



Can You Predict Powder Flow Behavior By Measuring Density

A general observation is that many powders, which exhibit only a small amount of compressibility (perhaps 10% going from a loosely consolidated state to a consolidation pressure of 10 kPa), will discharge from gravity feed hoppers with relative ease. A fair question to ask is whether the density of a powder can be used to quantify or predict flowability.

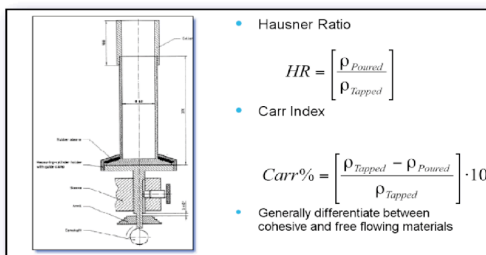


Figure 1 Tapped Density Test

Food industry powders, like confectionery sugar, are good examples of powders that have low density when loosely consolidated, but can increase their density significantly when compacted. The tapped density test (see Figure 1) is an easy way to quantify the change in density. A cylinder full of powder is “tapped” a specific number of times, say 100 or 150,

and the resulting volume is compared to the original. This ratio quantifies the degree of compaction. This gives a good idea of the density behavior, but unfortunately cannot predict whether the powder will flow in gravity discharge from a storage vessel.

Once a powder is compacted, the question is how much friction or resistance must be overcome for the powder particles to slide or flow against each other. The density test can only tell us how much compaction has taken place. Another technique is needed to resolve how much force it takes to create particle movement.

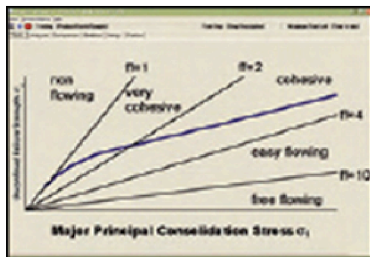


Figure 3: Flow Function Test Results

Instruments that use the well established principle of shear cell technology (see Figure 2) offer that solution. A fixed volume of loosely consolidated powder is placed into the shear cell and compressed by a plate to increasing degrees of compaction. At each compaction level, the shear cell forces the powder to slide against itself, there-

by quantifying the amount of yield stress that must be overcome to enable flow. This test is repeated at each compaction level to generate data that constitutes a Flow Function (see Figure 3) and a Density Curve (see Figure 4).



Figure 2: Brookfield Powder Flow Tester

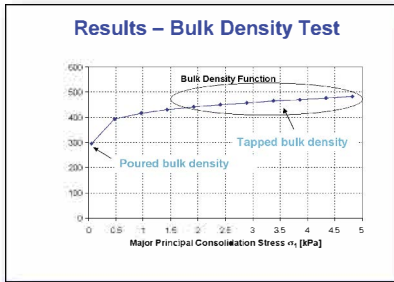


Figure 4: Density Curve for Consolidated Powder

Powder flow testers, which use shear cell methodology, have been around for a long time. Recent breakthroughs in the design of these instruments have made them much more affordable. In addition, they are now very easy to use, run tests automatically without direct operator involvement, and produce results that anyone in QC or R&D can interpret. The added benefit is that the density curve shows how much the powder compacts when subject to a consolidating force. The food industry knows that both pieces of data are critical to efficient processing of the powdered materials and proper packaging to achieve the correct fill amount.