Permeameters

Porous Materials, Inc.

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PMI
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Applications

Permeameters measure:

- Liquid Permeability
- Gas Permeability
- Microflow Permeability
- Diffusion Permeability
- Water Vapor Permeability

Permeameters are used in many industries such as chemical, biotech, pharmaceutical, food, beverage, fuel cells, batteries, and pollution control. Materials tested in permeameters include membranes, ceramics, filter media, sintered metal filters, hydrogels, paper, textiles, battery separators, powder beds, and pen tips.

Principle

Permeameters measure fluid flow rates. The measured flow rates are expressed in liters per minute (LPM) or any other required unit. Flow rate is often used to compute permeability defined by Darcy's law:

$$(k/\mu) = \underline{F} / [A (\Delta p //)]$$

The flow at average pressure ($\underline{F}$) per unit area (A) of the sample per unit pressure gradient ($\Delta p // $) across the sample is defined as the ratio of permeability (k) of the sample and viscosity (μ) of the fluid. The cgs unit of permeability is cm^2. Permeability is often given in terms of Darcy, Frazier, Gurley, or Rayle.

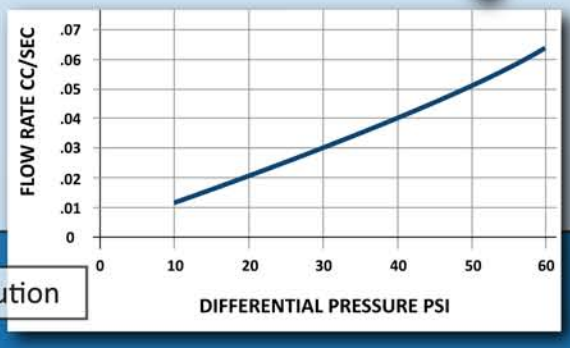
Liquid Permeameter

Instrument:
Liquid from a penetrometer tube is forced through the sample. The differential pressure on the liquid and the flow rate of the liquid are measured. Pressure is measured by a pressure transducer and liquid flow is measured by the penetrometer.

The fully automated instrument executes tests, and acquires, stores and displays data in the desired unit. Windows based operation of the instrument is simple.

Optional Features:

- Permeability of strong chemicals
- Multiple sample chambers for high volume testing
- Measurement at high pressures
- Measurement at elevated temperatures
- Permeability through sample under compression



Permeability of KOH solution

Microflow Liquid Permeameters

A Microflow liquid permeameter uses a programmable microbalance to accurately measure volume of a very small amount of liquid that may permeate through the sample.

Gas Permeameters

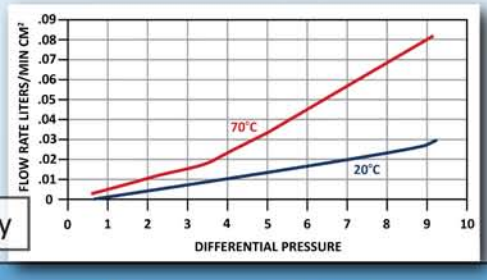
Instrument:

Gas under pressure is forced through the sample. The differential pressure and the flow rate of the gas are measured with pressure and flow transducers.

The fully automated instrument executes tests, acquires, stores and displays data in the desired unit. Windows based operation of the instrument is simple.

Optional Features:

- Permeability of a wide variety of gases
- Multiple sample chambers for high volume testing
- Measurement at high pressures
- Measurement at elevated temperatures
- Permeability through sample under compression



Effect of Temperature on Permeability

Envelope Surface Area, Average Particle Size & Average Fiber Diameter from Gas Permeability

Flow rate and different pressure measured in a gas permeameter is used to compute envelope surface area with the help of the Kozeny-Carman equation. Average particle size of particular samples is computed from envelope surface area. The average fiber diameter can also be computed using differential gas pressure and gas flow rate with the help of Davies equation.

