The influence of the surface tension of pendular bonds on the tensile strength of moist beds of bulk solids

T. EAVES* AND T. M. JONES
Department of Pharmacy, University of Nottingham, Nottingham, U.K.

The tensile strength of a bed of fine particle sized material depends upon a number of factors of which the main are, particle size and distribution, particle shape, surface roughness, chemical constitution and moisture (Eaves, 1971).

For non-cohesive materials it was found that increasing the moisture content increased the tensile strength of a bed at a fixed state of packing to a plateau where it is recognized that the moisture exists as pendular bonds between adjacent particles.

In this state, the tensile strength of an ideal system of monosize spheres may be estimated from an equation reported by Pietsch (1968).

For glass powder, which possessed negligible tensile strength when dry, a reduction in the surface tension of the wetting fluid produced a reduction in tensile strength of packed beds at fixed porosities over a range of liquid contents. The tensile strength at constant liquid content and packing density increased linearly with surface tension, consistent with the previously mentioned equation.

For materials with inherent tensile strength at dryness, increasing the moisture content was found to increase the strength of the bed at a fixed packing density to a maximum and thereafter to cause a decrease in tensile strength due to disruption of the inherent cohesive forces.

Beds of fine particle sized sodium chloride wetted with a fluid of lower surface tension than saturated sodium chloride solution showed a similar pattern of tensile strength changes but non quantitative reduction in values. This is attributed to a change in the location of the pendular bonds.

For calcium phosphate, however, liquid contents of up to about 50% by weight and of varying surface tensions were shown to produce little or no change in tensile strength and this is attributed to the location of liquid in the intraparticle voids where it is less likely to affect particle-particle interactions.

The bulk solids used were powders characterized in terms of size, size distribution, shape and density. The wetting fluids consisted of 5% w/w Tween 80 in either distilled water or a saturated solution of the solid being investigated. All measurements were made on pre-dried beds of bulk solids in a controlled temperature and humidity environment (Eaves & Jones, 1970) using tensile testing apparatus similar in design to that of Ashton, Farley & Valentin (1964).

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* Present address: Sandoz Products Ltd. Horsforth, Leeds.