THE PMI AUTOMATED SINGLE SAMPLE PULSE DECAY PERMEAMETER/POROSIMETER

APP-10K-A

PMI
Porous Materials, Inc.

Not just products...solutions.

Permeameter Principle

The PMI Advanced Single Sample Pulse Decay Permeameter/Porosimeter is used to measure gas permeability of samples such as oil well cores, tight gas sandstones and other very low permeability rock. The system creates a differential pressure across the core and monitors the resulting pressure decay over time using the unsteady state method. PMI software utilizes this data along with known system volumes to calculate permeability.

Description

The rock core sample is loaded in a holder and confining pressure is applied. The system is then charged with test gas to the desired pore pressure. Adequate time is given to allow this pressure to fully saturate the sample. After reaching equilibrium the upstream and downstream portions of the system are isolated from each other. A pulse is then created by raising the upstream pressure (or lowering the downstream pressure). Data is recorded throughout this process and is used in conjunction with known system volumes to calculate gas flow rates and permeability.

The rock core sample is loaded in a holder and confining pressure is applied. The system is then charged with test gas to the desired pore pressure. Adequate time is given to allow this pressure to fully saturate the sample. After reaching equilibrium the upstream and downstream portions of the system are isolated from each other. A pulse is then created by raising the upstream pressure (or lowering the downstream pressure). Data is recorded throughout this process and is used in conjunction with known system volumes to calculate gas flow rates and permeability.

The equipment is fully automated. Execution of the test, data acquisition, data storage and data management are all carried out by PMI Software. Operator involvement is minimal, and the instrument is robust and requires a minimal amount of care.

