ELSEVIER

International Journal of Pharmaceutics 198 (2000) 249–250

international journal of pharmaceutics

www.elsevier.com/locate/ijpharm

Letter to the Editor

The process of forming solid compacts by the application of pressure to a powder bed is not the sole preserve of pharmacy. There are several industries which use this process to form structures. As yet, however, it has not been possible to provide a comprehensive theory which relates the properties of the individual particles, the process conditions and the mechanical and dimension properties of the resultant compacts. If Pharmacy is to make a contribution to understanding this complex phenomenon, it is important to ensure that the experiments which are undertaken, the measurements made, and the results obtained are compatible with the laws of physics. Thus, papers such as that by Vachon and Chulia (1999) cannot make a useful contribution to the research field as it contains several fundamental errors in experimental design and interpretation of the results. A particular case in point is in the assessment of the mechanical properties of the compact. Here the authors have subjected a compacted specimen (whose dimensions are not given) to an axial load and expressed the results as a tensile strength. For any test procedure to be able to convert the applied load into a stress (a failure stress can be termed a strength), it is necessary to know the stress distribution within the specimen and to identify the magnitude of the stress in the observed failure plane. This analysis can be achieved in several ways. In some cases, a theoretical solution can be derived, e.g. that of the application of diametral loading to a disc (Den Hartog, 1952). An alternative is the approach of finite element analysis (Clough, 1965). A further alternative is photoelasticity (Frocht, 1948). However, for the axial compression of cylinders no attempt has yet been made to establish such a stress distribution, because the test itself bears a variety of severe shortcomings (Darvell, 1990).

In particular, the fact that Vachon and Chulia (1999) used compacts, of which one can assume that the diameter of the cylinder was more than 2 times larger than the tablet height makes any data analysis questionable, due to the dominant effect of shear failure. Practical studies have shown that the compressive strength initially measured increases with decreasing cylinder height and a constant cylinder diameter, but that it was impossible to derive a 'standardised value' by correction for the difference in slenderness ratio (Darvell, 1990). Calculation of the tensile strength in such a test procedure cannot be made by the expression:

$$\sigma = \frac{4F}{\pi D^2}$$

as used by Vachon and Chulia (1999) and to change this to a resistance 'R' by dividing by 2 has no theoretical basis.

In material science, axial tests are used only on cylindrical specimens whose height approximates to the diameter, to evaluate a compressive strength. Such tests are notoriously difficult to perform due to the complex stress patterns induced in the specimen and the presence of friction

PII: S0378-5173(00)00354-9

at the interface between the specimen and the platen. The type of failure which results when applying such tests was found to vary with the material of the compact (Newton et al., 1993). The type of load displacement curve is not mentioned by Vachon and Chulia (1999), nor is the failure plain of the specimen even mentioned, yet these are essential if an understanding of the fracture process is to be obtained. It is extremely unlikely that the tablet will fail by a single mechanism when subjected to axial loading. Hence it will be impossible to identify a tensile strength of the specimen.

In addition to the above error, Vachon and Chulia (1999) attempted to relate a strength value to a strength induced by bonding. The strength of a specimen is related to the crack propagation induced by the application of a stress. The formation of bonds will certainly occur during the compaction process but their rupture will be by an entirely different mechanism.

Thus the paper is flawed in both experimental design and interpretation of the results. Any relationships which do occur are fortuitous and not for the reasons proposed in the paper.

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