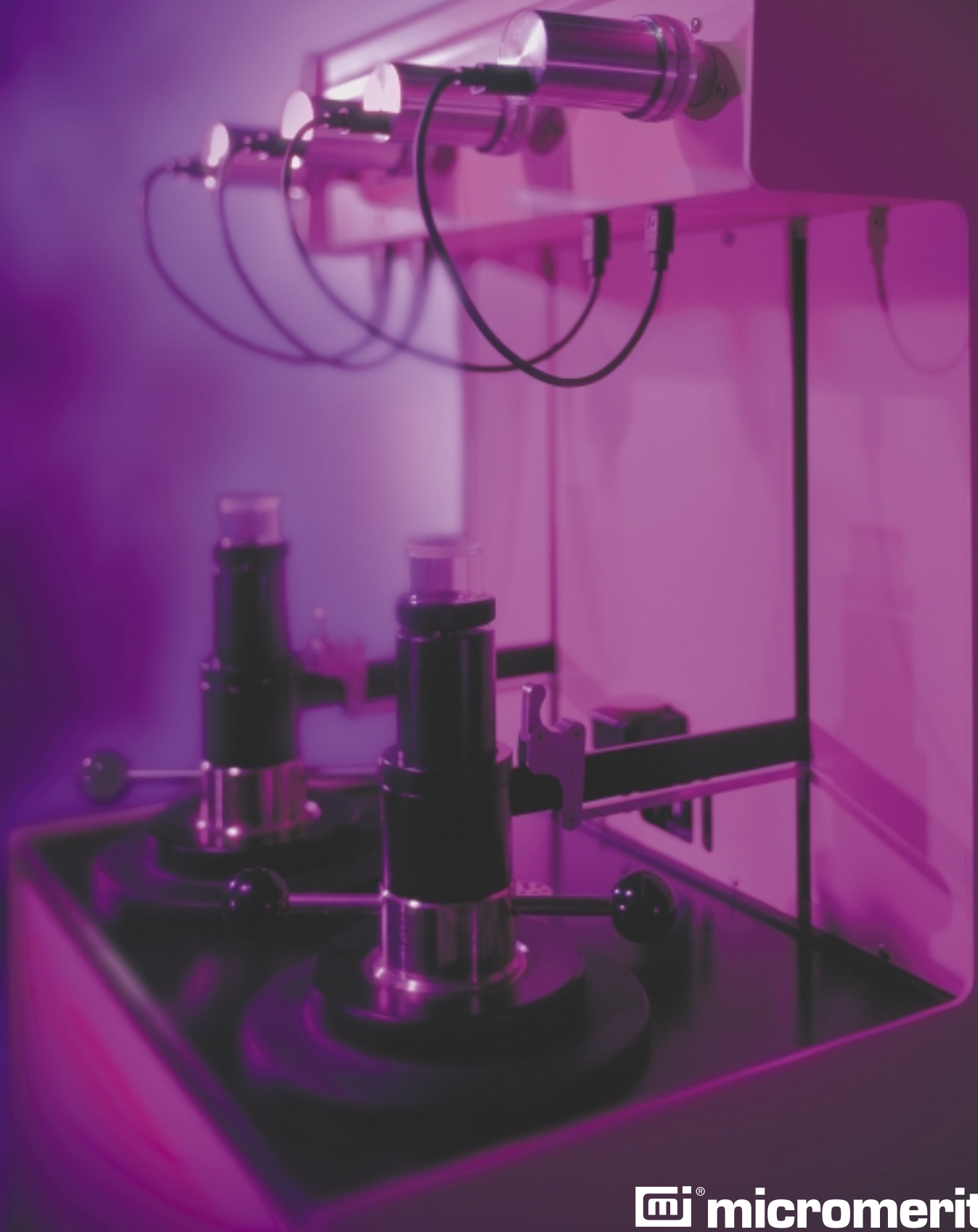


# AutoPore IV Series

---

## Automated Mercury Porosimeters



## THE COMPANY Behind the Product

### Reputation

Micromeritics has earned a reputation for manufacturing only high-quality products in the field of particle technology and for the high level of support we provide to the users of our products.

### Experience and Stability

Micromeritics has been manufacturing particle technology instrumentation for over 38 years. We have grown to be one of the world's largest manufacturers dedicated exclusively to the field of particle technology, and we continue to grow. We have a long, proud history and are well prepared for the future.

### Expertise of Staff

Micromeritics employs a staff of widely published research and applications scientists who contribute to the field of particle technology and support our users in making their own contributions. Our scientific staff includes Ph.D. and Masters level practitioners who have extensive experience in their respective fields including physical adsorption, chemical adsorption, particle sizing, and materials sciences.

