THE EFFECT OF PARTICLE SHAPE AND SIZE DISTRIBUTION ON THE RATE OF FLOW OF A LACTOSE GRANULATION DOWN AN INCLINED CHUTE

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The flow of powders and granules down an inclined tube or chute is a common occurrence in industrial solids handling processes. In earlier work at this School (Ridgway & Rupp 1970a, 1970b) the rate of flow of sand, and the degree of mixing of two superposed flowing layers, were examined as a function of particle shape for fractions with as narrow a size and shape distribution as possible. That work has now been extended to the flow of a range of size and shape distributions of a lactose placebo granulation (Thomas Kerfoot & Co.). Four batches of the granules were prepared by removing all material smaller than 120, 85, 60 and 44 mesh, and each of these batches was sorted according to particle shape using the shape-sorting table described in the earlier work (Jeffrey-Galion Co.). This gave 16 cuts differing in size and shape and these were allowed to flow down the inclined chute. The flow rate was measured as a function of the angle of inclination of the chute to the horizontal, and the minimum angle θ_0 that is necessary to cause flow estimated by graphical extrapolation of the results.

In almost all cases, an increase in particle shape factor led to a fall in the rate at which the powders would flow down the chute, due to the tendency of angular particles to slide rather than roll, so that friction between the powder and the chute will be increased. Since the frictional component of the forces acting on the flowing powder involves the term cos θ, it will fall in magnitude as the flow angle θ increases, thus reducing the difference in flow rates between rounder and more angular particles. Ridgway and Rupp found with sand that at an angle of 60^{o} the shape effect was virtually eliminated. With the rougher lactose particles, a difference is still discernible even at high angles.

In the absence of fine material below 44 mesh, particle shape has little effect on the zero flow angle. In the presence of finer material than this, an increase in particle shape causes an increase in θ_0. The apparent independence of θ_0 from shape for the coarser material suggests that the previously observed reduction of flow rate with increased particle shape is not solely due to friction between the powder and the chute, but may be attributable to internal friction within the flowing bed.

As the proportion of fine material increases, so the friction between the chute and the powder bed becomes the predominant factor in governing flow rate. The fine material reduces the space available within the bed for the larger particles to move about and so tends to give a more rigid bed. In addition there will be a greater area of contact with the surface of the chute. In support of this proposal is the observation that the original complete granulation has a higher θo value than any of the other powders, and it has by far the highest proportion of fines.

Ridgway, K. & Rupp, R, (1970). Chem.Proc.Eng., 51, (5) 82-85.
Ridgway, K. & Rupp, R. (1970). Powder Technol., 4, 195-202.