



**43rd Turbomachinery
30th Pump SYMPOSIA**

GEORGE R. BROWN CONVENTION CENTER
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Field Experience of Hydrophobic Membrane Filters for Corrosion Protection of Axial Compressor for Air Separation Plant

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Outline

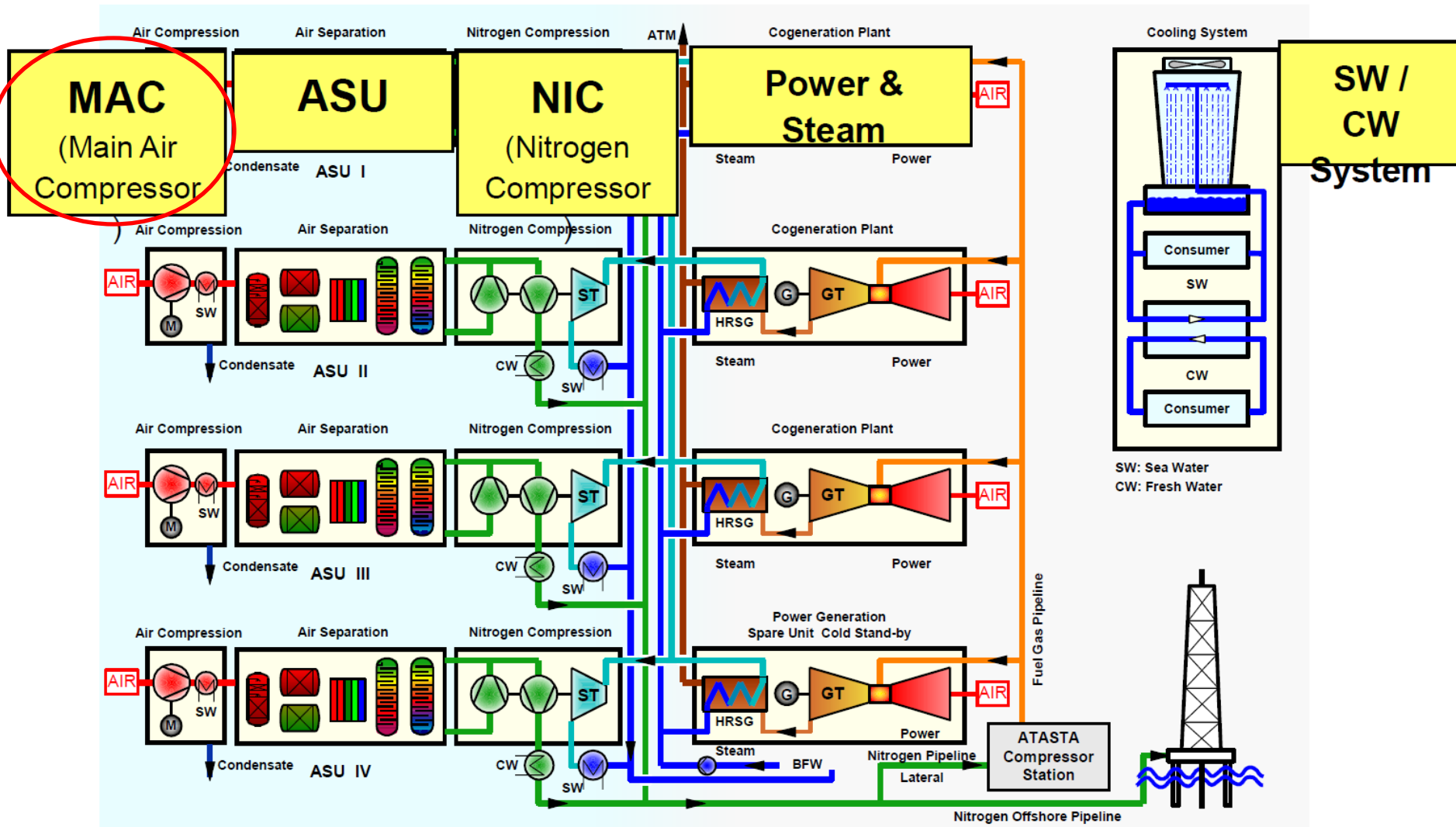
- Case Study Background
- Root Cause
- Mitigation Strategies
- Test Results
- Conclusions