### Support Network

Micromeritics has a worldwide network of over sixty direct offices and distributor offices staffed with personnel trained in applications and service support. This is our "front line" of support. Behind them is the corporate staff of Micromeritics experts. Operations, applications, and service support are available by phone, fax, and e-mail, and more likely than not, in the local language.

### High-Quality Data

Micromeritics' instruments are known for producing extremely high-quality measurements. We stand firmly behind our published specifications and will gladly demonstrate the performance of our products by way of an evaluation analysis on the sample of your choice.

### Dedication to Quality

Micromeritics is certified under the International Organization for Standardization and meets all requirements under ISO 9001 for quality management and quality assurance standards. Our instruments meet the CE requirements of the European community.

### Award-Winning Performance

Micromeritics is the recipient of numerous awards and recognition for product innovations. Not only do we have an impressive array of product awards, we also have been awarded recognition for industry support and for the exceptional quality of our operator manuals.

## Key Advantages Of Mercury Porosimetry

Mercury porosimetry can determine a broader pore size distribution more quickly and accurately than other methods. It can be used to characterize pores ranging from 0.003  $\mu\text{m}$  to 360  $\mu\text{m}$  using a single theoretical model. The data produced (mercury intrusion volume at various pressures) can be used to calculate numerous sample characteristics such as pore size distributions, total pore volume, total pore surface area, median pore diameter, and sample densities (bulk and skeletal).

## Relating Mercury Intrusion Pressure And Pore Size

Mercury porosimetry uses the Washburn equation to describe the intrusion of mercury into a porous material as a function of pressure applied to the mercury. Mercury is used because it is non-wetting and non-reactive for most solid surfaces. It also has a contact angle of about 130° for most solids and therefore requires the application of pressure before it will intrude into pores.

The AutoPore IV software allows you to enter the precise angle of contact between mercury and a solid sample surface. (For determining the exact contact angle, Micromeritics offers the Contact Anglometer Model 1501.) You can enter values for the advancing contact angle (intrusion), receding contact angle (extrusion), and mercury surface tension either before or after the analysis as need dictates.

To cause mercury to intrude sample pores, the AutoPore IV increases the pressure on the mercury inside the penetrometer (sample holder). The pressure required to force mercury into the pores of the sample is inversely proportional to the size of the pores. Only slight pressure is required to intrude mercury into large macropores, whereas much greater pressure is required to force mercury into mesopores. Clearly, the more accurate the pressure measurements, the more accurate the resulting pore size data.

To achieve accurate pressure readings and produce accurate data, the AutoPore IV combines an advanced pressure transducer system with a high-resolution analog-to-digital converter and specialized equilibration and measurement routines for data collection. In the equilibration mode, this high-resolution system provides detail-rich and accurate measurement of pressure. These data provide the basis for calculating pore volume, pore area, pore distribution, and sample density.

Alternatively, by applying the quick-scanning mode, you can have the pressure increase continuously to approximate equilibrium and provide even faster analyses with some loss of accuracy. Quality control personnel can apply this technique to check a sample for conformity to specification.



## AUTOPORE OPERATION

The AutoPore IV's low-pressure system permits linear and controllable pumpdown to prevent fluidization of fine, light powders, thus avoiding low-pressure manifold contamination. This same capability, used in reverse, also provides controlled pressurization for the purpose of acquiring precisely placed and closely spaced low-pressure data points.

The AutoPore IV Series Porosimeters are capable of reaching a target pressure to within 0.5% or less. Controlled pressure increases in increments as fine as 0.05 psia from 0.1 to 50 psia. The high-pressure generation system has been designed to reduce noise, and its manufacture is consistent with CE certification requirements.

