# The Key To Processing Food Powders Without Stoppages

## daily challenge in the food industry

Powder discharge from bins is a daily challenge in the food industry, especially for formulations that are naturally cohesive. The tendency is for particles to gradually move closer together while sitting in the bin, which leads to greater inter-particle friction once the mixture begins to flow downward into the hopper. "Ratholing" (see Figure 1) is one phenomenon that may result, which is a build up of powder material around the outer wall of the bin; the powder has consolidated so much that gravity alone is not sufficient to cause the particles to flow against one another. Another potential problem is "Arching" where build up of a cohesive powder block in the hopper opening can impede the flow of material out the discharge hole.

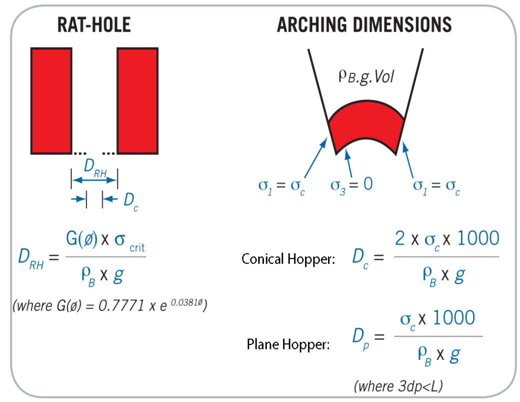


**Figure 1: Types of Flow Obstructions**

Both problems described above are daily occurrences in food processing. Examples of powders that exhibit cohesive behavior include a broad range of materials: beverages, cereals, chocolate, cocoa, cookies, flour, milk, starch, and spices/flavorings. Standard remedies to eliminate Ratholing and Arching are use of hammers to bash the hopper/bin and dislodge the built up material. See Figure 2. More expensive approaches include vibrators attached to the hopper/bin or air-assist systems that introduce pressurized air into the bin to help fluidize the powder. Regardless of the attempted solution, time is lost when the powder fails to flow and corrective action inevitably results in temporary shutdown of the process.

**Figure 2: Example of Hopper Suffering from Hammer Rash**

Techniques for predicting potential flow problems have had limited success. Flodex cup has been the tool of choice for most processors. It is an affordable device that uses a simple method to drain powder from a cup with a hole in the bottom and give a go/no-go indication of powder flowability. The reason that this method does not work is its failure to assess the "consolidated" behavior of the powder. Material placed in the Flodex cup is in a "loose fill" condition. Particles are moving freely with respect to one another. This does not characterize what is happening to powder in the bin where consolidation begins instantaneously as soon as powder is poured in. The taller the bin, the greater the consolidating pressure that is applied to the powder in the hopper section. Flodex Cup does not evaluate this condition; therefore it cannot predict what will happen when discharge from the bin is initiated.

**Figure 3a: Trough with Powder Sample**

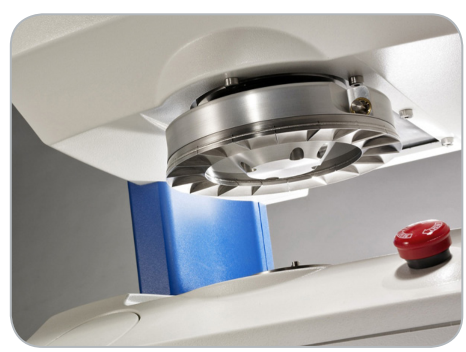

**Figure 3b: Specially-Designed Vane Lid Fits onto Powder Sample**

Shear cells offer the correct technical approach for assessing powder cohesiveness. The powder sample is placed in a trough (see Figure 3) and compressed to various consolidating pressures using a specially designed lid that pushes down on the sample. This technique gives important information on how powder density changes as it is consolidated. Figure 4 shows a graph of powder density vs. consolidating stress. Powders that experience a density change of 35% or more are strong candidates for exhibiting highly cohesive behavior during processing. The ability to identify these problem powders beforehand allows formulation scientists to add flow aids to facilitate processing and manufacturing engineers to control the fill levels in bins, thereby limiting consolidation of the powder.

