Abstract for CHoPS

On the Convergent Flow Property Behaviour of Different Fine Dry Powders Across Wide Size Ranges, and the Concept of Critical Particle Size

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Abstract

It is well known that fine, dry powders exhibit cohesive behaviour and that this increases with finer particle size. To date, no standardised model has been put forwards that can be used to represent this variation, because even for the same particle size, each powder substance has a different Flow Function from others.

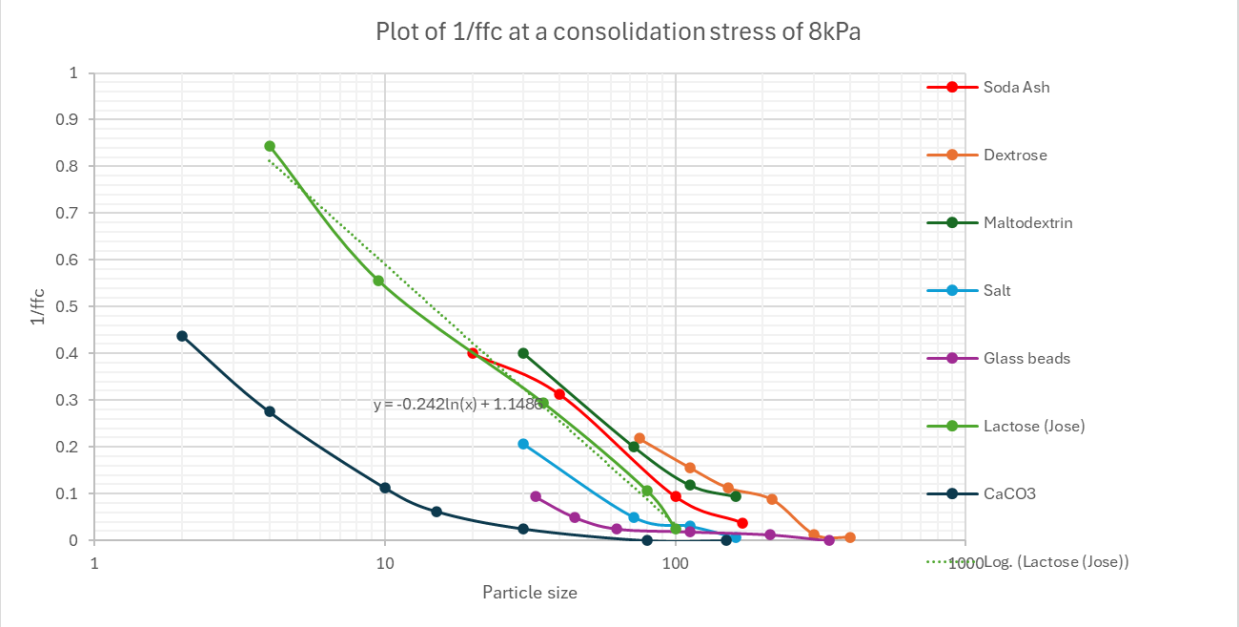
In this study, a substantial number of dry powders (not modified with glidants, surface coating etc) have been subjected to shear testing to obtain their Flow Functions, each across a range of particle sizes. Plotting the data on the ratio of unconfined failure strength to compaction stress, versus particle size (for a given compaction strength) shows that they exhibit strikingly similar behaviour except that they are shifted in terms of particle size.

The authors therefore propose the concept of "critical particle size" at which a powder transitions from free flowing to non-free-flowing. Using this concept, it is found that when plotting the data on the basis of the ratio of median particle size to critical particle size for each powder, the data for all powders collapses onto a single curve.

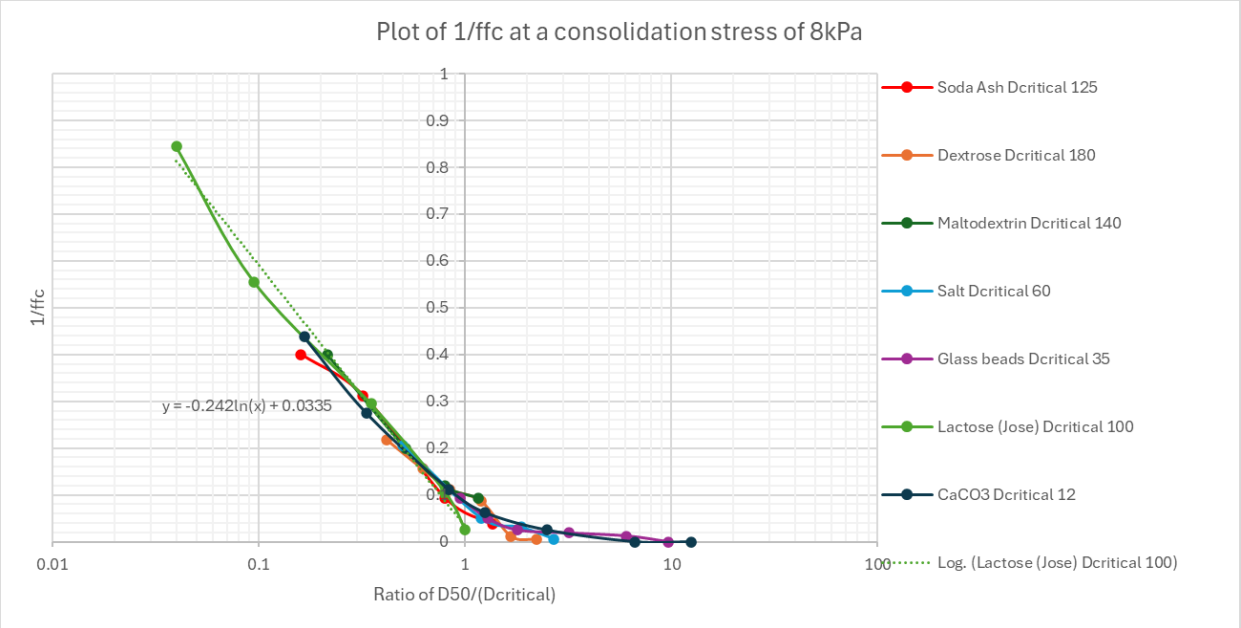
This potentially makes the representation of the cohesive behaviour of powders simpler in that for any given substance, its entire flow behaviour across all size ranges can be represented by the single value of critical particle size. Once this critical particle size is determined, then flow functions of the same substance in different particle sizes can be predicted by reference to the one standard curve. This has great potential for use in digital assistance to the formulation of powders in many different industries, especially pharmaceuticals, foods and battery materials where particle size may need to be changed for the purposes of functionality, and the effect on handling and packing properties computed.

(Preview overleaf)

Plotting 1/ffc against particle size, at a fixed compaction stress:-



But normalising with respect to particle size, by taking the particle size at which 1/ffc=0.1 and dividing the particle size of each data set by the critical size for that substance, the data all collapses onto one curve:-



I think this is a remarkable finding.