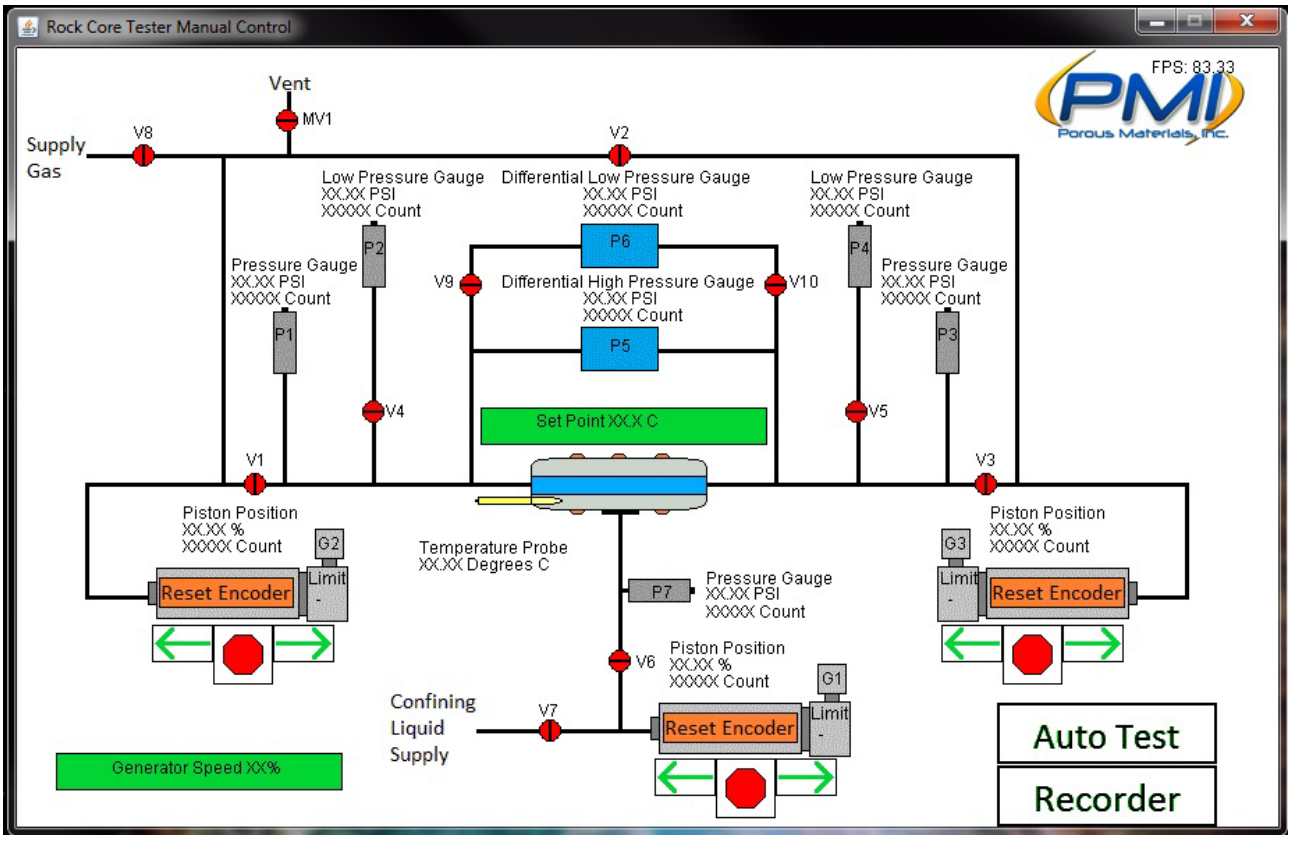
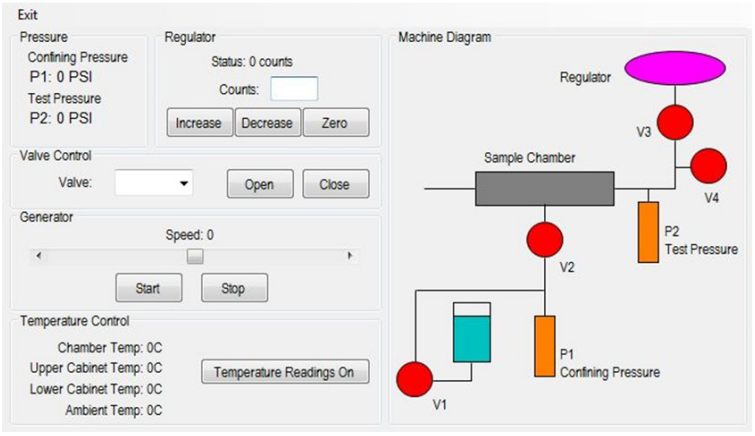
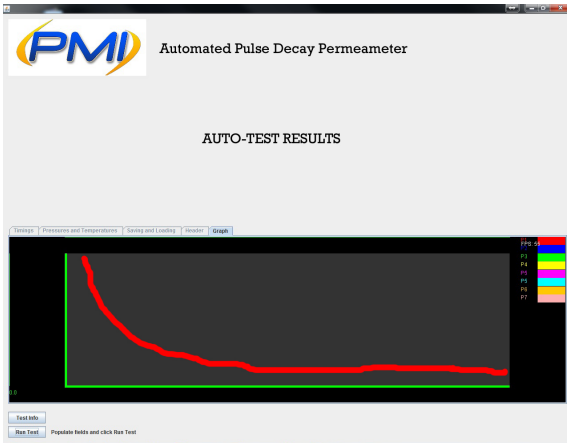


Figure 1

Permeameter Application

Industries worldwide utilize PMI Permeameters like the PMI Advanced Single Sample Pulse Decay Permeameter/ Porosimeter for research and development and quality control. Uses Boyles Law and software calculation of Klinkenberg. Applicable industries include: Oil refineries, Oil and gas exploration, Geotechnical, Geophysics, Automotive and Battery development.





Scope and Application

In order to characterize and develop a reservoir/ field it is essential to assess the porous space of the reservoir rock and also to understand the flow behavior of the fluids within the porous space of the rock (porosity). The flow behavior of the reservoir fluids is characterized as the permeability of the rock. Determination of this basic property comes under routine core analysis and the air/gas Permeameter is used to measure the permeability of 1.0 and 1.5 inch sized core samples with suitable lengths at variable confining pressures and ambient conditions.

