Quantachrome INSTRUMENTS

Powder and Porous Solid

Density

by Gas Pycnometry, Tapping and Solid Displacement

True Density & Tapped Density Analyzers

• Mining • Pharmaceutical • Foams
• Food Powders • Spices & Grains

PENTAPYC™ 5200e

Five station, automatic pycnometer for specific volume and true (skeletal) density determination of porous solids and powders. Each of the five stations can be individually "tailored" for different sample amounts and shapes. Stand alone operation and 2-way ethernet communication to PC, interface to electronic balance and direct printing of results. Easy-seal™ covers ensure reproducible operation. A thermostatted version (T-model) for increased temperature stability and control is available.

ULTRAPYC™ 1200e / MICRO-ULTRAPYC™ 1200e

Single station, automatic gas pycnometers for volume measurement of porous solids and powders. The Ultrapyc can measure samples of up to 135 cm^3 and down to 0.1 cm^3. Other standard features including availability of a thermostatted version are the same as in the Pentapyc. Additional vacuum purge option reduces consumption of analysis gas.

ULTRAFOAM™ 1200e / PENTAFOAM™ 5200e

Upgraded gas pycnometers for cellular plastics applications conforming to ASTM D6226. Pre-programmed modes include open and closed cell, isometric compressibility and rigid foam fracture. Both retain all the features of the standard automated pynometers including normal density mode, with rapid switching between methods via keypad or PC.

True and Apparent Density of Solids

The density of a sample is defined as its mass divided by its volume. For a given mass, evaluating a sample's density simply involves measuring its volume. The volume of homogeneous solids with well defined geometry can be readily calculated from their dimensions. However, most solids consist of heterogeneous combinations of particles with varying sizes and shapes. In such cases, volumes are most accurately measured by fluid displacement, following Archimedes' principle. Helium gas is the preferred displacement fluid because of its small dimensions and ideal gas behavior. Automated gas pycnometers provide non-destructive volume measurements with extremely high precision and speed. Both these parameters are of utmost importance for applications for which sample purity, buoyancy, or packaging are key. True densities are obtained when the helium penetrates all open pores and there are no closed or inaccessible pores in the material. When open or closed pores are present (as in rigid cellular plastics), techniques are available to assess their apparent density and calculate their open and closed void or cell contents. True and apparent density measurements are extremely valuable and reliable tools to quickly and routinely characterize the structure and quality of solid materials such as catalysts, ceramics, foams, minerals, metal powders, soils, cements, pharmaceuticals, and many more.

Visit www.quantachrome.com for more detailed instrument specifications and downloadable brochures.

AUTOTAP™ / DUAL AUTOTAP™

Tap density analyzers for bulk density and powder packing studies including Hausner Ratio and Carr index for predicting flow-ability. Built-in counter for error-free operation. Automated one and two sample models feature unique adapters for range of sample cylinder volumes. Rugged construction for troble-free performance. Both units conform to ASTM test methods B527, D4164 and D4781, MPIF 46, USP<616> method II and ISO 787/11. Also used for envelope (geometric) density measurement by dry powder displacement. The units' control panel can be disabled thanks to a lock at the front of the instrument, which enables the user to prevent others from tampering with the counter settings. If additional sound insulation is desired, an optional noise reduction cabinet is also available to accommodate either Autotap™ model.

Open and Closed Cell Content of Rigid Cellular Plastics

Foams and various rigid cellular plastics are formed by trapping gas bubbles in a solid. Typical examples include Styrofoam™ cups and bed mattresses. Based on their pore structure, foams are characterized as open or closed cell structures. In open cell structures the pores are interconnected and can be readily filled with surrounding fluids. When filled with air or water, open cell foams make excellent thermal insulators or sponges. In contrast, pores in closed cell foams are not interconnected. This makes them stronger, denser, and able to float in liquids. Closed pores can be filled with selected gases to improve their performance as heat and sound insulators. Their high resilience, impermeability, and light weight make rubber foams popular as floor mats, gaskets, and shock absorbers.

Bulk and Tap Density and Sample Porosity

True and apparent densities can be readily evaluated using gas pycnometers. However, many applications also require knowledge of packing density and porosity. Materials that consist of discrete particles, flakes, pellets, or granules contain void spaces between and inside the particles. Voids are regions which contain something other than the considered material. Since bulk density is evaluated by dividing sample mass by bulk volume, voids tend to lower the packing or apparent density of a material. The degree to which bulk density is affected by voids can be precisely measured by controlling packing parameters, as done with Autotap™ tapping density analyzers. For applications requiring the measurements of particle volumes including voids, either non-wetting fluids or solid particles or known dimensions can be used. For example, the PoreMaster™ series mercury porosimeters can determine apparent sample volumes including pores of specified decimeters down to 3.5 nm. If the volume of pores with radii below 3.5 nm is significant, or if porosity estimates are required, the use of a helium pycnometer is recommended.

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Comparison of Density Analysis Equipment at a Glance

Instrument Model	Automatic (A) or Manual (M)	No. of Sample Stations	Sample Volume Range[cm^3]	Large Sample Cell Precision[b] [%]	No. of Inter-changeable Sample Cells	Balance Interface Port	Thermal Control Option	Multi Language Software Capability	Degas by Flow[F], Pulse[P], or Vacuum[c][V]
Pentapyc™ 5200e	A	5	0.1-135	0.01	3	√	√	√	F, P
PentaFoam™ 5200e	A	5	0.1-135	0.01	3	√	√	√	F, P
Ultrapyc™ 1200e	A	1	0.1-135[a]	0.01	3(6[a])	√	√	√	F, P, V
UltraFoam™ 1200e	A	1	0.1-135[a]	0.01	3(6[a])	√	√	√	F, P, V
Micro-Ultrapyc™ 1200e	A	1	0.1-4.2	0.01	3	√	√	√	F, P, V
Autotap / Dual Autotap	M	1 or 2	10-1,000[d]	[b]	6[d]	--	--	--	--

[a] Optional Micro/Meso/Nano Cell Kit Extends Range to 0.1 cm^3.
[b] Varies with sample cell dimensions, sample volume and/or sample preparation; higher precisions achievable for optimum combinations.
[c] Optional vacuum degassing using pump.
[d] 250 cm^3 is standard; other cylinders with capacities between 10 and 1,000 cm^3 are optional.

Selected International Standards Applicable to Density Analysis

ASTM D4892-14
Standard Test Method for Density of Solid Pitch (Helium Pycnometer Method).

ASTM D2638-10
Standard Test Method for Real Density of Calcined Petroleum Coke by Helium Pycnometer.

ASTM B923-10
Standard Test Method for Metal Powder Skeletal Density by Helium or Nitrogen Pycnometry.

ASTM UOP851-08
Density of Powders and Solids by Helium Displacement.

ASTM D6093-97(2011)
Standard Test Method for Percent Volume Nonvolatile Matter in Clear or Pigmented Coatings Using a Helium Gas Pycnometer.

ASTM D4164-13
Standard Test Method for Mechanically Tapped Packing Density of Formed Catalyst and Catalyst Carriers.

ASTM D4781-03(2013)
Standard Test Method for Mechanically Tapped Packing Density of Fine Catalyst Particles and Catalyst Carrier Particles.

ASTM B527-14
Standard Test Method for Determination of Tap Density of Metal Powders and Compounds.

Visit www.quantachrome.com for more detailed instrument specifications and downloadable brochure
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Serving Porous Materials and Powder Characterization Needs Since 1968