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PHYSICAL AND BIOLOGICAL AEROSOL PENETRATION AND FACE-SEAL LEAK CHARACTERISTICS OF INDUSTRIAL AND HEALTH-CARE RESPIRATORS

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Respirators, also referred to as masks when the entire device is a filtering facepiece, are worn in industry and health-care environments as a last defense against toxic and infectious aerosols. Masks that have traditionally been used in hospitals have been effective barriers for retaining large expelled droplets from the health care workers, after release through speaking, coughing, or sneezing. Many of today's hospital procedures produce submicrometer-sized aerosol particles which are insufficiently retained by conventional surgical masks. Also, the spread of multi-drug resistant tuberculosis via airborne transmission has become of utmost concern in public institutions. Our research efforts on respiratory protection has for over ten years been focused on the filtration and face-seal leak characteristics of industrially used respirators (Willeke and Krishnan, 1990; Chen and Willeke, 1992b; Chen, Lehtimäki and Willeke, 1992, 1993). During the last two years we have added research on health-care masks, which we have tested with physically inert test particles (Chen and Willeke, 1992a; Weber, Willeke et al., 1993) and, most recently, with aerosolized microorganisms.

Performance tests of available surgical masks showed filter penetration from 20% to 100%, depending on the mask used. In comparison, a dust-mist respirator used in industrial settings had significantly less penetration through its filter medium. When the surgical masks had artificially induced face-seal leaks, the concentration of submicrometer-sized particles inside the mask increased slightly; in contrast, the more protective dust-mist-fume respirator showed a considerable increase in aerosol penetration into the mask. This is due to the higher pressure drop across the higher-performance mask, which forces more

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aerosol flow through the face-seal leak. We conclude from these measurements that the traditionally used surgical masks may be insufficient in environments containing potentially hazardous submicrometer-sized aerosols. If more protective masks are worn, fit testing should be considered to ensure that the mask/respirator be properly fitted to the wearer's face.

We have developed new respirator fit testing methods, both for filtering facepieces and for elastomeric respirators with removable cartridges. These methods differentiate the air flow through the face seal leak from the flow through the filter material (Krishnan, Willeke *et al.* 1994a and b; Myojo, Willeke and Chen, 1994).

Our recent studies with a diversity of challenge bacteria have shown that the aerosol tests with ideal, spherically-shaped test particles give conservative measurements of bacterial aerosol penetration. The latter is less, depending on the shape and size characteristics of the bacteria.

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