

GAS DISPLACEMENT
PYCNOMETRY SYSTEM

ACCUPYC II 1345





ACCUPYC II

GAS DISPLACEMENT PYCNOMETRY SYSTEM

Gas pycnometry is recognized as one of the most reliable techniques for obtaining true, absolute, skeletal, and apparent volume and density. This technique is non-destructive as it uses the gas displacement method to measure volume. Inert gases, such as helium or nitrogen, are used as the displacement medium. Density calculations using the gas displacement method are much more accurate and reproducible than the traditional Archimedes water displacement method.

The AccuPyc II 1345 Series Pycnometers are fast, fully automatic pycnometers that provide high-speed, high-precision volume measurements and true density calculations on a wide variety of powders, solids, and slurries. After analyses are started with a few keystrokes, data are collected, calculations are performed, and results displayed. A minimal amount of operator attention is required.

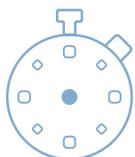
BENEFITS



Maintain product integrity with this non-destructive test



Adapt instrument configuration to meet your sample size needs



Maximize your results with superior speed of analysis, accuracy, repeatability, and reproducibility



Eliminate error with programmable automatic repeat and data acquisition set to your tolerances to comply with your SOPs



Minimize cost and space requirements - low maintenance and small footprint



Operate with either a keypad or Windows® software



Use a variety of gases



Increase efficiency and compliance with barcoding compatibility



Eliminate procedural steps with direct input from an analytical balance

MORE INSTRUMENTS, IN MORE COUNTRIES



APPLICATIONS

Application	Discussion	Reference
Powder Metallurgy	Results of many intermediate and final processing steps are controlled by or related to skeletal density of the metal. In addition, the performance of many sintered or cast metal structures may be predicted from the skeletal density of the starting metal powder.	ASTM B923
Refractory Materials	True density is a useful value for: classification, detecting differences in chemical composition between supposedly similar samples, indicating mineralogical phases or phase changes, calculating total porosity when the bulk density is known, and for any other test method that requires this value for the calculation of results.	ASTM C604
Calcined Petroleum Coke	The density of calcined petroleum coke directly influences the physical and chemical properties of the manufactured carbon and graphite artifacts for which it is used. Density, therefore, is a major quality specification of calcined petroleum coke and is used as a control in coke calcination.	ASTM D2638
Soil	The specific gravity of soils that contain extraneous matter (such as cement, lime, etc.) or water-soluble material (such as salt) must be corrected because of the precipitate that forms on the specimen after drying. If the precipitate has a specific gravity less than the parent soil grains, the uncorrected test result will be too low. If the precipitate has a higher specific gravity, then the uncorrected test value will be too high.	ASTM D5550
Powder Coatings	Total solids content can be used to determine minimum coverage obtainable with different coating blends. Mixtures of dry pigments can be monitored by comparing measured density with theoretical density based upon composition of the mixture.	ASTM D5965
Clear or Pigmented Coatings	Dried film density can be used in the determination of Volatile Organic Compound (VOC) content of clear and pigmented coatings. VOC is required by government regulations.	ASTM D6093
Rigid Cellular Plastics	Plastic foams exhibit different properties based upon the ratio of open and closed cells. Insulation foams limit thermal conductivity through pockets of trapped gases contained within closed cells. Flotation devices owe buoyancy to closed air-filled cells that prohibit water entry.	ASTM D6226
Pharmaceuticals	Composition of active and excipient ingredients can be monitored and controlled through determination of product density. Polymorphic, hydrated, and amorphous forms of products, as well as purity, can be determined by comparing measured density with theoretical and historical values.	USP 699