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



ASU Simplified View, with Integrated Gas Turbine



Ref. Schueler, T. and Beysek, G. (2010) The proven cryogenic Air Separation Process adapted to the needs of CCS (IGCC & Oxyfuel). Inst of Chem Eng 10th Annual European Gasification Conference, Oct 4-6, 2010, Amsterdam, Netherlands

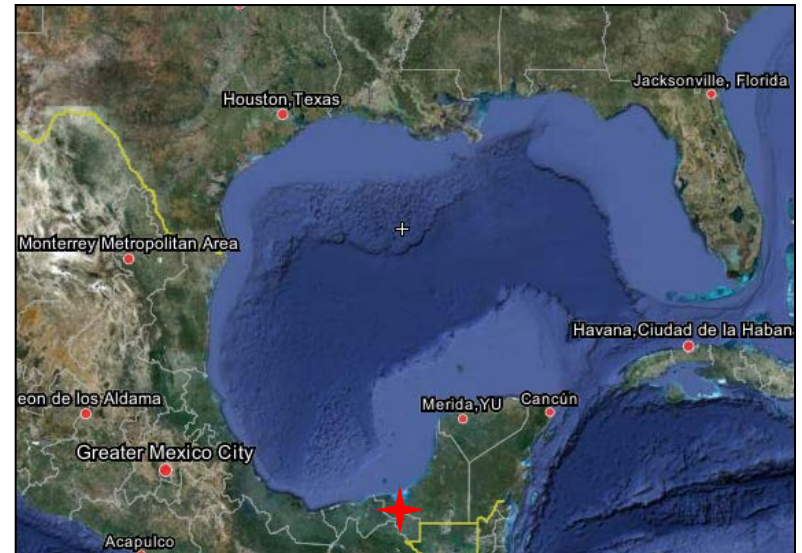
Damaged Compressor Blades

- 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



Gulf of Mexico – Arial View

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



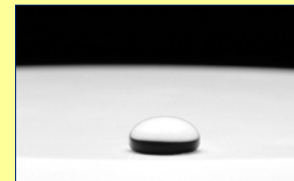
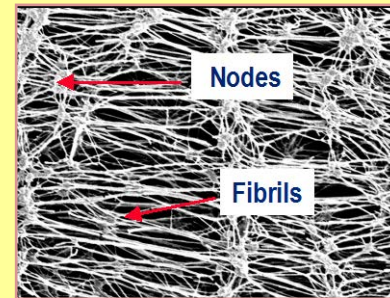
Gaskets not sealing on tubesheet

Mitigation Strategies

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

What is ePTFE?

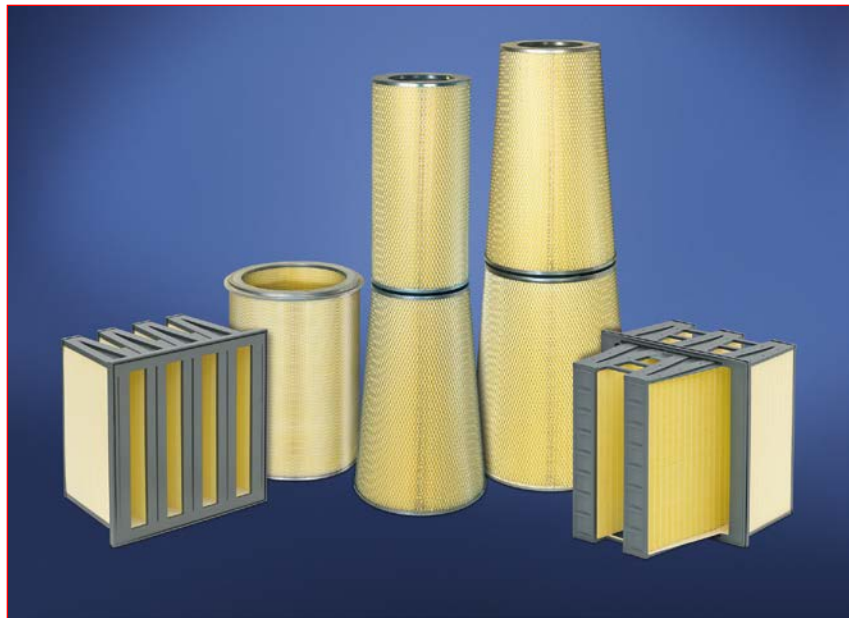
- Expanded PTFE (poly-tetrafluoroethylene)
- High surface tension/high porosity
- Hydrophobic
- Water and salt resistant
- Air permeable



