ISO-29461 part 5

Marine and offshore filtration testing

Test procedure evaluation

Update 2017.10.06

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Objective

Simulate marine and offshore challenges in an accelerated lab test.

Must be repeatable and preferably possible to automate.

Challenge

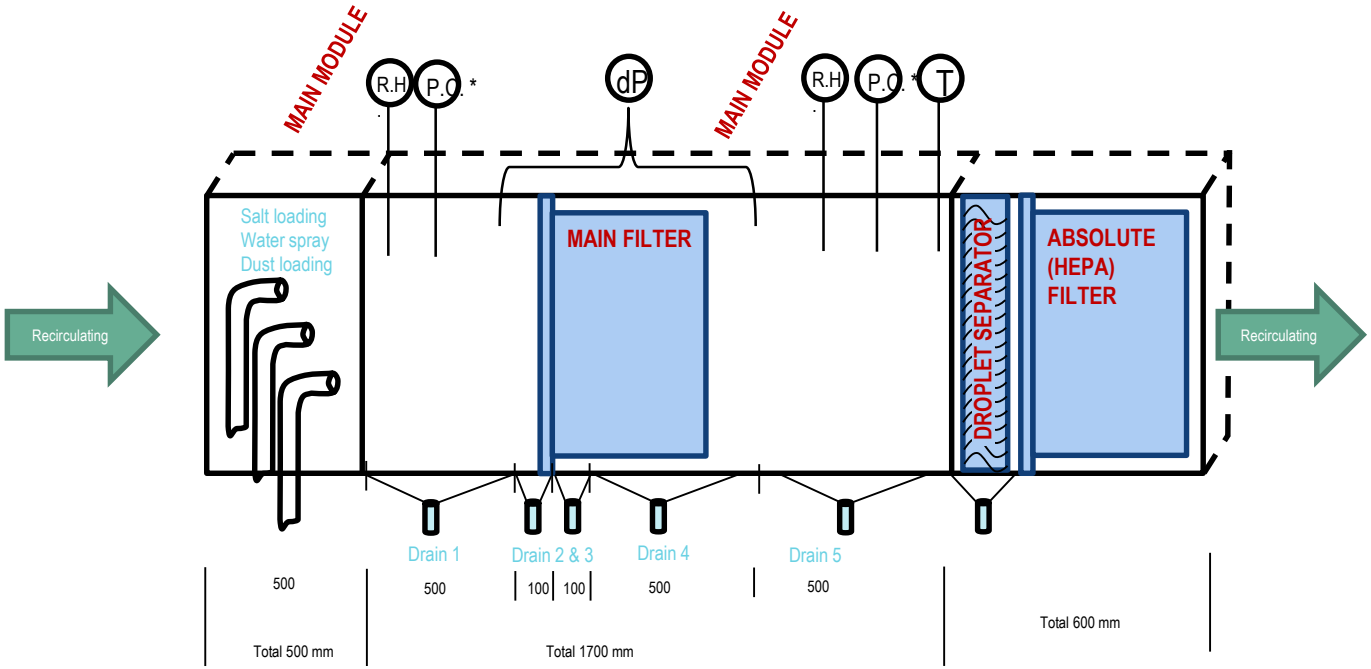
Offshore symptom is water and salt bypass after a period of time often without experiencing high pressure drops.

In general a limited amount of dust – mostly combustion particles from exhausts.

Relative humidity varies but environment is normally humid.

