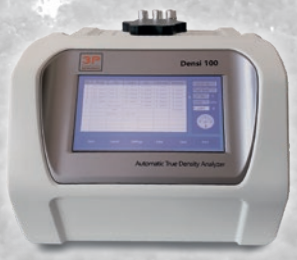
3P INSTRUMENTS

Characterization of
particles · powders · pores

Powder Characterization Analyzers

Easy and norm-compliant determination of

- True, Bulk and Tapped Density
- Floodability and Flowability
- Cohesion and Powder Angles
- Porosity and Dispersibility



Powder Characterization Overview

Introduction

For 30 years, 3P Instruments has been standing for analytical equipment and lab services on the characterization of particles, powders and porous materials in Europe. The intention of the department "Surfaces & Pores" is to offer a professional consultation and scientific solutions concerning our analytical instruments and methods to customers in the fields of research, development or quality control of powders and porous materials. We are mainly focused on the determination and evaluation of characteristics such as the BET surface area, pore size distribution, porosity, pore volume, adsorption capacity, chemisorption parameters, breakthrough analysis, mixed gas adsorption, density and permeability.

Applications

Building materials

Personal care and cosmetics

Soils and sediments

Glass and ceramics

Food and beverages

Paints and inks

Pharmaceuticals

Polymers and metals

Contents

Different Powder Characteristics – Overview

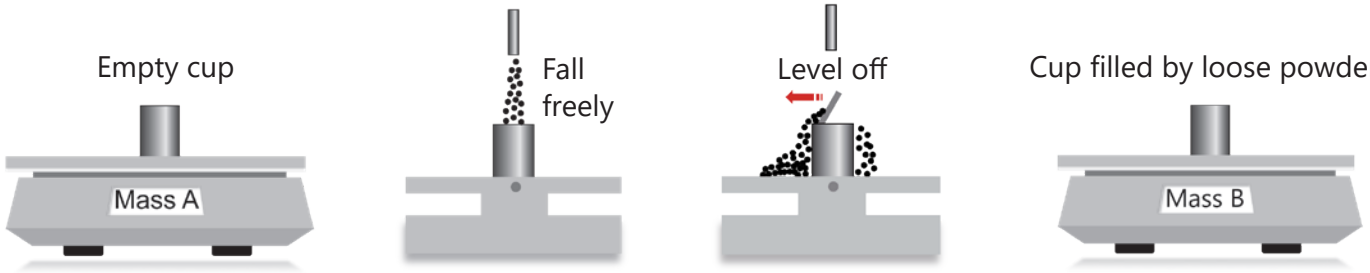
Although the macroscopic properties of powders are decisive for their evaluation and the quantification of these properties is essential for the production, processing and packaging of powders as well as for the transport, storage and application, there are only few possibilities to quantify these parameters. Most instruments have insufficient accuracy and reproducibility and can therefore only be used to a limited extent for a specific powder engineering.

With the PowderPro Series, 14 parameters of metallic and non-metallic powder samples can be determined according to ASTM D6393:

- Carr Angle of Repose
- Carr Angle of Collapse
- Carr Angle of Difference
- Carr Angle of Spatula
- Carr Packed Bulk Density
- Carr Loose Bulk Density
- Tapped Density
- Carr Compressibility
- Carr Dispersibility
- Carr Uniformity
- Carr Cohesion
- Voidage
- Flowability index
- Floodability index

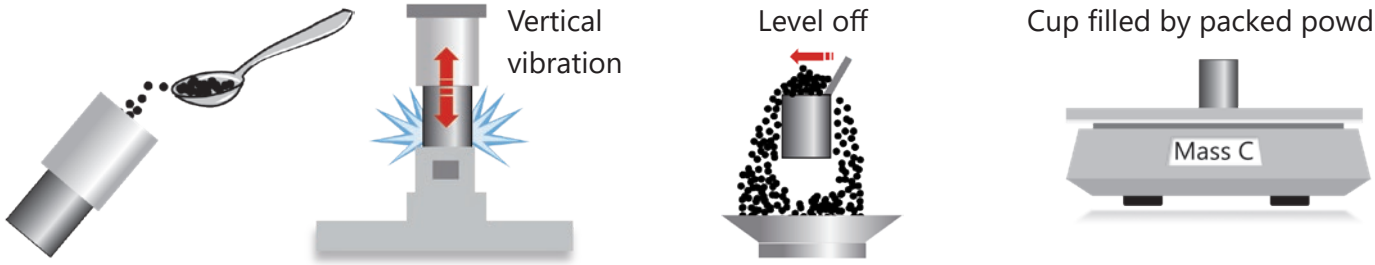
Flowability Parameters

Bulk Density (ρ_B)



