Gas Turbine Intake Air Filtration

Issues and Topics of Interest

Olaf Brekke, ETN Air Filtration Meeting, Brussels, February 17, 2015.

Background

- Statoil has ~140 gas turbines in operation (~130 offshore).
- Drives gas compressors, pumps and electrical generators.
- Gas turbine performance deteriorates during operation.
- Typically about 70 to 85 percent of all gas turbine engine performance loss accumulated during operation is attributable to compressor fouling.

5 x GE LM2500+ (~145 MW)

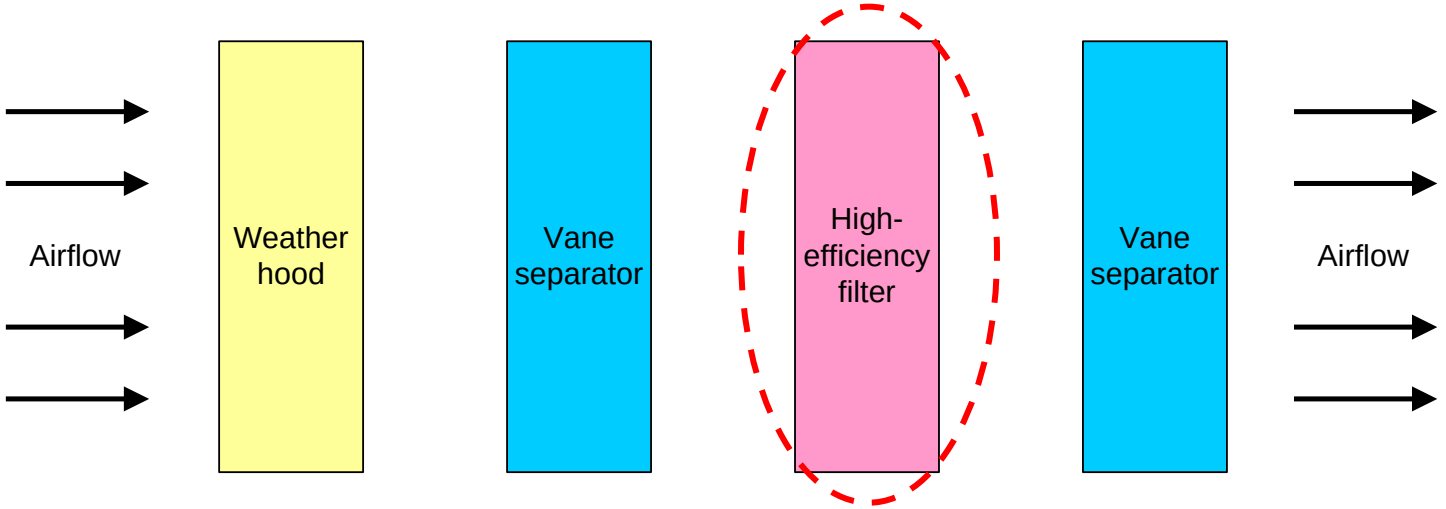
[Statoil]

11 x GE LM2500 (~220 MW)

[Statoil]

Offshore intake air filtration system

- A typical gas turbine intake air filtration system on the Norwegian Continental Shelf (NCS) is a static system which consists of several stages.

