The Cost of a Powder Stoppage

Powder Jams

Operations managers cope with powder jams on a recurring basis. At least once a month, there may be a more significant event that brings production to a halt and seriously affects output for that day. You my hear words like: "Quick, get the hammer. Bang the hopper a couple of times until you can see the powder coming out again. Once you get it going, stay there for a few minutes in case it jams again. Check the fill level and make sure that we have plenty of powder in there. Let me know if you see anything else." However, the more critical statement that might come is: "Stop production. Shut everything down. We have a serious jam." This indicates that product quality may no longer meet specification.

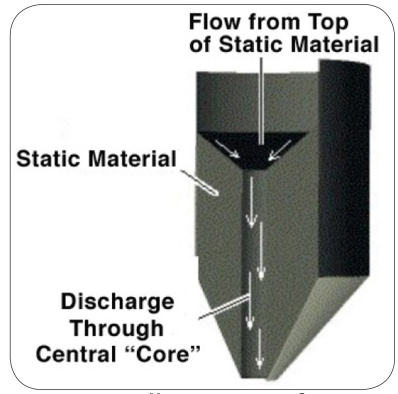

Figure 1: Illustration of "Core" Flow in Hoppers

These words are spoken every day throughout industry when powder feed operations suddenly stop or behave erratically. The simple solution to bash the hopper may ultimately work, but doesn't really get to the heart of the problem. Why does the powder stop flowing? Is there a way that this could be predicted beforehand?

And what is the true cost of a total powder stoppage? How many people are affected by shutting down operations? One plant manager said that this is the most difficult problem that he faces once a month on average. There may be up to 5 people that stop work and turn their attention to the problem. Manpower lost in a half-day shutdown of 3 hours or more can cost $2500 to $5000 alone. Productivity may suffer more dramatically depending on the value of the product. Total cost can easily approach $10,000 or more.

Figure 2: Shear Cell Being Loaded with Powder prior to Testing

Production supervisors know from experience which powder types tend to be problematical. Processing starts off ok when the hopper is full. But as the hopper empties, flow can become erratic. Is there something that causes things to change with how the powder flows?

Many hoppers operate in "core" flow behavior, also known as "funnel" flow. (See Figure 1) The material at the topmost level in the hopper moves down through the center of the hopper and discharges before the material around the outside. The last powder put into the hopper is the first to discharge. The material around the outside experiences some degree of compaction. Sometimes, this compaction may be sufficient to prevent the powder from discharging as the bin empties.

The American Society of Testing and Materials (ASTM) has established a scientific method D6128 that can be used to predict the flow behavior of the powder. The type of instrument that can run this test uses a "shear cell" (see Figure 2) to compact the powder and then determine how much force it takes to flow the powder after compaction. The data produced by this test is called a "Flow Function". (See Figure 3) The important result its ability to determine the cohesiveness of the

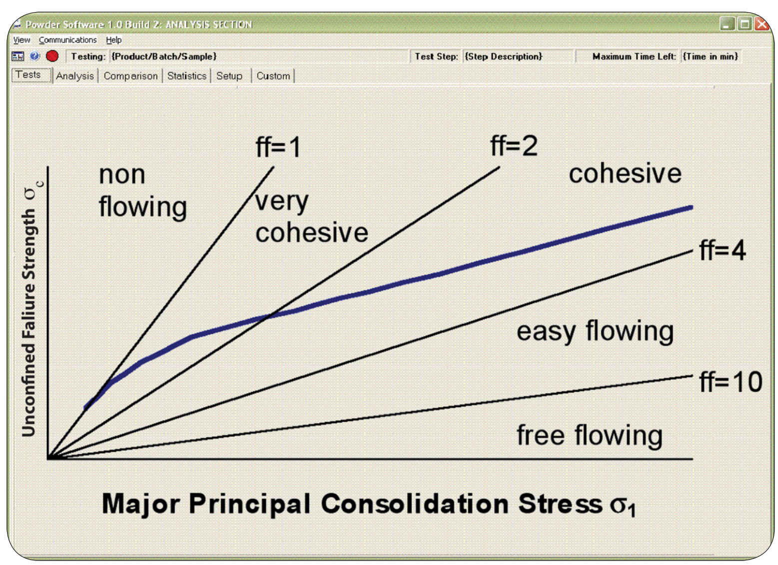

Figure 3: Flow Function Graph for Powder with Regions of Flow Behavior

powder. Note in the graph that regions of flow behavior type are indicated: free flowing, easy flowing, cohesive, very cohesive, non-flowing.

The important number from the data analysis is the "arching dimension", which determines whether the powder has enough strength to bridge the hopper opening. This single number is useful in predicting whether the hopper will jam. Given this information, production supervisors have a way to know beforehand whether the powder will flow reliably.

Another useful piece of information from the D6128 test is the density curve that shows how density increases with compaction pressure in the bin. This data can be compared to information from the tap test, a common method used in the pharmaceutical world.

Shear cells are now becoming a more common QC tool used throughout the powder processing industries. They can quickly predict potential problems before each production run in less than 15 minutes. These devices had been an expensive investment up to 5 years ago, but can now be purchased for less than $20,000. Advancements in instrument design coupled with data processing capability make them the most efficient method for avoiding potential powder jams. This investment is small in comparison to the money spent resolving powder stoppages. Now is the time to take action if your QC test methods are either non-existent or antiquated.

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