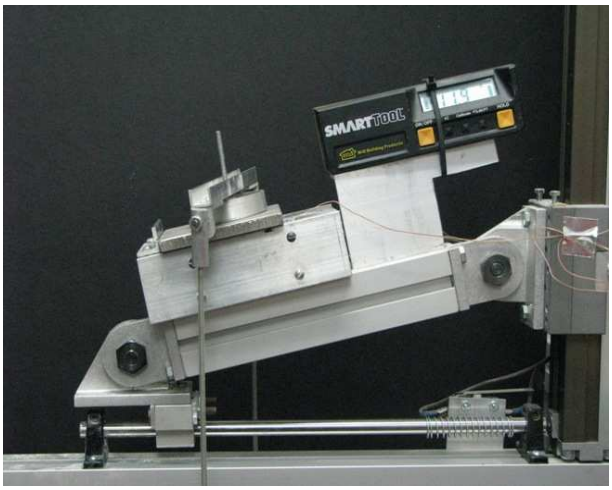
Friction Angle

Material Flow Solutions, Inc.



Bulk solids obey columbic frictional behavior against container and process equipment surfaces. Wall ***friction angle*** is the angle of slide under normal gravity flow for a given bulk solids against a particular wall surface finish. It is a function of the stress level applied to the wall surface as well as the temperature of the bulk material and wall surface. It is measured by heating material to a given temperature, placing it in a cell on a given wall sample plate, applying a normal pressure to the bulk material, and then inclining the plate until the material slides. The angle measured from the horizontal is the wall friction angle. It is used to determine mass flow/funnel flow behavior in bins or hoppers, and velocity profiles in process equipment.

The ***friction angle*** is used to compute the recommend mass flow angle for conical bins. This mass flow angle represents the slope angle of the conical hopper measured from the vertical that will produce flow along the walls. Conical hoppers must be steeper than this to cause flow along the walls. It is important to point out that the recommended mass flow angles in this report are a function of the shape of the bin. Plane flow hoppers converge in one direction at a time and also have a recommended mass flow angle that will produce flow along the walls. However, plane flow mass flow angles generally require about 10 to 12 degrees flatter than corresponding conical angles to achieve mass flow. It is also important to point out that mass flow does not mean plug flow. Substantial velocity gradients can exist in mass flow bins. The recommended mass flow angle also depends on the solids contact stress in the bin. The stress level in a given bin depends on the position in the bin.

At Material Flow Solutions, Inc., we compute the range of pressure expected in a given bin configuration and use the worst-case scenario to compute a recommended mass flow angle for flow in a conical hopper.

PRACTICAL APPLICATIONS of ***friction angle*** data include, but are not limited to:

- Preventing bin hang-ups
- Estimating velocity profiles
- Computing residence time distribution functions
- Predicting segregation
- Designing chute and transfer points

7010 NW 23rd Way, Suite A
Gainesville, FL 32653