



# Advanced Macro/ Micro/ Nano Porometer

MMN-1500A

*includes ability to  
perform **Gas-Liquid** and  
**Liquid-Liquid** Porometry*



*Not just products... solutions.*

## Description

The new PMI Advanced Macro-Micro-Nano Porometer combines the of the benefits of our Capillary Flow Porometer and our Liquid-Liquid Porometer conveniently into one product. The machine yields objective, accurate and reproducible results, considerably reduces test duration, and requires minimal operator involvement. Advanced Porometers are fully automated and are designed for linear turbulence-free test has flow. Trusted PMI porometers, like the Advanced Macro-Micro-Nano Porometer, have been used for R&D and quality control in many industries worldwide for over 3 decades.

## Applications

This sophisticated instrument has found applications in a wide variety of industries including (but not limited to) Chemical & Biomolecular Engineering, 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, textile, and health care products.

It is capable of measuring a wide variety of pore characteristics such as pore diameter, pore distribution and liquid flow rate. The Advanced Macro-Micro-Nano Porometer is also designed to calculate pore structure of materials having a wide spectrum of pore sizes from relatively large to relatively small (please see specifications section for further details).



# Principle

## Liquid-Liquid Porometry

A wetting liquid spontaneously fills the pores of the material. Two immiscible wetting liquids are selected. Liquid 1 with lower surface tension is used to fill the pores of the sample. Liquid 2 is added to the top of the sample and is pressurized to displace the first from the pores and flow through the empty pores. The flow rate of Liquid 2 is also measured without wetting the sample with Liquid 1. The pore diameter is related to the surface tension of the two liquids. The flow rates yield pore distribution and liquid permeability.

$$D = 4 \gamma_1 \cos \theta_1 / p$$

Where:

D = pore diameter

$\gamma_1$  = Interfacial surface tension of liquids

$\cos \theta_1$  = contact angle of liquid 1 on pore surface

p = differential pressure applied on the sample by liquid 2

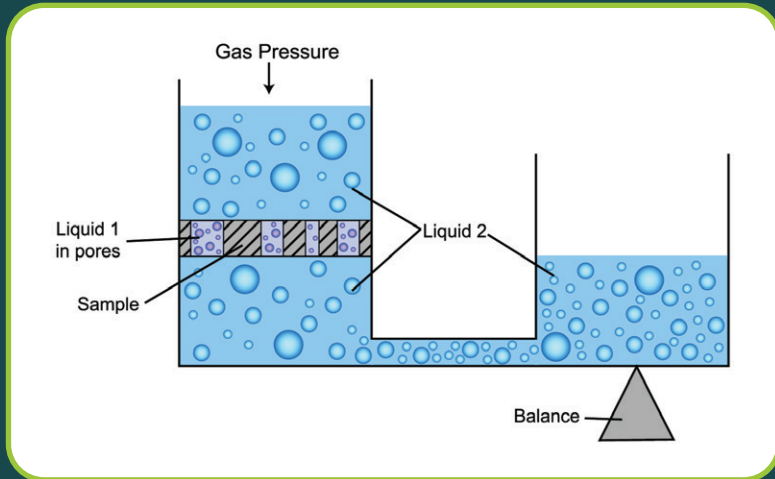


Fig. 1 Principle of Liquid Liquid Porometry

## Capillary Flow Porometry

A wetting liquid is allowed to spontaneously fill the pores in the sample and a non-reacting 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 = pore diameter,

