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Unwanted clogging of high efficiency flat sheet filter media in fractional efficiency measurements

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Measuring fractional efficiency of HEPA filter media

To measure the efficiency by particle size of high-efficiency particulate flat sheets of air filter media reliably, it is necessary to use a relatively high concentration of synthetic aerosol upstream of the sample.

The maximum upstream particle concentration is set by the maximum concentration that the measuring system allows without coincidence errors for the particle sensing instrument in series with a dilution system. Some standardized test methods also set the maximum concentration at a fixed value of 10^7 cm^{-3} to avoid any alteration of the size distribution of the test aerosol due to coagulation. However, a high particle concentration upstream of the test sample of the filter material can clog the media sample tested. This can both increase the media pressure drop and change its fractional efficiency. Measurements made in this condition would not be reliable because filter media properties would change because of the test aerosol.

Tested media and experimental procedure

We studied four different kinds of filter media. At two different media velocities (at 1.7 cm/s and 3.0 cm/s) we measured the fractional efficiency as a function of the particle size in the 100-3000 nm size range . Our measurements included the determination of the initial fractional efficiency of the filter media before and after discharging them by exposure to vapors of isopropyl alcohol (IPA) for 24 hours. The tested media were:

- Medium A: a HEPA Polyester Pleatable (stated to be H13 per EN 1822);
- Medium B: a High Efficiency Woven PTFE Fabric;
- Medium C: a HEPA Polyester Pleatable (stated to be H14 per EN1822) with efficiency very close to 100%;
- Medium D: a traditional HEPA Fiberglass sheet.

Measured fractional efficiency

In Figure 1 is shown the fractional efficiency of media A, B and D. The curves for medium C are not represented because the measured efficiency was always close to 100%, both before and after the discharging process. The fractional efficiency of media A and B decreases after the discharging process. In contrast, there is no significant decrease of efficiency of medium D after the neutralization process.

The concentration and the exposure time to the synthetic aerosol, and the procedure to remove the electrostatic charges on the fibers, were carried out in the same way for all filter media tested.

