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Filtration of Airborne Microorganisms: Collection and Reaerosolization Characteristics

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All human beings are exposed to a diversity of airborne microorganisms most of the time. Human exposure to a wide range of microorganisms may result in allergic, toxic or infectious desease. Filtration is an effective way to protect human beings from potentially harmful organisms. In our studies, we have examined the collection and reaerosolization characteristics of filters that are used primarily for respiratory protection. The focus of the presentation will be on our new testing and analysis methods and on the principal conclusions resulting from our studies.

In this study, we have investigated the bacterial penetration through filter materials for different bacterial shapes, aerodynamic sizes and flow rates. The bacterial penetrations have been compared with those of spherical corn oil particles of the same aerodynamic diameter tested under the same conditions. Bacteria, ranging from spherical to rod-shaped with a high aspect (length to width) ratio, were selected as test agents. Among these, *Pseudomonas fluorescens* physically simulates *Mycobacterium tuberculosis* by shape and size. The concentrations of bacteria upstream and downstream of the filter were measured with an Aerosizer (Amherst Process Instruments Inc., Hadley, MA). This instrument was found to effectively and dynamically measure the bacterial concentration of submicrometer-sized bacteria. The results indicate that the spherical corn oil particles and the spherical *Streptococcus salivarius* bacteria have similar penetration. Rod-shaped bacteria penetrate less. The penetration difference between the spherical and rod-shaped bacteria depends on the aspect ratio of the bacteria. For an aspect ratio of 4, the penetration of these elongated bacteria is about half that of spherical ones.

Particle reentrainment from polymer and glass fiber filters was investigated by measuring the number of reentrained particles when loaded filters were subjected to air velocities higher than typical filtration velocities. The filters were loaded with mono- or polydisperse solid particles or liquid droplets. The maximum reentrainment air velocity used in the tests was 500 cm/s, almost one hundred times the 6.6 cm/s filtration velocity during particle loading. For the test conditions, the reentrainment of 0.6 to 5.1 μm particles increases approximately with the square of particle size and reentrainment velocity, and decreases with increasing relative humidity. The rise time in reaching the reentrainment air velocity has negligible influence on the degree of reentrainment. Particle and filter type were found to significantly affect particle reentrainment. The minimum reentrainment velocity decreases with increasing particle size. Electrical charges on the filter fibers significantly increase the collection of submicrometer particles, but their reentrainment is only slightly impeded by the embedded charges.