$\gamma$  = surface tension of liquid

$\theta$  = the contact angle of liquid

p = differential gas pressure

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

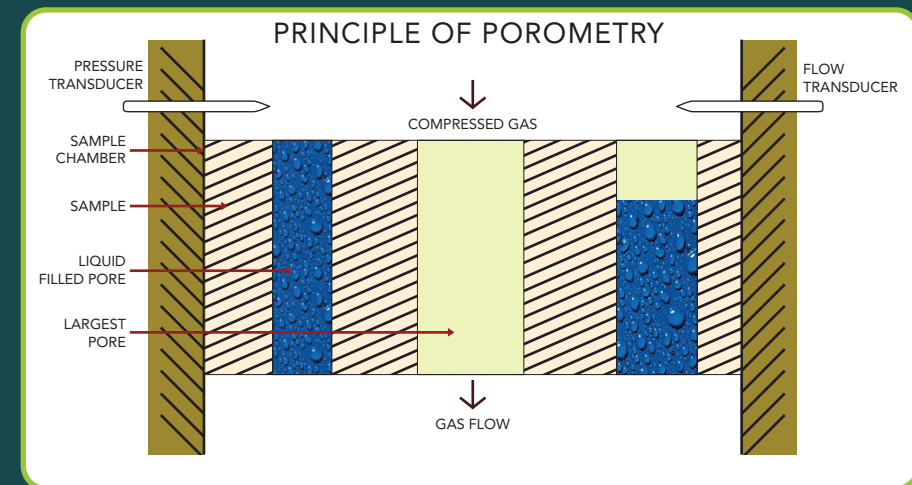


Fig. 2 Principle of Capillary Flow Porometry

## TESTING 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:

$$f = -d[(f_w/f_d) \times 100] / dD$$

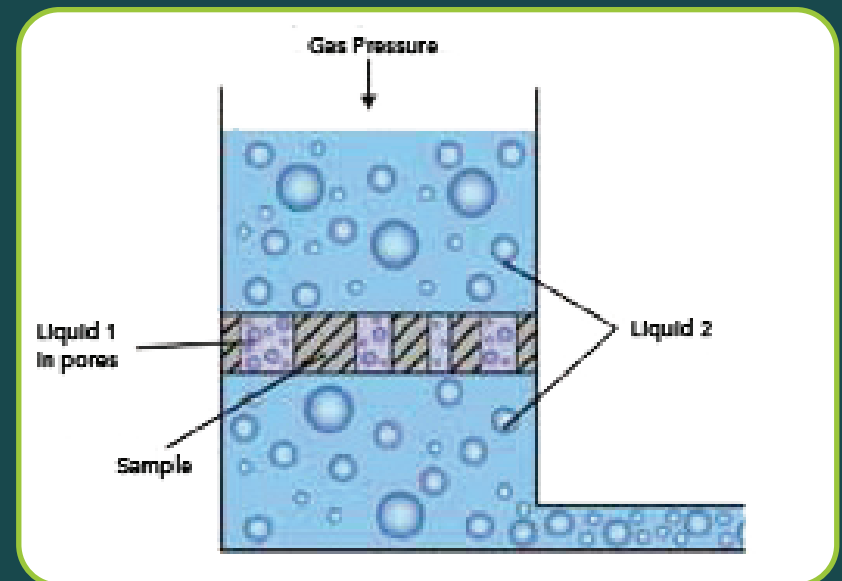
$f_w$  = flow rate through wet sample

$f_d$  = flow rate through dry sample

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

Two immiscible & saturated wetting liquids such as silwick and alcohol are taken. Pores are filled with silwick and alcohol is pressurized to displace the silwick and flow through the pores. Automatic addition of wetting liquid greatly reduces test time. The amount of liquid flowing out is measured in balance. Alcohol flow rate and differential pressure are measured. Because surface tension of silwick and alcohol are low, contact angles are taken as zero. Mean flow pore diameter and pore distribution are computed like CFP.

