

What is powder analysis?



Particulate materials constitute a large group of solids that can range in size from sub micron particles to large rocks and minerals. AMETEK Brookfield's Powder Flow Tester measures the flow behavior of bulk solid materials that have a top particle size of 1mm in diameter using the standard volume 263cc shear cell or 250 microns using the small volume 43cc shear cell. In many instances, powders with larger particles can still be characterized effectively by sieving the material and testing the fines (the fines control the flow properties of a material with a wide size range). The generic term used by AMETEK Brookfield to name these materials is "powder", therefore the name of our instrument is "Powder Flow Tester".

Unlike liquids which, under the influence of gravity, tend to have a horizontal surface, powders exhibit a structure, due to internal friction and cohesion, which allows them to form piles with angles relative to the surface on which they are placed. At ambient conditions, powders do not change flow behavior when subjected to variable shear rates, whereas most liquids do. However, pressure controls the strength of a powder (i.e., increases the resistance to flow) whereas a liquid will show limited change in rheology under pressure. In other words, the consequence of subjecting a powder to a compressive force is that the powder will flow less easily; the relationship between the compressive stress applied to consolidate the powder and the strength it obtains is the measurement of the powder flowability, or its "Flow Function".

There is a need throughout industry to characterize powder flow properties and flow behavior. The AMETEK Brookfield Model PFT Powder Flow Tester is a precision instrument of robust design that satisfies this need and more.

What are the industrial issues with powders?

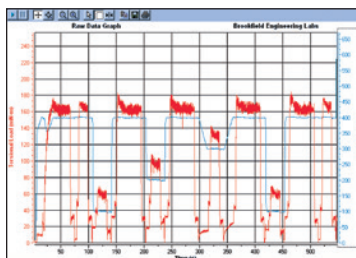
The classic problem with powders is their failure to discharge reliably from bins, hoppers, silos, etc., and poor or unpredictable flow in feeders, dosing machines, packing machines, etc. This causes unwanted interruptions in the production process, leading at times to complete plant shutdown in order to correct the flow restrictions and stoppages. It also leads to variations in pack weight, mixture, performance and sensory properties of powder products.

Quality Control Departments are constantly dealing with raw materials in powder form, which come from multiple suppliers. The variability in particle size and distribution, moisture content, and basic ingredients requires a battery of incoming inspection tests, none of which assure that proper flow will take place when loaded into the plant equipment. The Powder Flow Tester is a single-solution instrument which can resolve this uncertainty.

R&D Departments are constantly adjusting formulations of powder products to satisfy customer demand for improved properties: better coating action for paints, enhanced taste for spices, rapid dissolving of chemicals when put into solution. New formulations do not necessarily have the same flow properties, thereby leading to production problems when the process is scaled up to high volume. The AMETEK Brookfield Powder Flow Tester can predict those problems so they can be prevented.

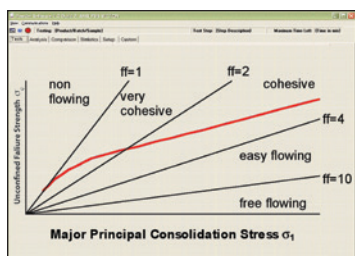
How can flow problems with powders be eliminated? Using a Jenike Shear Cell.

Scientific work has been conducted with shear cells for over 50 years to evaluate powder flowability. AMETEK Brookfield collaborated with The Wolfson Centre at University of Greenwich, England, to evaluate these earlier methods before designing its unique annular shear cell now known as AMETEK Brookfield Powder Flow Tester, or simply PFT.



Test algorithm for AMETEK Brookfield PFT requires compression of the sample contained in an annular shear cell to defined axial loads followed by torsional shearing to determine powder failure strengths.

PFT test data produces a graph called “Flow Function”, similar in concept to the “Flow Curve” generated by a Viscometer measuring liquids for viscosity behavior. Flow Function plots compression applied to the powder sample (called Consolidation Stress) on the x-axis vs. yield stress for onset of powder flow (known as failure strength) on the y-axis.



Flow Function curve from PFT test appears in red. Note that industry has established five regions of flow behavior ranging from “non flowing” to “easy flowing”.

Analysis of Flow Function data leads to calculation of values for Fill and Final Bulk Density, Arching Dimension and Rat Hole Diameter. Critical outlet dimensions for feeders and hoppers should exceed the Arching Dimension and Rat Hole Diameter values to minimize potential blockages in mass flow and core flow respectively. A second test on the powder sample called Wall Friction provides additional information for calculation of the hopper half angle needed to achieve mass flow behavior.

All values are calculated automatically by PFT without operator involvement other than loading the powder sample onto the instrument and measuring the weight.

By comparing Flow Function and Wall Friction data for various formulations, powders can be benchmarked and ranked for flowability. New formulations can be quickly compared to existing powder products that have processed successfully in manufacturing. Adjustments can be made to the formulation by the addition of a flow aid and the resulting Flow Function will tell whether the change is sufficient to eliminate potential flow issues.



To perform a calibration check on your Powder Flow Tester, use certified BCR-116 limestone powder. Run the standard Flow Function test at 5 consolidation stresses and record the failure strength values. They must be between published min/max values for the instrument to pass. BCR-116 limestone powder is supplied in 3.2kg jars and certified by the European Commission, Community Bureau of Reference. Contact AMETEK Brookfield for more information.

Why Choose AMETEK Brookfield?

AMETEK Brookfield has over 80 years experience in providing reliable, low cost viscosity and texture measurement instruments while offering high quality product support. We are now using this recipe for success to expand our line of physical testing products to include the Powder Flow Tester.

The AMETEK Brookfield Powder Flow Tester is the simple answer to industry needs:

The purchase price is a small fraction of current devices on the market.

A competent lab technician can run tests and collect data within minutes, eliminating the need for a powder specialist.

The automated analysis provided by the Powder Flow Pro software calculates various properties of the powder, including the critical dimensions for reliable powder flow out of the hoppers, feeders, bins and silos.

The Wolfson Center for Bulk Solids Handling Technology at the University of Greenwich, England, has worked closely with AMETEK Brookfield to design the Powder Flow Tester, thereby, ensuring its suitability for practical industrial use.

Applications

R&D, Incoming Materials Inspection, New Product Formulation, Quality Control, Process Plant Design

Adhesives

Additive
Manufacturing:
3D Printing

Cosmetics

Chemicals

Construction:

Cement
Fly Ash
Gypsum
Hydrated Lime

Detergents

Equipment

Manufacturing:

Silos
Bins
Feeders
Hoppers

Energy:

Biomass
Coal

Fluxes

Food:

Beverages
Biscuits
Cereal
Chocolate
Cocoa/Milk Powder
Cookies
Crackers
Flavorings
Flour
Seasonings
Spices

Gunpowder/ Ammunition

Healthcare Products:

Tablets

Minerals

Nutraceuticals

Personal Care

Products:

Talcum Powder
Pharmaceuticals
Starch

Properties Measured

Flow function
relation between consolidation stress
and powder strength

Angle of internal friction

Angle of wall friction

Cohesive strength

Bulk density

Arching dimension

Rat-hole diameter

Hopper half angle