DENSITY ANALYSIS

micromeritics®

Micromeritics gas pycnometers are being used worldwide to obtain material density measurements. These measurements are necessary in the manufacture of many of today's products. Simply defined as mass divided by volume (g/cm^3), density measurements guide the formulation process and influence the overall quality of manufactured products.

Measuring the volume of a rigid, solid material of simple geometry is straightforward. However, measuring the volume of a material with an irregular shape presents a challenge. Archimedes succeeded in measuring the density of King Hiero II's crown by immersing it in water and measuring the volume of water displaced. This technique, now known as pycnometry, is still appropriate for nonporous objects and, with variations, for porous objects. Now, however, the displaced medium may be a gas, liquid, or fine powder.

Many materials have within their structure pores made up of cracks, crevices, and tortuous passageways. This leads to three different definitions of density, each requiring different techniques for measurement. The first type of density measurement determines only the solid volume of the sample material (by excluding the open pores and voids within the material), while the second determines the density of the sample as defined to include the open and closed pore spaces within. The third definition of density defines sample volume in terms of the volume of a container into which a quantity of material composed of multiple pieces can be placed. This measurement includes not only the pore spaces within each piece but also the spaces among the pieces and requires a still different technique of assessment.

CERTIFIED ISO9001 MANUFACTURER

PYCNOMETERS

For over 37 years, Micromeritics has dramatically improved both the speed and accuracy of density measurements. Our pycnometers are based on proven techniques and deliver consistent and reliable measurements. By providing innovative technology for determining absolute, envelope, and bulk density, Micromeritics is playing an essential role in meeting industrial needs.

ABSOLUTE DENSITY

Absolute density (also termed the true, real, apparent, or skeletal density) is obtained when the volume measured excludes the pores as well as the void spaces between particles within the bulk sample. Until recently absolute density was determined using water or another liquid which was expected to fill the pores in the sample, thus removing their volume from the measurement. Sometimes the material was subjected to boiling in a liquid to ensure pore penetration and sometimes the sample was evacuated prior to immersion to assist pore filling. However, surface tension effects and entrapped gases resisted the filling of very small pores.

Micromeritics offers helium (or other gas) pycnometers that are much more accurate and easier to use. They are faster than liquid-based techniques because gases easily, quickly, and thoroughly fill the minutest pore spaces. The absolute density determined by helium pycnometry is being ever more frequently referred to simply as the 'helium density.'

ENVELOPE DENSITY

Envelope density (sometimes called the bulk density) is determined for porous materials when pore spaces within the material particles are included in the volume measurement. The Micromeritics envelope density analyzer uses a free-flowing dry powder as the displaced medium. The material to be tested is surrounded by this medium that does not penetrate pores but conforms to irregular surface contours to form a tight-fitting 'envelope.' This dry powder medium permits rapid, easy-to-make density measurements without damaging or contaminating the sample. Envelope density values are less than absolute densities when the material is porous; values for absolute and envelope density are equal for nonporous materials. Total porosity can be calculated from a measure of both absolute and envelope density on the same material.

Micromeritics offers pycnometry instruments that can rapidly measure the envelope density of porous objects of irregular size and shape.

BULK (TAP) DENSITY

The density obtained from filling a container with the sample material and vibrating it to obtain near optimum packing is also called bulk density by some. It frequently is referred to as 'tap' density because it has traditionally been measured by mechanical devices that lift then drop the container, producing a loud tapping noise. Such a measurement is of great interest in packing and shipping items like breakfast cereal and other bulky products. Tap density is not an inherent property of a material but depends on particle size distribution and shape as well as measurement techniques. Since interparticle voids are included in the measurement, tap density is always a lesser value than envelope density.

Micromeritics provides instruments which have the ability to obtain precise results comparable to traditional tap density measurements. They are ideal for obtaining the packing densities of powder and bulk materials.