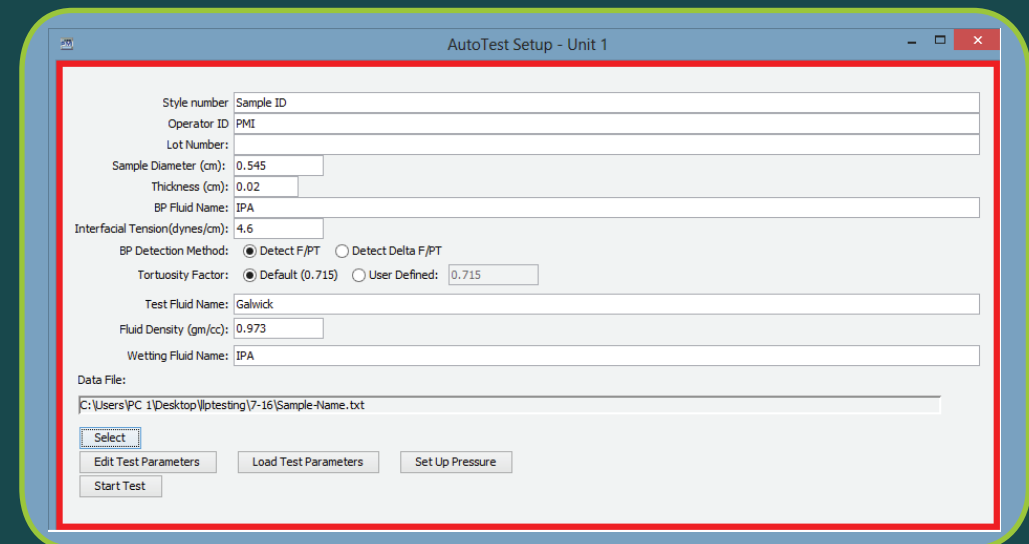
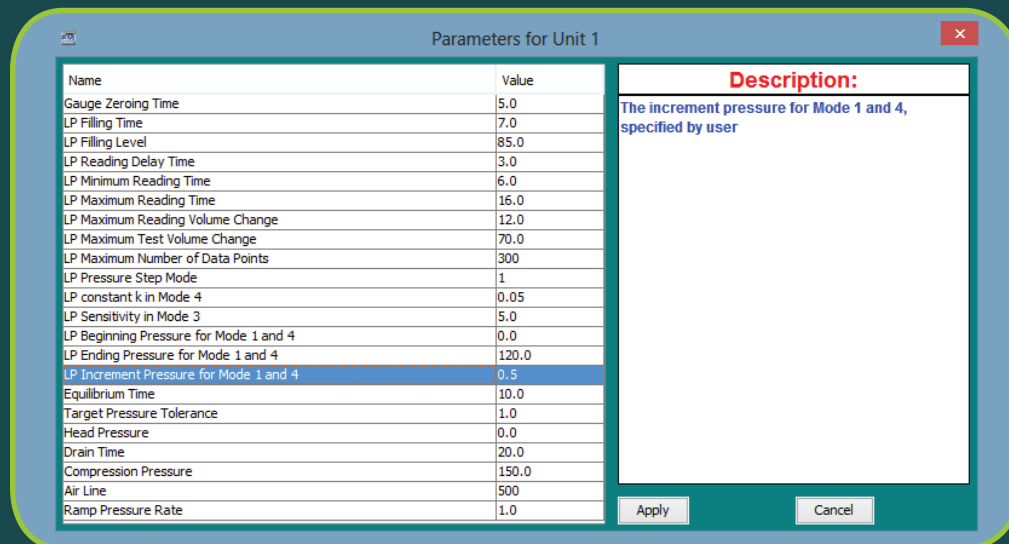
## TESTING PROCEDURE



# 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 settings for beginners and full access to all relevant measuring parameters for advanced researchers.

- Capwin manages manual instrument control, automated measuring routines 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 and screen views
- Capwin user manager for comprehensive user management regarding user access control
- Remote diagnostic from anywhere in the world
- Links to databases, outputs to: MS Excel, Text files, and other formats upon request
- User defined paths and sub directories for data filling



Capwin Software Screen



# Unique Features

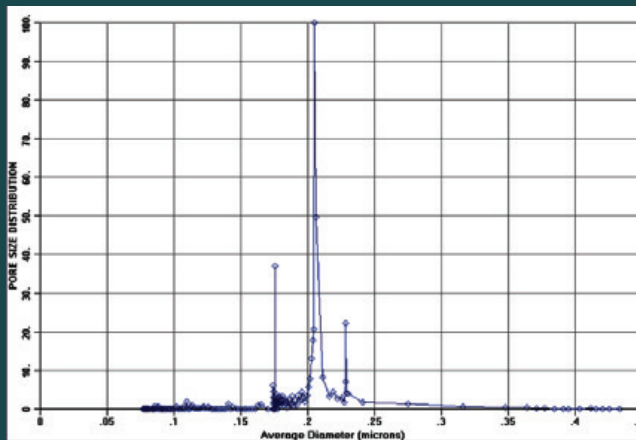
- Pore diameters down to 3 nanometers are measurable
- Application for Ultra Filtration and Nano Filtration
- Mercury Free, Non-destroy testing
- Very low liquid permeability measured
- Fully automated, user friendly operation

