THE INFLUENCE OF NOZZLE/PISTON CLEARANCE ON THE EFFICIENCY OF A CAPSULE-FILLING DOSATOR

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When capsules are filled by a dosator type machine, fill weights are essentially governed by the quantity of powder sectioned by the descending dosator nozzles, providing the powder is satisfactorily retained in the nozzle during transfer to the capsule body. It follows that an expected fill weight can be estimated from the bulk density, γ, and depth, L, of the powder bed, and the internal cross-sectional area of the nozzle, a.

$$W_e = \gamma La$$

(This calculation assumes that the distance from the tip of the piston, in its highest position, to the nozzle outlet, is greater than the depth of the bed.) If the expected fill weight is to be achieved, much of the air present inside the nozzle must be displaced by powder as it enters the bed. The clearance between the piston and the nozzle bore is presumably a route of escape for the air, hence the role of this clearance was studied.

Two particle size fractions of crystalline lactose, +37.5-53 µm and +75-105 µm, were filled into size 0 capsules on an instrumented filling rig which had been purpose-built to simulate the indexing motion of machines such as the Zanasis. The simulator carried one dosator, the piston of which was operated pneumatically. Load cells were fitted for measuring compression and ejection stresses, and compression displacement was measured using a displacement transducer. The powder was contained in a series of aluminium cylinders of internal diameter 19 mm and depth 20 mm, enabling an accurate estimation of bulk density to be made. These cylinders were carried on an indexing turntable in such a way that only one capsule was filled from each packing.

A size 0 dosator nozzle was used in combination with, (i) a size 0 piston and (ii) a size 1 piston. The measured nozzle/piston clearances were found to be 0.06 mm and 0.51 mm respectively. Both combinations were used to fill a number of capsules with each size fraction of lactose. Compression stress was maintained at approximately 5 MNm^{-2} throughout, and for each capsule, the fill weight and the compression displacement were recorded. Fill weights for the first ten capsules in each run are shown in Table 1.

With both size fractions, fill weights were a little below the expected levels (450-460 mg) using the size 1 piston. With the size 0 piston, much lower fill weights were obtained, and unusually high compression displacements were recorded.

It is concluded that insufficient clearance between piston and nozzle bore can hinder the escape of air from the nozzle and thus prevent part of the expected fill from entering the dosator.

Table 1. Capsule fill weights

Particle Size (µm)	Piston Size	Capsule Number									
		1	2	3	4	5	6	7	8	9	10
+37.5-53	0	322	307	287	267	257	254	265	196	230	214
+37.5-53	1	390	386	378	384	395	410	372	382	424	420
+75-105	0	305	283	284	261	236	243	233	251	252	263
+75-105	1	403	397	387	387	384	408	390	384	398	390

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