$$Bulk\ Density\ (\rho_B) = \frac{Mass\ B - Mass\ A}{Volume\ of\ the\ Cup}$$

Tapped Density (ρ_T)



$$Tapped\ Density\ (\rho_T) = \frac{Mass\ C - Mass\ A}{Volume\ of\ the\ Cup}$$

Powder Characterization Overview

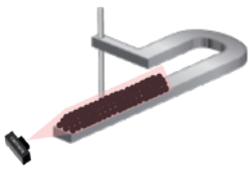
Compressibility (C_p)

$$Compressibility\ (C_p) = \frac{(\rho_T - \rho_B)}{\rho_T} \times 100\%$$

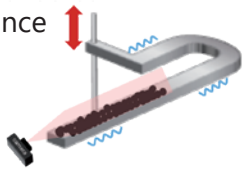
Angle of Repose (θ_R)

Image processing technology

Angle of Spatula (θ_{SP})



Shocked once



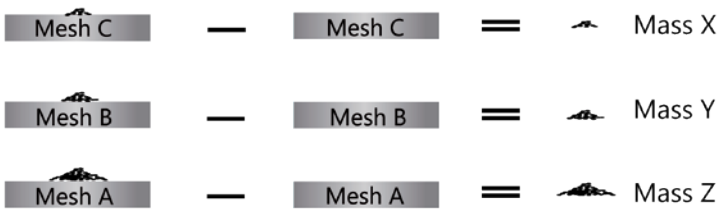
Before shock impacts

After shock impacts

$$Angle\ of\ Spatula\ (\theta_{Sp}) = \frac{\theta_a + \theta_b}{2}$$

Cohesion (C_h)

Vibration



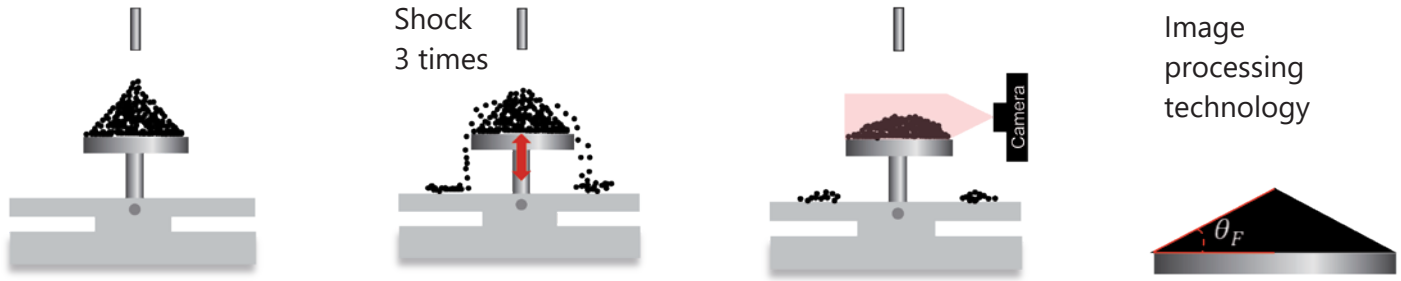
$$Cohesion\ (C_h) = (X \times 5\% + Y \times 3\% + Z \times 1\%) \div 0.1\ g \times 100\%$$

Uniformity (U_f)

$$Uniformity\ (U_f) = \frac{Particle\ size\ at\ the\ 60\ \%\ point\ of\ the\ cumulative,\ undersize\ PSD}{Particle\ size\ at\ the\ 10\ \%\ point\ of\ the\ cumulative,\ undersize\ PSD} = \frac{D60}{D10}$$

Floodability Parameters

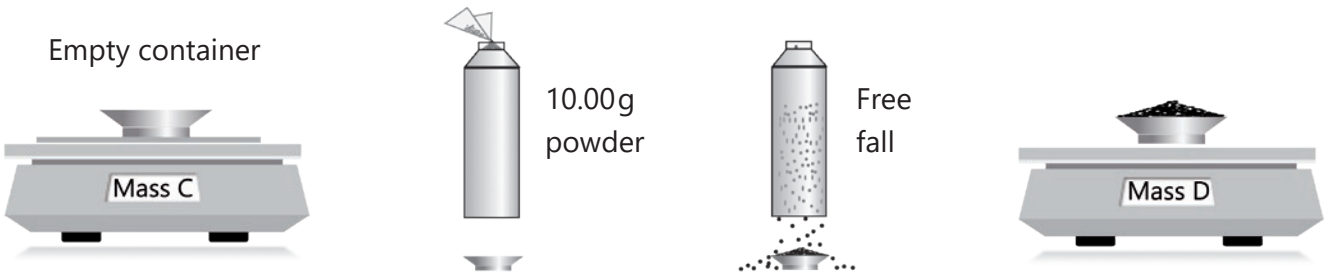
Angle of Fall (θ_F)



