

Mercury Porosimeters Pascal Series

Pascal mercury porosimeters consist of three modules that can be combined to produce the complete porosity spectrum of a large variety of porous materials and powders. Samples can be investigated in a wide pore or particle size ranges. All operations related to the sample preparation and large porosity studies are carried out automatically by the Pascal 140. Characterization proceeds with the high pressure modules, Pascal 240 and 440, down to lower limits of pore size.



Many solid and powder materials both natural (stones, soils, minerals, etc.) and manufactured (catalysts, cement, pharmaceuticals, metal oxides, ceramics, carbons, zeolites, etc.) contain a certain void volume of empty space. This is distributed within the solid mass in the form of pores, cavities, and cracks of various shapes and sizes. The total sum of these void volumes is called porosity.

The type and nature of porosity in natural materials depend on their genesis (for instance rocks can be of igneous, sedimentary or metamorphic origin) while in man-made materials depend on their manufacturing and generally it can be controlled. Porosity strongly determines important physical properties of materials such as durability, mechanical strength,

permeability, adsorption properties, etc. The knowledge of pore structure is an important step in characterizing materials, predicting their behavior under different environmental conditions. The Pascal Series mercury porosimeters are the ultimate solution provided by Thermo Electron to characterize automatically and quickly a wide range of materials.

Available Pascal models

PASCAL MODEL	140	140 W ULTRA MACRO	240	440
Functions	Automatic degassing, mercury filling, low pressure porosimetry	Automatic degassing, mercury filling, ultra low pressure porosimetry	High pressure porosimetry up to 200 Mpa	High pressure porosimetry up to 400 Mpa

PRESSURE DETECTION

Measuring range	0.01 to 0.1 Kpa 0.1 to 400 Kpa	0.01 to 0.1 Kpa 0.1 to 400 Mpa	0.1 to 200 Mpa	0.1 to 400 Kpa
Transducer resolution	0.01 up to 0.1 Kpa 0.1 up to 400 Kpa	0.01 up to 0.1 Kpa 0.1 up to 400 Kpa	0.01 up to 100 Mpa 0.1 up to 200 Mpa	0.01 up to 100 Mpa 0.1 up to 400 Mpa
Accuracy	Better than 0.25%	Better than 0.25%	Better than 0.2%	Better than 0.2%

MEASURING RANGES

Pore size (diameter) (*)	116 - 3.8 μ	900 - 3.8 μ	15 - 0.0074 μ	15 - 0.0036 μ
Particle size (diameter) (**)	330 - 15 μ	3,000 - 15 μ	40 - 0.015 μ	40 - 0.01 μ

VOLUME DETECTION	140		140 W ULTRA MACRO	240		440
Available dilatometer	CD3/CD3P	CD6/CD6P	(in addition) S-CD6	CD3/CD3P	CD6/CD6P	CD3/CD3P
Volume detection system	Capacitive	Capacitive	Capacitive	Capacitive	Capacitive	Capacitive
Accuracy	Better 1% FS	Better 1% FS	Better 1% FS	Better 1% FS	Better 1% FS	Better 1% FS
Internal volume	15 cc	35 cc	50 cc	15 cc	35 cc	15 cc
Max. sample size for solid materials (d x h)	12x40 mm	25x25 mm	25x25 mm	12x40 mm	25x25 mm	12x40 mm
Max. detection volume	0.5 cc	2 cc	2 cc	0.5 cc	2 cc	0.5 cc
Volume resolution	0.0001 cc	0.0005 cc	0.0005 cc	0.0001 cc	0.0005 cc	0.0001 cc

ANALYTICAL PARAMETERS
PASCAL SERIES POROSIMETERS

Max. number of points	2500 each module
Pressurization (***)	Automatically volume/pressure equilibration by P.A.S.C.A.L. system or Continuous Scanning
Available pressurization speed ranges	1 to 9 intrusion / 1 to 9 extrusion - independent selection
Instrument control	By computer and control panel
Computer connection	Serial RS232 port, maximum 4 instruments connectable to the same computer

PHYSICAL	PASCAL 140	PASCAL 240 AND 440
Weight	55 kg	68 kg
Power supply	110/130-220/240 V, 405-385 VA, 50/60 Hz	110/130-220/240 V, 110 VA, 50/60 Hz
Dimensions (w x d x h)	40 x 67 x 85 cm	40 x 67 x 85 cm
Environment	15-35 °C, 30-85 % RH	15-35 °C, 30-85 % RH

(*) Pore size range calculated using contact angle = 141.3, Hg surface tension = 480 N/cm. Maximum pore size diameter is strongly dependant on the sample nature, on the mercury purity and on the real contact angle between mercury and the material under test. Maximum and minimum allowed values are here reported

(**) Particle size range calculated using Kp factor = 4.65. Maximum particle size diameter is strongly dependant on the sample nature, on the mercury purity and on the real contact angle between mercury and the material under test. Maximum and minimum allowed values are here reported

(***) PASCAL= Pressurization by Automatic Speedup with Continuous Adjustment Logic

Software specifications

Designed for Microsoft Windows 2000/XP.