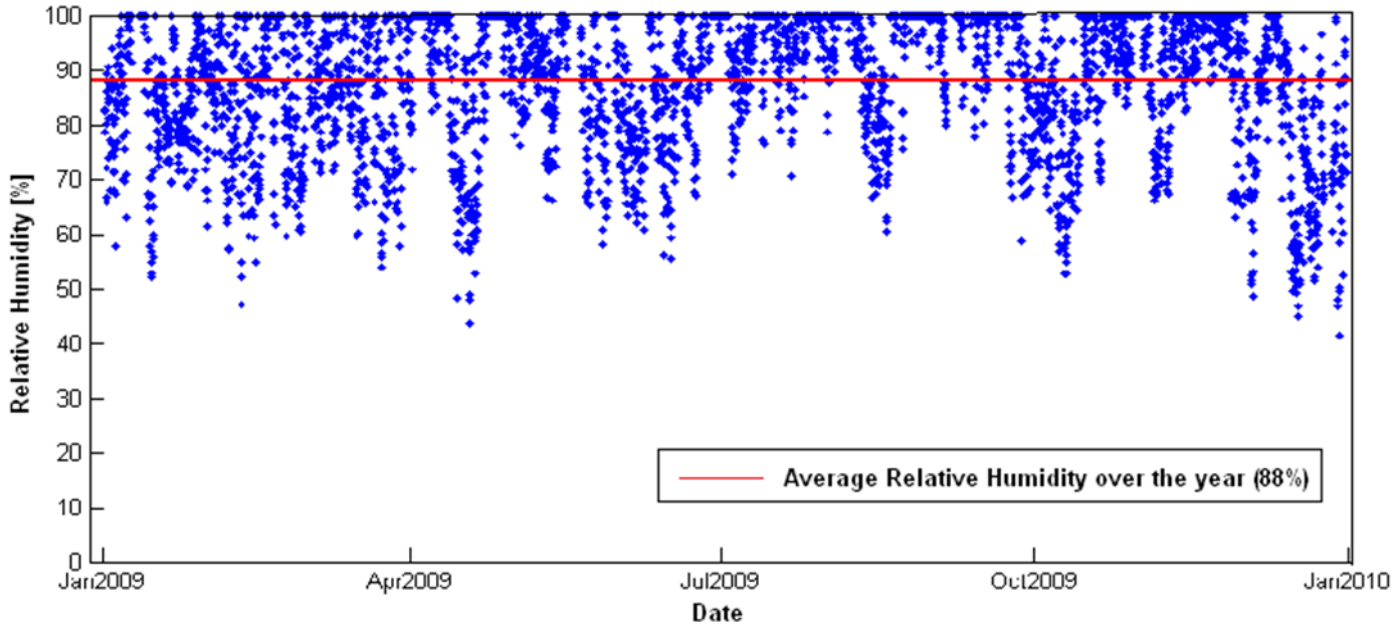


Typical layout of filter system for offshore application.

- Both low velocity (face velocity: ~2.5 – 3.5 m/s) and high velocity (face velocity: ~3.5 – 6 m/s) systems are in operation.
- Systems from several different suppliers with several different configurations are in operation.

Offshore operating conditions

- Sodium-based salts are the dominant component of the compressor fouling in offshore gas turbine installations.
- The main component in salt aerosols offshore is sodium chloride (NaCl).
- Salt will normally be present in liquid droplet form because of the high relative humidity offshore (>45%).

