

# THE PMI CAPILLARY FLOW POROMETER



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,  $\gamma$  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.

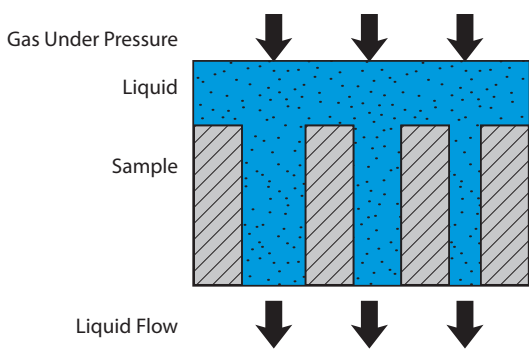


Figure 1

Principle of liquid permeability test

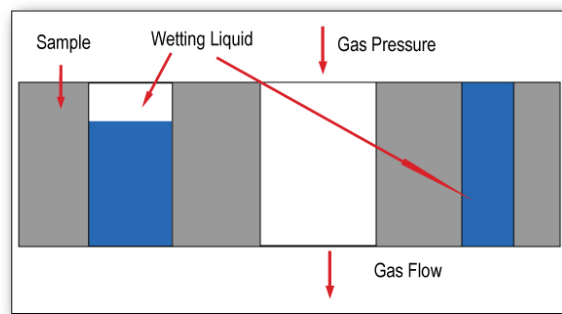


Figure 2

Basic principle behind analyzing pore structure

# Description

The PMI Capillary Flow Porometer is used for R&D and quality control in industries worldwide such as filtration, nonwovens, pharmaceutical, biotechnology, healthcare, household, food, hygienic products, fuel cell, water purification, and battery. Samples often tested include filter media, membranes paper, powders, ceramics, battery separators and health care products.

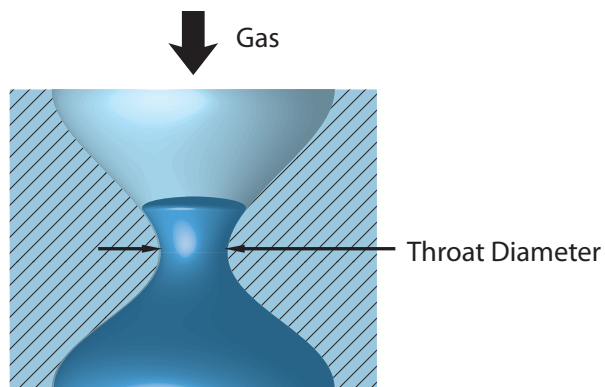


Figure 3

Typical pore analysis procedure

## 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 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-ring is eliminated. Automatic addition of wetting liquid reduces test time appreciably. This sophisticated instrument has found applications in a wide variety of industries.

## Testing Capabilities

- Diameter of the most constricted part of a through pore (pore throat)
- Mean flow pore diameter (50% of flow is through pores smaller than the mean flow pore)
- Pore diameter range)
- Pore distribution:  
 $f = -d[(f_w/f_d) \times 100] / dD$   
f<sub>w</sub> = flow rate through wet sample  
f<sub>d</sub> = flow rate through dry sample

## Optional Features

- Liquid Permeability: Measuring 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
- Multiple test mode
- Shuffled smoothness test
- Burst pressure test
- Use of desired fluid including strong chemicals
- Elevated temperature test

## Multi-Mode Instruments

- QC, Clamp-On, In-Plane, and Compression modes may be combined
- In-Plane test permits measurement of pore in the x-y plane
- In-Plane test permits insitu determination of pore diameter and structure of each layer of the multi-layer media

## PMI Software

We work closely with our customers to provide the most user friendly software for porometry. PMI Capwin software is updated to meet customer needs & requirements. The comprehensive software can be used for all PMI porometers. The software is customized to offer convenient operation with default setting for beginners & full access to all relevant measuring parameters for advanced researchers:

Component:

