(800) 628-8139 or (508) 946-6200
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Powder Flow Analysis of Flour

Understanding flour's flow properties is essential for efficient handling, storage, and processing.

Test Equipment:

- Instrument: Brookfield Powder Flow Tester (PFT)
- Trough: 230 cc, 6-inch diameter (Standard Volume)
- Lid Types:
  - Vane Lid, 33cc, 6-inch diameter
  - Wall Lid, 2B finish, 6-inch diameter
- Type of Test: Flow Function Test, Wall Friction Test
- Conditions: Room Temperature (70-72°F), Humidity: 24%

Test Method:

A PFT equipped with Powder Flow Pro software was used to evaluate the flour. The procedure involved:

Flow Function Test Duration: 25 minutes

Wall Friction Test Duration: 13 minutes

1. Scooping the flour into the trough.
2. Using the scraping tool to evenly distribute the powder throughout the trough.
3. Recording the sample weight and entering it into the software.
4. Running a standard flow function test followed by a wall friction test.

Parameters Measured:

- Flowability: Very Cohesive to Cohesive
- Wall Friction Angle: 12° (0.5 kPa) to 9.5° (4.75 kPa)
- Bulk Density: 530 kg/m³ (fill density) to 880 kg/m³

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Analysis:

- Hopper Shape: Conical
- Critical Arching Dimension:
    - Plain Hopper: 71.7 mm
    - Conical Hopper: 143.3 mm
- Rat-Hole Diameter: Dependent on bin diameter

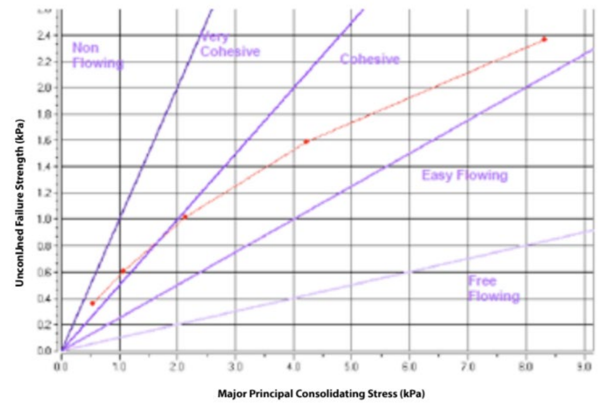

Figure 1: Flour Flow Function Graph
Failure Strength vs. Consolidating Stress

Results:

Flow Function:

The flowability of flour at different levels of consolidating stress is illustrated in Figure 1. The results indicate that flour is generally cohesive except at very low levels of consolidating stress (below 2 kPa), where it becomes very cohesive and difficult to flow.

Wall Friction:

Figure 2 represents the angle of wall friction at different levels of normal stress. The angle of wall friction measures the friction between the sliding powder and the wall of the hopper or chute at the onset of flow. Using a 304 stainless steel lid, the angle of wall friction is about 12° at low normal stress (0.5 kPa) and decreases to about 9.5° at higher normal stress levels (4.75 kPa). Wall friction angles greater than 30° indicate the material will have difficulty sliding against this surface.

Bulk Density:

Figure 3 shows the bulk density of flour at different levels of consolidating stress. The flour has a fill density of about 530 kg/m³, which increases to approximately 880 kg/m³ at around 4.5 kPa of consolidating stress. A free-flowing powder typically shows small changes (less than 30%) in bulk density, while a cohesive powder exhibits significant increases (greater than 30%). The change in bulk density for flour is 66%, indicating it is a cohesive, hard-to-flow material.

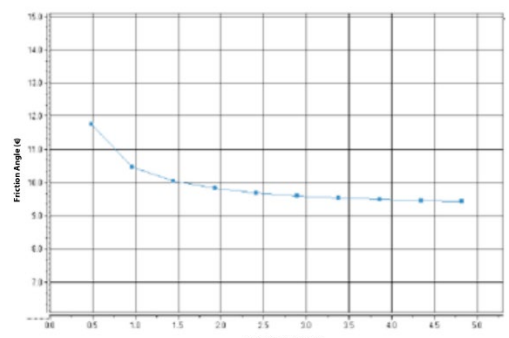

Figure 2: Flour Wall Friction Graph
Effective Angle of Wall vs. Normal Stress

Conclusion:

Flour is a very cohesive powder at low consolidation stress levels and remains cohesive at higher consolidation stress levels. This suggests potential flowability issues as the hopper empties, including:

- **Arching**: Formation of a cohesive bridge over the outlet.
- **Rat-Holing**: Powder flows only from the center, leaving the rest static against the walls.

The critical arching dimension of 104.8 mm (4.192 inches) provides a conservative estimate to prevent arching, provided the minimum outlet dimension of the hopper exceeds this value. The large arching dimension indicates that flour will be difficult to flow.

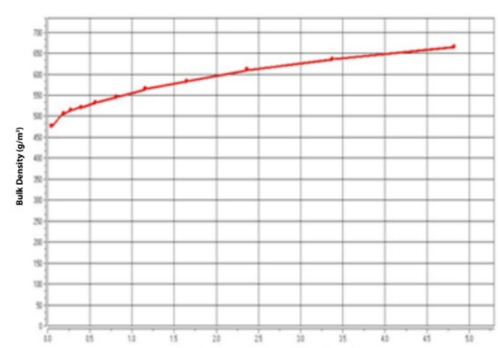

Figure 3: Flour Bulk Density Graph
Density vs. Consolidating Stress