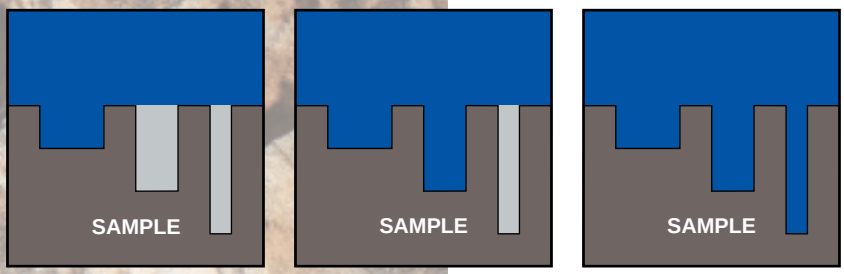
POROSIMETRY

micromeritics®

INNOVATIVE TECHNIQUE

Mercury porosimetry characterizes a material's porosity by applying various levels of pressure to a sample immersed in mercury. The pressure required to intrude mercury into the sample's pores is inversely proportional to the size of the pores.

To perform an analysis, the sample is loaded into a penetrometer, which consists of a sample cup connected to a metal-clad, precision-bore, glass capillary stem. The penetrometer is sealed and placed in a low pressure port, where the sample is evacuated to remove air and moisture — the user controls the speed of the evacuation, and there's no need for a separate preparation unit. The penetrometer's cup and capillary stem are then automatically backfilled with mercury. Excess mercury is automatically drained back into the internal reservoir; only a small amount remains in the penetrometer.



As pressure on the filled penetrometer increases, mercury intrudes into the sample's pores, beginning with those pores of largest diameter. This requires that mercury move from the capillary stem into the cup, resulting in a decreased capacitance between the now-shorter mercury column inside the stem and the metal cladding on the outer surface of the stem.

The instrument automatically collects low pressure measurements over the range of pressures specified by the operator. Then, the penetrometer is moved to the high pressure chamber, where high pressure measurements are taken. Data are automatically reduced using the low and high pressure data points, along with values entered by the operator, such as the weight of the sample and the weight of the penetrometer loaded with mercury.

THE RIGHT PRESSURE POINTS

Micromeritics' mercury porosimeters give you complete control in determining the pressure points at which readings are taken. You can specify exact pressure points, to maximize readings taken where intrusion occurs, or you can use linear pressure ramping within a range you choose. You can even combine the two methods for a pressure routine customized for your sample.

No matter what pressure routine you choose, Micromeritics' AutoPore series porosimeters can automatically collect additional data points when a significant intrusion is detected. What volume reflects a "significant" intrusion? You control that decision.

PROVEN SCIENCE

Mercury porosimetry is based on the capillary law governing liquid penetration into small pores. This law, in the case of a non-wetting liquid like mercury, is expressed by the Washburn equation:

$$D = \left(\frac{1}{P}\right) 4\,\gamma\,\cos\,\varphi$$

where D is pore diameter, P is the applied pressure, γ the surface tension of mercury, and φ the contact angle between the mercury and the sample, all in consistent units. The volume of mercury V penetrating the pores is measured directly as a function of applied pressure. This P-V information serves as a unique characterization of pore structure.

The Washburn equation assumes that all pores are cylindrical. Although pores are rarely cylindrical in reality, this equation provides a practical representation of pore distributions, yielding very useful results for most applications.

As pressure increases during an analysis, pore size is calculated for each pressure point, and the corresponding volume of mercury required to fill these pores is measured. These measurements taken over a range of pressures give the pore volume versus pore size distribution for the sample material.

