Minutes of Air Filtration Meeting

12 May 2017, MAN PrimeServ Academy, Oberhausen, DE

ETN Attendees:

Scott Taylor	AAF
Francesco Anzelini	ADGAS
Marco Tappani	Ansaldo Energia
Marc Van den Eynde	Camfil
Richard Ringström	Camfil
Wim Van Gelder	Donaldson
Andrew Thomson	EMW
Arnaud Lambert	ENGiE
Ugo Simeoni	ETN
Mike Garnett	Freudenberg
Marco Blarasin	GE Oil & Gas
Carlo Coltri	Mann Hummel Vokes Air
Olaf Brekke	Statoil
Dominique Orhon	Total
Wilson Poon	W.L. Gore & Associates

1. Introduction by ETN Officer

U. Simeoni opened the meeting and welcomed the participants. He presented the agenda and the objectives of the current meeting. He went through the list of actions agreed during the meeting on 16-17 November 2016.

2. Updates research done on the air composition

S. Taylor presented the research done on the definition of the aerosol. He explained that the liquid water content is in the range of 0.02 - 5 g (water) m^{-3} and the droplet size in the 0.5 to 50 µm range. However the min, max and average droplet size have to be discussed within the ISO TC 142 during the next meeting.
According to the droplet size range identified, S. Taylor has requested information to the vendors for an internal mix atomiser and its dispersion pattern but he still didn't receive any feedback.

3. Presentation tests done at Camfil's lab

R. Ringström presented the tests carried out at Camfil's facility, whose objective is to simulate marine and offshore challenges in an accelerated lab test which should be repeatable and preferably automated.
The test configuration adopted would allow to add the "droplet separator" and the "pre-filter" if the manufacturer would like to test a filtration system rather than a single element.
The main challenges that were taken into consideration from Camfil were:

- Water and salt bypass after a period of time;
- Inclusion of combustion particles from the exhaust;
- Relative humidity varies but environment is normally humid.

It was asked if Camfil has taken into consideration the generation of soot particles.
R. Ringström said that the generation of soot particles would be possible with equipment already available on the market. However they are very costly and not environmentally friendly for the operators of the tests.

In the tests carried out at Camfil's lab particles smaller than 1µm were recreated and an automated schedule with clear time and intervals was set up, alternating high and low relative humidity. The following parameters were set in the tests:

- Ultrafine dry NaCl is sprayed continuously;
- Test starts with ultrafine fresh water sprayed in oil mist;
- Relative humidity is cycled – 1,5h per cycle.

R. Ringström highlighted the advantages and the challenges of the approach taken by Camfil:

Advantages:
- Fully automated
- No dust
- No need to handle filters during the test
- Stable
- No expensive consumable

Challenges:
- Difficult to quantify size or position of leak
- Visual detection – water spray needs to be monitored
- Small amounts of water will not run towards drains unless the surface is with very low friction.

The results of the tests have been divided in three categories:
1. Poor result – 0-2 cycles → Filter not suitable
2. Good result – 15-19 cycles
3. Excellent result - >20 cycles

R. Ringström explained that the method used by Camfil was focusing on reproducing the failure mechanism in the offshore environment, rather than generating exactly the same environment of one specific area. He also underlined that Camfil hasn't boosted the pressure drop to create the failure mechanism. The test was stopped when the leakage happened.
R. Ringström stated that it is possible to correlate the behaviour of the filter with the amount of salt passing through the filter. He said that if the test should be loaded with dust, there may be an issue with the repetitiveness. The approach used was to inject very low particles over the time and show the efficiency of the filter. The cycling of low and high humidity would reproduce the aging effect.