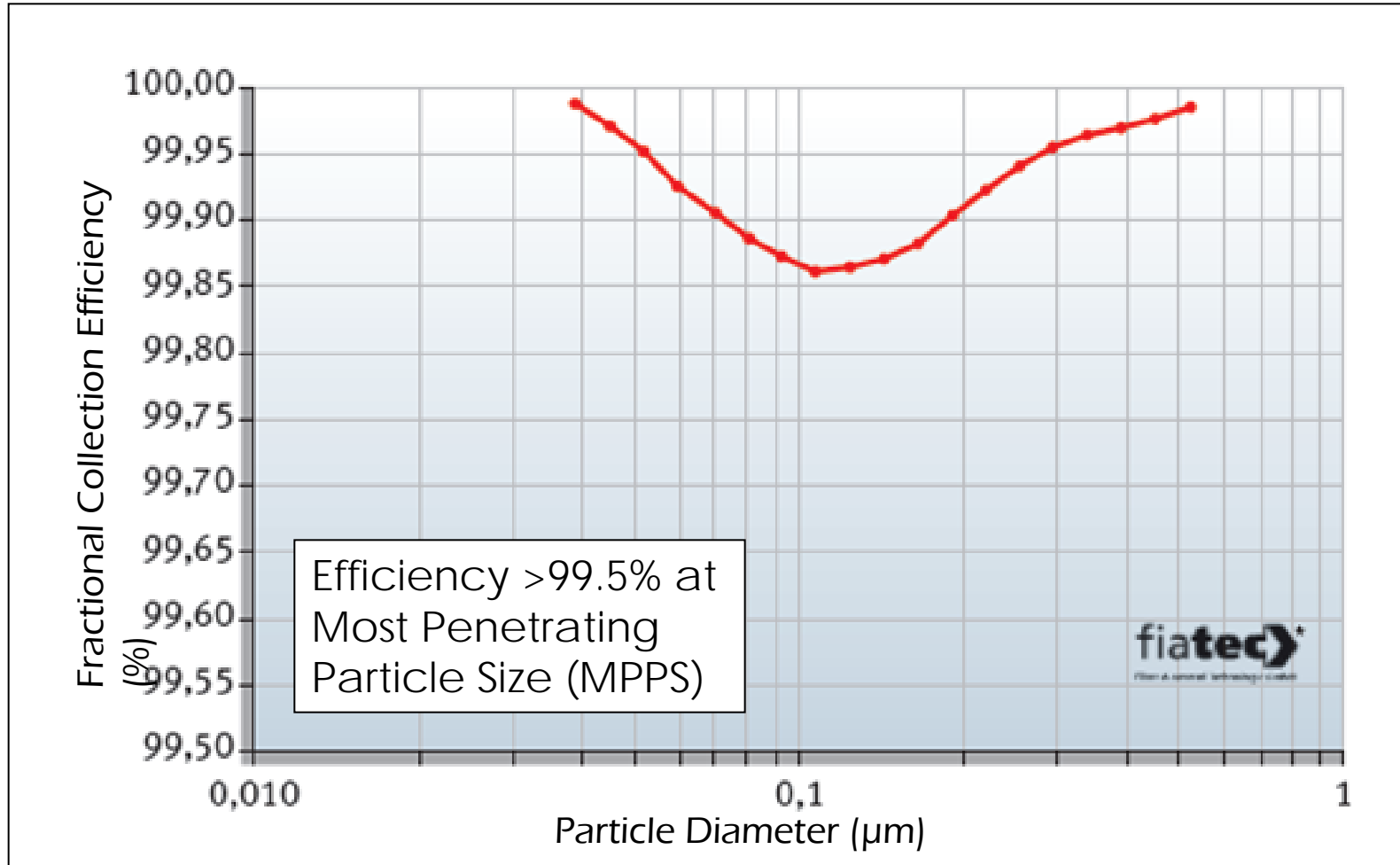
* High Efficiency Particulate Arrestor

Hydrophobic HEPA Filters

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

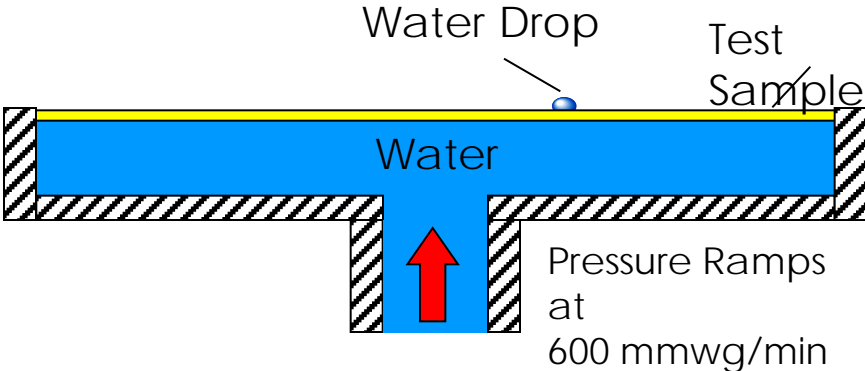


E12* Filtration Efficiency