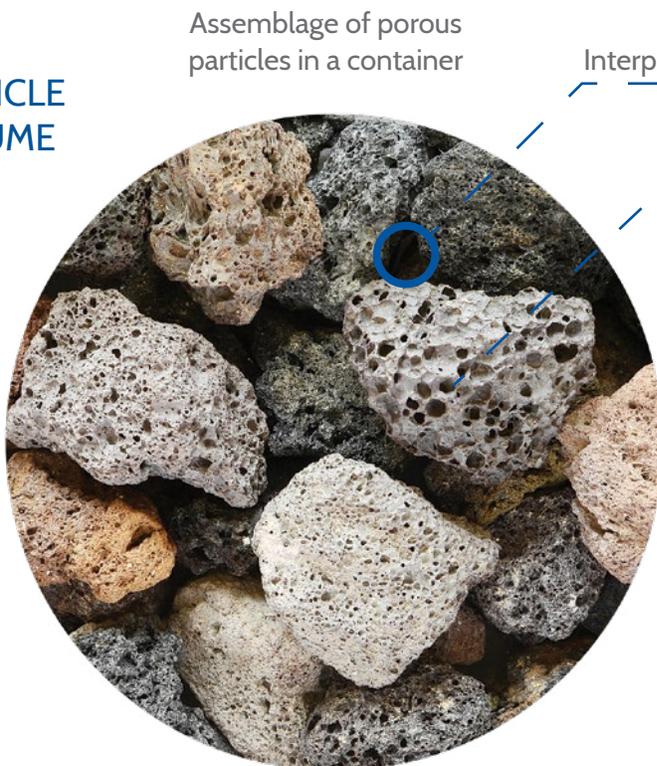
NTRIES, TO MORE SATISFIED USERS



DENSITY MEASUREMENT

On an elementary level, the volume of a solid material can be calculated by measuring its length, width, and thickness. However, many materials have within their structure surface irregularities, small fractures, fissures, and pores. Some of these voids or pores are open to the surface or closed within the structure of the solid material. Therefore, differences in the material volume depend on the measurement technique, measurement method, and the conditions under which the measurements were performed.

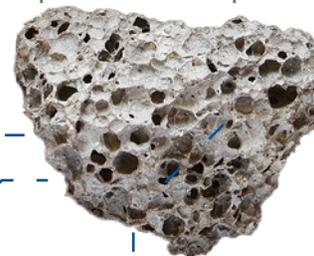
PARTICLE VOLUME



Assemblage of porous particles in a container

Interparticle void

A single particle containing open and closed pores



The envelope



Surface void included within the envelope



DENSITY

VOLUMES INCLUDED IN DEFINITION

Density Type	Definition	Material Volume	Open-Pore Volume	Closed-Pore Volume	Inter particle Volume	External Void Volume
True (Absolute)	The mass of a substance divided by its volume, excluding open and closed (or blind) pores	⊕				
Skeletal (Apparent)	The ratio of the mass of the solid material to the sum of the volume including closed (or blind) pores	⊕		⊕		
Envelope	The ratio of the mass of a substance to the envelope volume (imaginary boundary surrounding the particle)	⊕	⊕	⊕		⊕
Bulk	Mass of the material divided by the volume occupied that includes interstitial space	⊕	⊕	⊕	⊕	
Tap	Apparent powder density obtained under stated conditions of tapping	⊕	⊕	⊕	⊕	

FERTILIZERS

Knowledge of the bulk density is of interest in package sizing, in calibrating volumetric feeders or applicators, and in determining the storage capacity of bins and transport vehicles. Apparent density information can be used in segregation studies and development of granulation processes. True density measurements are important in process control and the design of process equipment.



MINING CORES

Simple physical measurements of a circular core cylinder's diameter and length allow the envelope volume to be calculated. A gas displacement pycnometer, with a larger sample chamber designed specifically to accept intact drill cores, provides a low-cost, time-saving, non-destructive technique for measuring the skeletal volume. Knowing the envelope and skeletal volumes allows the total pore volume and percent porosity of the core sample to be determined.