- Capwin manages manual instrument control, automated measuring routines ("jobs") and report print out or graph
- Capwin Data manager for interactive evaluation of measured data as well as providing sophisticated tools for creating reports & generating templates for graphs, tables & screen views
- Capwin user manager for comprehensive user management regarding user access, control & assignment of specific jobs
- On line diagnostic from anywhere in the world
- Links to data Bases ( SAP, Lims, etc.)
- User defined definitions of paths & sub directories for data filling

## 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

## Specifications\*

- Pressure Accuracy: 0.15% of reading
- Test Pressure: 100, 200, and 500 psi instrument versions (700, 1400, 3500 kPa instrument versions)
- Pressure & Flow Resolution: 1/60,000 of full scale (1 part in 60,000)
- Maximum Pore Size Detectable: 500 mm
- Minimum Pore Size Detectable: Varies with intrusion liquid (see fig. 5)
- Flow Rates: Up to 200 SLPM (liters per minute)
- Sample Sizes:
  - Standard: 0.25" - 2.5" diameter (up to 1.5" thick)
  - Standard: 5 mm - 60 mm diameter (up to 40 mm thick)
  - Others available
- Sample Geometry: Sheets, Rods, Tubes, Hollow Fibers, Cartridges, Powders

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



Fluid	Surface Tension dynes/cm	Diameter $\mu\text{m}$ (100 psi Porometer)	Diameter $\mu\text{m}$ (200 psi Porometer)	Diameter $\mu\text{m}$ (500 psi Porometer)
Water	72	0.30	0.15	0.06
Mineral Oil	34.7	0.14	0.07	0.03
Petroleum Distillate	30	0.12	0.06	0.03
Denatured Alcohol	22.3	0.09	0.05	0.02
Silwick	20.1	0.08	0.04	0.02
Porewick	16	0.07	0.03	0.014
Galwick	15.9	0.07	0.03	0.014

Figure 4

Intrusion Liquid Chart

## Specifications\*

Parameters	CFP 1100A	CFP 1200A	CFP 1300A	CFP 1500A
Standards	ASTM F3t6, others on request	ASTM F3t6, others on request	ASTM F3t6, others on request	ASTM F3t6, others on request
Measuring principle	Flow	Flow	Flow	Flow
Pore size min	0,06 microns	0,06 microns	0,06 microns	0,06 microns
Max	500 microns	500 microns	500 microns	500 microns
Pressure range	100 psi	200 psi	300 psi	500 psi
Sample size standard (1.5"/40mm thick)	0.25"-2.5' dia	0.25"-2.5' dia	0.25"-2.5' dia	0.25"-2.5' dia
	5 mm to 60 dia	5 mm to 60 dia	5 mm to 60 dia	5 mm to 60 dia
Unique Sample Chamber	On request	On request	On request	On request
Sample geometries, (optional)	Sheets, rods, tubes hollow fiber, cartridge powder etc	Sheets, rods, tubes hollow fiber, cartridge powder etc	Sheets, rods, tubes hollow fiber, cartridge powder etc	Sheets, rods, tubes hollow fiber, cartridge powder etc
Flow rate	200 SLPM, others available on request	200 SLPM, others available on request	200 SLPM, others available on request	200 SLPM, others available on request
Flow resolution	1 in 60,000	1 in 60,000	1 in 60,000	1 in 60,000
Pressure controller	Up to 4, each controller to be selected based upon application	Up to 4, each controller to be selected based upon application	Up to 4, each controller to be selected based upon application	Up to 4, each controller to be selected based upon application
Pressure sensors	Up to 4	Up to 4	Up to 4	Up to 4
Pressure regulator switch	Auto	Auto	Auto	Auto

## Special Features

- Adjustable pressure on O-rings through pneumatically controlled piston-cylinder device
- Measurement of pressure close to the sample to minimize pressure drop correction
- Straight flow path avoiding turbulence
- Versatile sample chamber for a variety of samples and test modes

## 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!*



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