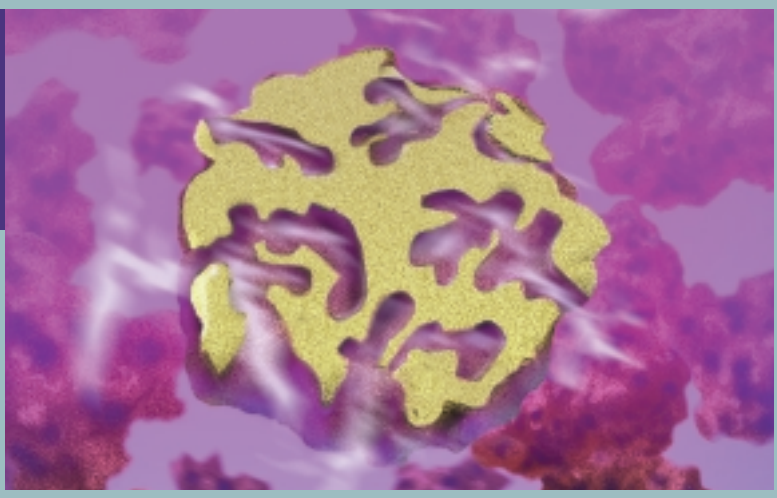
DENSITY DEFINED

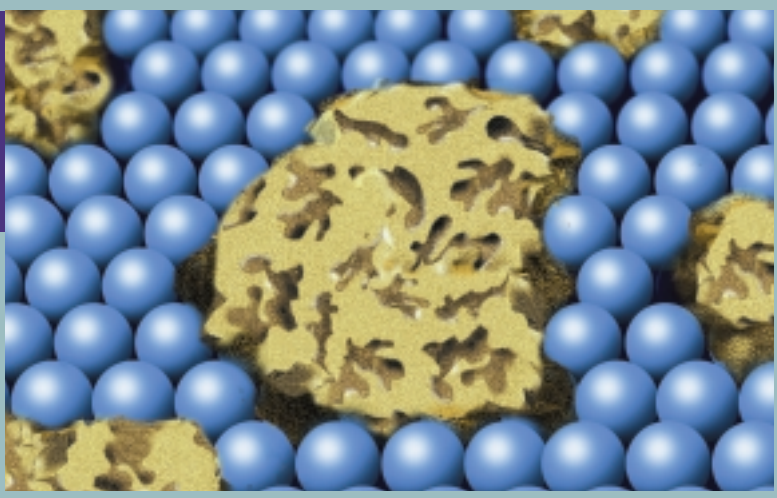
British Standards Institution definitions of density

Absolute powder density - The mass of powder per unit of absolute powder volume.

Apparent powder density - The mass of a powder divided by its apparent volume.

Absolute powder volume - The volume occupied by a powder excluding all pores and voids.





True density - The mass of a particle divided by its volume, excluding open and closed pores.
Envelope volume - The external volume of a particle, powder, or monolith such as would be obtained by tightly shrinking a film to contain it.
Bulk density - The apparent powder density under defined conditions.
Tap density - The apparent powder density obtained under stated conditions of tapping.

APPLICATIONS

Reducing the weight of some products is often desirable for performance as well as economic reasons. Many manufacturers strive to develop materials that are partially porous yet still fulfill their function. Density measurements play a key role in these developments. In other products, preventing porosity is important. Closed air bubbles (cells) are desirable in home-insulating materials, but an open cellular structure is required for automobile and furnace filters. Producers thus keep a check on closed and open cells by density evaluation.

A noted decrease in density from a reference value can indicate a void within the product, an undesirable situation for some manufactured products such as those composed of laminates. An increase in density may indicate a process is optimized. For example, the density of a polymer increases as it approaches its crystalline state.

The number of industries that depend on density determination is extensive. In the agricultural industry, the density of grains, feeds, tobacco, fertilizer, insecticides, and soil samples are measured. The ceramic industry uses density and specific gravity measurements on ceramic whiteware materials. In the pharmaceutical industry, density measurements are correlated with solubility rates of powders and tablets. The production of construction materials such as insulation, bricks, and tiles requires the determination of absolute density. The manufacture of carbon and graphite materials requires bulk density measurements. Studying the reaction rate of porous catalysts is augmented by measurements of particle density and volume. Other industries that benefit from density measurement include plastics, glass, powder metallurgy, paint, textile, and pulp and paper.

From raw material to finished product, density measurements support a wide variety of industrial needs. Micromeritics' experience in the field of density measurement began in 1961, when we introduced our first hand-operated helium pycnometer. In 1981 we developed the first commercial automatic gas pycnometer. Today, Micromeritics is a leading provider of instruments that determine density. We support these products with a worldwide network of personnel trained in applications and service support. Our pycnometers deliver fast, accurate, and reliable measurements to determine absolute, envelope, and bulk density measurements.

A partial list of materials that utilize density determination

Carbon black	Coke	Lactose	Resins
Carbon cloth	Dolomite	Limestone	Silica
Catalysts	Film	Metal parts	Starch
Cement	Foam	Nickel	Talc
Ceramic	Graphite	Pigment	Tungsten carbide
Clay	Iron oxide	Polyester fiber	Zeolite
Coating powder	Kaolin	Quartz	Zinc oxide

MICROMERITICS. SETTING THE PACE WORLDWIDE.

Micromeritics is approaching a half-century of experience in providing innovative products to the particle technology marketplace. Instrumentation developed by Micromeritics has been the recipient of awards for design excellence on numerous occasions. Our instruments have been chosen as the standard of performance by many multi-national corporations. As a result of this, Micromeritics is pleased to provide products and product support to customers around the globe. The driving force of our Company is to develop and support high-quality, high-performance instrumentation of unmatched accuracy and utility, never losing sight of the primary importance of satisfying the needs of our customers.

Micromeritics maintains a high level of interest in the needs of the many industries it serves and aggressively responds to these needs. It is this response that firmly establishes Micromeritics as one of the world's leading suppliers of particle technology instruments.

Micromeritics has over 50 sales, service, and distribution offices throughout the world.

micromeritics®

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