Features

Automatic blank correction, automatic sample volume correction, automatic mercury density calculation and correction, up to 20 customizable report formats, unit choice selection (micron, nanometer angstrom, mm³/g, cc/g).

Available calculations

Total pore volume, percentage porosity, specific surface area (4 models, cylindrical, conical, spherical, plate), bulk (envelope) density calculated from vacuum up to 400 Kpa, apparent density measured at maximum pressure, pores size distribution (tabular format with automatic or customized ranges), particle size distribution (tabular format with automatic or customized ranges)

Graphs

Intruded volume vs pressure, cumulative pore volume vs pore size, derivative dV/dR (or dV/dlogR) vs pore size, percentage histograms vs pore size, particle percentage histograms vs particle size.

Reporting

Report can be customized and memorized. Reporting on printer or in electronic format (Excel, text, etc.) for further reprocessing. All raw or corrected data can be printed or exported.

Safety certifications

All Pascal models are CE certified by external certification institute according to electromagnetic compatibility and safety (CEI EN 61010-1:1994, EN 61010-1:1993 according to EEC Directive no. 73/23 modified by EEC Directive no. 93/68). In addition the high pressure models Pascal 240 and 440 are certified according to the Pressure Equipment Directive (97/23/CE – PED).

Pascal accessories

Mercury filling device

It is designed to prepare two samples simultaneously before the high pressure analysis when a Pascal 140 unit is not available or not necessary. The Filling Device allows to degas two samples under vacuum at the same time and to fill the dilatometers with mercury. It accepts the dilatometers CD3, CD3P, CD6 and CD6P. The unit must be connected to a suitable vacuum pump which is not included (optionally available).

Cleaning kit for used mercury

It is a special kit which allows recycling the used mercury after the experiment, until the metal is completely oxidized (process which is normally very slow if some care is used to keep mercury far from contact with air). The only possible treatments to remove the oxide are chemical cleaning with acids or distillation under vacuum, operations which cannot be performed by the cleaning kit. In this last case it is necessary to contact specialized companies.

The main operations allowed by the cleaning kit are the following:

- separation between mercury and solid samples by means of filtration and slow decantation
- contaminated samples disposal in a suitable sealed container
- mercury cleaning from dielectric oil
- Storage of cleaned mercury in a suitable sealed container

The kit also includes some useful tools to collect mercury if accidental spillage has occurred and a special detergent to remove any trace of dielectric oil or silicon grease from the disassembled dilatometer.

The kit encloses an instruction manual in English.

Calibration kit for mercury porosimeters

It is a complete kit to periodically verify the calibration of the capacitive volume detection. It can be used with all the porosimeters of the Pascal series. The kit also includes two useful extraction pistons to open the dilatometers when they occasionally stick under pressure and an instruction manual in English.





Certified reference materials for Pascal validation

The Pascal users can now test and certify their high pressure porosimeters by analyzing these samples regularly. The standards permit to check the proper calibration of both the volume and the pressure measured by the instruments. Every package contains the certified sample and the complete instructions to analyze the samples properly. Please refer to the following table for the proper choice of standard. The reference materials can be chosen according to the customer's sample properties in terms of pore size and pore volume, as the three materials cover a wide range of pore volume and pore size.

CERTIFIED REFERENCE MATERIAL	SPECIFIC PORE VOLUME AT 200 MPA (mm ³ /g)	AVERAGE PORE WIDTH D ₅₀ (nm)	MOST FREQUENT PORE WIDTH (nm)	QUANTITY (g)	PENETRATION PRESSURE RANGE (MPa)
PM 120 (α Allumina)	546.8	228.0	232.2	15	5 – 10
PM 121 Glass Beads I	621.9	15.1	15.3	12	85 – 125
PM 122 Glass Beads II	922.6	139.0	140.2	10	8 - 15