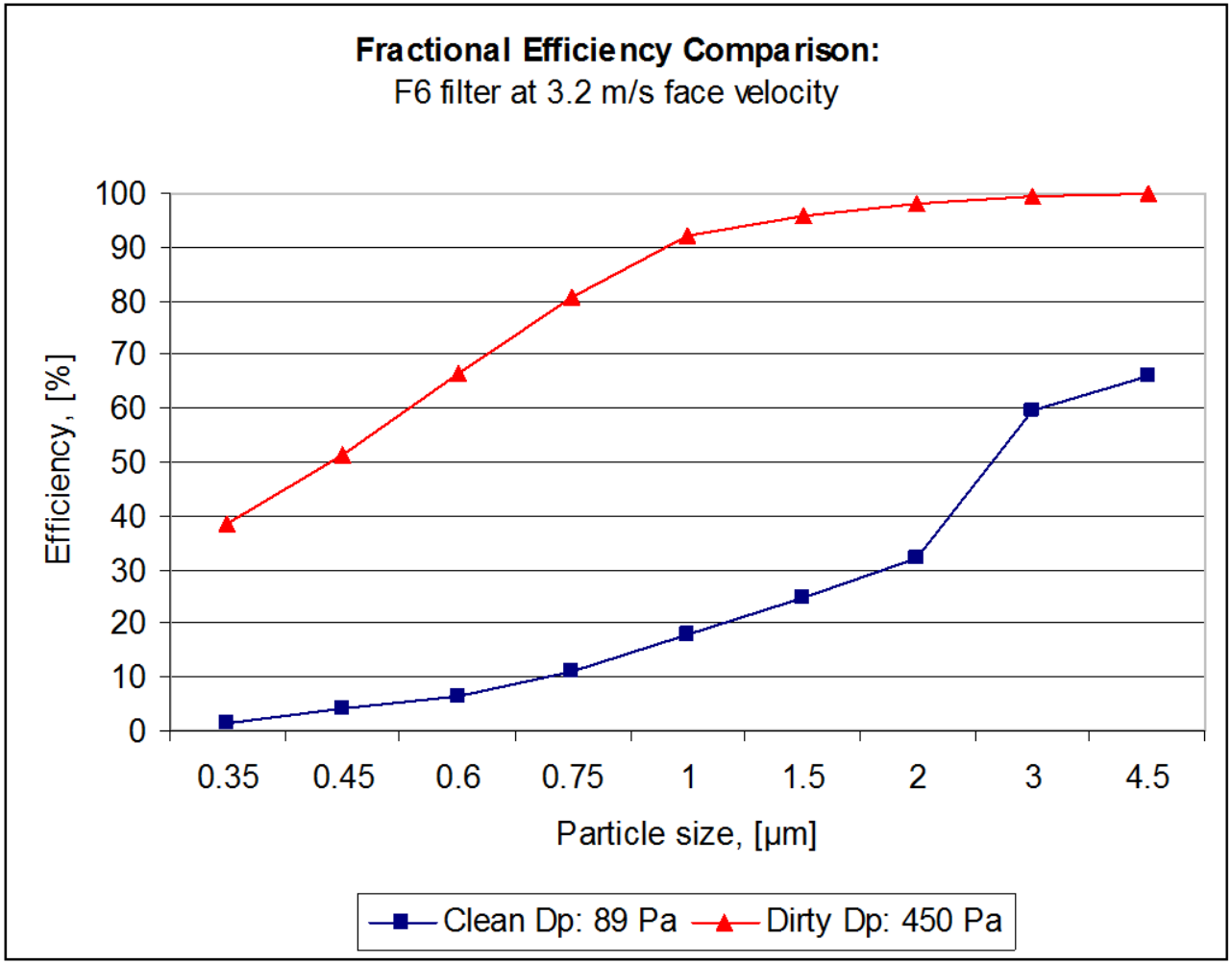


International standards

	EN779	ASHRAE 52.1	ASHRAE 52.2
Humidity	RH<75%	Outdoor air during dust-spot efficiency testing. Prevent fog, rain, sleet and snow from entering test duct.	20%<RH<65%
Salt	Not covered	Not covered	Dry KCl
Hydrocarbons	Importance of electrostatic forces	Not covered	Not covered

- The test conditions in the international HVAC air filtration standards for general ventilation differ considerably from what can be expected offshore.
- The test results do not provide a basis for predicting either operational filter performance or life.