Test section

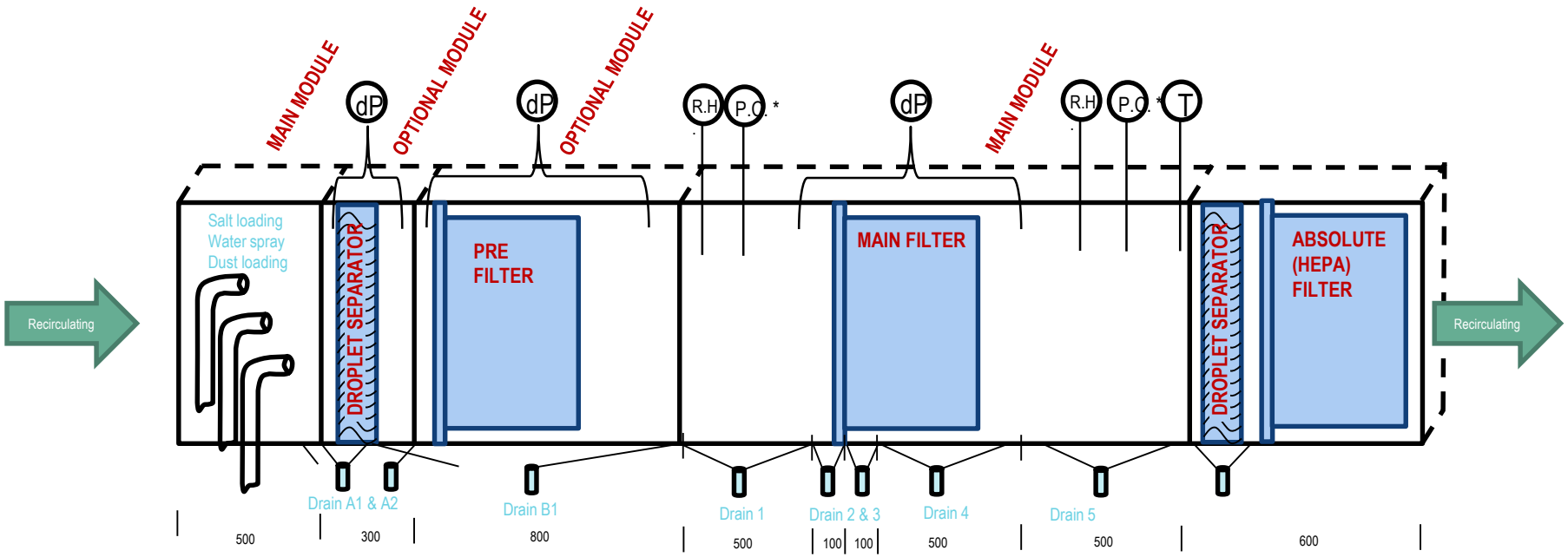
Duct cross section size: 650x650mm



* P.C.: = Particle counter or flame photometer

Test section - system test possibility

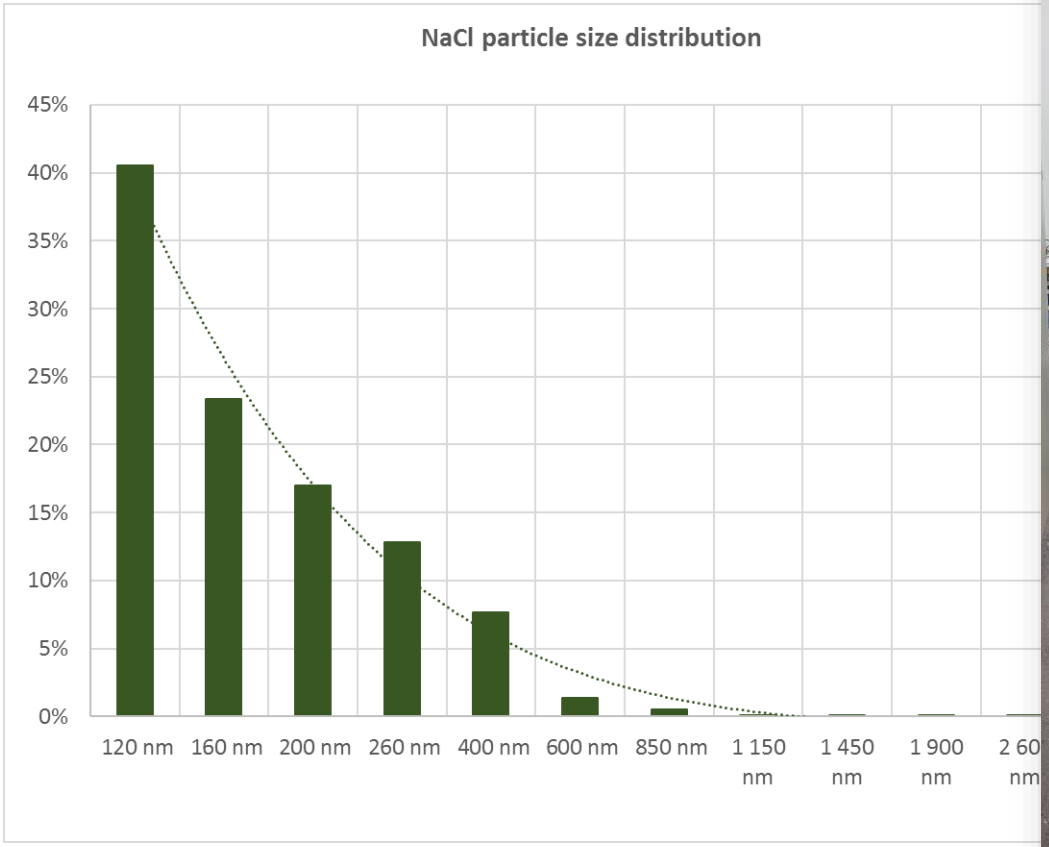
Duct cross section size: 650x650mm



* P.C.: = Particle counter or flame photometer

NaCl particle size distribution

- Majority of particles are smaller than 1 micron



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Why ultrafine salt particle generation?

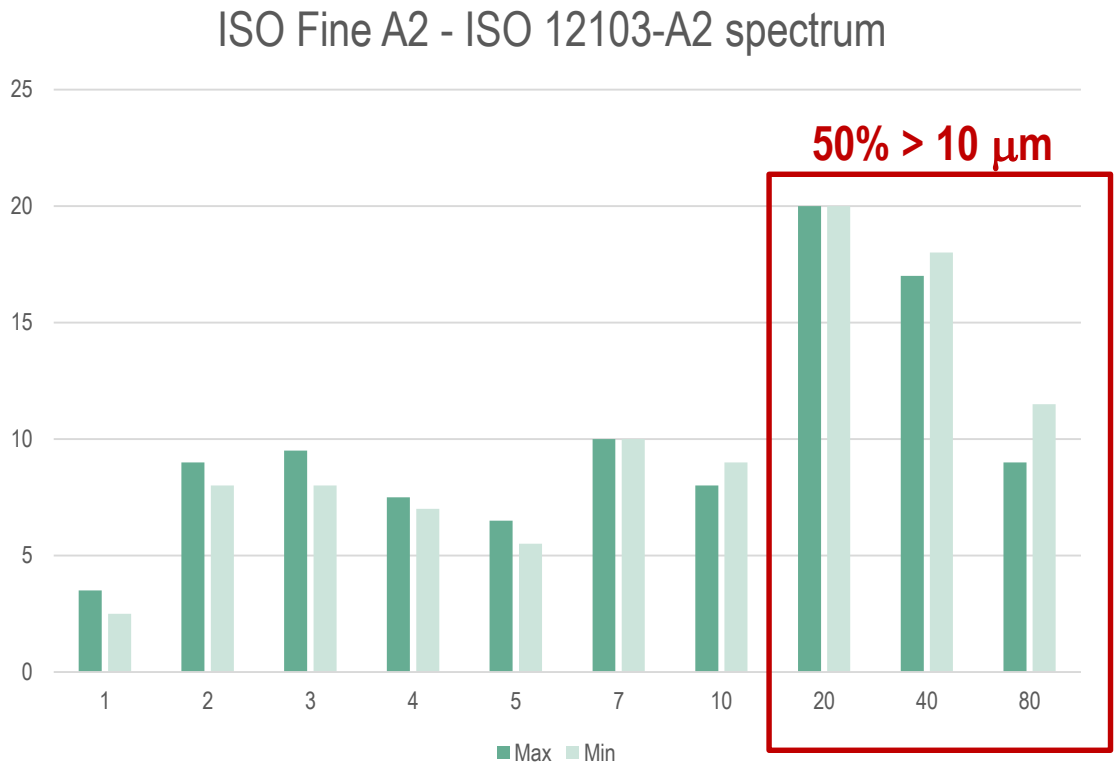
Sea-salt aerosol (SSA) is an important constituent of natural marine aerosol to which anthropogenic aerosols must be compared when assessing their climatic influence. Size distributions of particles, produced by bubbles from coastal oceanic breaking waves, were found to have **sizes as small as 0.01 μm (10nm), with 60% smaller than 0.1 μm (100nm) diameter**. The thermal stability of these particles and their growth factor measured under increasing humidity indicate that most are sea salt.

