Application Note

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Powder Flow Analysis of Corn Starch

Corn starch is a versatile ingredient widely used for thickening sauces and gravies, as well as in baking. Understanding its 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: 47.5%

Test Method:

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

Flow Function Test Duration: 25 minutes

Wall Friction Test Duration: 13 minutes

1. Scooping the corn starch 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 Easy Flowing
- **Wall Friction Angle**: 35° to 29°
- **Bulk Density**: 625 kg/m³ (fill density) to 800 kg/m³

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Analysis:

- **Hopper Shape**: Conical
- **Critical Arching Dimension**: 63.1 mm (2.5 in.)

Results:

Flow Function:

The flowability of the corn starch at different levels of consolidating stress is illustrated in Figure 1. The results indicate that corn starch is more easy flowing at higher consolidating stresses (above 6 kPa), while at very low consolidating stresses (below 1.4 kPa), it becomes very cohesive and difficult to flow.

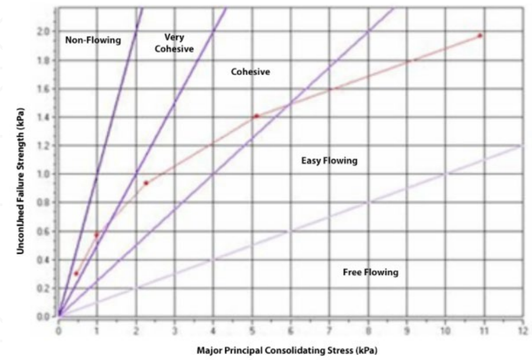

Figure 1: Corn Starch Flow Function Graph

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 stainless-steel lid, the angle of wall friction is about 35° at low normal stress (0.5 kPa) and decreases to about 29° at higher normal stress levels (4.75 kPa). Wall friction angles above 20° are considered high.

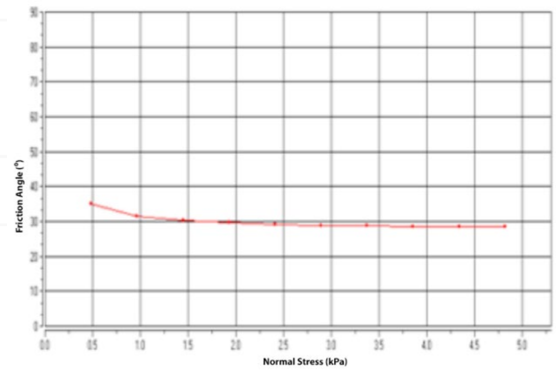

Figure 2: Corn Starch Wall Friction Graph

Bulk Density:

Figure 3 shows the bulk density of corn starch at different levels of consolidating stress. The corn starch has a fill density of ~625 kg/m³, which increases to approximately 800 kg/m³ at around 11 kPa of consolidating stress. In general, an easier flowing powder shows small changes (less than 30%) in bulk density, while a cohesive powder shows large increases (greater than 30%). The change in bulk density for corn starch is 28%, indicating it is on the cusp of being a cohesive, difficult-to-flow material.

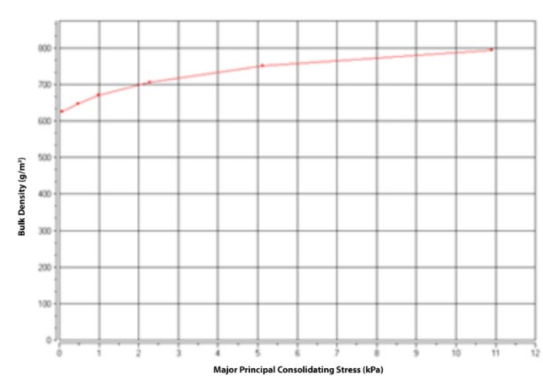

Figure 3: Corn Starch Bulk Density Graph

Conclusion:

Corn starch exhibits varying flow characteristics depending on the level of consolidation stress:

- **Very Cohesive** at low consolidation stress levels (below 1 kPa).
- **Cohesive** at consolidation stress levels from 1 kPa to 6 kPa.
- **Easy Flowing** at high consolidation stress levels (above 6 kPa).

This variability means that corn starch may experience flowability issues as the hopper empties. Potential problems:

- **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 63.1 mm (2.5 inches) provides a conservative estimate to prevent arching, provided the minimum outlet dimension of the hopper exceeds this value.