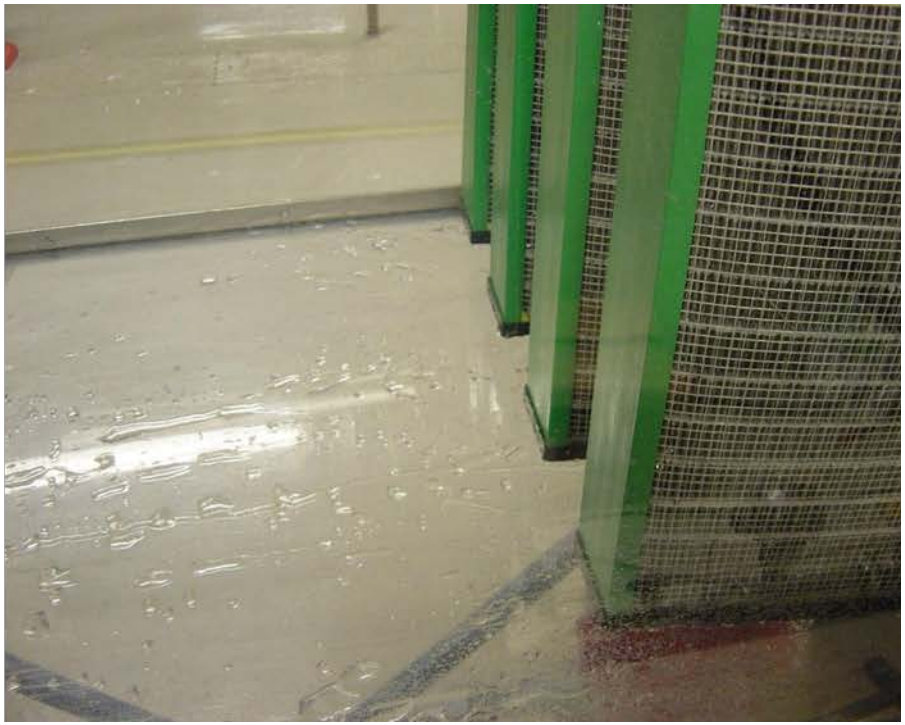
Used filter performance



Statoil

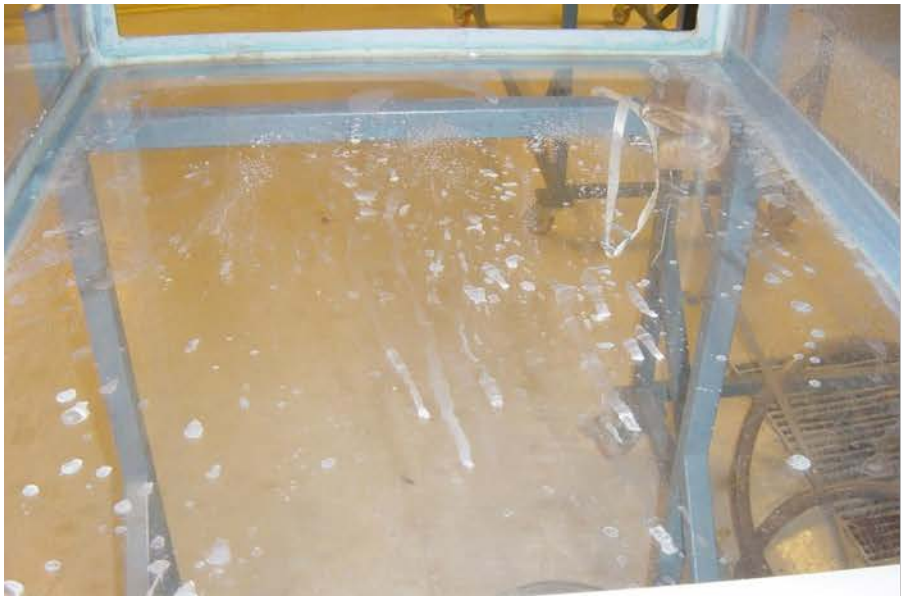
Shedding and re-entrainment

- Accumulated particles in the filters are shed off from the filter and re-entrained into the airflow on the downstream side of the filter during operation in wet/humid conditions.