Source: JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 111, D06202, doi:10.1029/2005JD006565, 2006

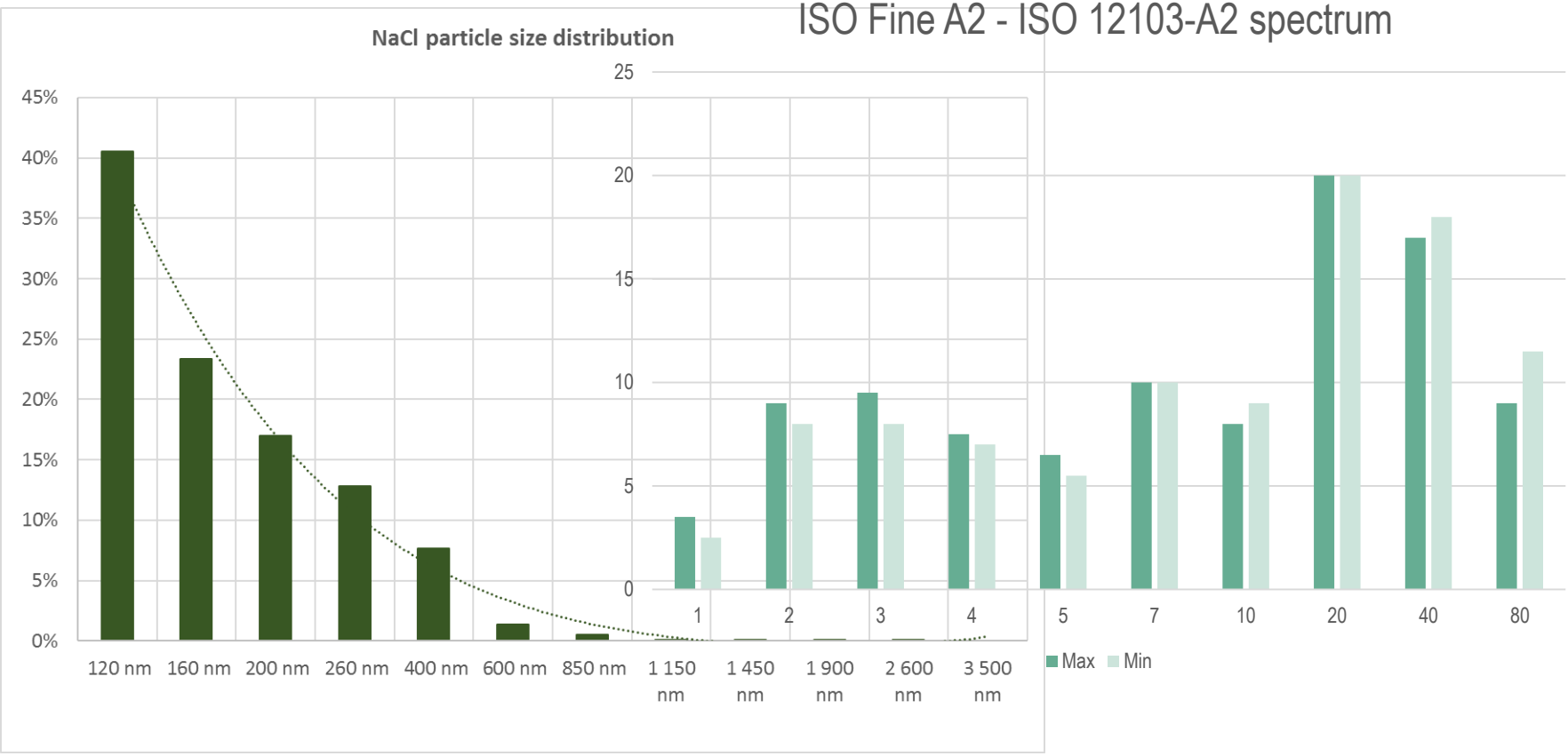
Ultra fine sub micron particles will directly penetrate into the entire 3-dimensional depth of the media where salt water spray droplets will mostly impact on the 2-dimensional surface of the media.

