

# Advanced Capillary Flow Porometer

Patented 2007

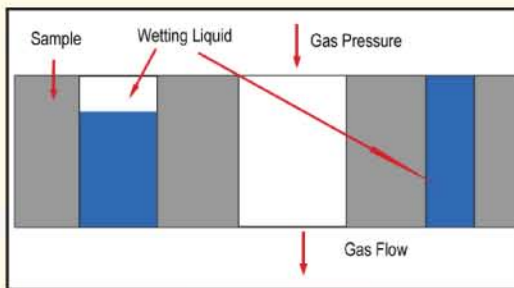
## Principles of Operation

A wetting liquid is allowed to spontaneously fill the pores in the sample and a nonreacting pressurized gas is allowed to displace the liquid from pores. The gas pressure and flow rates through wet and dry samples are accurately measured.

The gas pressure required to remove liquid from the pores and cause gas to flow is given by:

$$D = 4 \gamma \cos \theta / p$$

where  $D$  is the pore diameter,  $\gamma$  is the surface tension of liquid,  $\theta$  is the contact angle of liquid, and  $p$  is the differential gas pressure.

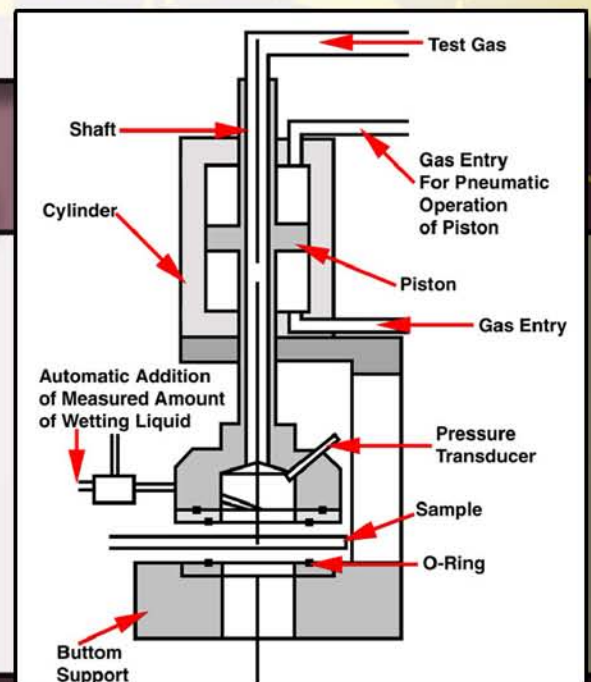


From measured gas pressure and flow rates, the pore throat diameters, pore size distribution, and gas permeability are calculated.



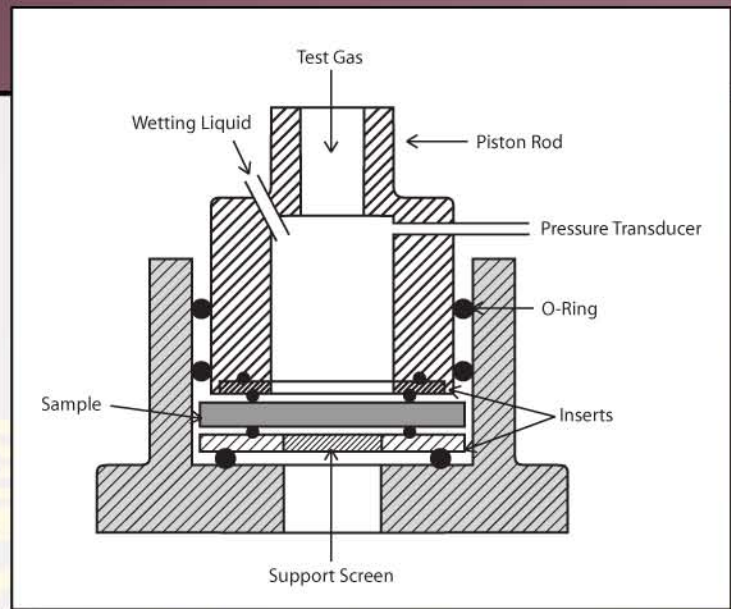
## Unique Features of the Instrument

- Turbulence free test gas is introduced through a hollow piston rod (shaft).
- Pneumatically opened piston cylinder arrangement is used to uniformly apply desired pressure on o-rings.
- The pressure transducer measures pressure close to the sample so the pressure drop correction is minimized.
- Measured amounts of wetting liquid are automatically added to the samples at the desired time during the test so that the same amount of wetting liquid is added each time.