Pulse Decay Permeability Results

5/23/2014 12:00:00 AM

Sample Details

Sample ID:	1 micron membrane
Lot Number:	01
Sample Diameter(cm):	1.91
Sample Length(cm):	0.002
Upstream Volume(m^3):	0.000025741

Test Parameters

Confining Pressure(PSI):	2000
Test Pressure(PSI):	84.6

Permeability Results

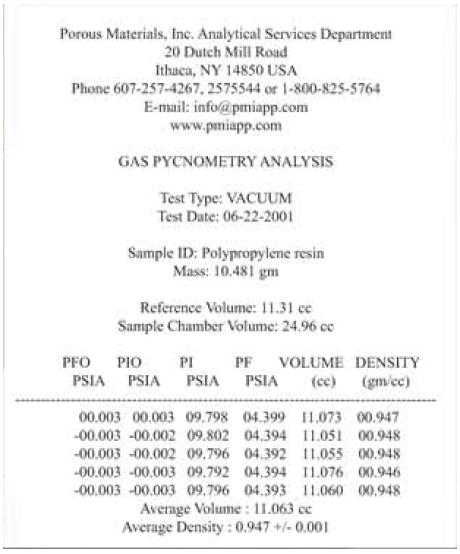
Differential Pressure	Darcies	Millidarcies	Microdarcies	Nanodarcies
67.71087	1.78675E-06	0.001786748	1.786747979	1786.747979
67.38454	1.73685E-06	0.001736855	1.736854588	1736.854588
67.06737	1.69608E-06	0.001696085	1.696084765	1696.084765
66.75937	1.65465E-06	0.001654646	1.654646458	1654.646458
66.4587	1.62258E-06	0.001622576	1.622575757	1622.575757
66.16537	1.58998E-06	0.001589983	1.589982938	1589.982938
65.8702	1.60713E-06	0.001607126	1.607126123	1607.126123
Average Darcies:	**1.61793E-06**	**0.001617926**	**1.617925648**	**1617.925648**

Porosimeter Application

The PMI Helium porosimeter measures the direct grain volume and pore volume at isothermal conditions. Grain density and porosity are directly measured.

Operating Procedure

PMI's Advanced Gas Porosimeter is fully automatic, provides high-speed, high-precision volume measurements and density calculations. The instrument uses Helium drawn into a reference volume, and is stabilized at around 100psi. Core samples are held in a matrix cup and isolated by valves, then helium is expanded into the sample chamber. When the pressure stabilizes, the pressure is recorded. Sample grain volume is determined using comparison to calibration disks of a known volume.



Porous Materials, Inc. Analytical Services Department
20 Dutch Mill Road
Ithaca, NY 14850 USA
Phone 607-257-4267, 2575544 or 1-800-825-5764
E-mail: info@pmiapp.com
www.pmiapp.com

GAS PYCNOMETRY ANALYSIS

Test Type: VACUUM
Test Date: 06-22-2001

Sample ID: Polypropylene resin
Mass: 10.481 gm

Reference Volume: 11.31 cc
Sample Chamber Volume: 24.96 cc

PFO PSIA	PIO PSIA	PI PSIA	PF PSIA	VOLUME (cc)	DENSITY (gm/cc)
00.003	00.003	09.798	04.399	11.073	00.947
-00.003	-00.002	09.802	04.394	11.051	00.948
-00.003	-00.002	09.796	04.392	11.055	00.948
-00.003	-00.003	09.792	04.394	11.076	00.946
-00.003	-00.003	09.796	04.393	11.060	00.948

Average Volume : 11.063 cc
Average Density : 0.947 +/- 0.001

Description

A rock sample is held in the sample chamber and compressive stress is applied. While the sample is under compressive stress, the desired properties are measured. The PMI Automated Porosimeter System has been specially designed for testing core samples. Core samples are held in a sleeve which (pneumatic or hydraulic) compresses the sample. The instrument the test, data acquisition, data storage, & data measures the loss of a known amount of gas to computer porosity. The equipment is fully automated. Execution of management are all carried out by PMI software. Operator involvement is minimal, and the instrument is robust and requires a minimal amount of care.

