Particle resuspension from indoor flooring materials

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Introduction

Particle resuspension from indoor surfaces is an important problem for human exposure and indoor particle transport, particularly for supermicron particles. Resuspension is usually reported either as a critical velocity, the velocity at which 50% of deposited particles resuspend, or as a force of adhesion, the force that is required to be overcome to detach particles from a surface. Most research on the subject has tended to focus on idealized particle-surface systems (i.e. polished brass) and offers limited insight about processes that occur on non-uniform indoor materials. The goal of this investigation is to explore the relationship between critical velocity and particle diameter for indoor flooring materials.

Materials/Methods

The methods used in this work are described in detail in Lohaus (Ph.D. Thesis, Department of Civil, Architectural, and Environmental Engineering, The University of Texas at Austin, 2007). Clean samples of linoleum and wood flooring measuring 0.15 m square were seeded with monodisperse polystyrene latex (PSL) particles with a fluorescent tracer and with diameters of 0.5, 3.1, and 5.0 μm. Samples were then placed in a 0.3 m × 0.3 m cross-section test duct and exposed to a uniform velocity of 0 – 15 m/s for 2 minutes. Exposed samples were than submerged in isopropyl alcohol and the fluorescence of the solution was determined with a fluorometer. The relative fluorescence, F, was determined with Eqn. 1:

$$F = \frac{(SE - UU)}{(SU - UU)} \quad (1)$$

where SE is the fluorescence of the seeded exposed sample, UU is the fluorescence of an unseeded and unexposed sample (i.e., background), and SU is the fluorescence of a seeded but not exposed sample. Thus $F = 1$ if no resuspension occurs and $F = 0$ if all of the particles on the surface resuspend. The critical velocity is therefore the velocity at which $F = 0.5$. Approximately 20 - 30 samples were exposed for each particle size and flooring material combination.

Results

Critical velocities for 3.1 and 5.0 μm particles appear below in Table 1. 0.5 μm particles did not show any resuspension ($F = 1$) at 15 m/s indicating that very large velocities are required to suspend small particles. Particle resuspension occurs at a lower velocity for larger particles and was within uncertainty for the two different flooring materials.

Table 1. Critical velocities (m s^{-1}).

	3.1 μm	5.0 μm
Linoleum	8.3±0.6	6.2±2.3
Wood	9.7±9.9	5.7±3.0

The results are consistent with some classical models of particle/surface interactions that suggest that particles first begin rolling on a surface and eventually detach from the surface.

Conclusions and Implications

Particle resuspension is inversely related to particle diameter. Resuspension of 0.5 – 5.0 μm particles occurs at much higher bulk velocities (order of 10 m s^{-1}) than are typically found in indoor environments (order of cm s^{-1}). These very high velocities only typically occur in HVAC systems or near diffusers. However, particle resuspension is also closely linked with air turbulence and acceleration and these results suggest that these two parameters should be measured in future experiments on resuspension.