Angle of Difference ($\Delta\theta$)

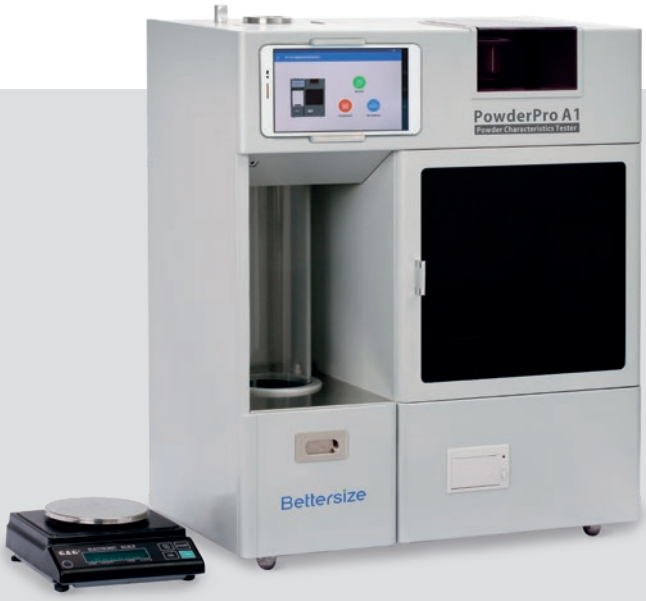
$$Angle\ of\ Difference\ (\Delta\theta) = Angle\ of\ Repose\ (\theta_R) - Angle\ of\ Fall\ (\theta_F)$$

Dispersibility (D_S)



$$Dispersibility\ (D_S) = \frac{10.0\ g - (Mass\ D - Mass\ C)}{10.0\ g} \times 100\%$$

PowderPro Series Powder Characteristics Tester



PowderPro A1

The PowderPro A1 allows a comprehensive, fast and accurate characterization of powders with respect to macroscopic powder properties. This new type of physical test device combines many advanced technologies such as computer or tablet computer-based controlling via Wi-Fi connection, fully automatic digital image processing technology or a 3D electromagnetic material processing. With the PowderPro A1, 14 parameters of metallic and non-metallic powder samples can be determined according to ASTM D6393 (see page 3).

The Powder Pro A1 is therefore an indispensable tool for the understanding and investigation of powder materials.

One App – multiple devices!

- The PowderPro A1 can be connected via Wi-Fi with smartphones and tablets using the Powder Tester App. This enables you to remotely operate the device from another room. The one and only App in the powder characteristic market is designed to offer you the most user-friendly way to measure up to 14 physical properties of your samples. The App is intuitive and easy to operate across different devices, without the need to read the user manual to start a measurement.
- The PowderPro software is also available for PC, and it is as user-friendly as the Powder Tester App.

Benefits and Features

- Angle measurements using a CCD camera and image processing routine
- Fully automatic computer or tablet computer controlling (tablet computer is included in the delivery) guarantees easy handling and use
- Standardized operating procedures (SOPs) ensure highly accurate and reproducible results
- Direct data communication via connection to electronic balance
- New technology for the measurement of the Packed Bulk Density for a smooth powder surface and thus higher accuracy (rotating cylinder for horizontal meniscus)
- Freely selectable vibration frequencies between 50 to 300 min^{-1} at two different amplitudes (tapping heights, 3 or 14 mm) for the determination of the Packed Bulk Density
- Comprehensive accessory set included in delivery
- Compliant with ASTM D6393-14, USP32-NF27<616>, EP7.0 07/2010:20934 and ISO 3953

Figure 1 *Software Screenshot*

Figure 2
The included printer outputs the report directly after the measurement. The data are additionally saved in the software

PowderPro M1

The PowderPro M1 is a basic version of PowderPro A1. It can perform the same measurements and analyses of PowderPro A1 through manual process. The PowderPro M1 is frequently used in the educational sector.

