Solve Hang-up Problems in Process Design

Material Flow Solutions, Inc.

Material hang-up (arching and/or ratholing) problems are generally caused by one of four things: cohesive forces between powder particles or granules, external forces, inter-particle locking, or elastic constraint issues. It is critical to understand the type of hang-up that you may be experiencing.

Cohesive and external forces. Most common is generation of cohesive blockages due to adhesive forces between particles. This causes bulk material to support shear and normal forces, allowing the material to remain stagnant under normal gravity feed situations. In this case, bulk unconfined yield strength must be measured as a function of stress applied. The basic criteria to prevent hang-up in any process equipment is a limiting condition. Hang-ups occur in equipment if the strength of the bulk material exceeds the local stresses acting to break up a stagnant zone. Unconfined yield strength is defined as the major principle stress required to induce material to yield or fail in shear. All bulk materials have weight and some processes operate in such a way as to induce external stresses in the material. If the combination of the process geometry, material weight, and external forces can induce stresses greater than the yield strength in all portions of the equipment, then the material will flow. In all cases, mass flow must be achieved in the process to allow material to travel through the system unimpeded by ratholing.

Particle inter-locking. If hang-up is due to particle interlocking then the outlet size must be at least 6 times the particle size. For conditions where the particle size distribution is wide or multi-modal the question of which particle size to use is a question of engineering judgment and we can help you make that decision.

Elastic constraint. In the case where the hang-up is caused by elastic constraint issues, traditional yield strength does not control flowability. Material in the process equipment is in a confined state and the yield strength is defined for an unconfined state. This results in a pseudo-strength that is due to the extra confining pressure. It is critical that the design induce flow along the walls to prevent or release the elastic constraining condition. Traditional mass flow design principles do not likely apply.

Ultimately, there may be dozens of mass flow designs that will work with any given material. Thus, there is not just a single solution. At Material Flow Solutions, we will help you find the optimal solution. ***PRACTICAL APPLICATIONS*** of ***hang-up data*** include, but are not limited to:

- Avoiding process flow conditions caused by arching
- Avoiding process flow conditions caused by ratholing
- Maintaining product quality
- Increasing the bottom line

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