ISO Fine A2 – particle distribution

Size µm	Volume larger than size %
1	96,5 - 97,5
2	87,5 - 89,5
3	78,0 - 81,5
4	70,5 - 74,5
5	64 - 69
7	54 - 59
10	46 - 50
20	26 - 30
40	9 - 12
80	0 - 0,5



Small particles to load the 3d media structure



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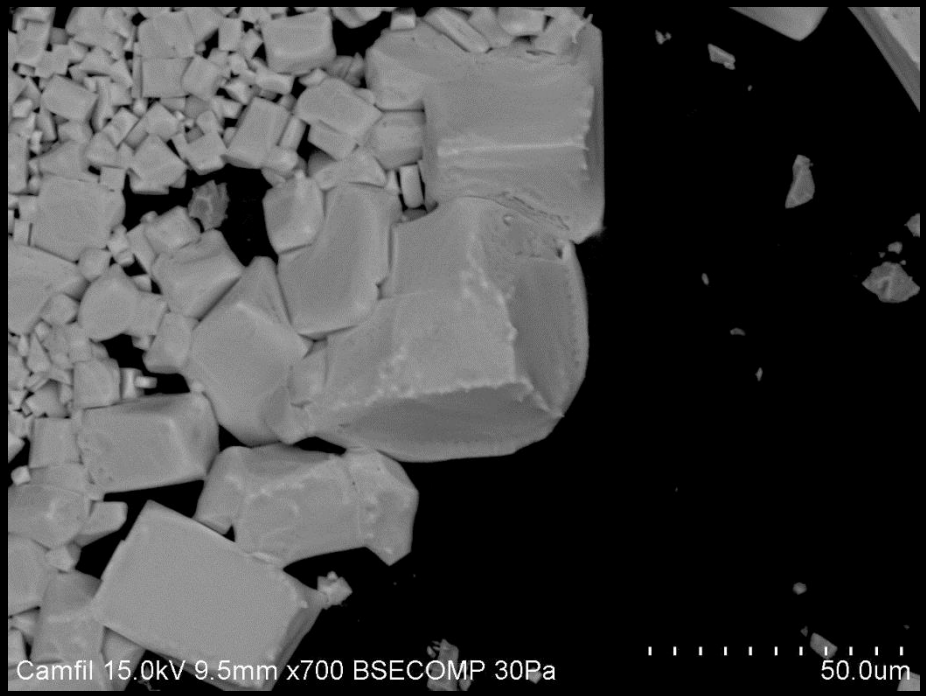
Camfil 15.0kV 7.9mm x500 BSE3D
100um

Sea salt - NaCl - Sodium Cloride



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Test procedure

- Ultrafine dry NaCl (or KCl) is sprayed continuously throughout the entire test.
- Test starts with ultra fine fresh water spray in 48minutes, 0,2 liter/minute (9,6 liter) *(4 250 m3/h)*
- Relative humidity is cycled Hi/Lo in approx. 1,5h cycles
  Hi means close to 100%
  Lo means between 25-40%

Time	Simulation	Length
08:00	**Water spray**	00:48
08:48	Low r.H.	01:33
10:21	High r.H.	01:33
11:54	Low r.H.	01:33
13:27	High r.H.	01:33
15:00	**Water spray**	00:48
15:48	Low r.H.	01:37
17:25	High r.H.	01:37
19:02	Low r.H.	01:37
20:39	High r.H.	01:37
22:16	Low r.H.	01:37
23:54	High r.H.	01:37
01:31	Low r.H.	01:37
03:08	High r.H.	01:37
04:45	Low r.H.	01:37
06:22	High r.H.	01:37

Advantages

- Can be fully automated
- No dust (=less variation and less messy)
- No need to handle filter during test
- Stable (reasonable tolerance)
- No expensive consumables