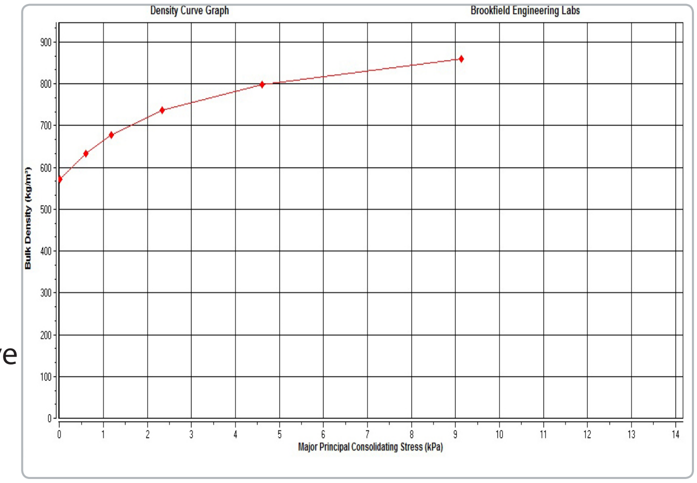


**Figure 4: Graph of Powder Density vs Consolidating Stress**

Flow behavior assessment is the ultimate capability made possible with the shear cell. The vane lid has pockets that contain small quantities of the powder as the lid pushes down on the trough. At each consolidating pressure, the shear cell rotates the trough relative to the lid and measures the interparticle friction in the plane where lid meets trough. This predicts how much resistance, known as "Failure Strength", the powder will have to flowing downward under the influence of gravity in the bin. The Flow Function in Figure 5 is the scientific data from the shear cell test. Industry has agreed on defined regions of flow behavior, ranging from "free flowing" to "non-flowing". Problem powders in the food industry often fall into the "cohesive" and "very cohesive" regions.

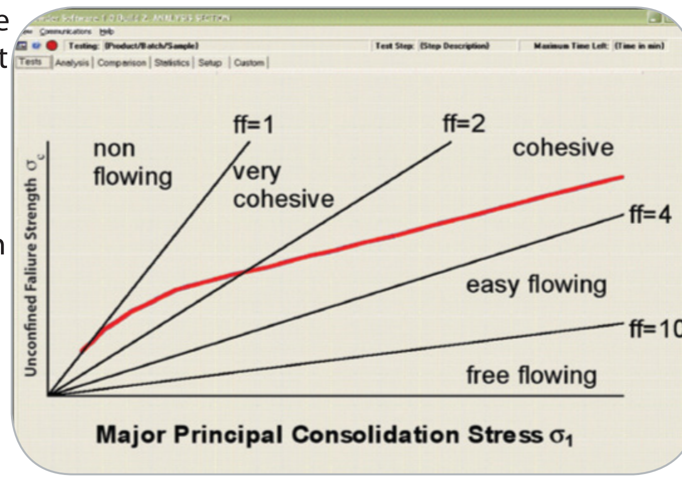


**Figure 5: Flow Function Shows Failure Strength vs. Consolidating Stress**

The food industry is moving steadily toward adoption of the shear cell for evaluation of powder flowability. The proven scientific basis for this method of measurement is the undisputable answer to the uncertainties of earlier techniques that left powder processors guessing about flow behavior. Advancements in the analytical tools built into the software used with shear cells calculate values for problems like "Ratholing" and "Arching". Bottom line is the ability to predict dimensions for hopper opening and half angle in order to achieve uninterrupted flow, a sure win for any food processor.

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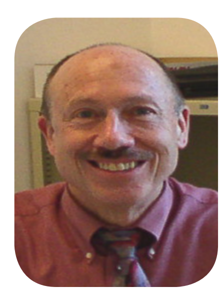

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