Field Experience of Hydrophobic Membrane Filters for Corrosion Protection of Axial Compressor for Air Separation Plant

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Outline

- Case Study Background
- Root Cause
- Mitigation Strategies
- Test Results
- Conclusions
Case Study: Air Separation Plant, Nitrogeno de Cantarell

- Generates nitrogen for enhanced oil recovery (EOR)

- Capacity: 1500 mmSCFD (50000 t/d)

- 5 trains/axial compressors driven by 62,000hp electric motors

- 5 Power Plants, producing 360 MW of electrical power and 980 t/h of steam in total
Damaged Compressor Blades

- Corrosion lead to blade cracking and resulted in several blade liberation events
Root Causes

- Harsh environment
  - 6.5km (4 miles) from sea
  - Mist from salt water cooling tower
  - Flares and soot particles from nearby oil refinery

- Air intake problems
  - Fouling of compressor blades
  - Corrosion of parts
  - Binding of IGV bearings
  - Damaged compressor blades
Condition of Intake Air System

Clean side of filter contained corrosion and dirt particles.

Buildup of dirt particles, chemicals, iron (rust) that eventually passed through the silencers to the compressors.

Deposits on silencers appeared to be salt, iron and dirt, all contributors to compressor fouling.
Condition of Intake Air System

- Damaged Filters
- Misaligned Filters
- Gaskets not sealing on tubesheet
Mitigation Strategies

- Improvement of inlet filter house
- Installation of hydrophobic HEPA* filters

What is ePTFE?

- Expanded PTFE (poly-tetrafluoroethylene)
- High surface tension/high porosity
- Hydrophobic
- Water and salt resistant
- Air permeable

* High Efficiency Particulate Arrestor
Hydrophobic HEPA Filters

- E12 filtration efficiency
- Removes water and soluble salts
- 3 to 5 times costs of conventional filters
E12* Filtration Efficiency

Efficiency >99.5% at Most Penetrating Particle Size (MPPS)

* EN1822.2009
Water Tightness - AATCC 127 Test Method

Conventional Filter

Hydrophobic Membrane Filter

Pressure Ramps at 600 mmwg/min

Flooded in 15 seconds

1st Drop 2 min

Time Lapse Pictures
Case Study Air Separation Plant

• In early 2011, inlet filter houses refurbished and hydrophobic HEPA filters installed.

Cylindrical/conical hydrophobic HEPA filters with coalescers installed in refurbished inlet filter house.
Results

- Analytical data
  - chloride measurement
  - metallurgy

- Boroscope pictures
  - IGV bearings
  - compressor blades
Results

- After 4 months, MAC was shutdown for visual inspection. Results were astounding. Water washing stopped
- After 18 months run time, inspection revealed a highly remarkable reduction in blade fouling
- Intermittent rotor blade crack test inspections found no further incidents of blade cracking
Daily Pressure Drop Trend
Performance of Filters Measured in Laboratory

<table>
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<th>ASU Unit</th>
<th>Hours</th>
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<tbody>
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<td>MAC #1</td>
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Conclusion

- At one of the largest air separation plants, ingestion of drifts from the salt-water cooling towers and soot from nearby refinery lead to corrosion of the air compressor blades and binding of the IGV bearings.

- Improvement of the intake filter house and installation of hydrophobic membrane filters greatly improved reliability of the compressors by filtering corrosive particles and stopping water ingestion.

- Filters returned from the field were analyzed and the pressure drop increase, an indication of filter loading rate, was moderate.
Acknowledgement

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