THE PMI ADVANCED CAPILLARY FLOW POROMETER

PMI
Porous Materials, Inc.

Not just products...solutions.

Principle

A wetting liquid is allowed to spontaneously fill the pores in the sample and a nonreacting gas is allowed to displace liquid from the 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, γ is the surface tension of liquid, θ 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.

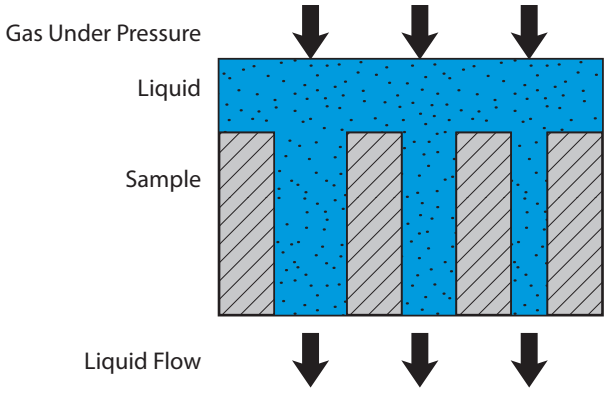

Figure 1

Principle of liquid permiability test

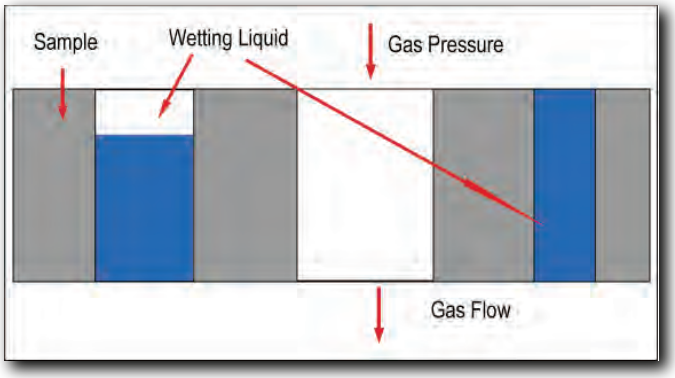

Figure 2

Basic principle behind analyzing pore structure

Application

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 turbulance-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 chamberto apply pressure on the o-ring is eliminated. Automatic addition of wetting liquid reduces test time appreciably. This sophisticated instrument has found applications in a wide variety of industries.

Unique Features & Advantages

- 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 rest so that the same amount of wetting liquid is added each time, which makes the tests **more accurate**
- Controlled Compression Experiments
- Easier to use
- **More reproducibility** - the sample never moves during the test as everything is automated
- Allows testing of flat membranes and hollow fibers

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 sideways 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

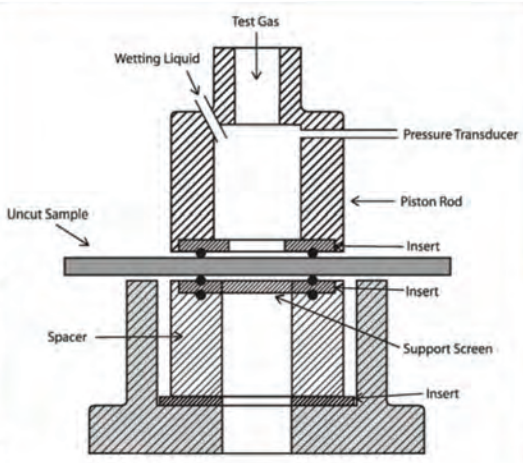

Figure 3

Sample Chamber

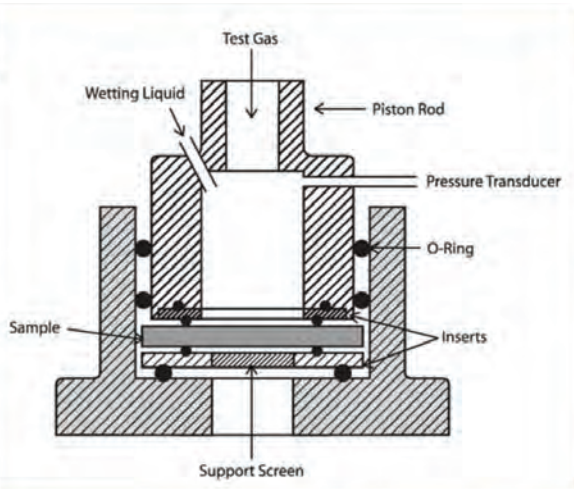

Figure 4

Sample Chamber with Spacer

Features

- Testing of small samples as well as complete parts
- Any sample geometry (Example: sheets, rods, tubes, hollow fibers, cartridges, & powders)
- Any nonwetting liquid
- Tests in QC, research, or any number of user defined modes
- See-through sample chamber for visual observation of test available
- Real time graphic display
- Window based software for all control, measurement, data collection, data reduction, and report preparation

