GEO&G GT Air Filtration Systems Overview

ETN Air Filtration Meeting
Topics Review
Feb 17, 2015

Imagination at work.

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- Impacts on Technolgy Needs
- GEO&G International Standard Needs Perception

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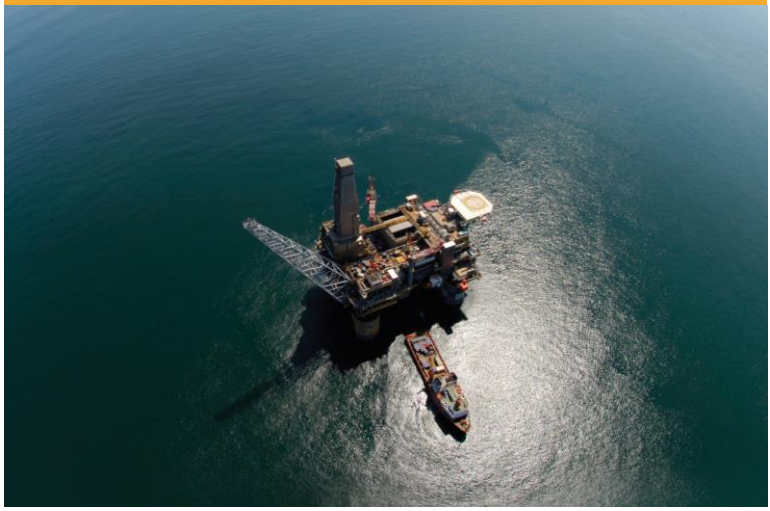
Market Needs Perceptions

- These two Market Segments rate AFS features in a not so different scale per GEO&G perception.
- Other Market Segments (e.g.: Power Generation Utilities) may have different ratings

	Offshore	LNG
Size & Weight	HH	L
Real world performances (includes salt removal)	HH	HH
Service Life Avoiding unscheduled stops	HH	HH
Easy and Safe Maintenance	HH	HH
Total Cost (Capex + Opex)	HH	HH
Cost	H	H

LNG Plants

Offshore Platforms and FPSOs



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How these needs reflect on Market Evolution

Size & Weight **Service Life**	**High velocity EPA AFSs SeaSmart™** **High Capacity Filter Elements (24” deep)**

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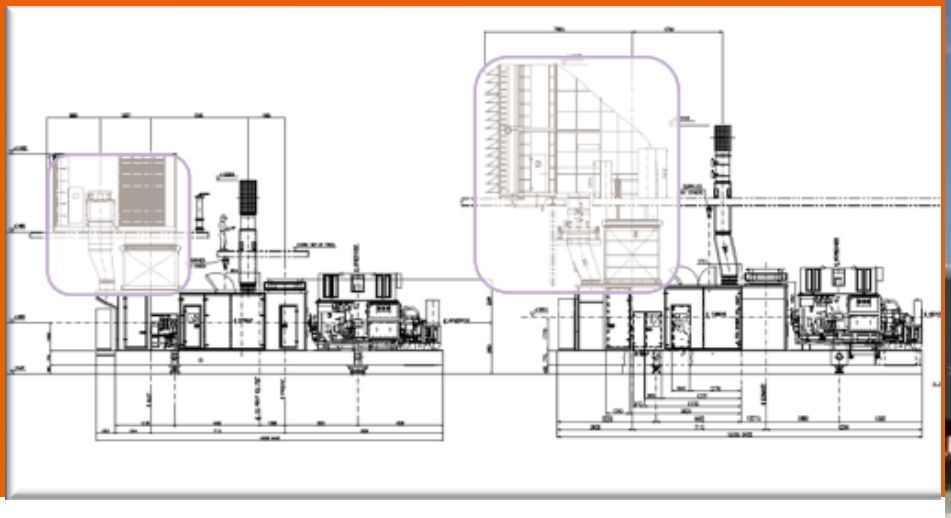
Size and Weight

- High capacity F and E class filters (24” deep, almost 50 m^2 of filter media)
- High Velocity E-grade AFSs (SeaSmart™). Introduced late 2013, more than 30 units sold up to date.