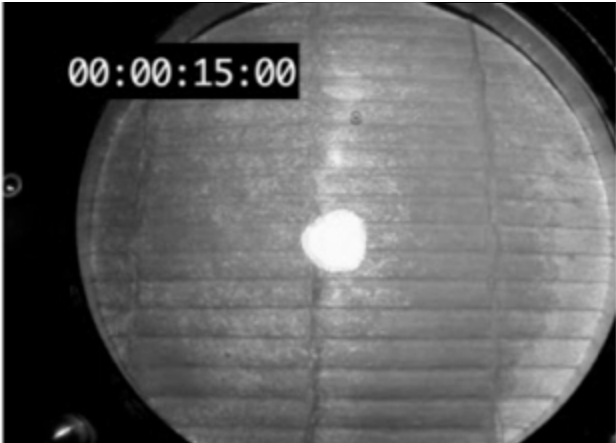
* EN1822.2009

Water Tightness - AATCC 127 Test Method

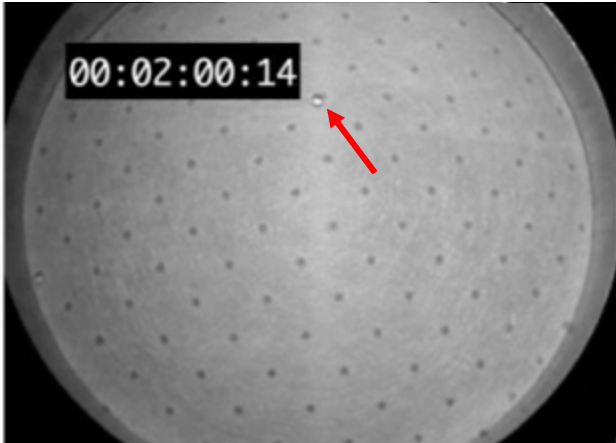


Conventional Filter

Hydrophobic Membrane Filter



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.