### Choice Of Analysis & Report Parameters

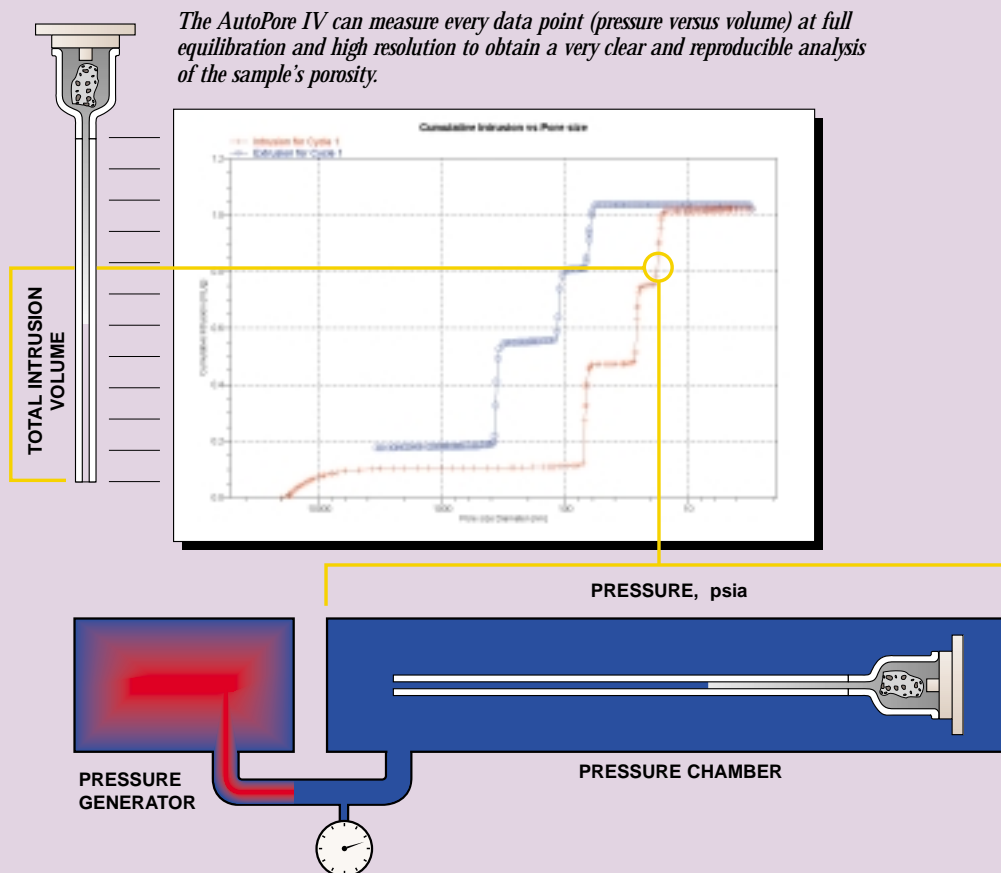
The AutoPore offers various options for obtaining important sample information as quickly as possible and for presenting the data in a format, which you can design. Analysis options include choice of analysis variables, equilibration techniques, and pressure points at which data are collected. After operating conditions for the instrument have been chosen, they

can be stored as a template and then reapplied to other samples, saving time and reducing the potential for human error.

A selection of report options lets you customize many aspects of the data pages. You can select a specific range of data to be used in calculations, arrange columns of tabular data, select cumulative, incremental, or differential plots, scale the X-axis to display in either logarithmic or linear format for pore size, report actual or interpolated data, and select data presentation units such as psia or MPa, diameter or radius, and micrometers or Angstroms.

### Data Reduction

The AutoPore IV generates tabular and graphical reports of percentage pore volume vs. diameter, and summary report of percentage porosity in user-defined size ranges. The user has the ability to average several analyses and to use the 'resulting average' analysis as a reference with which to compare subsequent analyses. A "standard," single, user-defined analysis may also be entered and used for subsequent comparisons. SPC reports are available with user-defined parameters.



In addition to the standard data reduction methods, the AutoPore IV Series also provides the following capabilities:

**Mayer-Stowe Particle Size**

Reports equivalent spherical size distributions

**Pore Tortuosity**

Characterizes the efficiency of the diffusion of fluids through a porous material

**Material Compressibility**

Quantifies the collapse or compression of the sample material

**Pore Number Fraction**

Reports the number of pores in different size classes

**Pore-throat Ratio**

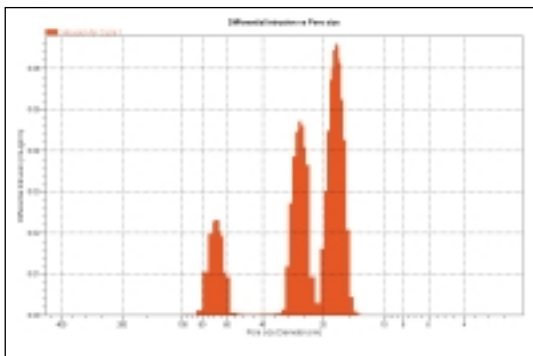
Reports the ratio of pore cavities to pore throats at each percent porosity filled value

**Pore Fractal Dimensions**

Quantifies the fractal geometry of a material

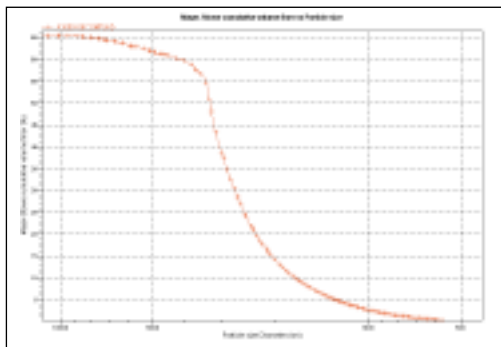
**Permeability**

Reports the ability of the sample to transmit fluid



*Distribution of pore volume by size of three different sizes of controlled pore glass.*

*The AutoPore uses the Mayer-Stowe calculation to determine particle size distribution from mercury porosimetry intrusion data.*



**Penetrometer Characteristics**

The penetrometer consists of a sample cup bonded to a metal-clad, precision-bore, glass capillary stem. The sample is placed in the sample cup; during analysis, mercury fills the cup and capillary stem. As pressure on the filled penetrometer increases, mercury intrudes into the sample's pores, beginning with those pores of largest diameter. The mercury moves in the capillary

stem like mercury in a thermometer resulting in a capacitance change between the mercury column inside the stem and the metal cladding on the outer surface of the stem. The AutoPore detects very slight changes in capacitance (equivalent to a difference of less than 0.1 microliter of mercury) so extraordinary resolution is achieved.