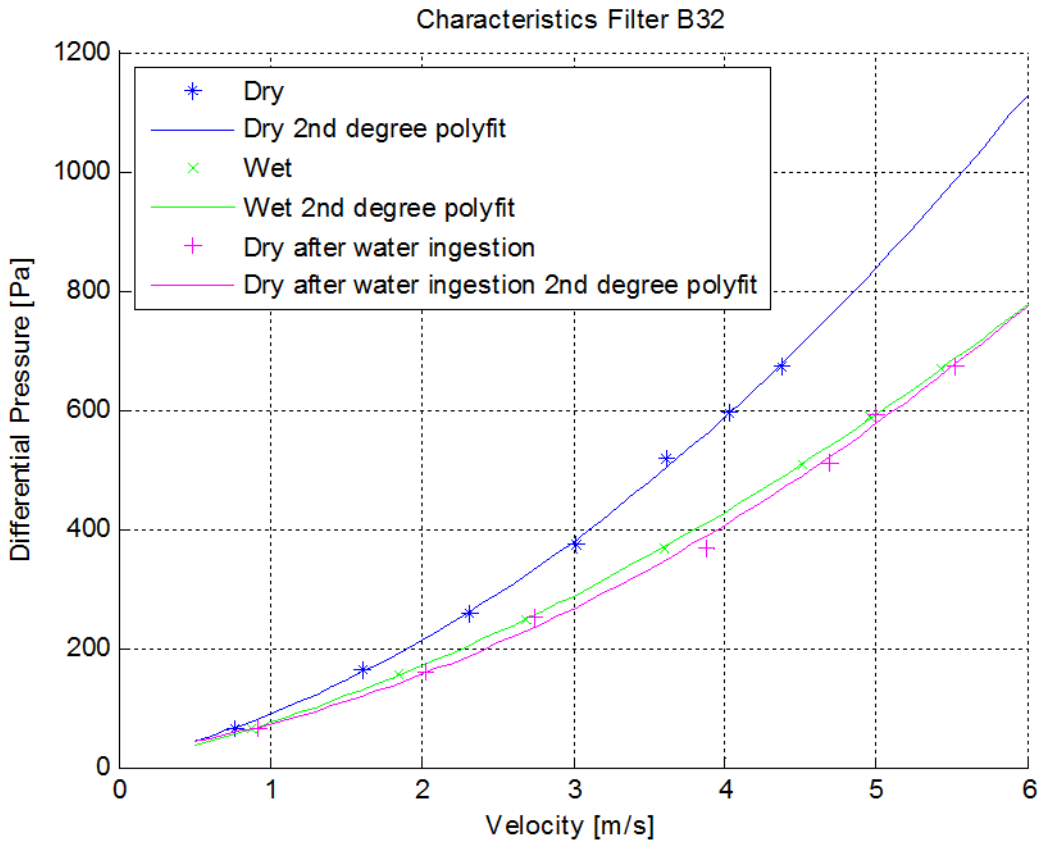
Shedding and re-entrainment

- Characteristic salt deposits observed in the filter holding module and farther aft in the duct after testing.
- This observation complies with observations offshore.

