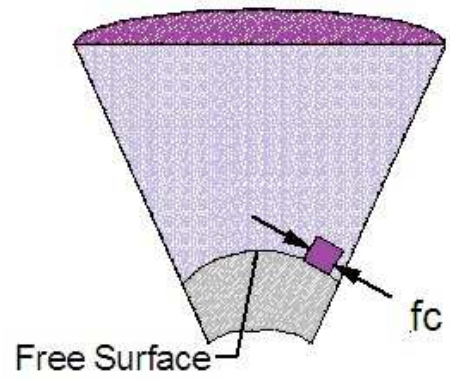
# Process Design to Avoid Hang-ups Caused by Cohesion Effects

## Material Flow Solutions, Inc.




***Cohesive flow problems*** are one of the main reasons a plant handling a bulk material fails to operate. When it is not possible to design a material free of integral cohesive flow properties, the system must be designed to handle the problem. Cohesion is a function of the unconfined yield strength of bulk material (fc).

Unconfined yield strength is the major principle stress that will cause material in an unconfined state to fail in shear and is a measurement of a material's cohesive flow properties. It is the primary flow property that governs the development of hang-ups in process equipment. It is used to compute critical arching and rathole dimensions for a given material in a bin or hopper. All hang-ups in process equipment result in the formation of a free surface. In a hang-up condition the material on a free surface is supported by stresses that act along the free surface and are equal to the unconfined yield strength of the material (fc).

When material is cohesive, it forms arches over conical outlets. The size of this outlet is determined by the degree of material cohesiveness. Therefore, measuring the cohesive properties of the full range of materials to be processed in a system is imperative to creating an optimal process design.

Another material property that often depends on material cohesiveness if its propensity to fluidize in a bed. This fluidization characteristic can be quantified and the data used to determine if, when, where and how gas injection must be included in the overall system design to keep material moving steadily through the process without channeling.

At Material Flow Solutions we routinely measure material cohesive and fluidization properties and have developed mathematical relationships that describe how cohesive behavior adjusts to changes in basic process scale properties. This methodology is founded on scientific principles and, therefore, can be extrapolated to many bulk solids and unit operations – making it a general approach. Using this approach, engineers can design processes to handle the full range of expected product and get it right the first time.

***PRACTICAL APPLICATIONS*** of knowing your materials' ***cohesion effects*** include, but are not limited to:

- Design to eliminate the potential for material hang-up in handling equipment
- Design custom processes to handle cohesive material
- Achieve consumer acceptability by maintaining reliable weight variations in packages
- Design optimal blending equipment to handle cohesive materials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