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How these needs reflect on Market Evolution

Size & Weight **Service Life**	**High velocity EPA AFSs SeaSmart™** **High Capacity Filter Elements (24” deep)**
Real world performances (include salt removal) **Avoiding unscheduled stops**	**EPA class AFSs are today more than 80% of new installations for these market segments.** **On-line Filter Swap©**

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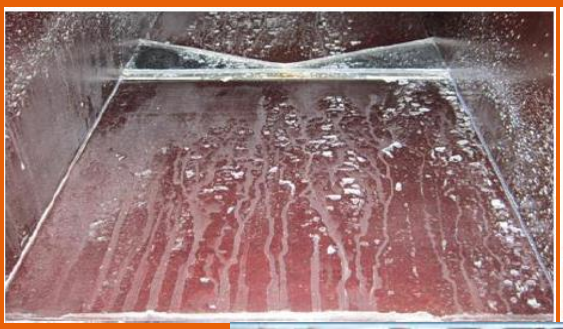
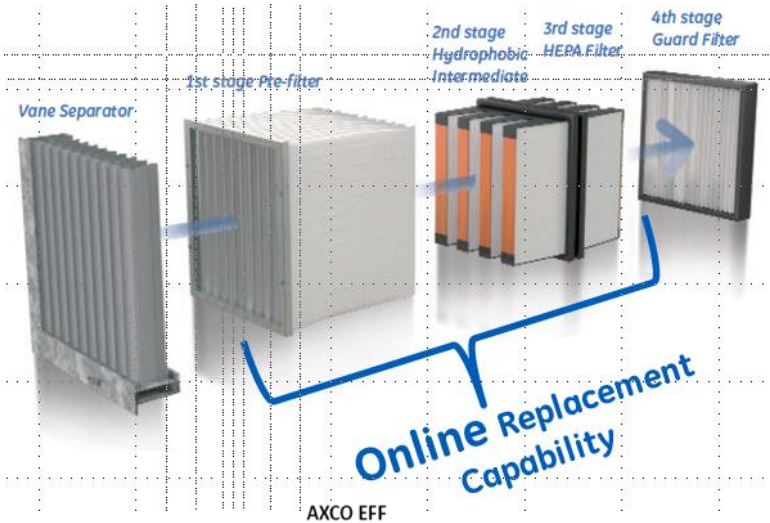
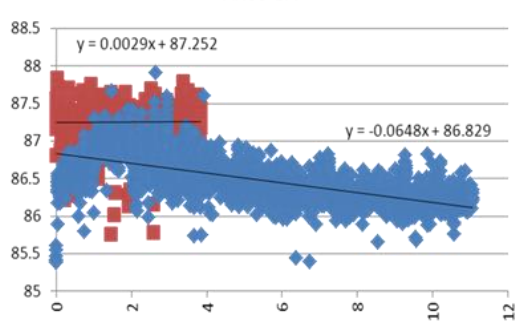
EPA

- High capacity F and E grade filter elements (17” and 24” deep), up to 50 m^2 of filter media per element)
- Online Filter Swap© is a standard feature of TrueFlex™ AFSs.
- Filter elements qualified for GT use.



- Protection vs. **Corrosion & Fouling**
- Increased **Power Output**
- Increased GT **Availability**
- Increased **Reliability**
- Increased **Fuel Flexibility**





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How these needs reflect on Market Evolution

Size & Weight **Service Life**	**High velocity EPA AFSs SeaSmart™** **High Capacity Filter Elements (24" deep)**
Real world performances (include salt removal) **Avoiding unscheduled**	**EPA class AFSs are today more than 80% of new installations for these market segments.** **On-line Filter Swap©**
Real world performances (include salt removal) **Avoiding unscheduled stops** **Systems easy and safe to maintain**	**AFSs upgrades business increases.** **Conflict between EPC and End User CTQs (Opex vs. Capex)**

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AFS Upgrades Opportunities

- Conflict between EPC and End User CTQs (Capex vs. Opex)
- #60 GTs' AFSs have been upgraded to E12 within the last 3 years (≈ 2 GWs)
- 1.5 GW to be added during 2015.

Design for Installation

- Minimal impact on existing structures and foundations.
- AFS replacement integrated within Train Major Overhaul schedule without any additional train down-time
- Single Lift removal and re-installation (#6 units in 3 days)

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How these needs reflect on Market Evolution

Size & Weight Service Life	High velocity EPA AFSs SeaSmart™ High Capacity Filter Elements (24" deep)
Real world performances (include salt removal) Avoiding unscheduled stops	EPA class AFSs are today more than 80% of new installations for these market segments. On-line Filter Swap©
Real world performances (include salt removal) Avoiding unscheduled stops Systems easy and safe to maintain	AFSs upgrades business increases. Conflict between EPC and End User CTQs (Opex vs. Capex)
Real world performances (include salt removal) Avoiding unscheduled stops	PJ AFSs penetration rate greatly reduced when compared with 2000s EPA stages are today often included in combined systems (PJ+static) for dusty and coastal environments