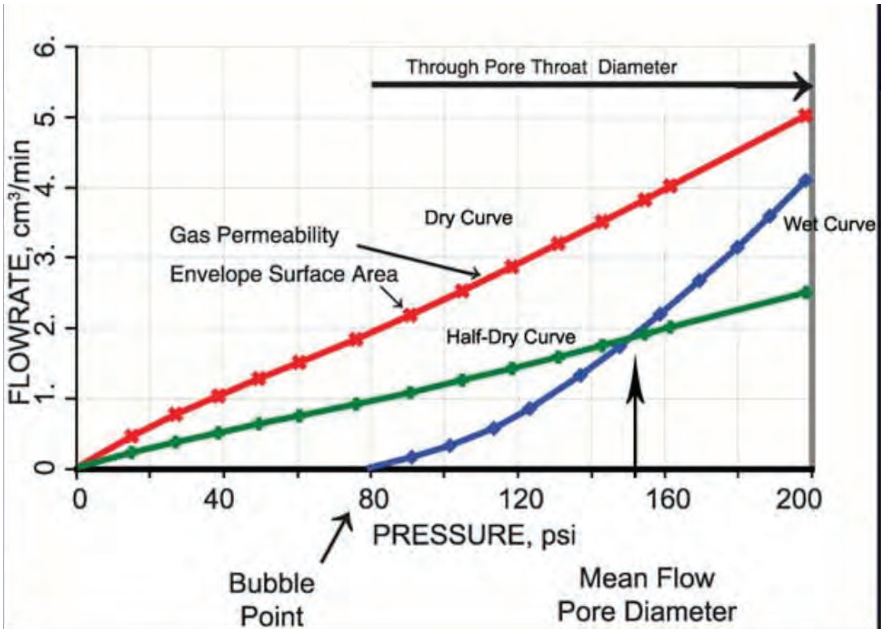

Figure 5

Flow through wet and dry samples with increasing differential gas pressure

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:

  f = -d[(fw/fd) x 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

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 pentrometer
- 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 tester
- 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

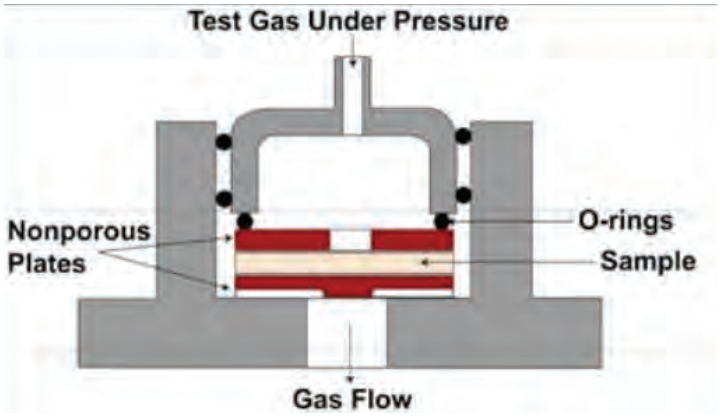

Figure 5

In-Plane Pore Structure Measurement

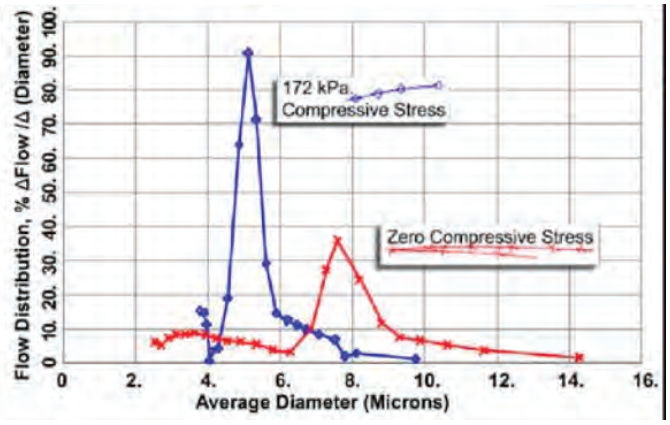

Figure 6

Effects of Compressive Stress on Pore Distribution

Specifications*

- Pore Size Range: 0.013 - 200 microns
- Permeability Range: 1 x 10^{-3} darcies
- Pressure Accuracy: 0.15% of reading
- Maximum Pressure: 500 psi
- Pressure Transducer Range: 0 - 500 psi
- Pressure & Flow Resolution: 1/60,000 of full scale (1 part in 60,000)
- Flow Rates: 200 LPM
- Sample Size: 1.75" - 2.5" diameter
- Sample Geometry: Sheets, Rods, Tubes, Hollow Fibers, Cartridges, Powders

** Other specifications for this machine are available. Specifications are subject to change without notice.*

Sales & Services

Our sales team is dedicated to helping our customers find which machine is right for their situation. We also offer custom machines for customers with unique needs. To find out what we can do for you, contact us.

