Combined Capillary Flow Porometer/ Liquid Extrusion Porosimeter

CFP-LEP-1100A

Not just products...solutions!

Principle (Capilary Flow Porometer)

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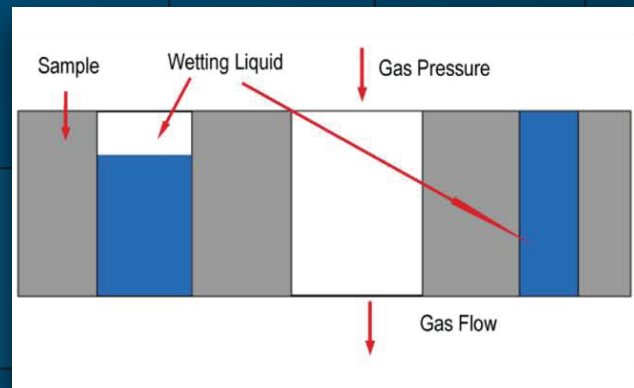
$$D = 4\gamma \cos \theta / p$$

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.

Description (Capilary Flow Porometer)

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.
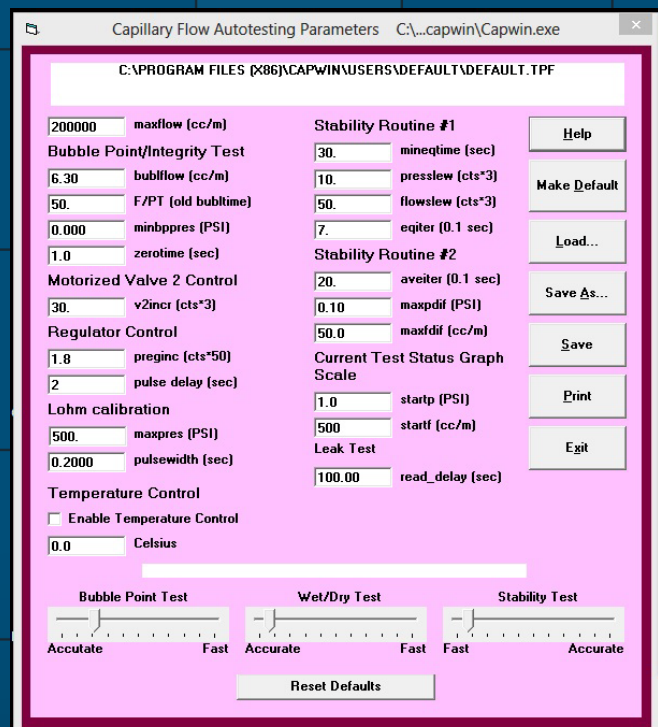
APPLICATION (Capilary Flow Porometer)

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.

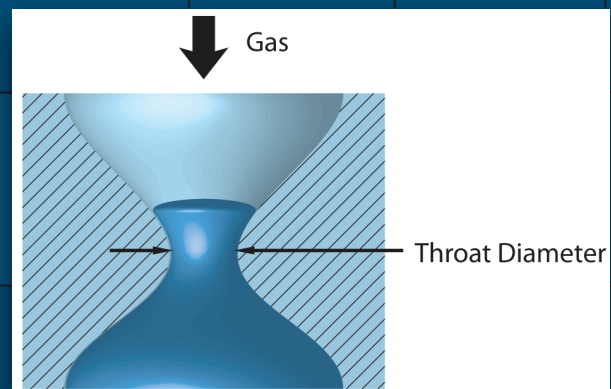# TESTING CAPABILITIES (Capilary Flow Porometer)

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:

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

fw = flow rate through wet sample
fd = flow rate through dry sample

Gas

Throat Diameter

FEATURES (Capilary Flow Porometer)

- 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
- 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
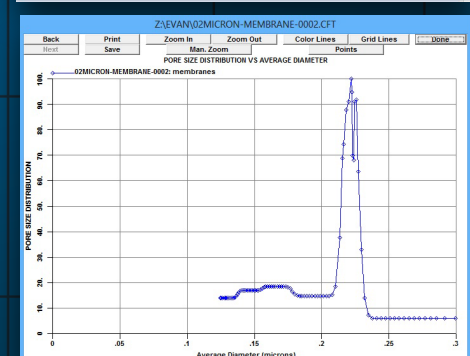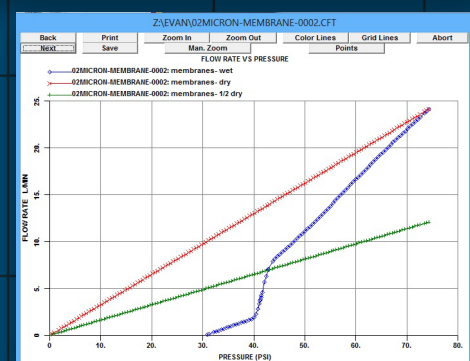
PMI Software

We work closely with our customers to provide the most user friendly software for porometery. 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 tor beginners & full access to ail relevant measuring parameters for advanced researchers:

- 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 forcreating reports & generating templates for graphs, tables & screen views