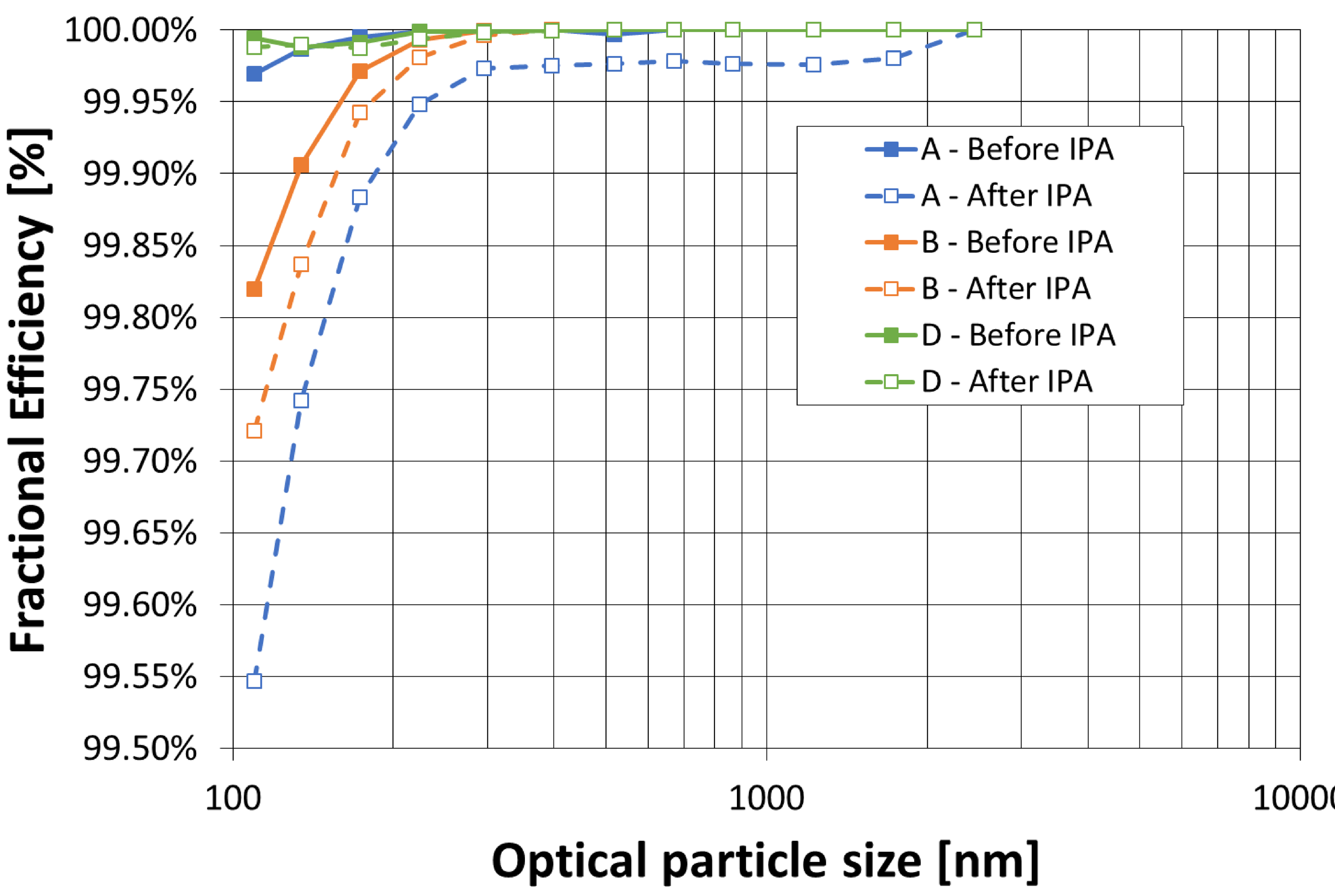

Figure 1. Fractional efficiency of media A, B and D at 3.0 cm/s before and after IPA exposure.

Geometric mean [nm]	Media A		Media B		Media C		Media D	
	Before IPA	After IPA	Before IPA	After IPA	Before IPA	After IPA	Before IPA	After IPA
109.54	99.9695%	99.5470%	99.8198%	99.7213%	100.0000%	100.0000%	99.9944%	99.9881%
134.16	99.9867%	99.7419%	99.9059%	99.8367%	100.0000%	100.0000%	99.9881%	99.9902%
173.21	99.9953%	99.8837%	99.9717%	99.9424%	100.0000%	100.0000%	99.9911%	99.9874%
223.61	99.9988%	99.9484%	99.9933%	99.9809%	100.0000%	100.0000%	99.9990%	99.9938%
295.80	99.9996%	99.9731%	99.9997%	99.9964%	100.0000%	100.0000%	99.9991%	99.9986%
396.86	100.0000%	99.9750%	100.0000%	100.0000%	100.0000%	100.0000%	99.9996%	99.9996%
519.62	99.9970%	99.9764%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%
670.82	100.0000%	99.9787%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%
866.03	100.0000%	99.9766%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%
1224.74	100.0000%	99.9761%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%
1732.05	100.0000%	99.9802%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%
2449.49	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%

Table 1. Fractional efficiency of media A, B, C and D at 3.0 cm/s before and after IPA exposure.

Unwanted clogging

Figure 2 shows the pressure drop increase of the materials as a function of the exposure time to the synthetic aerosol.