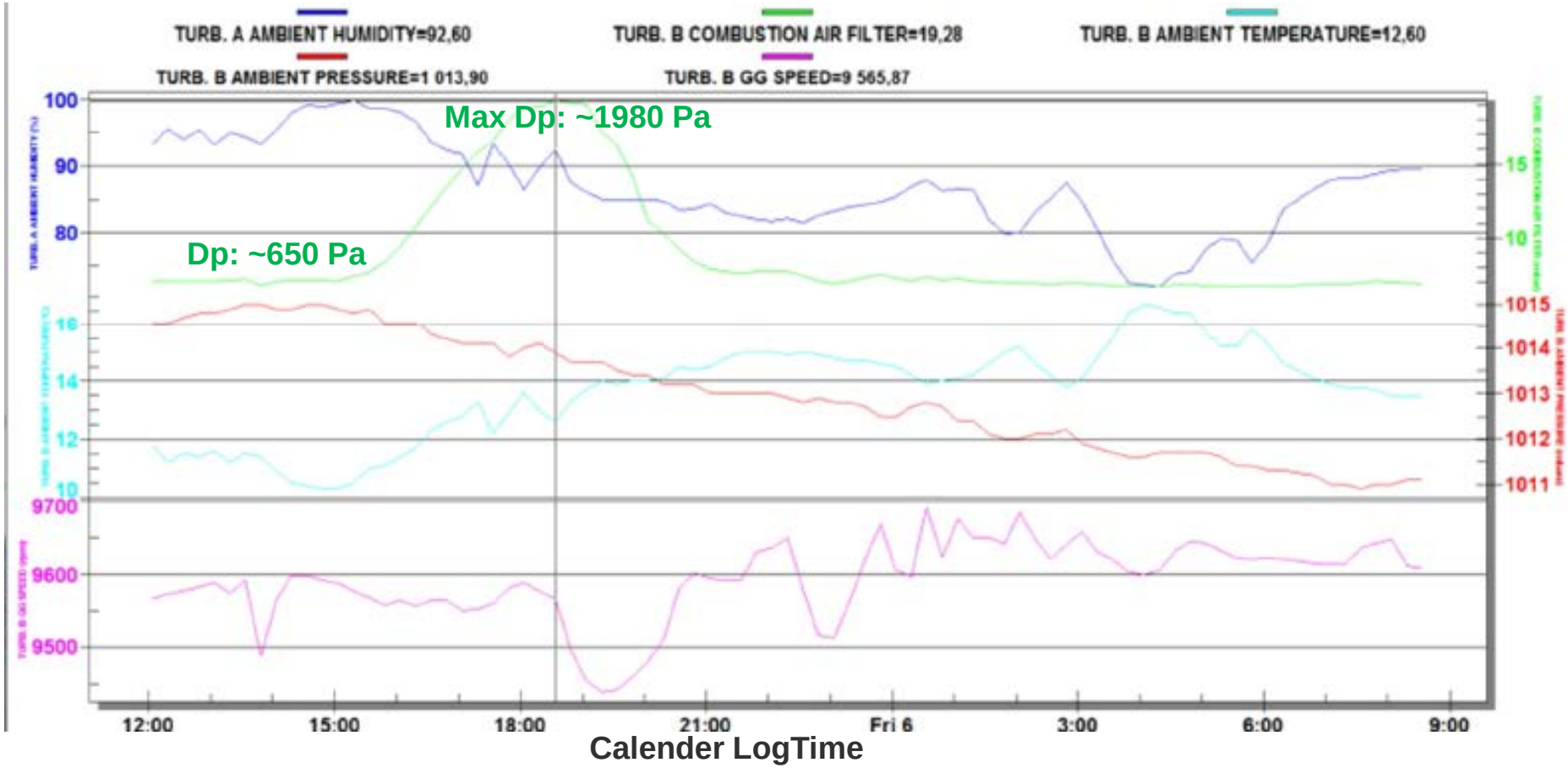


Shedding and re-entrainment

- Shedding and re-entrainment improves filter performance in terms of pressure drop, but causes increased fouling in the compressor section of the downstream gas turbine.



Spiking of filter Dp during foggy weather



Statoil

Summary

- Current standards for gas turbine intake filters do not provide a basis for predicting either operational filter performance or life.
- There are major shortcomings in how offshore-specific challenges are handled in international standards for gas turbine intake air filtration systems.
- Salt penetrates filter elements when operating in wet/humid conditions.
- Differential pressure drop is not a sufficient parameter for condition monitoring of intake air filter performance.
- **Better standards, better filtration systems, and better methods for monitoring of gas turbine intake air filtration systems performance are needed.**

List of relevant papers published at ASME Turbo Expos

Brekke, O., Bakken, L. E., and Syverud, E., 2009, "Filtration of Gas Turbine Intake Air in Offshore Installations: The Gap Between Test Standards and Actual Operating Conditions," *Proc. ASME Turbo Expo 2009: Power for Land, Sea and Air*, June 8–12, 2009, Orlando, FL, ASME Paper No. GT2009-59202.

Brekke, O., Bakken, L. E., and Syverud, E., 2009, "Compressor Fouling in Gas Turbines Offshore: Composition and Sources from Site Data," *Proc. ASME Turbo Expo 2009: Power for Land, Sea and Air*, June 8–12, 2009, Orlando, FL, ASME Paper No. GT2009-59203.

Brekke, O., and Bakken, L. E., 2010, "Performance Deterioration of Intake Air Filters for Gas Turbines in Offshore Installations," *Proc. ASME Turbo Expo 2010: Power for Land, Sea and Air*, June 14–18, 2010, Glasgow, UK, ASME Paper No. GT2010-22454.

Brekke, O., and Bakken, L. E., 2010, "Accelerated Deterioration by Saltwater Ingestion in Gas Turbine Intake Air Filters," *Proc. ASME Turbo Expo 2010: Power for Land, Sea and Air*, June 14–18, 2010, Glasgow, UK, ASME Paper No. GT2010-22455.

Thank you for your attention.

Contact information

Olaf Brekke
Leading Advisor Rotating Equipment
TPD TEX FOT MEC ROT
olbrek@statoil.com , cell: +47 911 48 087
www.statoil.com