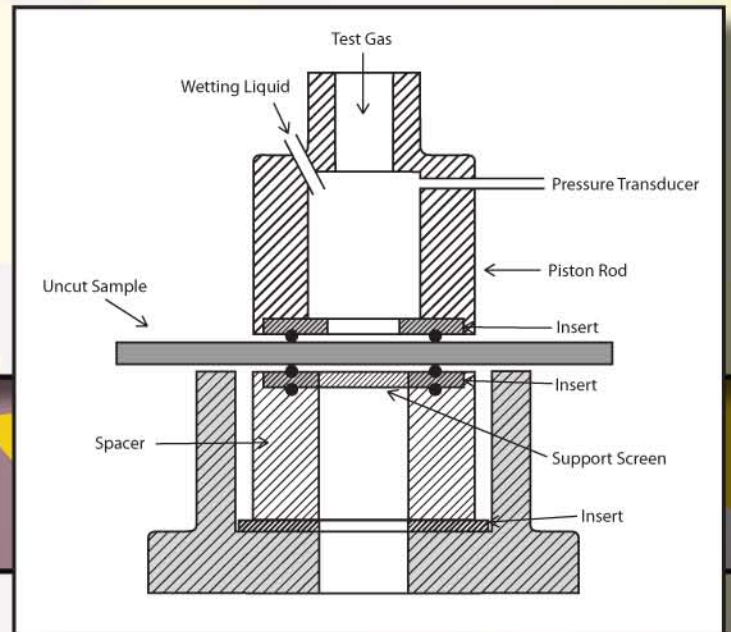


## Unique Features

- \* No need to undo the sample chamber assembly for wetting the sample.
- \* Considerable reduction in test duration.
- \* The sample is not disturbed during wetting.
- \* Exactly the same area is tested.
- \* Results are more accurate and reproducible.
- \* The sample chamber at the bottom of the piston rod contains o-rings on the outside (circumference) to prevent leak between the insert and the sample housing of the sample chamber.
- \* The sample chamber prevents sidewise leak through thick samples because of circumferential o-rings.
- \* Inserts with different opening sizes allow different size samples to be tested.
- \* The need for cutting samples for testing is eliminated with the use of spacers so that damage of the test material is eliminated and test time is further reduced.



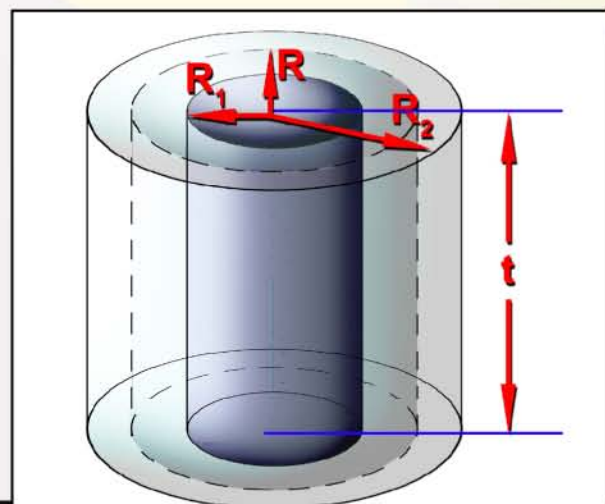
Sample Chamber



Sample Chamber with Spacer

## Features

- ⊙ Testing of small samples as well as complete parts
- ⊙ Many sample geometries (Example: sheets, rods, tubes, hollow fibers, cartridges, and powders)
- ⊙ Use of many nonwetting liquids (Example: water, alcohol, silwick, and galwick)
- ⊙ Tests in QC, research, or any number of user defined modes
- ⊙ See-through sample chamber available for visual observation of test
- ⊙ Real time graphic display
- ⊙ Window based software for all control, measurement, data collection, data reduction, and report preparation
- ⊙ Fully automated and computer controlled