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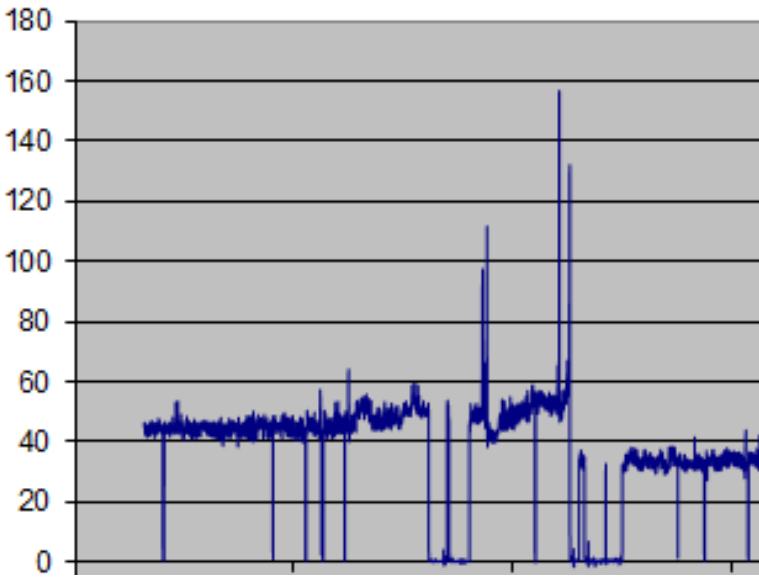
Real World Performances

- PJ AFSs are today installed only if needed and even combined with static EPAs and coalescing stages to avoid DP spikes
- Salts enter in dissolved state (*efficient Coalescers / Droplet Catchers act as barrier against water entrance)* or Solid salts, deposited on particulate filters, can deliquisce when filter elements get wet (F*ilter media as membrane / chemically treated microglass fiber have a strong impact on minimizing this phenomenon).



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ISO TC142 WG9
ISO-29461

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Filter Testing per International Standards

Duct sections:

1	Mixing chamber
2	Measuring chamber of the raw gas
3	Filter sample chamber
4	Measuring chamber of the clean gas and the final filter
5	Duct section with protection filter
6	Volume flow rate measuring system

Tests according to the currently available International Standards provide informations about:

- Filtration particle efficiency
- DP at different airflow rates
- Filter dust holding capacity (DHC)

Tests are run in controlled ambient conditions with standard test dust mixtures or aerosols (not reproducing real world conditions)

Often water effects, RH Level or special sticky contaminants are not considered.

Several CTQ features for a GT filter element are not addressed.

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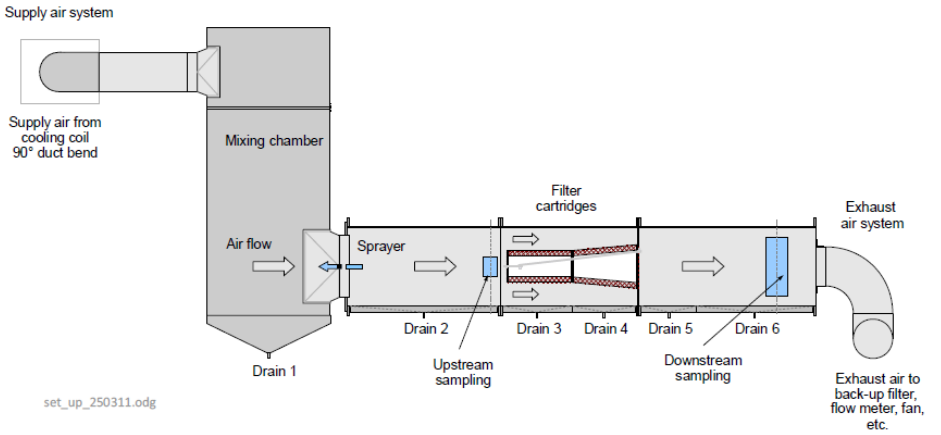
The efforts of TC142 WG9 would fill the gap in the available International standards for GT filter elements reducing the needs for current proprietary GE test procedures



Life test

(evaluating DHC of multistage configurations)

Integrity tests

(to limit the risk of FOD)

Environmental test

(in extreme conditions , T < -40°C or T> 50°C)

Water tightness test

(evaluating water removal effectiveness)

Salt penetration test

(evaluating salt removal effectiveness)

PJ filters cleanability test

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WHAT we would like to see included in

(.....more than a new efficiency classification Table)

- Validation of the system performances
  (not only the single stage performances).
- Production tests to show compliance with type test results. Inspection surveillance (Eurovent approach?)
- Site of installation assessment.
  How to properly collect useful and exaustive data to allow a proper design of the air filtration system.
- System real world performances.
  How to properly collect useful and exhaustive data to allow monitoring the air filtration system operation.

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Thank You

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