Microflow Gas Permeameters

Instrument:

Gas permeameters cannot measure gas flow rate accuarately when the flow rate through the sample is low. Such samples can be examined by microflow permeameters. In these instruments, gas is brought to the inlet side of the sample at a known pressure and the increase in pressure on the outlet side is measured. The gas flow rate F at STP is computed from the following relation:

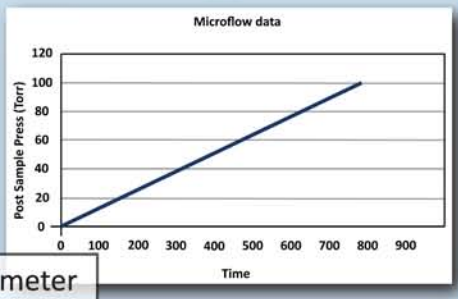
$$F = (V/p_s)\,(dp/dt)$$

Where V is volume of the outlet chamber, p_S is the standard pressure, (dp/dt) is the rate of pressure increase in the outlet chamber, and the test temperature is the same as the standard temperature.

The instrument is fully automated, and can include many optional features.

Optional Features:

- Microflow permeametry can be part of capillary flow porometry
- Measurement at elevated temperatures
- Measurement while sample is under compressive stress



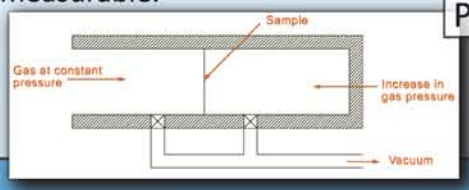
Data from microflow permeameter

Diffusion Permeameter

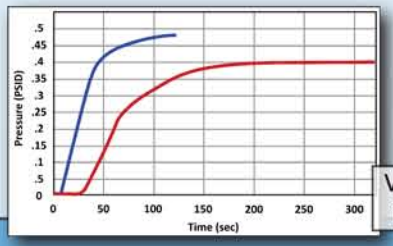
Instrument:

A Diffusion Permeameter can be used to measure gas permeability. The sample chamber of the instrument is first evacuated. Gas is then maintained at a constant pressure in the inlet side and the increase in pressure in the outlet side is measured. Flow rates are computed as in a Microflow Permeameter.

The instrument is fully automated. Because of evacuation, the instrument is capable of yielding very accurate results and the permeability of a variety of gases, including water vapor, is measurable. Flow rates as low as 10^{-4} cm^3/s are measurable.



Principle



Variation of pressure with time in the diffusion permeameter

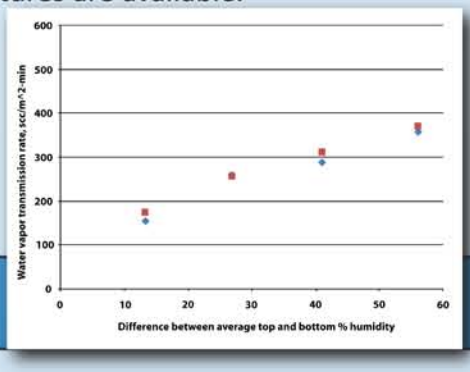
Water Vapor Transmission Analyzer

Instrument:

Two gas streams with well defined humidity flow over the two sides of the sample at specific test temperature and pressure. From measured flow rates and humidity of incoming and outgoing gases on each side, water vapor transmission rate is computed. Normally measurements are made at controlled temperature, atmospheric pressure and an imposed humidity gradually. A range of temperatures are available.

Other Features:

- Transfer under total pressure gradient
- Transfer under temperature gradient
- Transfer under temperature, pressure & humidity gradient



Gas Diffusion Analyzer

Instrument:

Two streams of gas flow on the two sides of a sample. The desired gas concentration is maintained on one side. Differential gas pressure is kept close to zero. The concentration of the gas at the inlet and the outlet on the two sides are measured using RGA. The gas transfer rate is computed from the flow rates and the concentrations of the gas.

- Flow Ability to create a wide range of testing conditions, including:
  - » Rate/Residence Time
  - » Static or Dynamic Pressure Gradients
  - » Static or Dynamic Temperature Gradients
- Versatile & User-Friendly software for:
  - » Fully Automated Tests
  - » Manual Control of all System Components
  - » Data Collection, Storage, Analysis, & Reporting
  - » Customized Testing Parameters
- Applicable for Wide variety of Sheet-like materials
- High Measurement speed, stability, & resolution
- Interchangeability of System Components

Carbon dioxide tranmission rate through a fabric

Temperature ° C	Humidity %	Concentration Difference %	Transmission Rate scc/cm^2-min
24.3	45	1.77	0.138