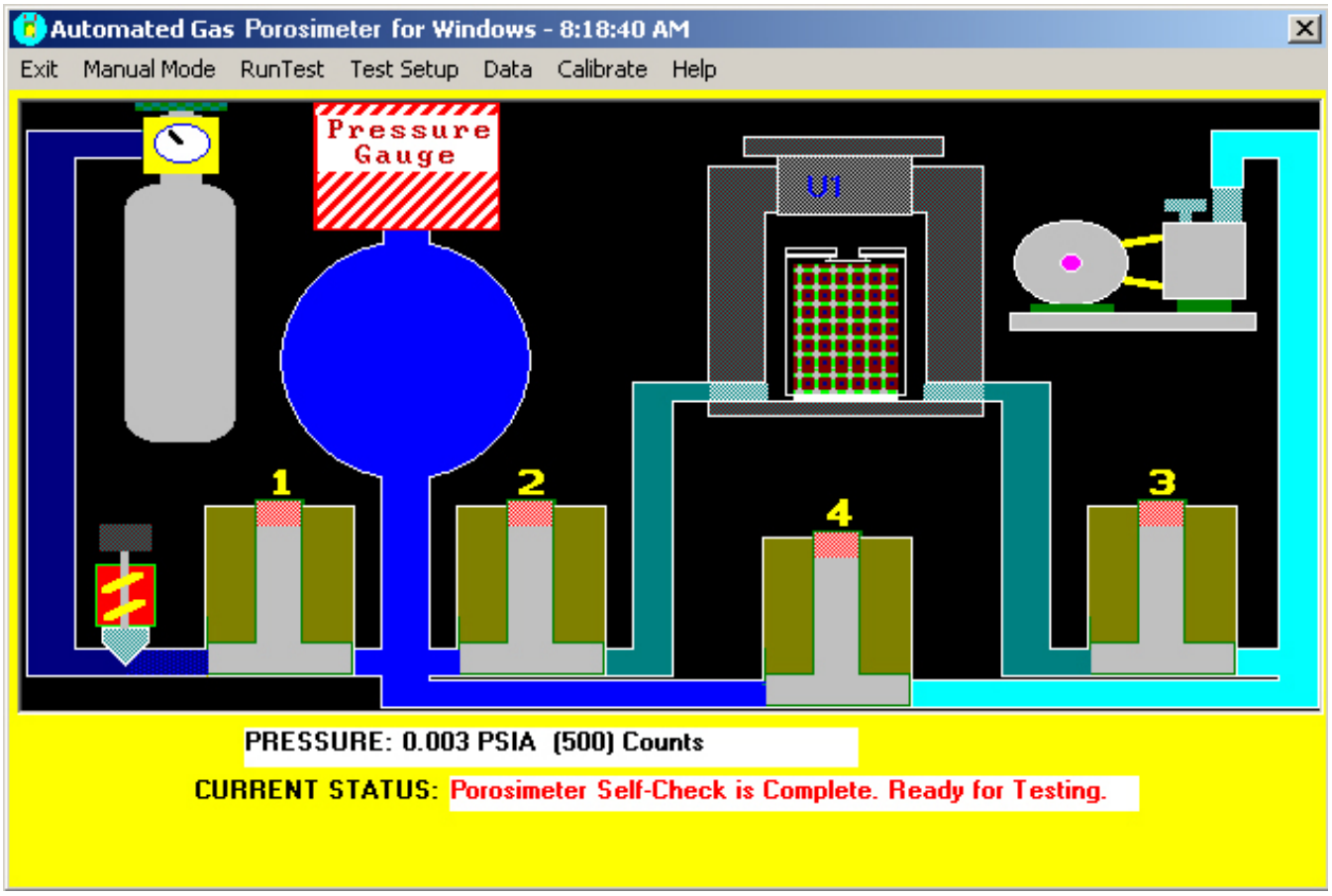


Figure 2

Features

A. Gas/ Helium Porosimeter

- Gas porosimeter allows to determine grain volume, bulk volume and porosity of core plugs of diameter 1 inch and 1.5 inch under ambient conditions and reservoir stress conditions.
- It is a self-sufficient, computer controlled unit inclusive of matrix cup for grain volume determination, reference cell, core holder, tubing, valves, digital read out devices, transducers, gauges and regulators etc.
- Core holder permit to change the core plugs without dismantling the core holder and facilitate routine analysis of large number of samples in succession.
- Equipment be supplied along with standard calibration check plugs to calibrate the equipment at different stage of time covering the entire range.
- The instrument is computer based and capable of performing automatic data acquisition analysis, processing so as to give following parameters:
    1) Pore volume
    2) Grain volume
    3) Grain density
    4) Bulk volume
    5) Porosity at ambient and under reservoir conditions.
    6) Overburden Pressure up to 5000 psi
- System offered duly coupled with suitable PC controller consisting of operating software, application software, hard copy printer, color monitor and a laser color printer.
- All wetted parts are made of corrosion resistant material and full system is rust proof.

