Influence of particle and filter charge on collection efficiency of air filters in an externally applied electric field

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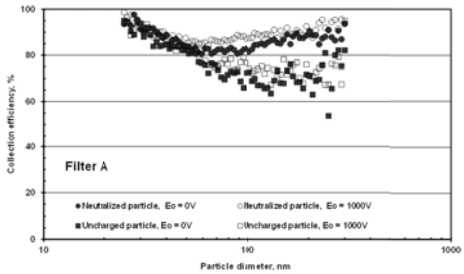
Electrostatic forces have been widely used for enhancing the performance of air filters. Particle charge, filter charge, and external electric field can raise filtration efficiency without any increase of pressure drop of filter. Charged filters have very high initial collection efficiency, but the filter charge gradually loses its effect as particles are captured on filter fibers (Walsh and Stenhouse, 1997). Applying an electric field across filter media can be an alternative method to overcome the drawback of charged filters, even though it has several limitations to extend its application. In this work, the effectiveness of electric field applied to air filters was experimentally examined.

Three different filter media were used for test, as listed in Table 1. Filter A is an electrically charged filter provided by a company. Filter A has a 3-layer structure, and its middle layer is composed of polypropylene fibers of 2~10 μm in diameter. Filter B is prepared by immersing Filter A into isopropanol and drying. This is general process to get rid of filter charge. Thus, Filter B can be accepted as non-charge filter. Filter C is a commercial micro-glassfiber filter (Type A/E, Pall Corp.). NaCl particles as test aerosol are generated via an atomizer and diffusion dryer. Aerosol neutralizer was used for bipolar charging of particles, which is denoted as 'neutralized particle'. 'uncharged particle' was supplied to filter by removing charged particles from 'neutralized particle' via an electrostatic precipitator. Electric field was formed across filter media using two metal meshes as electrodes between which an electric potential of (-)1000 V was applied. The filtration velocity was fixed at 5.3 cm/s through this study.

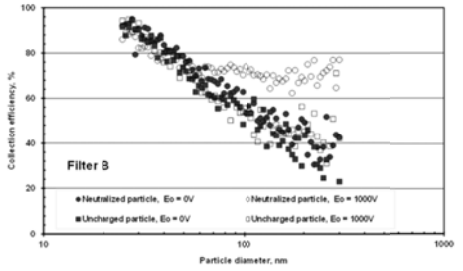
Table 1. Fundamental properties of tested filter media.

sample	filter charge	fiber material
Filter A	charged	polypropylene
Filter B	IPA treated	polypropylene
Filter C	as received	glass fiber

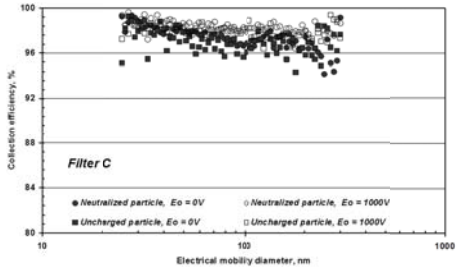
As can be seen in Fig. 1, Filter A shows the minimum efficiency of 80% for 70 nm neutralized particles, while approximately 70% efficiency for 150nm uncharged particle. The effect of external electric field was very little for Filter A. From the results for the non-charge Filter B, it can be known that Filter B has no charge and the dominant electrostatic force acting on neutralized particles is Coulombic force due to the particle charge and external electric field. Filter C is a highly efficient filter media whose minimum efficiency is over 96%, thus external electric field made only little difference in filter efficiency. Additionally, there was no significant effect of electric forces on collection efficiency for the particles smaller than 50 nm in diameter under experimental conditions of this work.



(a) Filter A



(b) Filter B



(c) Filter C

Figure 1. Collection efficiency of tested filters for NaCl particles under various electrostatic conditions.

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Walsh, D.C. and Stenhouse, J.I.T. (1997) *J. Aerosol Sci.*, **28**, 307-321.