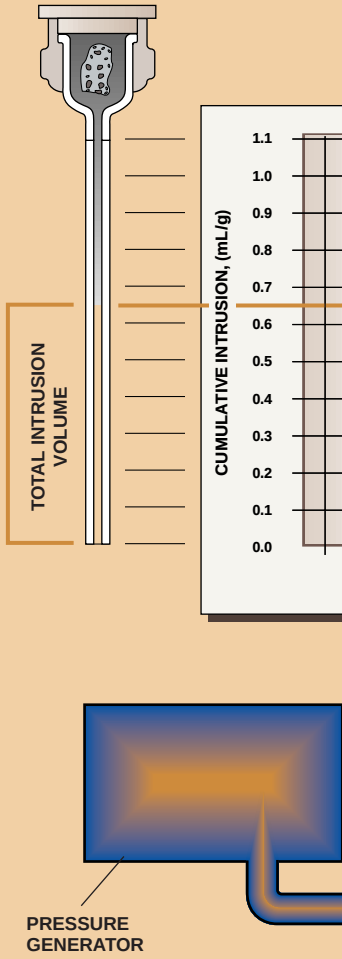
If decreasing pressures are included in the analysis, extrusion data are also calculated using the Washburn equation. Extrusion P-V curves usually differ from intrusion curves because of mercury entrapment and because there is no driving force to bring the mercury out of the pores during the extrusion phase of the analysis. Differences between intrusion curves and extrusion curves can be used to characterize channel restrictions and the structure or shape of pores.

Pore diameters may be offset toward larger values on extrusion curves because receding contact angles are smaller than advancing contact angles. This results in equivalent volumes of mercury extruding at lower pressures than those at which the pores were intruded. Also, pore irregularities, such as enlarged chambers and "ink-well" structures sometimes trap mercury.

Micromeritics' mercury porosimeters determine pore size distributions with outstanding volume resolution: better than 0.1 microliter.

Mercury porosimetry can determine a broader pore size distribution with greater speed and accuracy than other methods.

And, Micromeritics' mercury porosimeters provide comprehensive data for a wide spectrum of applications.



WIDE APPLICABILITY

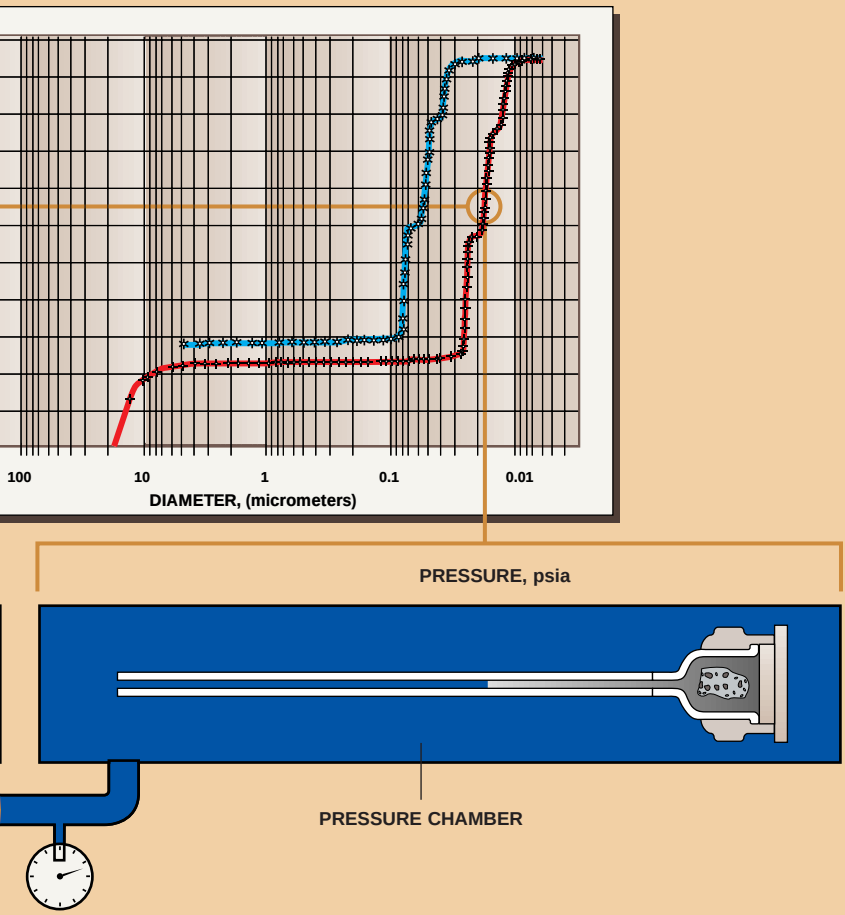
Micromeritics' mercury porosimeters can accurately analyze samples in many forms, from powders and granules to sections and chunks. Because mercury is non-wetting and non-reactive to most materials, it can be used to analyze a vast range of samples, including reservoir rocks, refractory materials, resins, pigments, carbons, catalysts, textiles, leather, adsorbents, pharmaceuticals, membranes, filters, ceramics, papers, fuel cell components, and other porous materials.