Benefits and Features

- Standardized operating procedures (SOPs) ensure highly accurate and reproducible results
- Direct data communication via connection to electronic balance
- New technology for the measurement of the Packed Bulk Density for a smooth powder surface and thus higher accuracy (rotating cylinder for horizontal meniscus)
- Freely selectable vibration frequencies between 50 to 300 min-1 at two different amplitudes (tapping heights, 3 or 14 mm) for the determination of the Packed Bulk Density
- Comprehensive accessory set included in delivery
- Compliant with ASTM D6393-14, USP32-NF27<616>, EP7.0 07/2010:20934 and ISO 3953

Specifications		
Model	**PowderPro A1**	**PowderPro M1**
Measurement	Fully automatic by CCD camera	Manual
Parameters	8 (measured) + 5 (calculated)	
Materials	Metallic and non-metallic powders	
Conformity ASTM	ASTM D6393-08/D6393-14	
Conformity ISO	ISO 3953	
Conformity USP	USP32-NF27<616>	
Conformity EP	EP7.0 07/2010: 20934E	
Repeatability	≤ 3 %	
Drop height	3 or 14 mm	
Vibration frequency	50 – 300 times per minute (continuous adjustment)	
Control terminal	Tablet PC (included), PC or mobile phone	–
Dimensions	L 600 x W 350 x H 730 mm	
Weight	42 kg	38 kg
Power supply	AC 220 V, 50/60 Hz, 230 W	

3P densi Series Gas Pycnometers

3P densi Series

True density is the mass per unit volume for a material in the absolutely dense state. The 3P densi series is a compact and automated density analyzer for powders and solids as well as for the characterization of foamed materials for the determination of skeletal density. To perform a measurement with the pycnometer, the sample is filled into the sample cell. Sample preparation is performed in continuous or pulsed gas flow. Preparation, measurement and repeated measurement are carried out automatically. Repeated measurements are optionally affected either by pre-setting a user specified tolerance (Autostop) or a user specified number of runs. The sample volume of 3P densi 100L ranges from 10 cm^3 up to 100 cm^3, the 3P densi 100S holds sample cylinders from 1 cm^3 up to 10 cm^3. The instrument is easy to handle thanks to the 10-inch (25.4 cm) touch-screen.

Benefits and Features

- Easy to handle the instrument by the 10-inch (25.4 cm) touch-screen
- Additional measurement option for measuring of the closed cell content for foams and other samples
- Measurements are fully automatic
- Continuous self-diagnostics monitor and signal fault conditions that may arise. The transducer is reset to zero prior to each run.
- Front panel LEDs display the operational status at all times
- Sample temperature is displayed with an accuracy of ±0.1 °C
- Compliant with DIN 66137-2

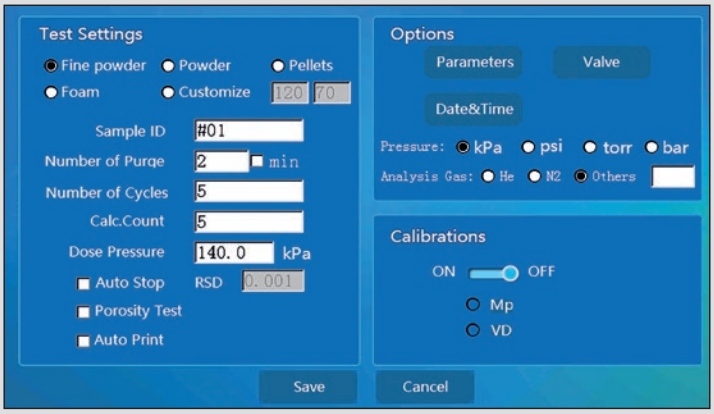


Figure 3 *Easy-to-use software with different settings*

Specifications	
Test parameters	True density, true volume, determination of open porosity of solid materials, open and closed cell content of foams
Sample cells 3P densi 100L	100 cm^3 cylinder (49 x 58 mm) 10 cm^3 cylinder (18 x 39 mm) optional Other geometries and sizes on request
Sample cells 3P densi 100S	10 cm^3 cylinder (18 x 39 mm) 1 cm^3 and 3.5 cm^3 cylinder optional Other geometries and sizes on request
Precision	0.0001 g/cm^3
Accuracy	≤ ± 0.03%
Reproducibility	≤ ± 0.02%
Dimensions	L 380 mm x W 280 mm x H 280 mm
Weight	10 kg
Power requirements	AC 220 V ±20 V 50/60 Hz, 100 W

BeDensi T Pro Series

Tapped density is the ratio of the mass of particles to the total volume of powders that are filled into container after tapping under specific conditions. The total volume is the sum of true volume of particles, the pore volume of open and closed pores in powders, and interstitial volume between the packed particles after vibration.

