S2.1.2 EFFECT OF RELATIVE HUMIDITY AND PARTICLE STATE ON LOADING CHARACTERISTICS OF NANO-FIBER COATED AIR INTAKE FILTER MEDIA BY POTASSIUM CHLORIDE, AMMONIUM SULFATE, AND AMMONIUM NITRATE SUBMICROMETER PARTICLES AND COMPARISON WITH CONVENTIONAL CELLULOSE FILTER MEDIA

Chenxing Pei, Qisheng Ou, David Y.H. Pui
University of Minnesota

Air intake filters are widely used to remove particles in the ambient air to protect automobile engines and gas turbines. The mass of the particles that an air intake filter can hold before reaching the designated pressure drop reflects the life of the air intake filter. The higher the mass loading a filter can hold, the longer the replacement period. However, the current lab loading test conditions do not reflect the actual working environment. For example, NaCl and KCl are commonly used in the lab as the test particles because they are cheap, non-toxic, and insensitive to changes in relative humidity. Thus, the filter test standards do not strictly regulate relative humidity during testing. In ambient air, NaCl and KCl are found in lower concentrations than (NH4)2SO4 and NH4NO3, and their hygroscopicities are extremely different. Therefore, it is worthwhile to use (NH4)2SO4 and NH4NO3 to mimic the ambient particles for air intake filter loading tests, and considering their hygroscopicities, to control the relative humidity and the state of the particles during these tests.

For a hygroscopic salt particle, when the relative humidity in the environment is above its efflorescence relative humidity and below its deliquescence relative humidity, the particle can be in either a dry state or a wet state. In this study, synthetic Nano-fiber coated cellulose filter media were loaded with sub-micron particles of KCl, (NH4)2SO4, or NH4NO3 respectively until a specific pressure drop was reached. This process was repeated at different relative humidities and different particle states. To compare the volume loadings between different salts, the particle distributions were generated to be alike and the volume loading was calculated from the mass loading and the salt density. The results show that the volume loadings of all particles are dependent on relative humidity, the higher the relative humidity, the higher the volume loading. The (NH4)2SO4 and KCl volume loadings were similar, but (NH4)2SO4 was a little greater than KCl when particles were dry. The NH4NO3 particles could only be generated in the wet state and the volume loadings were greater than other wet particle loadings but less than other dry particle loadings. By comparing current results with the volume loading of conventional cellulose filter media at the same pressure drop, we conclude that dry particles can load more on Nano-fiber coated cellulose filter media, while wet particles can load more on conventional cellulose filter media.