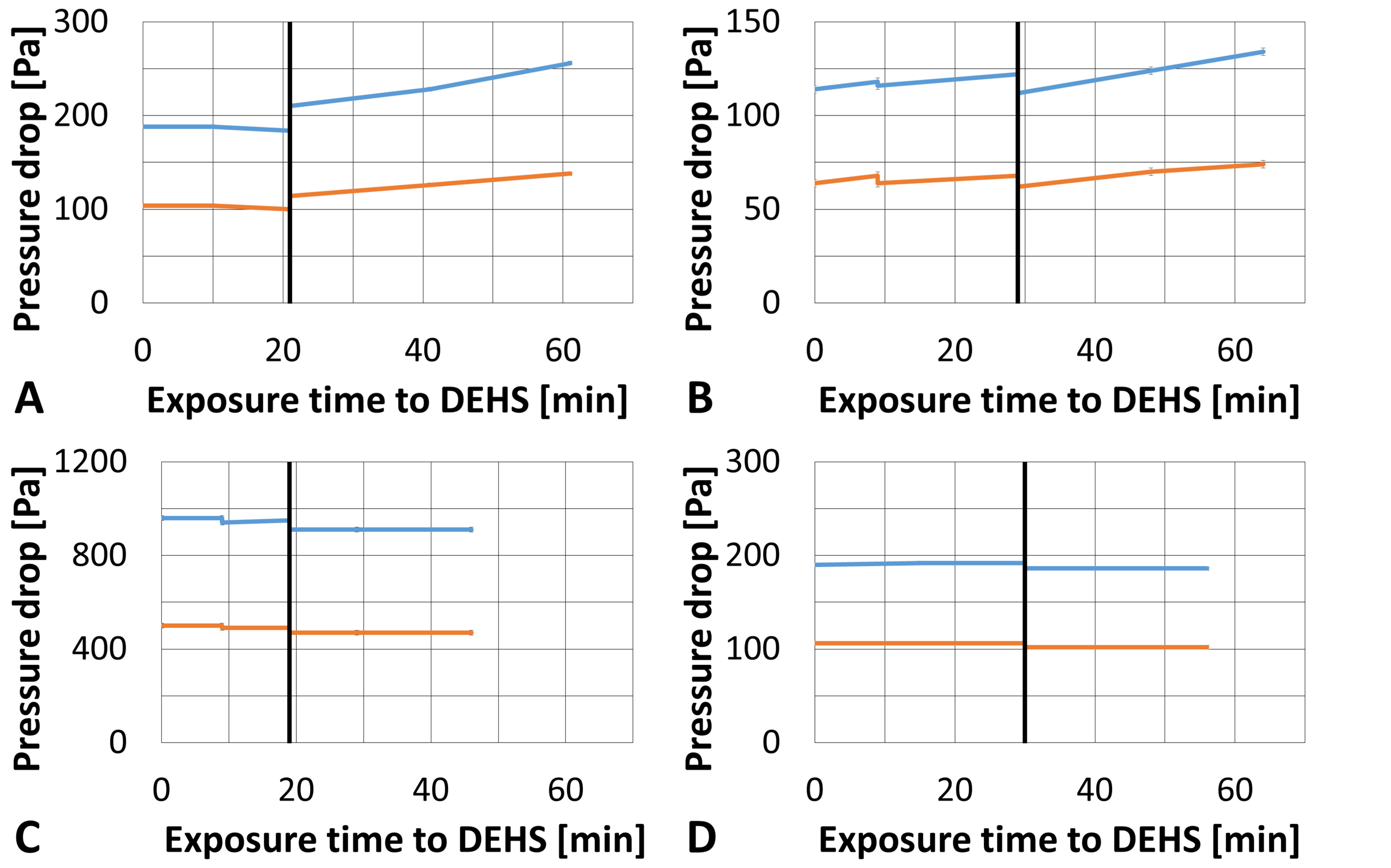

Figure 2. Pressure drop of medium as a function of exposure time to DEHS. At 3.0 cm/s in blue and at 1.7 cm/s in orange.

Figure 2.A, shows that before the neutralization process, the pressure drop of medium A is stable over time and there is no evidence of clogging due to the test. In contrast, after the neutralization process, the pressure drop increases significantly after exposure to the synthetic test aerosol.

Figure 2.B shows that before the neutralization process, the pressure drop of the medium B increases during the exposure to the test aerosol. After the neutralization process, the clogging process becomes even more evident.

Figure 2.C and Figure 2.D show that pressure drops for media C and D do not increase before and after the neutralization process.

Facilities used to perform the measurements

Figure 3. Syntethic (DEHS) aerosol generator.

Figure 4. Filter media test rig.

Figure 5. Dilution system.

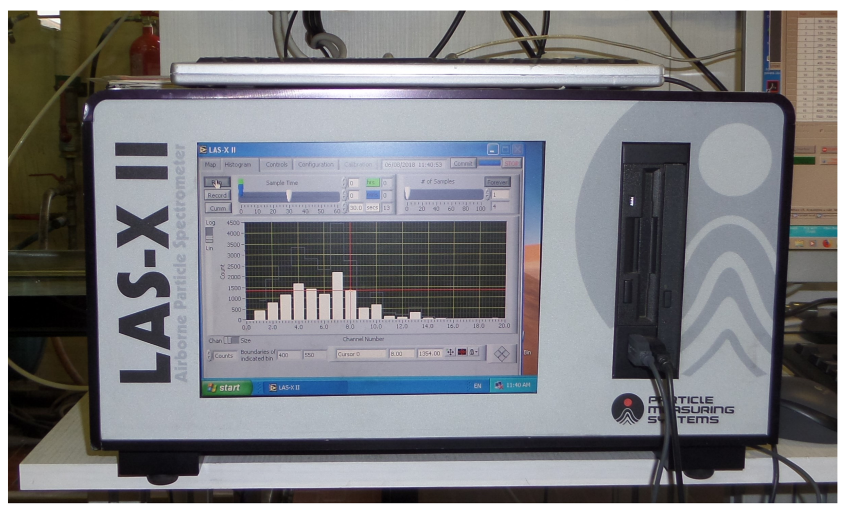

Figure 6. Particle spectrometer.

Conclusion and recommendations

Taking into consideration all the tested media, the exposure to IPA vapor of media A and B affects their properties so that the clogging effect becomes evident during testing for fractional efficiency.

In order to reduce the time of exposure to the synthetic aerosol and thus reduce clogging, the fractional efficiency measurement could be performed at only one media velocity for each filter media sample. However, the uniformity of the different samples should be guaranteed.

References

1) EN 1822 (all parts), *High efficiency air filters (EPA, HEPA and ULPA).*

2) ISO 29463 (all parts), *High-efficiency filters and filter media for removing particles in air.*

3) R.C. Brown. Air Filtration. An Integrated Approach to the Theory and Applications of Fibrous Filters. Pergamon. 1st Edition. 1993.

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