We are committed to customer support including specific service products, short response times & customer specific solutions. To quickly & flexibly meet our customer's requirement, we offer a comprehensive range of services.

Customize your machine today!

Porous Materials, Inc.

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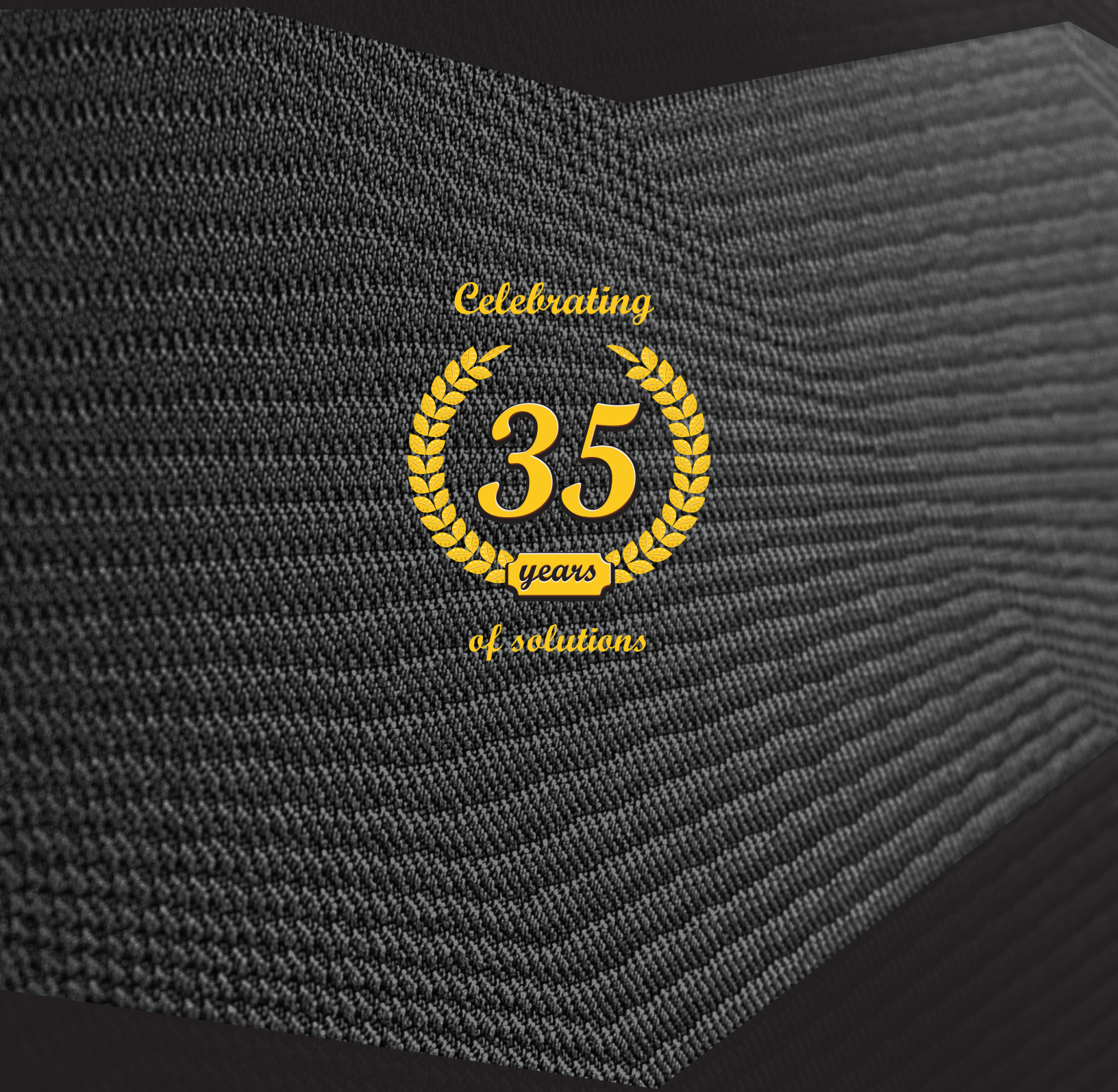
The most advanced, accurate, easy to use and reproducable porometers in the world.



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