INTERPARTICLE ADHESION FORCES IN ORDERED MIXES

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Random powder mixing will only occur when there are no interactions between particles (Lacey 1943). In a binary mix of large free-flowing particles and small cohesive particles, the fine fraction may adhere to the coarse fraction (carriers) this prevents randomisation and produces an ordered mix (Hersey, 1975). The formation of ordered mixes depends on the interparticulate adhesion forces which hold ordered units together. A centrifugal method for calculating adhesional forces in fine particles, developed by Krupp (1967), was modified for use with pharmaceutical powder mixes. The adhesional forces in ordered mixes containing sucrose (S) and 1% fine salicylic acid (SA) particles were compared with the interparticle forces binding SA to the direct compression excipients, Emdex (E) and Dipac (D). A sample from each ordered mix was placed in a specifically constructed specimen cell which fitted into an ultracentrifuge rotor. During rotation any dislodged drug particles were separated from carrier particles onto a collecting unit which was subsequently analysed for SA content. Figure 1 shows the relationship between the quantity of drug particles adhered to carrier particles and the magnitude of the adhesion forces. The quantity of drug particles bound to the surface of S particles diminished with increasing adhesion force and the amount adhering with a maximum measurable force of 1360 m.dyne (1.36 x 10^{-5}N) was 3% which was lower than the proportion of SA adhered to D or E at 1360 m.dyne (1.36 x 10^{-5}N) and was probably caused by surface irregularities on the rougher D and E particles producing increased interparticulate attraction forces. The adhesion profile of D and 1% SA ordered mixes was a composite of two curves (Fig. 1). The first section showed an initial loss of large quantities of SA particles from ordered units containing D. Approximately 20% of the fine SA particles were bound to D by adhesion forces less than 38 m.dyne (3.8 x 10^{-7}N) whereas in ordered mixes containing S or E carrier particles only 5% of SA particles had adhesion forces less than 38 m.dyne (3.8 10^{-7}N).

The adhesion forces binding E and SA were stronger than the forces in either S or D ordered mixes. Since only 35% of SA particles were adhered to E with forces less than 1360 m.dyne 1.36 x 10^{-5}N) large-scale segregation of these mixes would be improbable. Conversely, the disproportionately large quantity of weakly bound D and SA particles may be connected with the increased segregation tendency of Dipac ordered mixes (Rees & Staniforth 1978).

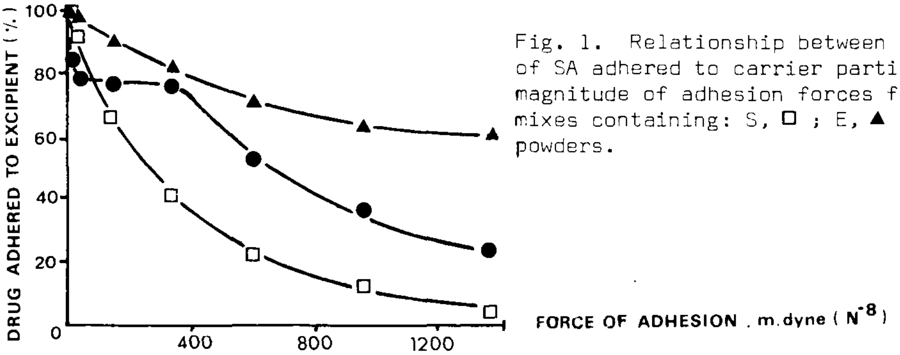

Fig. 1. Relationship between quantity of SA adhered to carrier particles and magnitude of adhesion forces for ordered mixes containing: S, □ ; E, ▲ ; and D,● powders.

Lacey,P.M.C.(1943) Trans. Inst. Chem. Eng. 21: 53-59
Hersey, J.A. (1975) Powder Technol. 11: 41-44
Krupp, H. (1967) Adv. Colloid. Int. Sci. 1: 111-239
Rees, J.E.& Staniforth, J.N. (1978) J Pharm. Pharmacol. Suppl. 30: 24P