B. Air/ Gas Permeameter

- The Gas Permeameter allow to determine gas permeability, slip factor and Klinkenberg corrected permeability of core samples to be based on unsteady state pressure drop method.
- Self-sufficient, computer controlled unit inclusive of core holder for 1.0 inch and 1.5 inch diameter samples, tubings, valves, digital readout devices, upstream and downstream pressure transducers, gauges and regulators etc.
- Quick change of sample plug facilitating analysis of many samples.
- Standard check plugs covering entire range.
- All the wetted and non-wetted parts are corrosion resistant.

C. Control and data processing system for both units

- The system function and operations are controlled through a user friendly compatible computer system of latest version. The configuration of the system are including all necessary interfaces for smooth functioning of total systems. The system hardware and software with following minimum facilities:
    - *Data porting:* The system have necessary interfaces so as to exchange data and communicate with the main unit.
    - *Data acquisition & processing system :* The system have necessary hardware and software to control and analyze the acquired data so as to provide final results using Boyle's law. TFT color monitor, Intel core i7 processor or above with minimum 500 GB HDD, 4 GB RAM, High resolution graphic card and a DVD RW and a Laser color printer.
    - *Software:* Latest window base operating software as well as Licensed version.

Technincal Parameters

A. Environmental Conditions:

- Terrain: To be used in laboratory
- Temperature Range: Ambient/ Room temperature(15 - 50º Celsius)
- Relative humidity: upto 90% without condensation

B. Power Supply :

220±10 V AC, 50 HZ, Single Phase

B. Duty Conditions:

Able to work for a minimum of approx. 24 hrs. continuously for the experimental jobs on determination of porosity and permeability of core samples.

Essential accessories

Core holder: Hassler type to facilitate quick change of sample plugs. Core holder capable of withholding confining pressure of up to 5000 psi, Material is of stainless steel SS 316. Able to accommodate 1.0 inch and 1.5 inch core plugs and length up to 3.125 inch. Supplied complete and self-sufficient including plug end face with multiple flow ports, connectors, tubing, etc.
Matrix cup: Matrix cup is capable to accommodate 1"and 1.5"diameter and length up to 3.125 inch.
Rubber sleeves: Rubber sleeves suitable for 1 inch and 1.5 inch (approx. 50 each) core plugs and length up to 3.125 inch. Sleeves are made up of viton rubber. The quality of sleeves is capable to withstand the pressure up to 5000 psi.

Specifications for Permeameter/Porosimeter

Porosity in % or in fraction terms : 0.0 to 40.0% (Accuracy=0.02% of true value)
Sample size : 1.0 inch and 1.5 inch diameter core plugs and length up to 3.125 inch
Gas supply : Compressed Air/ Nitrogen/ Helium will be supplied by an external source. However, devices for filtering and drying up of gases are installed with equipment being offered.
Core Holder : Hassler type of core samples of 1.0 inch and 1.5 inch diameter for grain volume/ pore volume measurement.
Confining Pressure : Up to 5000 psi with a suitable pressure transducer be provided for measuring the pressure up to 5000 psi.
Pressure Transducers :
Range : 0 to 5000 Psi or compatible to the equipment
Accuracy : 0.5% or better
Air Permeability Range : 0.001 to 10,000 mD
Confining Pressure range : Upto 5000 psi
Core Plug : Diameter 1.0 inch & 1.5 inch
Core Plug : Length Upto 3.125 inch or more
Check Plugs : Set of Permeability plugs of 1.0 inch and 1.5 inch diameter covering entire range.
Core holder for permeability to air determination : Quick release Hassler core holder to accommodate 1.0”and 1.5” diameter core samples and capable to deliver confining pressure up to 5000 psi.
Software and data acquisition system : The data acquisition and control software are user friendly customized software operating on windows OS and allow the direct measurement of Permeability & Klinkenberg permeability. Licensed version of operation software, TFT color monitor, Intel core i7 processor or above with minimum 500 GB HDD, 4 GB RAM, High resolution graphic card and a DVD RW, Laser color printer.
Digital Caliper Least count 0.01 mm.

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

PMI
Porous Materials, Inc.

20 Dutch Mill Rd, Ithaca, NY 14850, USA
Toll Free (US & Canada): 1-800-TALK-PMI (1-800-825-5764)
Phone: 607-257-5544 Fax: 607-257-5639

Email: info@pmiapp.com www.pmiapp.com