Filtration of aerosols with different shape on oil coated fibers

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It has been shown that perfectly spherical polystyrene latex (PSL) particles have higher filtration efficiency compared to cubic magnesium oxide (MgO) particles (Boskovic et al., 2005). This difference becomes more obvious with an increase of particle size from 50nm to 300nm. All experiments were conducted at 2cm/s filtration velocity to avoid the influence of inertial effects. This disparity was ascribed to the different nature of the motion of the spherical and cubic particles along the fiber surface, following the initial collision (Boskovic et al., 2005). The experimental work has also been extended to include sodium chloride (NaCl) particles of intermediate shape (cubic particles with rounded edges) and tested all three types of particles at a range of filtration velocities from 5 to 20cm/s (Boskovic et al., 2007). Particles of NaCl are being captured with efficiencies lower than those for PSL particles but higher than the efficiencies of cubic MgO particles, at the lowest filtration velocity. The difference between the filter efficiencies for collection of MgO and NaCl particles decreases with an increase in velocity. With velocity increase, the filtration efficiency of the cubic MgO particles, exceeds the filtration efficiency for the intermediate shaped NaCl particles, due to the dominating inertial effects of the denser MgO particles of similar size.

In this project, a thin coating of the polypropylene filter with a mineral oil was used, to absorb the energy of collision and, respectively, to minimize the particle bounce. Coating surfaces with oil or grease increases the adhesion energy, the deformation, and the dissipative energy and greatly reduces the problem of bounce (Hinds 1999). The filtration efficiency of spherical PSL, cubic MgO and intermediate NaCl particles was measured in the same size range as before (50-300nm), for 10 and 20 cm/s filtration velocity. It was found that tested particles, regardless of shape, have very similar filtration efficiencies, as is clearly seen in Figure 1 for 10 and 20cm/s filtration velocities respectively. The curves are all close together and the standard deviations have overlap, showing insignificant discrepancy in the results compared to our previous findings (Boskovic et al., 2005, 2007). We also compared our experimental results with theoretical filter efficiency estimated according to the classic approach (Hinds, 1999). For calculations, all parameters of filter had to be adjusted to take into account the alterations, due to fibre coating. To measure precisely the diameter of oil coated fiber, we used FEI Quanta 200 Environmental SEM (ESEM) which allows operation at moderate vacuum level and can be used for samples with slightly evaporative liquid (see Figure 2). It was found that the thickness of the fibre was increased by 7.4% and, correspondingly, packing density by 14.9%. The theoretical results are also shown in Figure 1. As is clearly seen, the theoretical predictions are in good agreement with our experimental results. The emission of oil was not influencing the process, as was verified by “zero” emission from the coated filter in absence of test aerosol supply. We have shown that the oil coating minimizes the amount of particle motion along the fibre after initial collision, making results for all particle shapes similar.