THEOPHYLLINE HYDRATE/ANHYDROUS SYSTEM: EFFECTS OF WATER OF HYDRATION ON MECHANICAL PROPERTIES OF COMPACTED BEAMS

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Studies of the effects of moisture on the physical properties of solid dosage forms are generally limited to the total water content of the formulation (Rees & Hersey 1972; Chowhan 1979). As the move towards direct compression continues, the effect of water of hydration of drugs and excipients on processability and compact properties is expected to assume greater significance. This study evaluates the Young's modulus E, tensile fracture stress (i.e. tensile strength), σ_t, and porosity differences of compacted rectangular beams of a typical hydrate/anhydrous system.

Theophylline anhydrous (T.A.) was obtained from Sigma Chemicals, Poole, England. Theophylline monohydrate (T.H.) was recrystallised from the anhydrous material in distilled water using a programmable batch crystalliser (Conair Churchill Ltd., Uxbridge, England). Powders were screened through a 710um and 600um sieve for T.A. and T.H. respectively prior to use to remove agglomerates. Equal weights (ca. 2.0g) of material were compacted in a rectangular punch and die set using a Denison press. Resulting beams were 60 mm x 7 mm x h mm, (h = thickness) and four beams were made at each of five pressures in the range of 24.0 - 143.0 MPa. A CT40 four-point beam bending rig (Bassam et al 1988) linked to a microcomputer was used to monitor stress/strain profiles and obtain E, and to measure σ_t.

Figure 1.

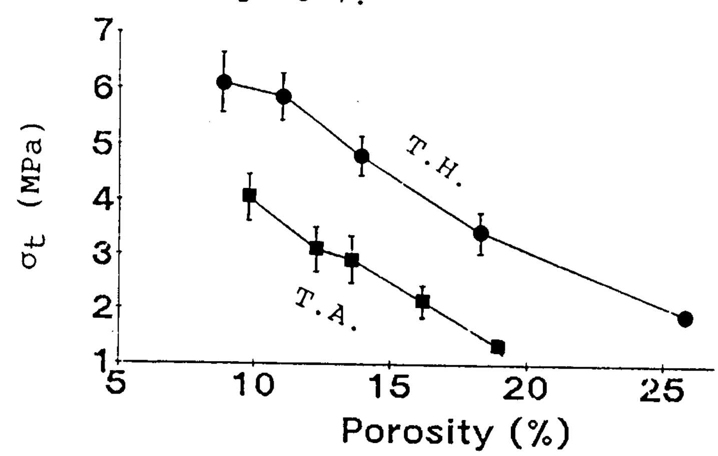
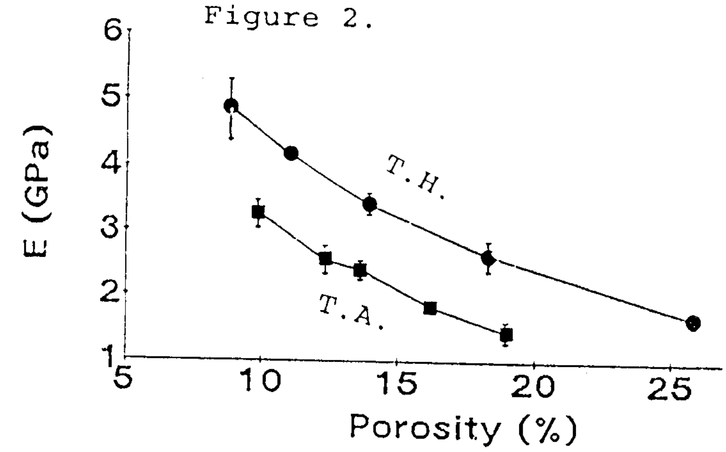


Figure 1, a plot of σ_t versus porosity, P(%), shows that compacts of the hydrate have a higher mechanical strength at equivalent porosities, indicating stronger bonding. The hydrate was also observed to undergo greater densification, especially at high compaction pressures. Compacts of the hydrate also have a higher Young's modulus at corresponding porosities (Figure 2), suggesting greater resistance to deformation.

Figure 2.



The modified mechanical properties of the hydrate are attributed to the lubricating action of water of hydration and plastic deformation during compaction enhancing molecular inter-planar slippage and subsequent bond formation. Such differences in compaction behaviour of the powder and mechanical properties of resulting compacts could be favourably exploited in direct compression processes.

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