S1.1.4 - *Electret Filter Media - from the Experimental Investigation of Discharging Methods to Numerical Optimization Potential*

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Electret filter media are used in aerosol filtration to remove particles from gases. They provide a high initial efficiency combined with a low-pressure drop as the fibers of the electret filter media are electrostatically charged. In addition to the mechanical deposition mechanisms, charged particles are deposited by the Coulomb effect and any (charged or uncharged) particles by dielectrophoresis. However, it is known that the charge and thus also the efficiency can degrade over lifetime. Testing standards take into account this aging by discharging electret filter media or the entire filter with isopropanol. In this work, experimental investigations on the influence of discharging methods on different charged electret filter media are performed by means of deposition experiments. The focus is on the discharging methods prescribed in DIN EN 779 (liquid isopropanol) and its replacement ISO 16890-4 (isopropanol vapor). After isopropanol treatment, the electret filter media are challenged with a sodium-chloride test aerosol with known charge distribution. The particle size distribution is measured upstream and downstream of the electret filter media

with a Scanning Mobility Particle Sizer (SMPS, TSI Model No. 3934). The experiments revealed that air permeability is a central influencing parameter. Small pores lead to a reduced discharge efficiency using liquid isopropanol, while both treatment methods are suitable for larger pores. With liquid isopropanol, the air inside small pores cannot be displaced, whereas this phase boundary does not exist for isopropanol vapor. An extension of the immersion time in liquid isopropanol to 24 hours leads to better discharge due to enhanced molecular diffusion across this phase boundary. Thus, ISO 16890-4 provides a suitable discharging method for electret filter media, while the immersion time according to the DIN EN 779 (at least two minutes) has proven to be too unspecific. Beyond the experimental investigations, the optimization potential of electret filters with respect to efficiency and long-term stability was investigated by Direct Numerical Simulations (DNS) of the deposition of the charged sodium-chloride particles. The simulations are carried out with the in-house developed software DNSlab. A suitable 3D model of the fibrous structure is obtained by mathematic generation, while the charged areas of the fibers are modeled in different patterns in an equivalent bipolar way. The particle trajectories inside the filter medium are calculated using the Euler-Lagrange approach considering the drag force resulting from the calculated flow field through the 3D model, Coulomb force and dielectrophoretic force due to the electric field in the pore volume around the charged areas and the Brownian particle motion. For initial efficiency, the numerical simulations revealed that fiber charge should be homogeneously distributed within the media depth. In contrast, for long-term deposition, the charge in the middle of filter media should be higher than on the outside. This leads to an extension of filter lifetime with the compromise of lower initial efficiency. Thus using the simulation tool, the optimization potential of electret filter media was shown.

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Testing