"Know Floe's Korner"

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"Know Floe's Korner" is a contribution from the members of Group 3c (Solids Handling & Processing). The objective of this section is to share their industrial learning experiences through a variety of articles & case studies. The first article in this series highlights some important issues related to bin/hopper design. Please send your comments to Shrikant Dhodapkar at sdhodapkar@dow.com.

Top 10 Tips For Reliable Flow From Hoppers

1. The design basis should include the full range of conditions in which a material is going to be handled and not just "typical" conditions. Establish the range of moisture content, additive content and operating temperature. For outdoor applications, consider the consequences of temperature cycling and whether there may be condensation in the head space (silo weeping) or on walls in contact with the material.

2. Check if any extended periods of storage need to be considered, not only in normal operation, but also arising from plant shut-downs, production cycles or weekends. Test the material for appropriate time consolidation.

3. Get a representative & traceable sample. Make sure that it is stable in time. If large variability is observed, understand the source (nature & range) of variability. Multiple samples must then be taken to establish the bounds on physical properties. Proper documentation of sample source and history is very helpful in troubleshooting if the hopper does not work as expected.

4. Wall friction test must be performed on a "representative" wall sample obtained from the fabricator. For example, mill finish aluminum sample from one fabricator may differ significantly from an aluminum sample from the other. If the material is highly abrasive, consider the effect of wear on wall friction.

5. Mass flow pattern results in smaller outlet size, more reliable flow for cohesive materials and some re-mixing of segregated material. The first-in-first-out flow also helps to prevent fluidizable powders from flushing straight through the hopper. However, mass flow hoppers are taller than funnel flow hoppers due to steeper cone angle.

6. Reliable flow out of a mass flow hopper requires the material to be discharged across the whole cross-section of the outlet. For example, a screw feeder with progressively increasing pitch can be used to draw material across the entire outlet. Improper selection and installation of feeder can destroy the flow pattern in a well designed mass flow hopper.

7. Consider using plane flow (one-dimensional converge) hopper instead of a typical conical geometry when the material is not free-flowing and outlet size is limited. The critical arching dimension in a plane flow channel is half as compared to a conical geometry. Also, the walls can be about 10 degrees shallower for plane flow hoppers. For very difficult to handle materials, do not be bashful to use flow promoting devices.

8. Discharge rate of a powder can be severely limited by its lower permeability as compared to granular material. Be sure to include discharge rate expectation in your design criteria.

9. Surface impediments on the hopper wall, weld splatters, offset flanges protruding gaskets, poke holes and badly installed liners are highly effective in preventing the material from sliding along the wall. Remember - "Protruding Lips, Sink Powder Ships".

10. Do not cut into the walls of a hopper to create additional discharge outlets. In most cases, they will disrupt the mass flow pattern and cause high wall stresses.

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