MECHANICAL PROPERTIES OF TABLETS IN FLEXURE AND DIAMETRAL LOADING

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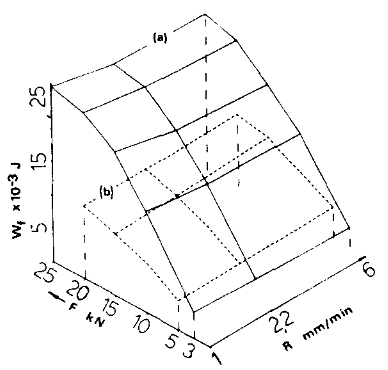
The mechanical strength and deformation properties of a tablet characterise the behaviour of powder during compaction. Commonly, the diametral compression test is used to measure tensile strength. Rees and Rue (1978) extended this test to determine work of failure of some direct compression excipients. Church and Kennerley (1984) also investigated the deformation behaviour of compacts, but using rectangular specimens in a flexure test.

Five different materials were studied: Avicel 102, Starch 1500, sodium chloride (Evans Medical Ltd.), Emcompress and anhydrous lactose (Sheffield Chemical Corp. New Jersey). These were compacted at forces from 5 kN to 25 kN. Sufficient material to produce a compact 2.49mm thick at zero theoretical porosity was compressed in a previously lubricated 12.7mm diameter die between flat punches using a Manesty reciprocating tableting machine. The tablets were stored for 48 hours at 25°C/53% RH. The tensile strength and failure deformation of ten replicate tablets were measured for each material at five different compaction forces using a mechanical testing machine (JJ Instruments model T 22K). Tablets were tested in diametral loading and also in flexure between two cylindrical fulcrums and a flat-faced anvil, 1mm wide. A displacement transducer recorded the relative movement of the platens at different rates of 1.0, 2.2 and 6.0mm/min.

Tensile strength values derived from the diametral compression test were lower than those obtained in flexure. For four of the materials studied the failure deformation of each specimen was similar in both tests suggesting that the deformation mechanism was the same. Only Starch 1500 showed a difference; lower failure deformation during the bending test was attributed to brittle behaviour of the specimen. Work of failure values were lower in the bending test, suggesting that tablets are less tough in flexure than in diametral loading (Fig.1a and b).



Work of failure (W_f) for Avicel compacts in (a) diametral (b) flexure test as a function of compaction force (F) and platen rate (R) (log scale).

The rate of loading did not alter the results in a flexure test (Fig.1b). However in diametral loading, platen rate affected tensile strength and work of failure, depending on the brittle or plastic nature of the test specimen. This indicates more complex behaviour in the diametral test and may partly be explained by shear stresses near the platens in the diametral test compared with pure tensile failure in the flexure test. From this comparison the flexure test may provide several advantages in determining the mechanical properties of tablets. The pure tension that occurs minimises errors in the tensile strength measurements. The localised failure of brittle materials at the points of contact with the platen, which causes non-recoverable deformation of the compact, may also be a disadvantage of the diametral test. It is concluded that the larger scatter of results in the flexure test is its main disadvantage. Depending on the type of specimen, coefficients of variance of 0-10% and 4-20% were observed in the diametral and flexure test respectively.

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