Tubular Hollow Sample

## Capabilities

- Diameter of the most constricted part of a through pore (pore throat)
- Bubble Point (the largest through pore throat diameter)
- Mean flow pore diameter (50% of flow is through pores smaller than the mean flow pore)
- Pore diameter range
- Pore distribution

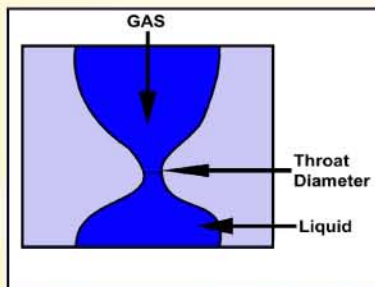
Distribution function f:

$$f = -d[(fw/fd) \times 100] / dD$$

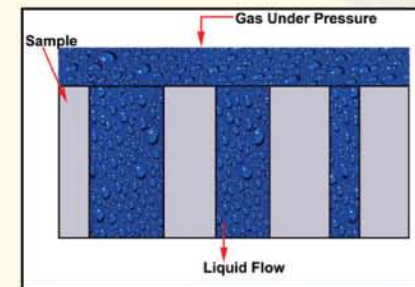
fw = flow rate through wet sample

fd = flow rate through dry sample

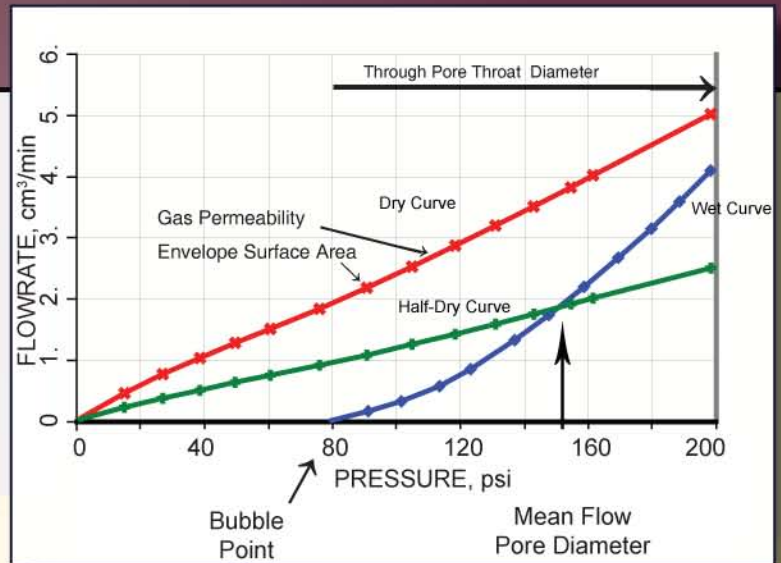
- Gas permeability in many desired units including Frazier, Gurley, Rayl, and Darcy



Pore Throat Diameter



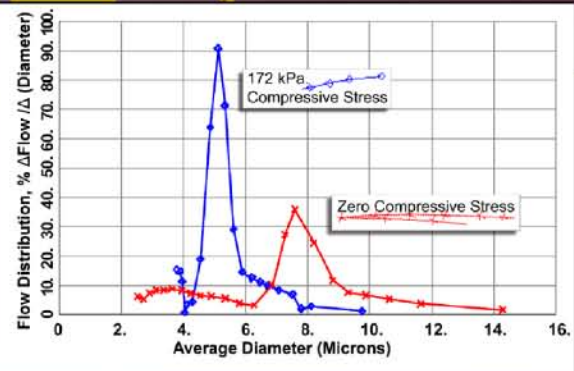
Liquid Permeability Test



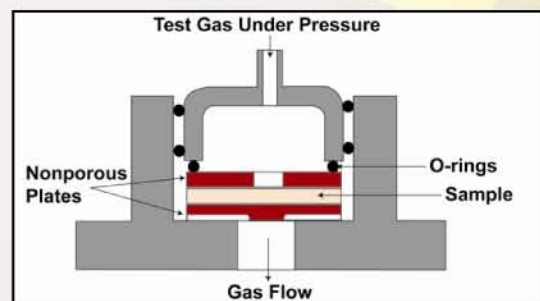
Flow through wet and dry samples with increasing differential gas pressure