The tapped density of powdered, granular of flakey material is highly dependent on the manner in which the particles are packed together. During tapping, particles gradually pack more efficiently, the powder volume decreases and the tapped density increases. Under controlled conditions of tapping rate, tap force and cylinder diameter, this condition of maximum packing efficiency is highly reproducible. Tapped density measurement (sometimes referred to as tapped bulk density, or just tap density) is formalized in a number of international standards to which BeDensi T Pro models are compliant. If you need to ensure the same fixed number of taps for all analyses, a special lockout feature is provided. This prevents unauthorized changes to the counter.

Benefits and Features

- Tapped density analyzer with 1, 2 or 3 sample cylinders
- 250 ml measuring cylinders and others
- Tapping speed 250 min^{-1}
- Drop height: 3 mm
- Rotating cylinder for horizontal meniscus
- Implemented label printer
- Simultaneous run mode
- According to DIN ISO 3953 and other norms

BeDensi Series Bulk Density and Flowability Instruments

BeDensi Series

Bulk density is the mass per unit volume of particles that is packed into a container without external force. The total volume is the sum of true volume of particles, the pore volume of open and closed pores in powders, and interstitial volume between the packed particles. Bulk density is also known as loose density, loose packing density, loose bulk density and volumetric density.

Bulk density and flowability are the basic parameters of powder material characterization. Since these parameters significantly depend on the measurement conditions, their determination is defined in different norms depending on the material type. Accordingly, a defined performance of measurements or the use of instruments of defined and norm-compliant dimensions and designs is required.

BeDensi B1

- Bulk density instrument for non-metallic powders, using natural deposition method
- Compliant with GB/T16913.3-1997-Part III

BeDensi B1-S

- Scott capacity instrument for the norm compliant determination of the bulk density of metal powders
- Compliant with ISO 3923-2, ASTM B329-14

HFlow-1

- Hall flowmeter for the norm compliant determination of the flowability of metal powders
- Compliant with ISO 4490, ASTM B213-13

Watch the PowderPro A1 videos

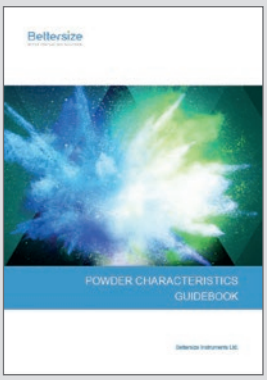
Angle of Spatula Measurement of Powder Materials

Bulk Density Testing of Non-metallic Powder Materials

Angle of Repose, Angle of Fall & Angle of Difference Testing

Tapped Density and Compressibility Measurement of Powder

Download the Powder Characteristics Guidebook



Wonder what powder characteristics are and why they are important? Have difficulties in tackling powder property measurements? Find out all solutions to your problems about powder characterization, in this helpful tool book written by Bettersize.

Download the AppNotes on Tapped Density Testing

Improving the tapped density of the cathode material to make a Lithium-ion battery hold more energy

Tapped density is – besides the particle size distribution – an important physical property of electrode materials and affects the energy density of a Li-ion battery (LIB). Thus, it is necessary to determine the optimal achievable tapped density in advance.

How to perform a standardized tapped density test for pharmaceutical powders

Tapped density gives an indication of compressibility and flowability of pharmaceutical powders. Using three excipients, the AppNote shows that the BeDensi T Pro series fully meets the standards of the United States Pharmacopoeia (USP) and European Pharmacopoeia (EP).

Optimizing food packaging size by measuring the tapped density

A reasonable packaging size in the food industry is important to optimize the packaging process and to decrease the transport costs. This article shows how the food container's size can be determined by measuring the bulk and tapped density.

Your partner in particle characterization

3P Instruments has over 30 years of profound expertise in the characterization of emulsions and dispersions, of particles and powders as well as surfaces and pores.

- 3P Instruments analyzers with various options
- Journal "Particle World" and biweekly news at www.3P-instruments.com
- LabSPA (Lab for Scientific Particle Analysis) for test and contract measurements
- R&D department working at scientific projects and solutions
- Experienced service team with direct access to test instruments
- Customer service and instruction briefing by highly qualified expert team
- Instrument rental and leasing is possible
- Friendly administration, optimized business processes, very short response times

We also offer particle size analyzers and BET surface analyzers:

Bettersizer S3 Plus

3P sync 400

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