S2.1.1 AIR INTAKE FILTER MEDIA LOADING BY SOLID AND OIL MIXTURES

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Current air filter test standards employ pure solid (ISO dust, carbon black, cotton linter, NaCl, KCl, etc.) or pure liquid/oil (DEHS, PAO, etc.) as testing aerosols. Only pure solid particles are used to assess the filter holding capacity/lifetime or to condition/age the filter in test standards. Filters used in field may face aerosols from various sources with different physical states, e.g. mixtures of solid and liquid (oil) particles for filters used for colloid/mist removal, including cooking or oil handling application, offshore oil drilling platform, and etc. Although the clean filter efficiency may not be affected much by aerosol physical state, the filter loading and clogging behaviors could be different. Most liquid aerosol filter loading studies employed pure oil, and our knowledge to filter clogging by mixture of solid and oil particles is limited.

In this study, particle loading and clogging behaviors on three types of air intake filter media (conventional cellulose, cellulose with nanofiber coating on top, and ePTFE) were tested using submicron solid and oil mixtures. Two different types of solid particles were generated: sodium chloride salts from a Collison-type atomizer and soot agglomerates from a home-made propane diffusion flame burner. The solid fraction was then mixed with oil particles generated from another Collison-type atomizer, in which DEHS or a series of high-viscosity PAO oil particles were generated. The solid and oil particle mixtures were loaded onto a 57-mm diameter flat filter media with controlled mixing ratio varying from 100%-0% (pure solid) to 0%-100% (pure oil) with 10% increment based on volume concentration. The holding capacity of cellulose media is found to increase with increasing oil fraction in the mixture; while the clogging on nanofiber or ePTFE switches between two patterns. At high solid fractions, solid-oil mixtures deposit on the surface of media, forming cake, which leads to higher holding capacities than conventional cellulose media. At high oil fractions, solid-oil mixtures form a paste-like thin film, which spreads out and coats on top surface of fine fiber layer in nanofiber or PTFE media, resulting in faster clogging and reduced holding capacities than cellulose media. Oil viscosity and mechanical strength of solid dendrite/cake are found to affect the clogging behavior, which relate to oil drainage and interaction between solid and oil after deposition.