## Optional Capabilities

- \* Liquid Permeability: Measures liquid flow rate through the sample when pressure is applied on excess liquid on the sample. Volume of liquid measured using a penetrometer.
- \* Pressure Hold Test
- \* Hydro-head (break through pressure) test
- \* Integrity test
- \* Envelope Surface Area, Average Particle Size, and Average Fiber Diameter obtained from gas flow rate through dry sample
- \* Multiple sample chamber
- \* Sheffield smoothness test
- \* Burst pressure test
- \* Use of strong chemicals as working fluid like KOH solution and saline solution
- \* Elevated temperature test up to 200°C
- \* Upgrades for:
  - Characterization of in-plane pores
  - Characterizing very low permeability samples
  - Sample under compression during test



Effects of Compressive Stress on Pore Distribution



In-Plane Pore Structure Measurement

## Applications

Advanced Capillary Flow Porometers yield very objective, accurate and reproducible results, considerably reduce test duration, and require minimal operator involvement. Advanced Porometers are fully automated and are designed for linear turbulence-free test gas flow. The pressure is measured close to the sample and therefore, the correction term in the differential pressure measurement is minimized. Required amount of pressure is uniformly applied on the o-ring seals on the sample and the need for hand tightening the cap on the sample chamber to apply pressure on the o-rings is eliminated. Automatic addition of wetting liquid reduces test time appreciably. This sophisticated instrument has found applications in a wide variety of industries.

## Specifications

### Pore Size Range:

0.013 - 500 microns

### Permeability Range:

$1 \times 10^{-3}$  - 50 darcies

### Sample Size:

1.75" - 2.5" diameter

### Pressure Range:

0 - 500 psi

### Pressurizing Gas:

Clean, dry, and compressed air or nonflammable and noncorrosive gas

### Pressure Transducer Range:

0 - 500 psi

### Resolution:

1 in 20,000

### Accuracy:

0.15% of reading

### Mass Flow Transducer Range:

10 cm<sup>3</sup>/min - 500,000 cm<sup>3</sup>/min

### Power Requirements:

110/120 VAC, 50/60 Hz  
(Others Available)

### Dimensions:

30" H x 19" W x 18.5" D

### Weight:

100lbs

## Other Products

Average Fiber Diameter Analyzer  
Bubble Point Tester  
Capillary Flow Porometer  
Capillary Condensation Flow Porometer  
Complete Filter Cartridge Analyzer  
Clamp-On Porometer  
Compression Porometer  
Custom Porometer  
Cyclic Compression Porometer  
Envelope Surface Area Analyzer  
Filtration Media Analyzer  
High Flow Porometer  
Integrity Analyzer

In-Plane Porometer  
Microflow Porometer  
Nanopore Flow Porometer  
QC Porometer  
Diffusion Permeameter  
Gas Permeameter  
Liquid Permeameter  
Vapor Permeameter  
Water Vapor Transmission Analyzer  
Liquid Extrusion Porosimeter  
Mercury/Nonmercury Intrusion Porosimeter  
Vacuapore  
Water Intrusion Porosimeter (Aquapore)

BET Liquisorb  
BET Sorptometer  
Gas Pycnometer  
Mercury Pycnometer

**Also Available:**  
Testing Services  
Consulting Services  
Short Courses

**Buy Rent Lease**

Porous Materials, Inc.  
20 Dutch Mill Rd, Ithaca, NY 14850 USA  
Tel: (607)-257-5544 Toll Free in USA & Canada: 1-800-TALK-PMI  
Fax: (607) 257-5639 Email: info@pmiapp.com

