Successful Implementation of Dry Gas Seal in High Pressure Recycle gas Compressor at Hydrocracker & Effect of Gas composition on DGS Performance
Why - Dry Gas Seal???

- M&I shutdown and Catalyst replacement once in 3 years.
- The life of wet seal rings system - 1.5 years to 2 Years (bottle neck)
- Unplanned shutdown resulted in loss of production and profitability.
- Enhancement of wet seal ring life is not possible; The Wet Seal system is obsolete.
- Latest Compressors are currently fitted with Dry Gas Seals.
Wet Seal failure

FAILURE OF HP SEAL RING – DISCHARGE SIDE - DRIVE END

FAILURE OF HP SEAL RING – SUCTION SIDE - NON DRIVE END
Wet Seal failure

SEVERE BABBIT PEEL OFF IN OUTBOARD LP SEAL RING

WORNOUT BABBIT LINING IN LP SEAL RING – DRIVE END
Wet Seal Vs Dry Gas Seal

**WET SEAL SYSTEM**

- Comprise of oil rings, pump, degassing unit, oil reservoir, overhead tank
- Limited life span - 2 years
- Frictional loss of 1 - 2% of compressor shaft power
- Leakage to flare: 40 to 200 scfm
- Lead to unplanned shutdown

**DRY GAS SEAL**

- Comprises of Dry Gas Seal cartridges, DGS rack
- Life over 5 years between overhauls
- Negligible frictional loss
- Minimum leakage to flare: 0.3 to 4 scfm
- Enhanced Eqpt. Reliability and Unit Availability
DGS - Techno-Commercial Benefits

Operating Cost

- Less Power Loss due to gas shear forces.
- Energy required to operate the Seal oil pumps & Auxiliaries are totally eliminated.
- Seal oil consumption – NIL

Maintenance Cost

- No Seal oil Pumps, Valves, Coolers, Reservoirs and Overhead tanks
- Instrumentation.

Gas Recovery Cost

- Due to very small clearance (3µ) between the stationary and rotating faces, leakage of gas to flare could be reduced to 0.3SCFM - 4 SCFM.
Seal Oil Area
Compressor & Instrument Panel
**DRY GAS SEAL SCHEMATIC**

- **EXTERNAL GAS**
- **FILTER MODULE**
- **PROCESS GAS**

**Filtered Process Gas**

- **N₂ Separation Gas**
- **Filtered N₂ Buffer Gas**

- **Process Gas + N₂ to Flare**

- **N₂ to Atmosphere**

**N₂ SECONDARY FILTER MODULE**

**VENT**

**FLARE**
Dry Gas Seal Layout
Dry Gas Seal Installation

Seal Oil Console dismantled
Dry Gas Seal - Installation

New Bundle shifting to position

New Bundle Assembly in progress
Dry Gas Seal Installation

DGS Rack Erection/ Leveling Completed
Compressor loop test

- To verify the mechanical integrity, a mechanical run test was conducted.

**TEST PROCEDURE:**
- System has to be pressurized with $N_2$ to 400psig
- Test speed - 8,000 RPM for minimum four hours

**PROJECT COMMISIONING**
- DGS Retrofit activity completed on 22\textsuperscript{nd} June 2012
- C-14-101: Commissioned on 22\textsuperscript{nd} July 2012
- C-14-102: Commissioned on 7\textsuperscript{th} August 2012
DGS Performance after Commissioning
Dry Gas Seal Performance

C-14-101 is in continuous operation since commissioning in June 2012

=> Zero failure in 30 months and counting……

➢ MTBF with Wet Seal system was only 18 months
Dry Gas Seal Failure

C-14-102 experienced DGS failure 4 times between June 2012 & up till now.

- Moisture inside filter housing
- Primary seal gas filter – Hydrocarbon deposit
- Condensate on Seal Faces
DGS Failure - DPT & Joule Thomson Effect

- **Dew Point Temperature (DPT):**
  - DPT is the temperature at which the Gas mixture will start to condense into Liquid.
  - Process Gas composition & Pressure affects the DPT

- **Joule Thomson Effect:**
  - Gas Pressure reduction leads to Gas Temperature reduction.
### Process Gas Composition: FEED Vs Actual

<table>
<thead>
<tr>
<th>GAS</th>
<th>FEED Data</th>
<th>Revised Data</th>
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<tr>
<td>Nitrogen</td>
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<td>I-Pentane</td>
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<tr>
<td>n-Hexane</td>
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Root Cause Analysis of Failure.....Conclusion

✓ Seal gas temperature is too close to the Dew Point Temperature (DPT).

✓ C6+ hydrocarbon due to the pressure drop across filters, orifices and between seal faces resulted in condensation due to “Joule – Thompson” effect;

✓ Condensate increased the friction between the seal faces that led to “Dry Gas seal Failure”.

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Effect of Gas Composition on DPT

Phase Envelope / Saturation Lines

FEED data Gas Composition

- Phase Envelope
- Saturation Line
- Isenthalp
- Isenthalp +20 K
- Process Points
Effect of Gas Composition on DPT

Phase Envelope / Saturation Lines

Actual Gas Composition
Solution - Improve Seal gas Temperature

**Short Term**

- Steam jacketing.

**Long Term**

- Use of electrical seal gas heater.
Steam Jacketing

FABRICATED STEAM JACKET TO IMPROVE EFFICIENCY OF SEAL GAS HEATING

Primary Seal gas Pre-heating by Steam jacket up to 1.6 metre

Steam Jacket DE Side

Steam Jacket NDE Side
DGS – Electrical Heater

Installation of Seal gas Electric heater

• A proven methodology to avoid Seal Gas condensation.
• The system consist of:
  • Electrical heater
  • Thyristor control unit in the control room.

System Description

• Heater outlet seal gas temperature signal given to the thyristor.
• The heater is only in service, if there is a certain gas flow, detected by the existing FI.
• A temperature sensor built into the heater monitors the block temperature and switches off the thyristor on set-point values.
• The condition of heater, thyristor, seal gas temperature, etc…is signalized in the DCS system.
Non-return Valve in DGS rack
Typical Electrical Heater Assembly
Conclusion

✓ Dry gas seal performance greatly depends on the process gas composition.

✓ Hence, it is imperative that all precautions are taken to ensure that gas composition in FEED data is accurate, so that unforeseen failure of seal gas condensation be avoided after commissioning.
Thank You!