Physical parameters of powders and release of aerosol

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Handling of bulk materials in the workplace can be a major source of release of airborne particles into the atmosphere. Worker exposure to such created ambient aerosols brings a risk of undesirable health effects. The ratio of mass of aerosolized particles to mass of handled powder in controlled conditions gives a dustiness index [$mg.kg^{-1}$].

The goal of this study was to correlate the measured dustiness indices with some physical parameters of powders, such as particle-size distribution, flowability and floodability. These parameters are currently used in connection with industrial conveying of bulk materials and transportation of powders since they often contribute significantly to ambient aerosol concentration in the workplace

Dustiness can be measured using several methods developed in different laboratories. Our choice was to use a method able to measure dustiness indices in three health-related aerosol fractions: inhalable, thoracic and alveolar. A standardized rotating drum (John Fish Holdings, UK) was used to measure dustiness. The method of Coulter-Counter (Coultronics®, US) was used to measure particle-size distribution, and the Powder Tester PT-S (Hozokawa Micron Corp., J) to measure mechanical properties of bulk materials.

Firstly, we assessed the variation of fused alumina dustiness as a function of particle-size. Two alumina powders, one fine (Aloxite 50, mass median diameter MMD=5.35 µm) and another coarser (Aloxite 125, MMD=11.15 µm) were mixed in several proportions and the dustiness of the mixtures measured.

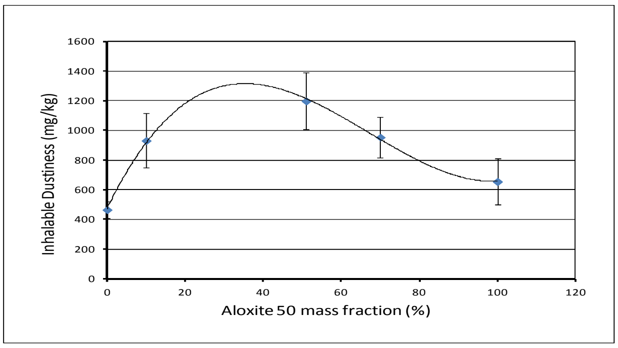

Figure 1 shows variation in inhalable dustiness index as a function of Aloxite 50 content in the mixture

It can be seen from Figure 1 that the finer material has a higher dustiness index than the coarser one but the maximum dustiness corresponds to the mixture with about 35% of coarser material. The mechanism of aerosol release during the powder handling involves both, fine and coarse particles: while fine particles have a higher propensity to be airborne, coarse particles bring the energy necessary to break inter-particle cohesion forces during handling. (Görner et al, 1989).

Several mechanical properties of powder materials have been defined in the literature: Angle of Repose, Angle of Fall, Bulk Density, Compressibility, Cohesiveness, Dispersibility, etc. After measuring them, we did not find a correlation between dustiness and these parameters. But we have found a relationship between dustiness and flowability or floodability. Both flowability and floodability are characteristics made up of several of the above-mentioned parameters and they characterize transport behavior of a powder.

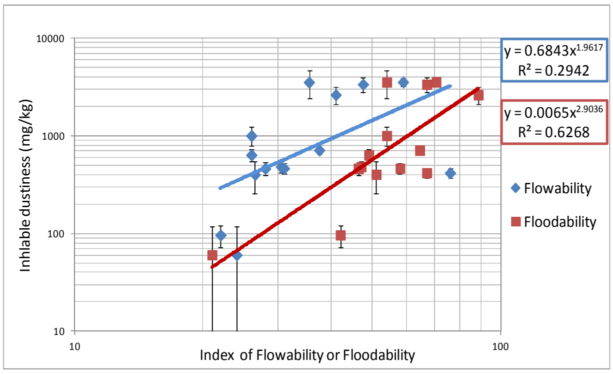

Figure 2 shows a relationship between inhalable dustiness and flowability or floodability of different powders

Figure 2 shows an approximately linear increase in dustiness with increasing flowability or floodability. Bulk materials with good conveying properties are dustier. It was also found (not shown here) that dustiness of coarser materials is better correlated with flowability while dustiness of finer materials is better correlated with floodability. All of these correlations were not statistically significant, probably due to the small number of experimental measurements.

In conclusion we can state that even when dustiness is connected to other physical parameters of bulk powders, it would be rather hazardous to estimate a dustiness potential from them. Dustiness index, if required, should be measured separately.

Görner, P., Pich, J. (1989) Generalized Theory of Dispersion Forces, *J. Aerosol Sci*. **20**. 735-747.