FLEXIBLE REPORTING

All Micromeritics mercury porosimeters provide comprehensive reporting capability, including graphs, tabular reports, and summaries. You can easily customize any report to accommodate your specific needs. For added flexibility, reports can be generated to screen, printer or file.

THOROUGH SAFEGUARDING

Micromeritics' mercury porosimeters feature multiple levels of safety systems for controlling pressure and mercury. Both the software and the instrument components guard against the generation of excessive pressure. Reservoirs and traps are designed to simplify mercury handling and ensure its safe containment.



COMPREHENSIVE RESULTS

Mercury Porosimetry can determine a broader pore size distribution more quickly and accurately than other methods. Comprehensive data provide extensive characterization of sample porosity and density. Available results include:

- Total pore volume
- Incremental volume
- Differential volume
- Log-differential volume
- % of total volume
- Total pore surface area
- Incremental area
- Median or mean pore diameter
- Pore size distributions
- Sample densities (bulk and skeletal)
- % porosity

OUTSTANDING ACCURACY AND RESOLUTION

The quality of a porosimeter's volume resolution depends upon its ability to accurately detect minute changes in capacitance, not on sheer numbers of readings. Micromeritics' instruments achieve extraordinary resolution because they can detect very slight changes in capacitance (typically a difference resulting from the movement of less than 0.1 microliter of mercury). To achieve precise pressure readings and to supply you with the most accurate data possible, Micromeritics' mercury porosimeters combine an advanced pressure transducer with high-accuracy analog-to-digital converters and special equilibrated measurement routines for data collection.

Two modes of operation let you develop a methodology that balances your requirements for speed and precise detail.

- Use equilibration mode for direct, detail-rich, accurate measurement. Data gathered during an equilibrated analysis provide an in-depth examination of the sample's porosity and enable you to characterize pore shape and structure.
- For even faster analyses (with reduced precision), use scanning mode, which approximates equilibrium by increasing pressure continuously. Scanning mode enables quality control labs to rapidly check samples for conformity with production specifications.

Computer-based calibration facilitates compliance with strict quality-control guidelines and ISO-9001 procedures.

CERTIFIED ISO9001 MANUFACTURER NORCROSS, GA

MICROMERITICS. SETTING THE PACE WORLDWIDE

Micromeritics has more than a quarter-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 preferred equipment 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 superb 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 a world leader in supplying particle technology instruments.

INNOVATION IN MERCURY POROSIMETRY

Micromeritics' mercury porosimeters continue this tradition of market responsiveness and leadership. We developed this technology to provide fast, reliable analyses in less time. Micromeritics' commitment to automated instrumentation means lower labor costs and fewer operator errors. Our instruments' compact size and innovative design provide flexibility and features that will prove their value to you time and time again.

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

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One Micromeritics Drive, Norcross, GA 30093-1877, U.S.A.
Domestic Sales (770) 662-3633, International Sales (770) 662-3660
Customer Orders (770) 662-3636, Fax: (770) 662-3696
Internet Web Site: http://www.micromeritics.com

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