Flow Solutions Group

Compressor Products & Services – Reduction of Methane Emissions

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Today’s Agenda:

• Environmental Benefits of Retrofitting From Wet to Dry Gas Seals

• Flowserve Compressor Blow Down Gas Recovery System

• Summary of Flowserve Global Compressor Products & Services
Gaspac Dry Gas Seals in single/dual/tandem configuration

- Leading in high pressure applications up to 450 bar
- Leading in high speeds: slow-roll up to 240 m/s (800 ft/s) \[ \sim 850 \text{ km/h (530 miles/hr)} \]
- Leading in high temperatures: -135 C up to 230 C
- Big diameters up to 360 mm (e.g. for the LNG market)

Diameters 1.5“ – 14.5“
ADVANTAGES: DRY SEAL VS OIL SEALS

- Reduced operating costs
- Increased reliability
- Increased efficiency
- Maintenance advantage
- Improved safety
- Environmental impact
JUSTIFICATION PROCESS

TANGIBLE FACTORS

- Oil Consumption, waste management
- Compressor and auxiliary efficiency
- Maintenance, call outs and downtime
- Losses due to process contamination
- Fugitive emissions
**FUGITIVE EMISSIONS**

- Wet seals vent 50 to 100 times more than Dry Gas Seals

- Cost of vented gas from Wet seals can range $100,000 to $300,000 / year loss

- Environmental laws and governmental regulations could present additional costs:
  - fines
  - carbon tax
ECONOMIC JUSTIFICATION PROCESS

RECIRCULATION LOSSES
EXAMPLE OF WET SEAL EMISSIONS

- 80 MM @ $4.5/MSCF
  = $360K / Year
- 40 MM @ $4.5/ MSCF
  = $180K / Year
- 20 MM @ $4.5 / MSCF
  = $ 90K / Year
JUSTIFICATION PROCESS

INTANGIBLE FACTORS

- Lost production due to contamination
- Efficiency loss due to contamination of pipeline, exchangers, catalysts
- Safety and asset risk management
Compressor Seal Fundamentals

GASPAC
TANDEM SEAL WITH INTERSTAGE LABYRINTH = GASPAC L
Compressor Seal Fundamentals

The Modular System

Standard:
48 Basic modules for
30 to 350 mm shaft

High Pressure Standard 250 barg*:
12 Basic sizes for
50 up to 140 mm shaft

* Pressures up to 425 barg available

Product side = Atmospheric side

+ ~ 25 special sized modules, eg. for screw compressors
Common Sources of Vented Gas

- Compressor Dry Gas Seal Leakage
- Instrument Vented Gas: Relief Valves, Control Valves, Vent Valves
- Reciprocating Compressors: Leakage From Distance Piece
- Compressor Wet / Oil Seal Trapped Gas via Degasser Tank
**Typical Flow of Vented Gas in a Sealing System**

**DRY SEAL SYSTEM**
- Supply Gas: 100 SCFM/seal
- Recycled: 98 SCFM
- Vented: 45 SCFM/seal
- Entrained Gas: approx. 15%
- Wet or Dry

**WET SEAL SYSTEM**
- Gas Out: 300 SCFM/seal
- HP Degasser Tank
- Vented: 2 SCFM/seal
- LP Degasser Tank
- Entrained Gas: approx. 15%

**Comments**
- Wet seal systems vent 20 – 100 times more gas than dry gas seal systems.
Emissions Example: Mechanical Dry Gas Seals

- A pipeline compressor fitted with two 150 mm shaft seals operating at a pressure of 25 bar will leak approximately 120 Nl/min
- Assuming utilization factor of 0.8, in a year of operation, the compressor seals will contribute 4.2 million liters to hydrocarbon emissions

Source: Duke Energy Inc.
Vented Gas Recovery System

INTEGRATED PLC

VENT HEADER

Vessel

V1

K1

K2

Accumulator / Dampener

V2

Flow Monitoring of All Recovered Gases

TO PROCESS

Flowserve Corporation Proprietary and Confidential
System Description
System Description

• Available configurations to recover variable volume and pressure of vented gas

• Built in redundancy – two compressors providing non-stop operation

• Mean time between compressor maintenance (MTBCM) – not less than 12 month

• With built in redundancy (0.5 utilization factor) – MTBCM is not less than 24 month.
Draw Down Gas Recovery System

- At shutdown pipeline compressor and isolated piping contain, on average, 10 000 scf / 285 Nm3 of natural gas.

- This gas is usually vented into atmosphere.
**Technical Data:**

- **Minimum Drawdown Pressure:** Atmospheric
- **Recommended Drawdown Pressure:** 2 to 4 bar
- **Injection (Pipeline Pressure):** up to 400 bar
- **Operating Temperature Range:** +5 to +45°C
- **Compression Units Capacity:** 200 to 1200 L/min
- **Electrical Area Classification:** Class 1 Div. 1 and 2
Why Recover?

- Provides compliance with Kyoto Accord, eliminates emission and requirement to purchase additional credits

- Provides reduction in cost for HC emission reporting as per EPA 2011 requirements and provides compliance with future emission reduction legislations

- Provides compliance with pending Canadian Emission Control legislation

- Provides compliance with existing and pending EU Regulations (ER4, ER5 and ER6)
A Leader in Compressor Seal Solutions...

• Industry’s broadest core products and services:
  – Control Systems
  – Gas Conditioning Systems
  – Application Design
  – System Upgrades
  – System commissioning

• Conditioning systems
  – Large array of systems designed to solve unique problems
    • Dew point, pressure variation, particles
  – Cleanpac™, Drypac™, Ampliflow™
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Thank you for your attention.