DETERMINATION OF TRUE WORK OF COMPACTION

C.I. Patel, J.N. Staniforth, J.P. Hart: School of Pharmacy, University of Bath, Claverton Down, Bath.

With the development of more accurate digital recording and processing devices De Blaey et al. (1971) were able to use force-displacement curves, obtained during tablet compression, for formulation studies. Processes which consume energy during tablet compression include: closer packing of loose powder particles, interparticle friction, particle-die wall friction, plastic flow and, finally, elastic deformation. De Blaey et al. (1971) have shown that the work required for the first two processess is negligible.In order to determine work of compaction these workers carried out a second compression and assumed that all plastic deformation was complete after the first compression and thus the second compression represented work required for elastic deformation. Ragnarsson et al. (1983) have also used this assumption. This study was carried out to check the validity of this assumption.

Using the internal clock of the microprocessor, time over which force application occurred was measured. 12.7 mm flat faced tablets were compressed on a fully instrumented eccentric press. Data acquisition and manipulation was achieved via a fast analogue-digital converter connected to a small microprocessor (BBC Model B).The direct compression excipients examined were microcrystalline cellulose (Avicel PH 102), Emcompress and Microtal. The work required to overcome elastic deformation for Emcompress and Microtal was found to decrease with number of compression without ejection. For Emcompress this value was found to fall from 0.282 J at the first compaction to 0.176 J at the nineteenth (Table 1). A similar decrease was observed with Microtal, falling from 0.230 J to 0.118 J. Microcrystalline cellulose was seen to attain a constant work for elastic deformation after the second compression (Table 1). Validity of the assumption made by De Blaey et al. (1971) and subsequently by Ragnarsson et al. (1983) does not seem to hold for all powders examined. The results suggest that more plastic powders such as microcrystalline cellulose attain constant work for elastic deformation much more readily than brittle materials.

In order to calculate the true work of compaction, it is imperative that a constant value of work for elastic deformation be established and only then can this value be subtracted from the gross work of compaction. The time over which this work was carried out was determined to enable the calculation of power of compaction. Instead of compaction pressure, power of compaction was plotted against tensile strength and toughness parameters. This consolidation parameter will be more useful when formulators encounter different times and rates of stress application, for example on an eccentric or a faster rotary tableting machine.

Table 1. Work required for elastic deformation for increasing numbers of compressions, true work and power of compaction for three direct compression excipients.

No. of compressions	1	2	18	19	True work J	Power J/s
Material						
Emcompress	.282	.250	.182	.176	5.26	71.0
Microtal	.230	.227	.117	.118	4.52	60.5
Avicel(PH102)	.420	.481	.483	.480	11.36	107.4

De Blaey, C.J. et al (1971) Pharm. Weekblad 106:241-250
Ragnarsson, G. et al (1983) J.Pharm. Pharmacol. 35:201-204