## TESTING REPORTS

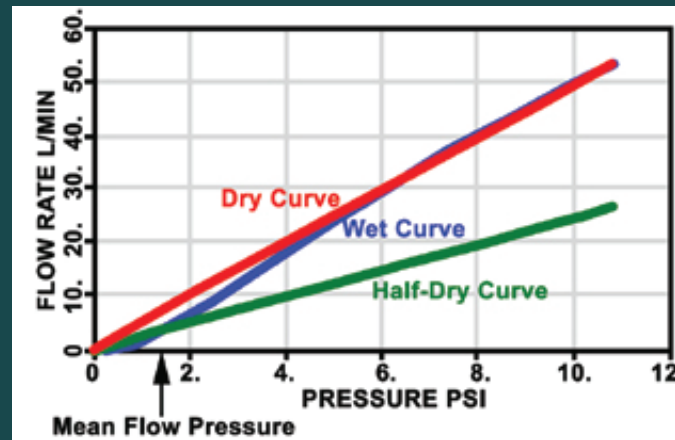
- 1) Single File Analysis
- 2) Multiple File Analysis, can graph up to 11 data sets simultaneously
- 3) Porometry Text Report and graph
- 4) Permeability Text Report and Graph (for Darcy, Gurley, Frazier, Rayl calculations)

### 5) Porometry Summary Report:

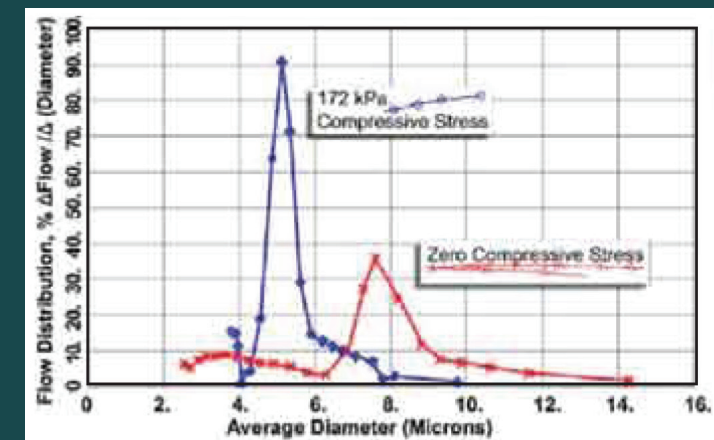
- Flow Rate vs. Pressure
- Cum. Filter Flow vs. Diameter
- Pore Size Distribution
- Pore Size Distribution vs. Diameter
- Pore Size Distribution and Cum. Filter Flow
- Frequency Distribution and Cum. Filter Flow
- Frequency Distribution (Log Scale)
- Cumulative and Differential Filter Flow



Pore size distribution vs average diameter (PTFE Membrane 0.1 um)



Wet, Dry, and Half Dry Curves



Effects of Compressive Stress on Pore Distribution

# SPECIFICATIONS

## Capillary Flow Porometer

- Pore Size Range: 3nm -1mm
- Permeability Range:  $10^{-13}$  -  $10^{-13}$  darcy
- Sample Size: 0.25" -2.5" diameter
- Pressure Range: 0 - 500 psi
- Pressurizing gas: Clean, dry, and compressed air or nonflammable, non-corrosive gas
- Pressure Transducer Range: 0 - 500 psi
- Resolution: 1 in 60,000
- Accuracy: 0.15% of reading
- Mass Flow Transducer Range: 10 cm<sup>3</sup>/minute - 200,000 cm<sup>3</sup>/minute
- Power Requirements: 110 VAC, 60 Hz (Others available)

- Pressure Range: 0 - 500 psi
- Pore Size Range: 3nm -1mm
- Resolution: 1 in 60,000
- Flow Resolution: 0.0001 cc/min
- Sample Size: 5mm - 50mm diameter thin films to 1" thick (Others Available)
- Unique Measurable Characteristics:
  1. Pore diameters down to 3 nanometers are measurable
  2. Fully automated, user friendly operation
  3. Very low liquid permeability measured
  4. Pressures needed are much less than those for Capillary Flow Porometer

## Liquid-Liquid Porometer

# SALES & SERVICE



**Customize your  
Machine Today**

We at Porous Materials Inc., have dedicated sales team helping thousand's of our customers identify the right solution for their scientific problems. We are also proud to offer customized instruments for your unique needs. Our service and applications team is committed to effective support with short response times, we offer comprehensive range of solutions from new and customized systems, calibration and maintenance to testing services. Explore more about us at [www.pmiapp.com](http://www.pmiapp.com)

The most advanced, accurate, easy to use and reproducible Porometers in the world.



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