Addressed by

AccuPyc II

AccuPyc II

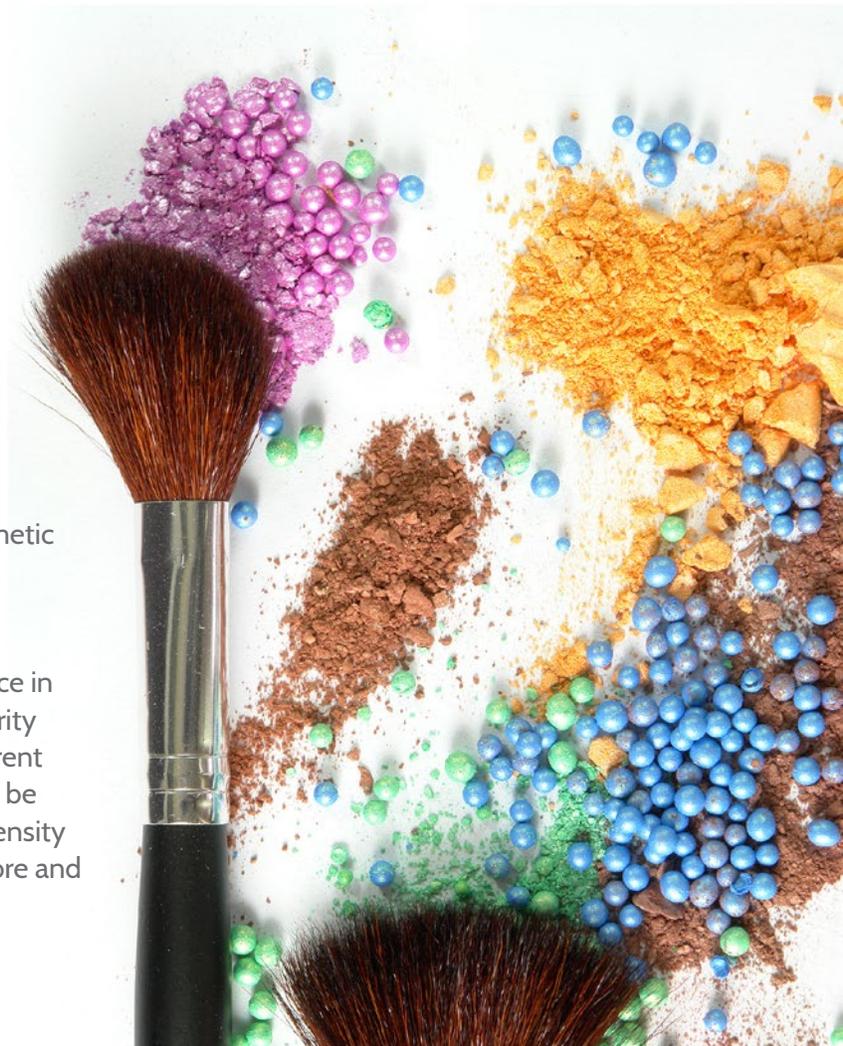
GeoPyc

GeoPyc

GeoPyc with T.A.P. function

COSMETICS

The presence of air bubbles in cosmetic preparations, such as lipsticks and powder cakes, is undesirable for a number of reasons. Trapped air can create pinholes and poor appearance in lipsticks and compromise the integrity of cakes. The effectiveness of different methods of air bubble removal can be evaluated by comparing the true density measurements of the material before and after air bubble removal.



GAS DISPLACEMENT PYCNOMETRY

PRINCIPLE OF OPERATION

This technique uses the gas displacement method to measure volume accurately. Inert gases, such as helium or nitrogen, are used as the displacement medium. The sample is sealed in the instrument compartment of known volume, the appropriate inert gas is admitted, and then expanded into another precision internal volume. The pressures observed upon filling the sample chamber and then discharging it into a second empty chamber allow computation of the sample solid phase volume. Helium molecules rapidly fill pores as small as one angstrom in diameter; only the solid phase of the sample displaces the gas. Dividing this volume into the sample weight gives the gas displacement density.



