Automatic weight-control in a rotary tabletting machine

K. RIDGWAY, J. J. DEER, C. LAZAROU AND P. L. FINLAY

Department of Pharmaceutics, The School of Pharmacy (University of London), 29/39 Brunswick Square, London, WC1N 1AX, U.K.

A Manesty Betapress 16 station rotary tabletting machine has been fitted with an automatic weight control system. With the control system in operation, constancy of tablet weight is maintained in the face of changes in machine operating speed and granule size or shape distribution; gradual drift due to wear is also held in check. An adjustable upper and lower weight limit can be set, and any tablet falling outside the limits (despite the constancy of the mean tablet weight) can be directed by a small air-blast onto a rejection chute.

The basis of the system is as follows:

(a) the pressure rolls have been modified by machining cavities in the axles so that piezoelectric load washers (Kistler Ltd., type 903A) can be mounted inside the axle body. As each punch head contacts the pressure roll, an electrical pulse is produced from the load washer. The pulse voltage is proportional to the pressure applied to the powder in the die by the punch.

(b) the pulses are amplified and fed to a discriminator unit. This unit inspects the voltage of each pulse. If it is within the acceptable limits for the tablet being made, nothing is done. If the pulse voltage is too high or too low, a signal is sent to a stepping motor which drives, through appropriate gearing, the fill adjusting screw on the machine. This screw sets the level to which each punch drops as it passes under the powder feeding frame, and thus the amount of powder entering the die. For a pulse which is too large, the screw is raised by one step of the stepping motor, so that the amount of powder is reduced. For a pulse which is too small, the reverse happens. Thus the machine is kept at and near a preset mean tablet weight.

(c) when a pulse is too high or too low, a signal is also sent to a small rapid-acting solenoid valve which controls a compressed-air supply. This signal is sent some four compaction events later, at the time when the out-of-specification tablet is just leaving the die table. The tablet is deflected by a jet of air so that it enters a chute for reject tablets, separate from the chute carrying the bulk of the within-specification tablets. Because the pulse discriminator locks onto the operating speed of the machine, change in machine speed makes no difference to the efficiency of the rejection system. The high and low levels for rejection can be set by the operator.

(d) the amplified pulses are available for recording either by a high-speed u.v. chart recorder, or by a storage oscilloscope. Both methods have been used. If provision is made to collect the tablets serially as they come from the machine, it is possible to produce individually weighed tablets, with a record of their weight, at the full output rate of the tabletting machine, 1500 tablets per minute.

(e) the force to eject each tablet has also been monitored and a signal obtained, though currently nothing is done with this information.

A number of test runs have been carried out with the system, to determine what the control limits are. The ultimate limit is, of course, the quality of the granulation used to feed the machine.

The properties of tablets made from direct-compression bases on an automatically controlled rotary machine

K. RIDGWAY, C. LAZAROU AND E. E. THORPE

Department of Pharmaceutics, The School of Pharmacy, (University of London), 29/39 Brunswick Square, London, WC1N 1AX, U.K.

Four direct-compression bases, Celutab in the hydrous and the anhydrous form, Emcompress special and spray-dried lactose, have been compared with a traditional lactose granulation with respect to the initial physical properties of the powder, their tabletting performance and the characteristics of the tablets produced. The tablets were made on an automatically-controlled instrumented machine, a Manesty Betapress, so that compression force was continuously monitored. The following tablet properties: tensile strength by diametral crushing, porosity, weight, coefficient of variation of weight, surface microindentation hardness and disintegration time were assessed for 180 batches of several hundred tablets. They were correlated with changes in compaction pressure, machine speed and tablet thickness.

Tablets were made from each material in three thicknesses: 3, 4 and 5 mm at a constant diameter of 12 mm using flat-faced punches. At each thickness, compaction pressures of approximately 90, 180, 260 and 330 MN m^{-2} were used, and at each pressure the tabletting machine was run at 700, 1100 and 1500 tablets/min.

Because Emcompress special (calcium dihydrogen phosphate) required a lubricant, 1·5% by wt of magnesium stearate was blended in with it, and with the other bases also in order to give comparability. In all cases the tap density of the powder was slightly increased by the addition of the lubricant. All the materials flowed well, and compressed without any sign of capping or difficulty in ejection, except for an initial test on unlubricated Emcompress special, when ejection difficulty was experienced.

Weight variation was small for all materials (coefficient of variation about 0·4%) but tended to increase with increasing machine speed and with decreasing tablet thickness. At the highest speed for 5 mm tablets, there was a great increase in coefficient of variation to above 2% due to difficulty in getting the powder to flow into the dies sufficiently freely.

Surface hardness and elasticity were independent of compaction force for all five materials, once a sufficient pressure had been applied to make a good tablet (usually 180 MN m^{-2}). The hardness was greater at the centre of the face than at the periphery.

The tensile strength decreased in the order Celutab hydrous, Celutab anhydrous, Emcompress, spray-dried lactose, lactose granulation. Machine speed had little effect. Plots of tensile strength against compaction pressure for lactose, both spray-dried and in granules, were linear, as reported by Fell & Newton (1970). This linearity cannot extend indefinitely, of course, but it does appear to cover the normal range of compaction pressures.

Mean disintegration times depended upon tablet thickness and upon compaction pressure. Celutab dissolved rather than disintegrated, the anhydrous form the more rapidly. Spray-dried lactose tablets dissolved to about 40% of their initial bulk, then fragmented. Emcompress tablets require a disintegrant and only a few were tested to check that they remained unaffected by two hours immersion in water at 37°. Lactose granulation tablets took the same time to pass the mesh as did Celutab anhydrous.

REFERENCE

FELL, J. T. & NEWTON, J. M. (1970). *J. pharm. Sci.*, **59**, 688.

Contribution of slip and Knudsen flow to tablet permeability measurements

W. T. RISPIN, A. B. SELKIRK AND P. W. STONES
School of Pharmacy, The Polytechnic, Sunderland, U.K.

A cell was constructed to measure the air permeability of tablets after ejection from the die. Measurements were made either by drawing or by blowing dry air through the tablet.

The values of the specific permeability, B_0, were found to be a function of the pressure drop across the tablet. The permeability equation of Carman and Malherbe (1950), which allows for slip flow, includes a pressure dependent term. Using a modified permeability,

$$B = e^2/k\,(1-e)^2S_0{}^2,$$

Carman's equation can be written as a quadratic equation in $\sqrt{B}$, i.e.,

$$\alpha B + \sqrt{B} = \beta,$$

where α and β are functions of the experimental variables and atmospheric pressure. The terms in B and $\sqrt{B}$ depend upon the contributions of slip and viscous flow respectively. Ignoring the slip flow term, B_0 can be calculated from $B_0 = e(\beta/\alpha)$, suggesting that the correct permeability should be obtained from an expression of the form, $e(B + \sqrt{B}/\alpha)$. This is a