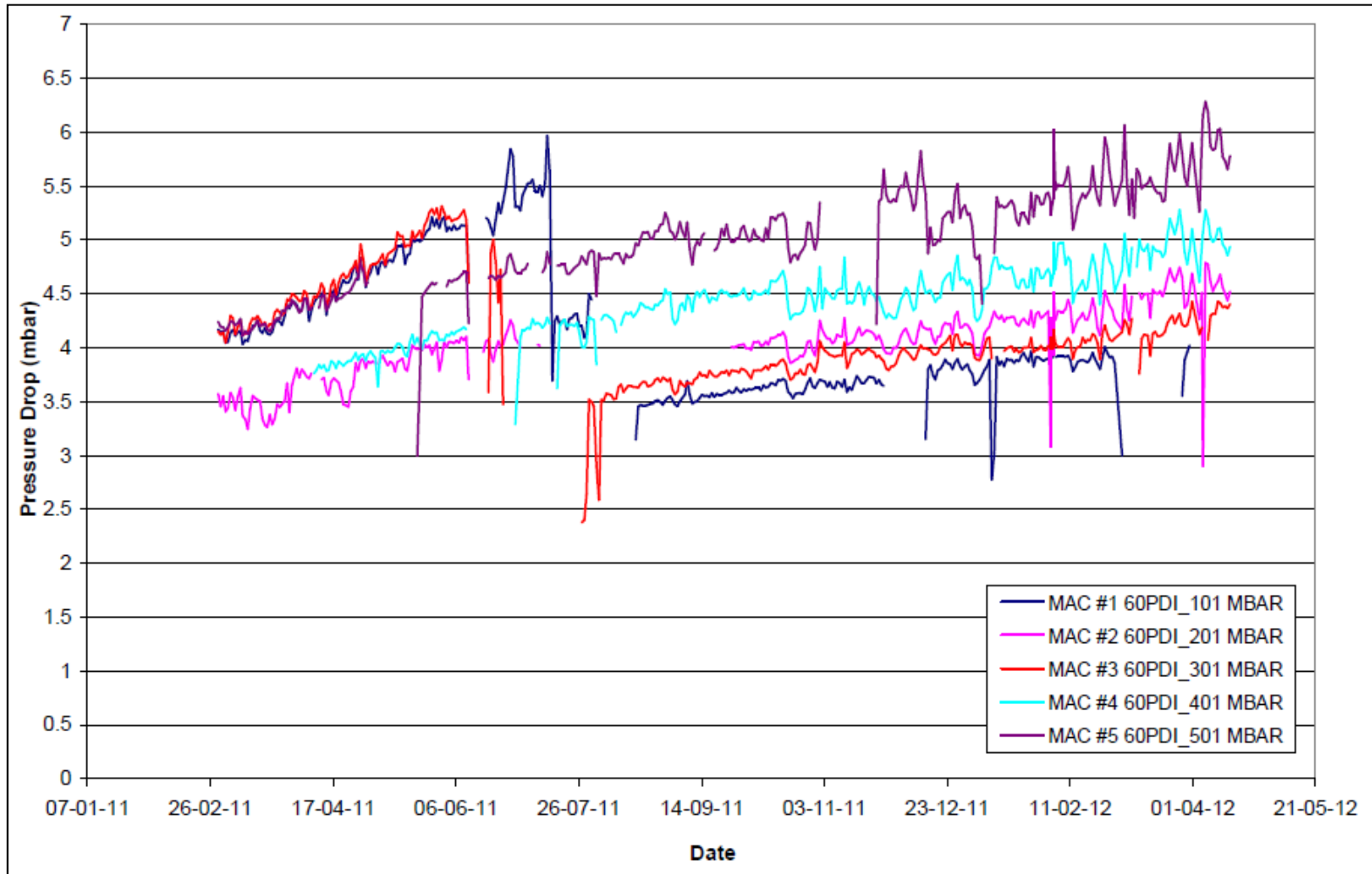
Results

- Analytical data
 - chloride measurement
 - metallurgy
- Boroscope pictures
 - IGV bearings
 - compressor blades

