6.625” (for HP)

Separation Seal Upgrade to overcome Repetitive Failures
Separation Seal Upgrade to overcome Repetitive Failures
Observations & Findings

- Lube oil accumulation inside seal bore
- High/hard spots
- Sharp edge / Irregularities
- Oil film on Secondary seal ring faces

Separation Seal Upgrade to overcome Repetitive Failures
Observations & findings

- Worn out seal rings
- Separation seal carbon segments in damaged and dislocated condition
- Carbon deposit

Separation Seal Upgrade to overcome Repetitive Failures
Observations & Findings

- Excess oil collected from both Primary & Secondary drain line
- Oil reached up to primary vent line
- Oil collected from vent line drain points

Separation Seal Upgrade to overcome Repetitive Failures
Observations & Findings

- Lube Oil migration issue found more severe at NDE (Thrust Bearing) relative to DE (Non Thrust) DGS assembly.

Separation Seal Upgrade to overcome Repetitive Failures
Root Cause Failure Factors

- Dusty climate effect on breather element function. (Equipment Strategy)
- Location of the oil-vapor extraction point from bearing housing
- Lack of physical restriction like baffle/deflector/labyrinth between bearing and separation seal.
- T-82 separation seal design does not work properly for compact Bearing Housing, where extraction of oil-vapor mixture is ineffective
Solution

Available Options

Option-1
Compressor / system retrofit
- Bearing housing modification:
- Maintenance Strategy upgrade
- Improving QA / QC for the new spares

Considered secondary for implementation

Option-2
Separation seal upgrades

Sequence of schemes considered:
1. Original seal (T-82) with oil deflector
2. Enhanced seal design (T-83)
3. T-83 with oil deflector.
4. Labyrinth seal design.
5. Non-contacting seal design (T-93FR).
6. T-93FR with oil slinger/deflector.

Implemented Successfully

Separation Seal Upgrade to overcome Repetitive Failures
Design Features of selected T-93FR

- Non-contacting for longer life and improved reliability.
- Bi-directional.
- Suitable for running with N2 separation gas irrespective of dew point.
- Self-centering design minimizes wear even during upset conditions.
- Robust cartridge design.
- Low heat generation, hence reduce coking.
“Upgrade existing DGSs to available technology of Non contacting type Separation Seal (T-93FR) with Oil Slinger / Deflector provision followed by related modifications in Main Gas Seal”

Options considered at RasGas to phase out the existing T82 Separation Seal with T93FR Separation Seal, but with Oil Slinger / Deflector provision to solve this oil migration issue.

This enhanced design was so far running successfully at RG.
New seal T-93FR drawing

Separation Seal Upgrade to overcome Repetitive Failures
1. **N2 Pressure Regulator:**

   T-93FR is designed to operate at low N2 pressure from 0.02 – 0.25 bar, while the old T-82 was in operation with higher range from 0.25 – 0.75 bar.

2. **N2 Gas Flow Meter:**

   With T-93FR seal system, N2 flow rate consumption will increase as per followings:-

   - Original T-82 range : 2 - 5 NM3/HR
   - T-93FR, cold static Range : 8- 12 NM3/HR
   - T-93FR, hot dynamic : 2 – 4 NM3/HR

---

Separation Seal Upgrade to overcome Repetitive Failures
New Seal T-93FR – Few Snap Shots

- Oil slinger (deflector)
- Bearing installation
- Bearing assembly

Separation Seal Upgrade to overcome Repetitive Failures
Separation Seal Upgrade to overcome Repetitive Failures
DGS Performance Monitoring

Separation Seal Upgrade to overcome Repetitive Failures
Conclusion

- DGS Upgrade with Floating Ring / Non Contacting Type T-93FR Separation Seal has so far successfully solved the Lube Oil Migration / Ingress issue.

- Oil Slinger provision along with Dual Segmented Floating Carbon Ring T-93FR Cartridge Assembly has proven as effective barrier between Main Gas Seal and Bearing Housing.

- This upgrade was carried out without any modification works on Compressor side.

- T-93FR Non contacting Type Separation Seal performance observed to be significantly better in comparison with T-82 and T-83 contacting type Separation Seals.

- Successful prototype implementation based on full OEM and End User contribution
Thank you !!

Questions ??