Granule consolidation during compaction

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A powder mix consisting of calcium orthophosphate 90% and barium sulphate 10% was granulated in a coating pan with 4% mucilage of Tylose. The particle size of both powders was 100% less than 90 μm. The resultant spherical granules were dried and the 387–500 μm fraction consolidated at 0·4 KN on an instrumented single punch machine using 3·20 mm flat faced punches. The granules were lubricated with 1% magnesium stearate before consolidation and the die carefully filled by hand in order that a series of small cylindrical aggregates, identical in weight, diameter and thickness was produced. The granular appearance of these small composites could be observed and each was considered to be one 'granule', which could be subsequently compacted at much higher pressures. Each cylindrical 'granule' was numbered and its volume determined from measurements of its dimensions.

Sucrose was granulated similarly using 7·5% PVP solution in I.M.S. as granulating agent. A 1 g quantity of the dried sucrose granules was introduced into a specially hardened die, 2·54 cm in diameter. After levelling, three 'granules' were positioned diametrically upon the surface of the sucrose granules; one in the centre and one each 5 mm from the die wall. A further 1 g quantity of sucrose granules was poured into the die and the mass compacted at 2 KN on a stationary precision press. 15 further compacts were produced at loads up to 400 KN. X-rays were taken of the compacts and from the developed radiographs determinations of the diameter and thickness of the 'granules' were recorded. The overall dimensions of the large compacts were measured. The "granules" were recovered from the large compacts by dissolving out the sucrose with water, and the dimensions of the recovered "granules" were determined.

It was found that no change in the cylindrical shape of the initial 'granules' occurred, and there was no evidence of fracture or lamination over the whole pressure range. There was a linear relation between log loads and the relative decrease in thickness of the 'granules' after removal from the large compacts. However, this linearity occurred only up to 210 KN inside the large compacts; thereafter an abrupt fall in thickness reduction was found as the loads increased to 400 KN. Inside the compacts the 'granules' increased in relative diameter linearly with compaction pressure up to 120 KN; there was a further linear relation from 120 KN to a maximum of 240 KN and then a fall in the graph to 400 KN was found. The recovered 'granules' possessed maximum relative diameter increase values at 64 KN 180 KN and 400 KN; the intra- and extra-compaction graphs for relative diameter increase exhibiting total dissimilarity. The relative volume reduction of the 'granules' inside the compacts increased linearly from $0{\cdot}3 \times 10^{-3}$ ml at 4 KN to $2{\cdot}75 \times 10^{-3}$ mls at 90 KN. A further relation, with a lower slope value, occurred between 90 KN to a maximum at 210 KN of $3{\cdot}6 \times 10^{-3}$ ml. Thereafter, the graph fell to $2{\cdot}55 \times 10^{-3}$ ml at 400 KN. After removal of the 'granules' from the large compacts, there was evidence of a volume reduction of the granules up to 210 KN, indicating that elastic recovery had taken place. It would appear that up to 210 KN, the 'granules' behave elastically, whilst beyond 210 KN plastic deformation then occurs.

Disaggregation of compressed tablets

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The disintegration test for compressed tablets has been shown in many cases, to be a poor index for predicting tablet performance (Wagner, 1973; Morrison & Campbell, 1965). Implicit in the disintegration test is the assumption that the rate of tablet breakup is directly related to the rate of surface area generation of the disintegrating tablet. This assumption can be misleading, since for adequate evaluation of surface area, the size and number of tablet fragments must be determined rather than size alone, which is the basis of the official

disintegration test. We describe a more critical test for evaluation of tablet disintegration, based on measurements of generated surface area, for tablets composed of varying proportions of intra- to extragranular maize starch.

Groups of calcium orthophosphate tablets were produced, 3/8″ in diameter at compaction pressures of 58·5, 87·6 and 116·4 MN m^{-2} using a constant amount of 10% starch mucilage as binder. Each group of tablets contained varying proportions of intra- to extragranular starch, from 0 to 15% w/w, the total maize starch content remaining constant at 15% w/w. Surface area generation of individual disintegrating tablets from each group was determined in a modified version of the apparatus used by Healey (1974 private communication). This consisted of a U.S.P. dissolution test rotating basket, submerged 3 cm below the surface of 200 ml of a solution of glycerin 60%, Isoton 40% in a 250 ml measuring cylinder. One tablet was introduced into the basket and the assembly rotated at 100 rev min^{-1} for 10 min in the disaggregation electrolyte. After 10 min the basket was removed and the contents of the measuring cylinder immediately analysed for particle volume using a Coulter Counter Model B with Model M volume converter. A 12 point analysis was carried out using a 560 μm orifice tube, enabling a distribution from 321–25 μm to be measured. The procedure was duplicated and repeated for each starch formulation and at each compaction pressure. A similar procedure was performed after 30 min disaggregation. The Model M volume converter produces values of the total volume occupied by the particles within each specific size interval, and from these data the total surface area in 200 ml of suspension was computed, assuming that the particles were solid spheres. This generated surface area is a measure of the extent of disaggregation of the tablet in a fixed time interval and relates to the external surface area of the tablet fragments. The graphs obtained are shown below. Decreasing the compaction pressure increased the surface area generated. Roughly 12 times the surface area is generated after 30 min than after 10 min. The best combination of intra- to extragranular starch was 2·5% intra/12·5% extra.

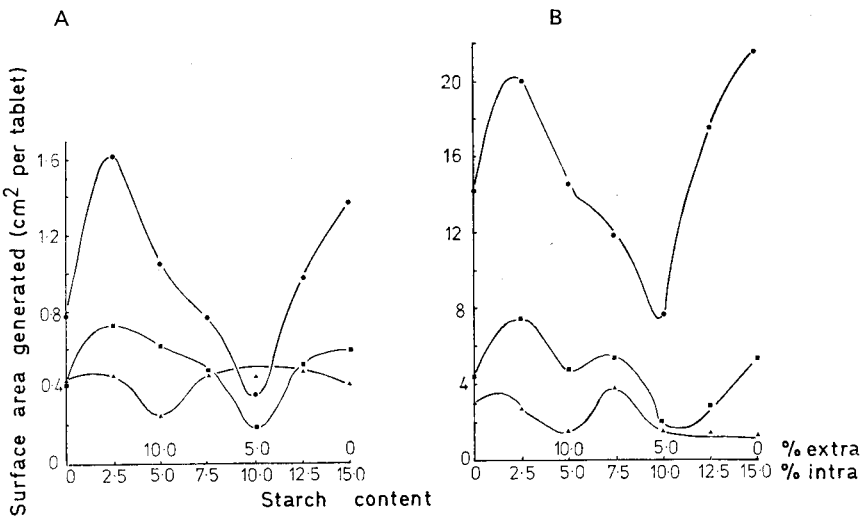

FIG. 1. Surface area generated with different combinations of intra- to extra-granular starch. Disaggregation time: A, 10 min; B, 30 min, compaction pressure: (MN m^{-2}): 58·5, ●; 87·6, ■; 116·4, ▲.

REFERENCES

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