GETTING POWDER OUT OF THE HOPPER

Tanks and vessels come in all shapes and sizes. Those used for processing powders have one inevitable issue for powders that are compressible. Core flow behavior is a given (See Figure 1) and the powder may eventually hang up when discharging. The consequence is unwanted interruptions to work and possible segregation issues that affect the mix of final product.

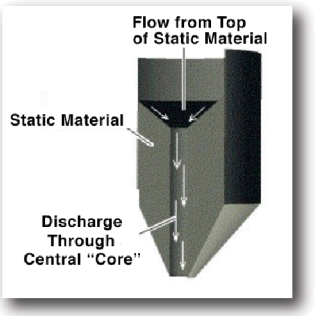

Figure 1: Illustration of Core Flow Behavior

Figure 2: Brookfield's Powder Flow Tester Shear cell with powder sample

The traditional methods used to measure powder flow behavior – the flow cup test and the angle of repose measurement – do not give the user any clear indication that the above problem will occur. A more scientific method is needed which assesses the internal friction of the powder particles against one another. The shear cell offers a proven technique for performing this type of measurement. (see Figure 2) The data output includes an objective assessment of powder flowability in the Flow Function (see Figure 3) and a prediction of the powder's ability to form blockages during discharge (arching over the hopper outlet or rathole formation in the tank).

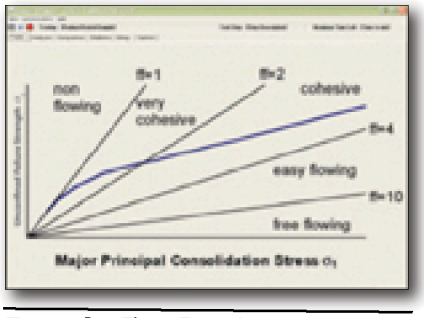

Figure 3: Flow Function Characterizes Powder Flowability

Note that the Flow Function is plotted on a graph which is segmented into different regimes of flow behavior, ranging from non-flowing on the left to free-flowing on the right. The x-axis indicates the amount of consolidation which the powder experiences. Equate this with the weight of the powder which exerts a downward force on the particles at the bottom in the hopper. The y-axis indicates the strength of the powder particles, or their ability to resist movement. In general, the strength of the powder is less than the consolidating force due to gravity, so flow will occur. However, when the powder strength and consolidating force are comparable, then flow problems will result.

The amount of consolidating force relates directly to the fill level of the powder in the tank or vessel. The material at the bottom is subject to the full force of consolidation when the tank is full. As the tank empties, the consolidating force also reduces. But the increased strength of the powder does not necessarily diminish. Think of how a snowball consolidates when pressed together. The compressed ball does not necessarily relax and fall apart when the compacting pressure applied by your hands is released.

Flow behavior in the hopper, where the tank converges to a small opening for powder discharge, is the key area of interest. The Flow Function gives us a clear visual indicator as to whether flow problems are likely to arise. The added advantage of this scientific method

for quantifying flow behavior is that mathematical calculations can predict the ability of the powder to form a stable bridge, or blockage, over the hopper outlet. Software available with today's shear cells does this automatically, giving the processor a clear warning signal when problems are likely to come up.

The science for assessing flow behavior of powders has existed for many years. A recent development in the user friendliness and low cost of shear cell equipment is the significant breakthrough.

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