- Capwin user manager for comprehensive user management regarding useraccess, control & assignment of specific jobs

- On line diagnostic from anywhere in the world

- User defined definitions of paths & sub directories for data filling

Specification (Capilary Flow Porometer)

- *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
- *Flow Rates:* Up to 200 SLPM (liters per minute)
- *Sample Geometry:* Sheets, Rods, Tubes, Hollow Fibers, Cartridges, Powders
- *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

Fluid	Surface Tension dynes/cm	Diameter μm (100 psi Porometer)	Diameter μm (200 psi Porometer)	Diameter μm (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

DESCRIPTION (Liquid Extrusion Porosimeter)

The PMI Liquid Extrusion Porosimeter is a unique instrument with the ability to measure through–pore volume, volume distribution and liquid permeability without using mercury. The instrument is employed for characterization of porous materials used in many industries suchas biotech, pharmaceutical, filtration, food, and environment. It produces no harmful effects on personnel or environment.
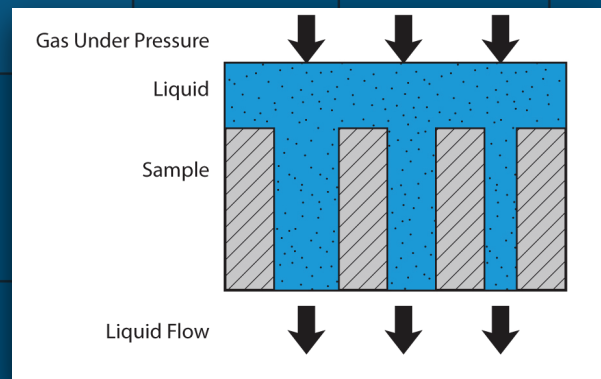

PRINCIPLE (Liquid Extrusion Porosimeter)

The sample is placed on a membrane in the sample chamber. The membrane is such that its largest pore is smaller than the smallest pore to be tested. The pores of the sample and the membrane are filled with a weting liquid. The pressure of a nonreacting gas is increased on the sample to extrude the liquid from the pores. The differential pressure, p, required to displace liquid from a pore is related to its diameter, D, surface tension of the liquid, γ, and contact angle of the liquid, θ.

$$p = 4γ \cos θ/D$$

The displaced liquid passes through the liquid–filled pores of the membrane and its volume is measured, while the liquid-filled pores of the membrane prevent the gas from passing through because of insufficient pressure. The gas pressure gives the pore diameter. The volume of displaced liquid gives the pore volume. Measurement of liquid flow rate without the membrane under the sample yields liquid permeability of the sample.
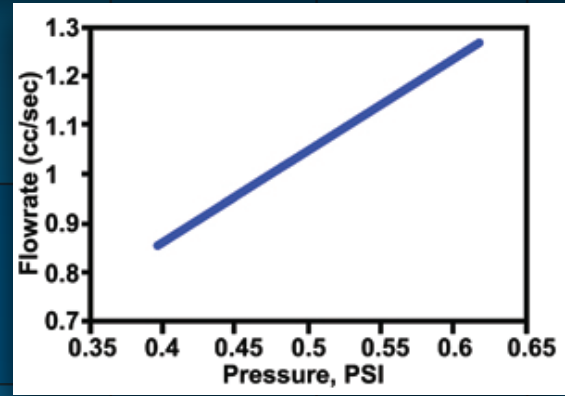

FEATURES (Liquid Extrusion Porosimeter)

- No toxic material like mercury is used.
- No health hazard and no disposal-related cost.
- Fully automated. Simple to use.
- Very little operator involvement.
- Highly reproducible & accurate.
- A wide variety of samples can be investigated.
- Pressure required almost an order of magnitude less than needed for mercury intrusion.
- Can be used for pressure sensitive materials.
- Only instrument capable of measuring through-pore volume.
- Capable of measuring very large pores (up to 1000 microns).
- Options includes measuring effects of application environment (stress, temperature, chemical environment) and liquid permeability.
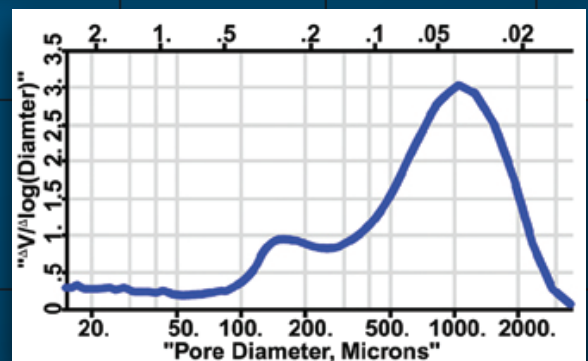
SPECIFICATION (Liquid Extrusion Porosimeter)

- Pressure Range: 0 - 100 psi (Others Available)
- Pore Size Range: 1000 µm - 1 µm
- Resolution: 1 in 20,000
- Intrusion Volume Range: 0.01cc - 10 cc
- Sample Size: .1 to 1" diameter (.1 to 1" tall) (Others Available)