Results

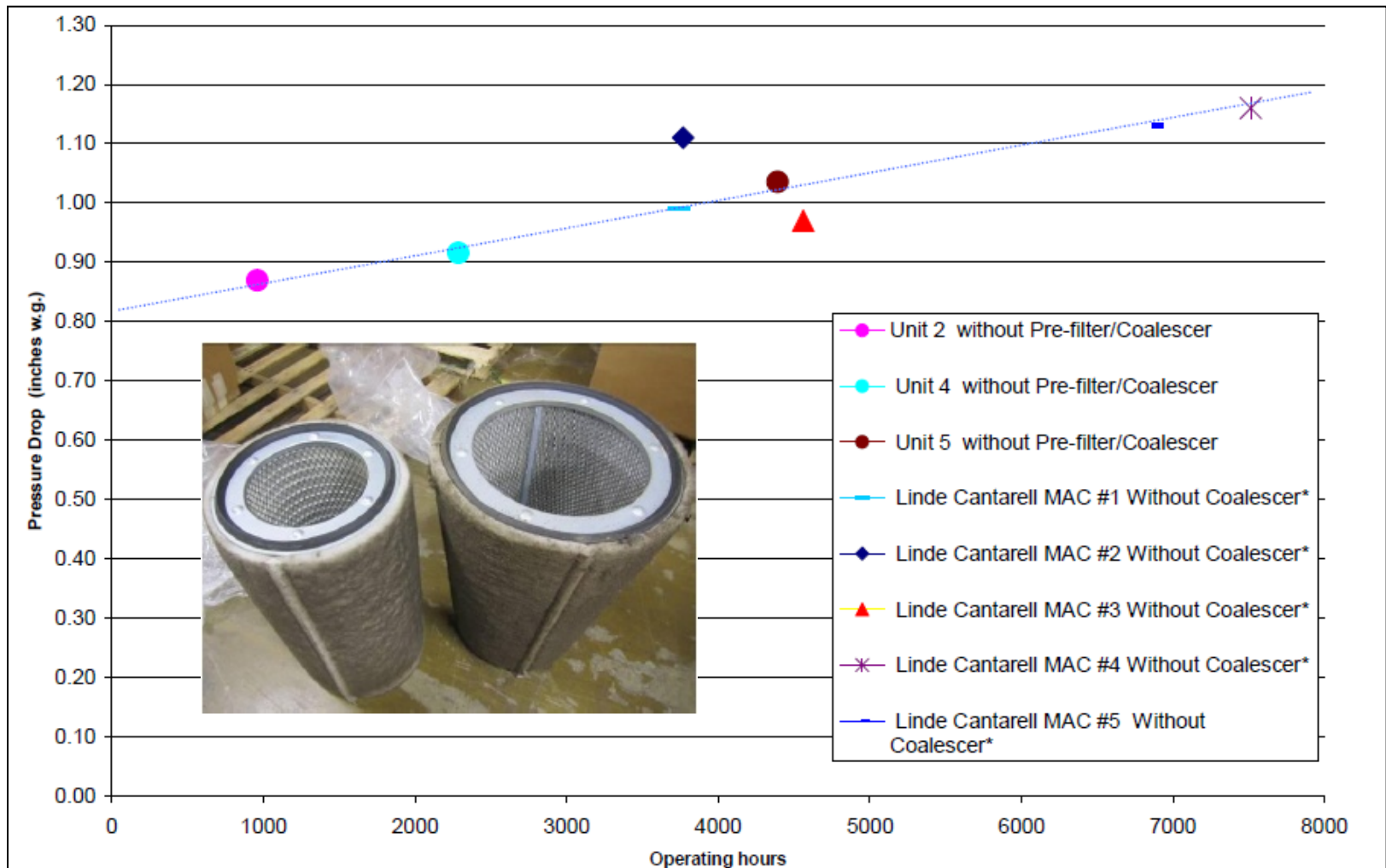
- After 4 months, MAC was shutdown for visual inspection. Results were astounding. Water washing stopped
- After 18 months run time, inspection revealed a highly remarkable reduction in blade fouling
- Intermittent rotor blade crack test inspections found no further incidents of blade cracking

Daily Pressure Drop Trend



Performance of Filters Measured in Laboratory

ASU Unit	Hours
MAC #1	3744
MAC #2	3768
MAC #3	4560
MAC #4	7512
MAC #5	6864



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

Acknowledgement

- David Snell, President
Gulf Coast Filters & Supply, Inc.