1 Inert gas flows
Into sample chamber

valve **a** opens then closes

2 Equilibrium is
reached

3 Gas flows into
second chamber
for volume measurement

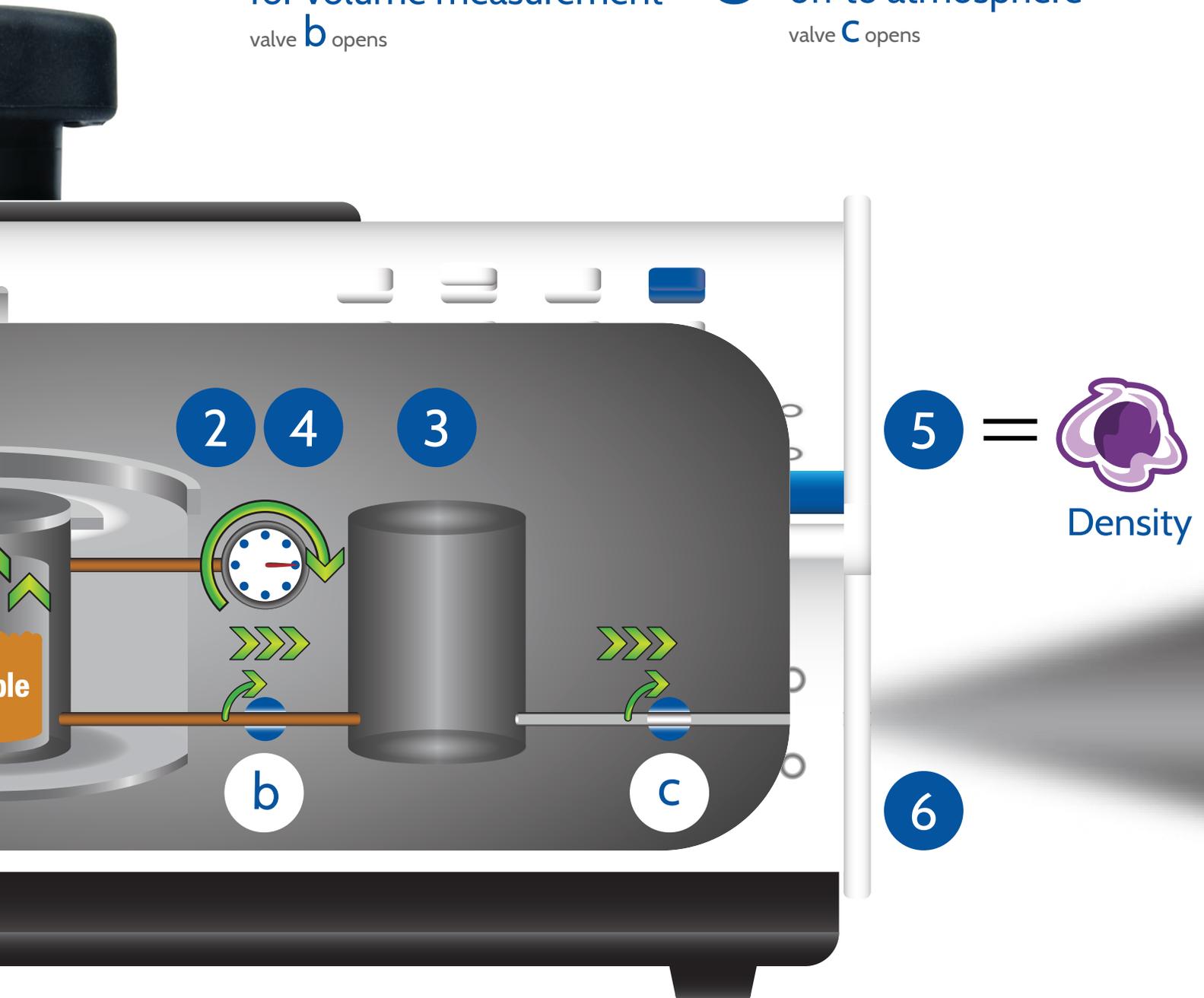
valve **b** opens

4 Equilibrium is reached
yet again

5 Volume divided into
sample weight
determines density

6 Pressure vented
off to atmosphere

valve **C** opens



HIGHLY ADAPTIVE SYSTEM

The AccuPyc II Pycnometer consists of an integrated control and analysis module. For those who require high throughput, analysis modules are also available in a single configuration, allowing you to attach up to five additional analysis modules to a single controlling unit. Each module has its own gas connection. A variety of sample chamber sizes can be selected to provide the best fit with your samples. The run precision mode allows you to achieve high repeatability. The instrument purges water and volatiles from the sample and then repeats the analysis until successive measurements converge upon a consistent result.

