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Micromeritics of Powders and Granules

Practical 15 - Bench practical

Aim

To measure particle and bulk properties of powders or granules and relate them to processing behaviour.

Principle

Particle size, shape and surface properties affect packing, flow, mixing and dissolution. Bulk and tapped density describe a powder bed under specified handling conditions rather than the true material density.

Several complementary measurements are needed because no single flow index fully describes behaviour in every manufacturing process.

Materials and Requirements

- Representative powder or granule preparations
- Suitable sieve or particle-size apparatus
- Graduated cylinder and tapping device
- Qualified flow-test arrangement and balance

Procedure

1. Record material identity, conditioning history, moisture condition and representative sampling method.
2. Measure particle-size distribution using a selected sieve, microscopy or instrumental method suitable for the material.
3. Weigh a defined mass and record initial bulk volume without uncontrolled compaction.
4. Tap using the defined procedure and record the final volume and endpoint used.
5. Determine the selected flow response, such as angle of repose, under a controlled geometry.
6. Calculate density and compressibility indices, retain individual results and relate the combined evidence to the intended process.

Observations and Record

Enter actual measurements or the supplied teaching data. Record the method, material identity, conditions and units.

Measurement	Mass or volume	Calculated response	Method conditions
Bulk volume	Record	Bulk density	Record
Tapped volume	Record	Tapped density	Record
Size fractions	Record	Distribution	Record
Flow geometry	Record	Angle or flow rate	Record

Calculations

- Bulk density = mass / bulk volume; tapped density = mass / tapped volume
- Carr index (%) = (tapped density - bulk density) / tapped density x 100
- Hausner ratio = tapped density / bulk density
- Angle of repose = arctan(height / radius)

Worked Example

Illustrative powder mass 50.0 g, bulk volume 100.0 mL and tapped volume 80.0 mL give densities 0.500 and 0.625 g/mL.

Carr index = 20.0%; Hausner ratio = 1.25.

For a cone height of 3.0 cm and radius 5.0 cm, angle of repose is about 30.96 degrees. Interpret all values with the material and test conditions.

Result and Interpretation

- Report the size distribution and flow evidence together.
- Different handling conditions can change the measured bulk properties.
- A classification from one index is a screening observation, not a guarantee of manufacturing performance.

Precautions

- Minimise powder segregation during sampling.
- Use defined tapping and flow-test endpoints.
- Control moisture and electrostatic effects.
- Use dust controls appropriate to the material.

Viva Questions and Answers

Why can small particles flow poorly?

Surface forces can become important relative to particle weight.

Is tapped density true density?

No; tapped density still describes a powder bed containing void spaces.

Why report the method?

Geometry and handling conditions influence the result.

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