Micromeritics also offers a large selection of penetrometer bulbs, volumes, stems, and closures designed to fit most sample forms, shapes, porosity, and quantity. The better the match between the sample, its porosity, and the measurement range of the sample cell, the more precise the results.

**Safety Systems**

The AutoPore features several levels of mechanical and electro-mechanical safety devices. First, the computer will not accept keyboard instructions to overpressurize the system. Second, the high-pressure system is mechanically unable to generate unsafe pressures. Third, a circuit stops generating pressure in the event of a failure in the computer. And fourth, the operating specifications of the pressure systems (low = 50 psia, high = 60,000 psia) are well below actual safety limits.

**Available Models**

The AutoPore IV Series is available in four models to best match the needs of individual quality assurance and research labs. The AutoPore IV 9500 has two low- and one high-pressure chamber. The 9505 has four low- and two high-pressure chambers. Both models can reach a maximum pressure of 33,000 psia and measure pore diameters ranging from 360 to 0.005  $\mu\text{m}$ .

The AutoPore IV 9510 has two low- and one high-pressure chamber. The 9520 has four low- and two-high pressure chambers. Both of these models can reach a maximum pressure of 60,000 psia and measure pore diameters from 360 to 0.003  $\mu\text{m}$ . The lesser models can be easily upgraded to increase the maximum pressure, increase the number of sample chambers, or increase both.

**Applicable Materials**

- |                      |   |
|----------------------|---|
| Reservoir rocks      | Adsorbents                                      |
| Refractory materials | Pharmaceuticals                                 |
| Resins               | Membranes                                       |
| Pigments             | Filters   |
| Carbons              | Ceramics  |
| Catalysts            | Papers  |
| Textiles             | Fuel cell components and other porous materials |
| Leather              |   |

# S P E C I F I C A T I O N S

## Low Pressure

Measurement:	0 to 50 psia (345 kPa)
Pore Diameter:	360 to 3.6 $\mu\text{m}$

## High Pressure

Measurement:	9500 and 9505 Atmospheric to 33,000 psia (228 MPa)
	9510 and 9520 Atmospheric to 60,000 psia (414 MPa)
Pore Diameter:	9500 and 9505 6 to 0.005 $\mu\text{m}$
	9510 and 9520 6 to 0.003 $\mu\text{m}$
Transducer Accuracy:	$\pm 0.10\%$ of full scale*
Transducer Hysteresis:	$\pm 0.05\%$ of full scale* for both the 33,000 and 60,000 transducer

\* *Transducer manufacturer's specifications*

## Penetrometers

Capillary Stem Intrusion Volumes:	0.38, 1.1, 1.7, 3.1, and 3.9 $\text{cm}^3$
Intrusion Accuracy:	$\pm 1\%$ of full scale intrusion volume
Sample Size:	Maximum: a cylinder 2.5 cm diameter by 2.5 cm long (1 in. diameter by 1 in. long)

## Equilibration Techniques

By Time:	0 to 10,000 seconds
By Rate:	0 to 1000.000 $\mu\text{L/g}$ per second
By Scanning:	Continuous

## Utility Requirements

Voltage:	100/120/220/240 VAC $\pm 10\%$
Frequency:	50/60 Hz
Power:	500 VA plus vacuum pump
Gas:	Nitrogen or other clean dry gas at 50 psig (345 kPa)
Vacuum Pump:	One required; 20 $\mu\text{mHg}$ (maximum) (may be purchased from Micromeritics or supplied by the customer)

## Physical

Height:	143 cm (56.25 in.)
Width:	54.3 cm (21.38 in.)
Depth:	78 cm (30.75 in.)
Weight:	250 kg (550 lb)

## Computer Requirements

Hardware:	333 Pentium processor or equivalent, 64MB RAM, 1GB hard drive, CD-ROM drive, 800 x 600 display capability
Software:	WindowsNT <sup>®</sup> V4.00 or greater

*In keeping with a policy of ongoing product improvement, specifications are subject to change without notice.*

*Windows NT is a registered trademark of Microsoft Corp.*

## 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®**

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

[www.micromeritics.com](http://www.micromeritics.com)

01/01/01