4. Presentation tests done at W.L. Gore's lab

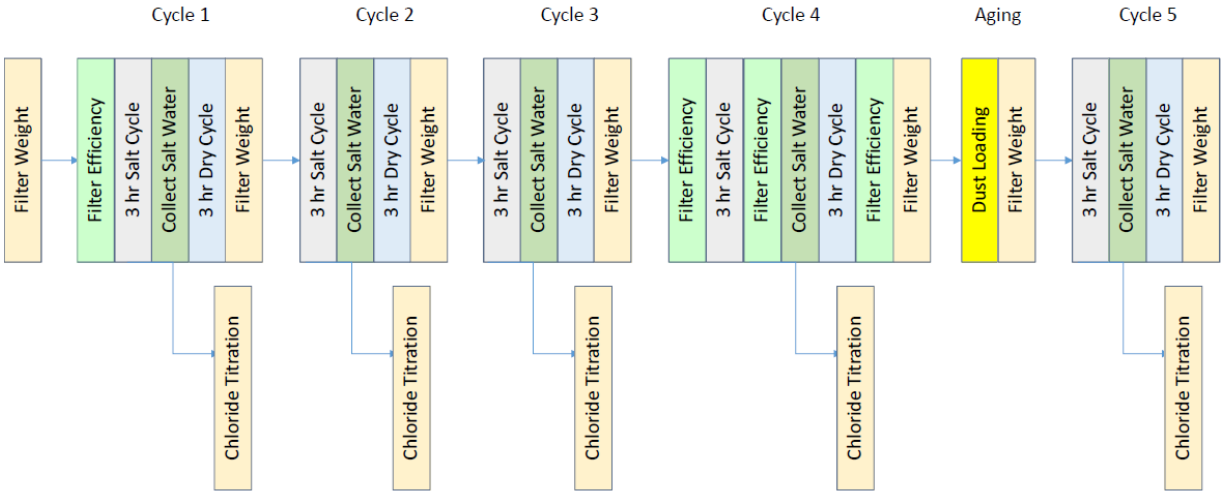
W. Poon reported on the work done in the last month in the subgroup and the tests carried out at W.L. Gore's lab. The following tasks have been accomplished:

- Review salt mist generation method with atomizing nozzle
- Develop method to measure salt breach
- Evaluate three inlet air filters for salt protection

He stated that the salt mist generation was done with the atomising nozzle (Spraying Sys 1/4J+SU11), underlining that the size distribution is influenced by:
- Liquid feed rate
- Air pressure
- Air flow

W. Poon reported that in the method used by W.L. Goore dust was loaded, as it is considered to influence the aging effect. The characteristics of the salt mist generation are described in the slide upload on the ETN Air Filtration webpage.
W. Poon described the Wet/Dry cycles used in the test:
- Salt breach cycle

    - 3 hours wet + 3 hours dry cycles
    - Repeat 4 times
- Aging of filter with dry dust loading
    - 1kPa final dP
- Repeat salt breach test
    - 3 hours wet (stop if dP > 1.5 kPa) + 3 hours dry cycles



W. Poon reported on the outcomes of the tests, which show that after the dust load, the behaviour of the filter was unstable, showing first a slope down and then up.

It was asked why in the test it was used potassium chloride rather than sodium chloride. W. Poon answered that the behaviour of the two solutions is the same but the potassium chloride is more soluble and therefore it is possible to have a higher quantity in the test. He then showed the results of the tests on three different filters.
W. Poon shared the following recommendations as outcome of the tests:

- The operating conditions of atomizing nozzles have big impact on the droplet size distribution. They must be clearly defined.
- The performance of the filters changed significantly after 3 wet and dry cycles. More cycles should be included in future work.
- Aging the filter to 1kPa caused one sample to leak. The duration of aging is influenced by the seasoned pressure drop of the filter.
- Two filter did not finish the last we/dry cycle due to dP exceeding 1.5 kPa.
- The test showed different performance of the filters.
- Measuring the weight of filter cumbersome and doesn't provide useful information.

The Users highlighted that during the inspections of their filters soot was also detected. Therefore it is beneficial to test the filters in presence of soot. R. Ringström will follow up internally to find capacity to run the tests with soot/hydrocarbon. M. Garnett stated that some test methods on soot/hydrocarbons are already present in literature.
It was agreed that M. Garnett and W. Van Gelder should look for existing test methods on soot/hydrocarbons.
It was agreed that the Users should define the soot/hydrocarbon composition.
O. Brekke stated that Statoil has carried out an analysis on compressor fouling and a paper has been submitted to ASME. It was agreed that the reference to the paper should be shared within the Working Group.
It was also highlighted that sodium chloride should be used and measured in the tests.
It was proposed and agreed that the two presentations showed during the meeting should be shared within the Working Group and the members should send their feedback.
It was agreed that R. Ringström and W. Poon should work together in order to harmonise the tests done.

5. Next meeting

It was proposed to schedule the next meeting before or after the ETN October's Workshop 2017, which is set to take place on 4-5 October 2017. It was agreed to confirm the date in September 2017, according to the progress that will be done on the tests.

Annex I: Action list

Action Owner	Description	Deadline date
R. Ringström, W. Poon	To share the presentations presented during the meeting.	2 June 2017
R. Ringström, W. Poon	To harmonise the two test procedures presented verify the feasibility to carry out other tests.	1 September 2017
All	To provide feedback on the two test procedures.	1 October 2017
O. Brekke	To share the reference to the paper submitted to ASME on compressor fouling analysis done by Statoil.	30 May 2017
D. Orhon, A. Lambert, O. Brekke	To define the soot/hydrocarbon composition.	16 June 2017
M. Garnett, W. van Gelder	To find information on existing test methods on soot/hydrocarbons.	16 June 2017