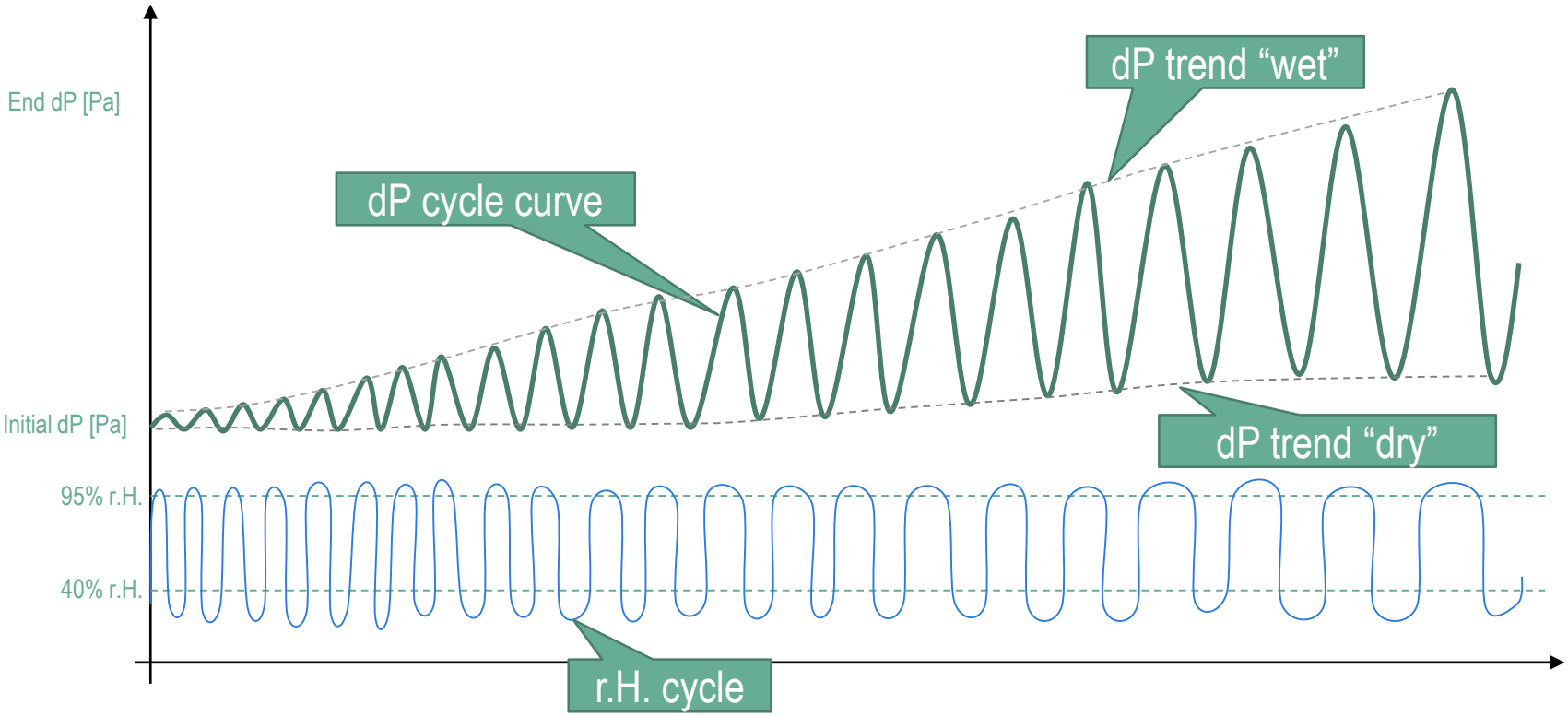
Challenges

- Difficult to quantify size or position of leak
- Visual detection – water spray cycle needs to be monitored by operator or camera.
- Small amounts of water will not run towards a drain unless surface is with very low friction.

Progress

1. Further cycles have been evaluated.
2. Added ISO-fine test dust
3. Not yet introduced oil or soot

Filter behavior during test



Observation.

dP did not need to increase much to create leakage through the filter – end vs initial could be a factor of 2.

Slow but continuous increase of dP when exposed to high dP shows that more and more salt is added.

Conclusion

- ISO Fine test dust – acts as a prefilter – preventing salt from penetrating the media.
- ISO Fine A2 does not represent real ambient dust
  - neither particle size distribution nor behaviour
- Demands manual operation and handling (prevents full automation)
- Oil and soot has not yet been tested – at least oil is possible but since method is new it would need more time to become a proven/validated method.