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INHALABILITY OF LARGE PARTICLES FOR MOUTH AND NOSE BREATHING

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This research seeks to better define particle inhalability, the fraction of ambient particles that are inhaled as a function of particle size, breathing conditions, and ambient air velocity and direction. Inhalation of large particles (10-150 micrometers) such as heavy metals, pesticides, radioactive materials, pharmaceuticals, wood dust, or corrosive materials have a local or systemic toxicity that poses a health risk regardless of where in the respiratory tract they deposit. More complete information of inhalability is needed to correctly assess the health risks of exposure to such particles.

Measurements of inhalability were made for solid particles using an open cycle, closed-jet, low-velocity wind tunnel having a 1.6 X 1.6 m cross section. Tunnel air velocities were 0.4, 1.0, 1.6 m/s. A life-size, full-torso mannequin was modified to collect the dust entering the mouth or nose. The inhalation path was connected to a mechanical breathing machine, which simulated human breathing with breathing patterns corresponding to three work rates. Minute volumes were 14.2, 20.8, and 37.3 L. The mannequin was either facing the wind or rotated slowly (0.06 rpm) with respect to the wind direction. Nine sizes of sieved aluminum oxide test dust were used. Dust concentration at the test section was determined with three isokinetic samplers. It ranged from 50 to 200 mg/m^3. Room turbulence was removed by screens and flow laminator (honeycomb) at the tunnel inlet. Controlled turbulence was introduced by a biplanar latice. At the test section air velocity was uniform to within 10% and dust concentration was uniform to within 15%.

Orientation averaged results are summarized in Figure 1. Nose inhalability followed the American Conference of Governmental Industrial Hygienist (ACGIH, 1985) Inhalable Particulate Mass criteria curve up to 30 micrometers. Beyond 30 micrometers inhalability dropped quickly reaching a value of less than 10% at 60 micrometers. Orientation-averaged mouth inhalability was higher than the ACGIH curve for particles from zero to 35 micrometers and lower than the curve for larger particles. It leveled off at about 35% for the largest particles. Breathing rate and wind velocity had little effect on inhalability for the range of conditions studied here.

Facing the wind inhalability results are summarized in Figure 2. Facing-the-wind orientation caused a small increase in nose inhalability for particles less than 60 micrometers compared to orientation averaged inhalability. Inhalability for mouth breathing with this orientation had the same trend as the ACGIH inhalability curve but was approximately 25% higher. Breathing rate and wind velocity had little effect on inhalability when facing the wind.

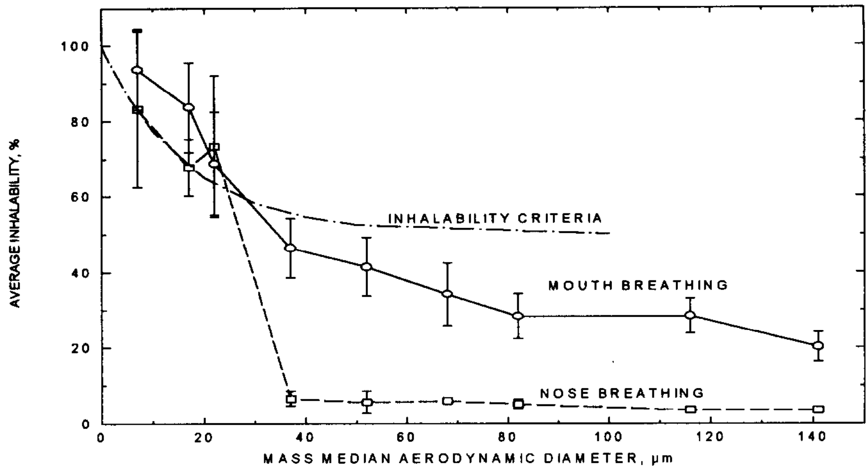

Fig. 1. Orientation averaged inhalability for mouth and nose breathing.

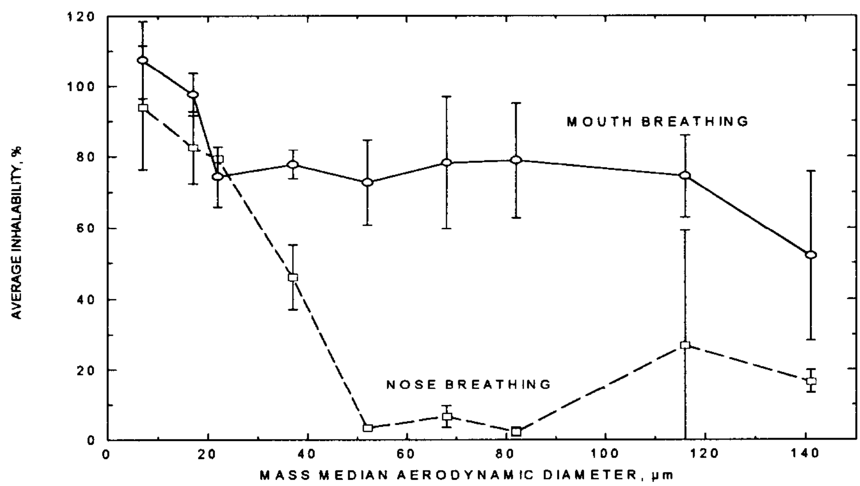

Fig. 2. Facing-the-wind inhalability for mouth and nose breathing.

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