SAMPLE ANALYSIS REPORT

Liquid Extrusion Porosimetry Analysis
for
ABC Company
on
29-07-2014
by
POROUS MATERIALS, INC. ANALYTICAL SERVICES DIVISION
20 DUTCH MILL ROAD
ITHACA, NY 14850 USA
PHONE (607)-257-5544 or 1-800-TALK-PMI

File:	\\Fileserver1\abdata\LEP\ABC Company\Sample 2_001i-mc-c.cst
Sample ID:	2 adv (piece 2)
Operator:	TLM
Lot Number:	9421
PMI Test Number:	T901
Purchase Order Number:	NA

Sample Weight =	4.2472 g
Bulk Density =	0.9606 g/cc
Liquid =	Galwick
Liquid Extrusion Contact Angle =	0 Degrees
Liquid Extrusion Surface Tension =	16 Dynes/cm

Cumulative pore volume in cc/g of sample
% total pore volume = % of total cumulative pore volume belonging to pores of diameter > D
Average pressure = square root of P(I)*P(I-1)
Pore size distribution function is equal to dV/dlog P
Surface area assumes cylindrical pores

Pressure PSIA	Pore Diameter Microns	Cumulative Pore Vol. cc/g	%Porosity Pore Vol. PSIA	% of total Pressure dlogP	Average ----- m2/g	dV ----- Surf. area	Cumulative
0.007	1325.5128	0		0	0.007	0.051	0
0.008	1159.8078	0.0029	0.282	0.729	0.007	0.053	0
0.009	1030.9658	0.0057	0.545	1.408	0.008	0.059	0
0.01	927.7021	0.0084	0.804	2.079	0.009	0.074	0
0.014	656.2053	0.0195	1.872	4.841	0.012	0.109	0.0001
0.02	463.8572	0.0359	3.444	8.904	0.017	0.187	0.0002
0.03	309.2659	0.0688	6.61	17.09	0.024	0.335	0.0006
0.04	231.9506	0.1107	10.633	27.489	0.035	0.514	0.0012
0.05	185.5433	0.1605	15.422	39.871	0.045	0.662	0.0021
0.06	154.6203	0.213	20.46	52.896	0.055	0.707	0.0034
0.07	132.5505	0.2603	25.005	64.646	0.065	0.648	0.0047
0.08	115.9868	0.2979	28.617	73.982	0.075	0.557	0.0059
0.09	103.0863	0.3264	31.355	81.061	0.085	0.481	0.007
0.1	92.7802	0.3484	33.467	86.522	0.095	0.412	0.0079
0.11	84.3504	0.3654	35.103	90.752	0.105	0.324	0.0086
0.12	77.3277	0.3777	36.278	93.789	0.115	0.219	0.0092
0.13	71.3713	0.3853	37.009	95.679	0.125	0.132	0.0096
0.14	66.2753	0.3895	37.417	96.732	0.135	0.073	0.0099
0.15	61.8567	0.3917	37.626	97.273	0.145	0.043	0.01
0.2	46.3921	0.3971	38.144	98.613	0.173	0.04	0.0104
0.22	42.1755	0.3987	38.303	99.023	0.21	0.047	0.0106
0.24	38.6615	0.4005	38.474	99.465	0.23	0.062	0.0108
0.26	35.6869	0.4027	38.681	100	0.25	0	0.011

Summary Sheet
for
ABC Company
on
16-02-2005

File:	\\Fileserver1\abdata\LEP\ABC Company\Sample 2_001i-mc-c.cst
Sample ID:	2 adv (piece 2)
Operator:	TLM
Lot Number:	9421
PMI Test Number:	T901
Purchase Order Number:	NA

Total intrusion volume =	0.4027 cc/g
Total % Porosity =	38.6807
Total Surf. area =	0.011 m2/g
Median Pore Diameter (Based on Volume) =	161.4953 Microns
Median Pore Diameter (Based on Surface Area) =	121.746 Microns
Standard Deviation (Based on Volume) =	64.8597 Microns
Standard Deviation (Based on Surface Area) =	45.6799 Microns
Average Pore Diameter (4V/S) =	146.6221 Microns
Diameter of maximum value of dV/dlogD =	154.6203

Input Test Variables

- [ ] Record Time Points [ ] Volume vs. Time Test [ ] Liquid Permeability [ ] Vacuum   Number of Repeats
- [ ] Initial Saturation [✓] Desaturation (normal test) [ ] Resaturation (hysteresis) 1

Sample Name:	Blank
Lot Number:	N/A
Run Number:	1
Operator:	jls

Mass of Sample: 1 g Density of Sample: 1 g/cc

File Name
C:\USERS\PMI\DESKTOP\BLANKS\LEP-BLANK-OPEN-008.PDT

Current Group: DEFAULT
Parameter File: C:\USERS\PMI\DESKTOP\LEP 1.5.18\DEFAULT\CSPARAM.INI

Change Group   Change Parameter File

Start Test   Cancel   [ ] Pause at end of test

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.

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Celebrating

35

years

of solutions

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Phone: 607-257-5544 Fax: 607-257-5639

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