UNIQUE RUN PRECISION

Increases the precision of analysis results by reporting data from five consecutive measurements that are within a user-specified tolerance. This feature allows early termination of analysis, thereby decreasing the number of cycles needed for accurate results.

MULTILINGUAL

The AccuPyc may be operated in five languages: English, French, German, Italian, or Spanish



ETHERNET PORT

An Ethernet port on the rear panel of the control module enables you to email reports, send data to a web browser for archiving, or interface with the AccuPyc Windows application



USB PORTS

USB ports on the rear panel of the control module allow for connection to a printer (output of analysis and calibration results in either ASCII or Excel formats) and keyboard (alphanumeric character input). The USB port is also used for installing software upgrades.

INTEGRATED CONTROL AND ANALYSIS MODULE

Can control up to five additional external analysis modules



SIMPLE CALIBRATION PROCESS

Allows you to easily determine the volume of the instrument sample cell and expansion chambers using a traceable standard volume. After calibration, the cell and expansion chamber volumes are stored automatically.

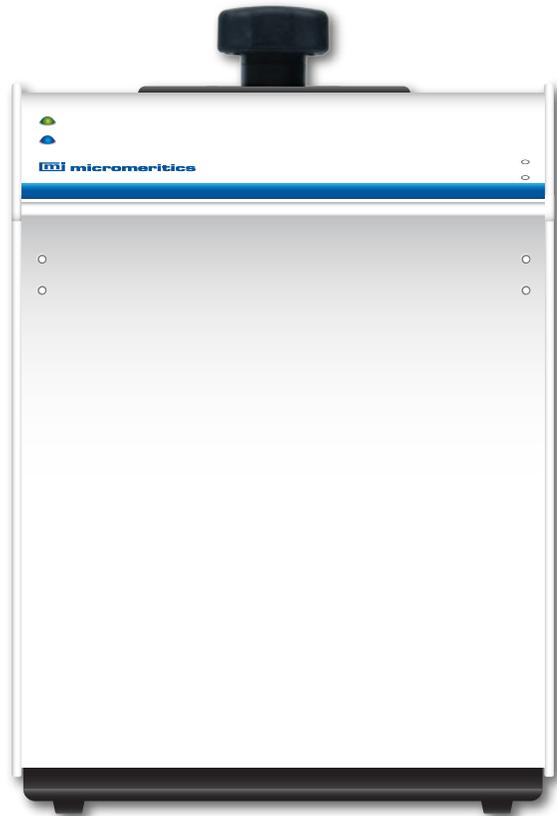
DIRECT SAMPLE MASS INPUT

Sample mass may be directly input from an analytical balance



COREPYC

Specialized unit with 2000-cm³ sample chamber size



BAYONET CAP FITTING

Provides superior repeatable seal compared to screw-type fitting



FIVE STANDARD SAMPLE CHAMBER SIZES

1 cm³, 10 cm³, 100 cm³, 350 cm³, and 2000 cm³



2000 cm³



350 cm³



100 cm³



10 cm³



1 cm³

MODEL SELECTION

Sample Cup Capacity	Sample Cup Dimensions	Available MultiVolume Insert Kits	Temp Control Type	Catalog Number
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AccuPyc II 1345 Instruments

1 cm ³	1.14 cm ID x 1.1 cm D	0.1 cm ³		134/50001/00
10 cm ³	1.85 cm ID x 3.95 cm D	1.0 and 3.5 cm ³	N/A	134/50000/00
100 cm ³	4.62 cm ID x 6.18 cm D	10 and 35 cm ³		134/50002/00

AccuPyc II 1345 Remote Analysis Instruments

Bundle includes Control module and 2-ft cable connected to Analysis modules.

1 cm ³	1.14 cm ID x 1.1 cm D	0.1 cm ³		134/50031/00
10 cm ³	1.85 cm ID x 3.95 cm D	1.0 and 3.5 cm ³		134/50030/00
100 cm ³	4.62 cm ID x 6.18 cm D	10 and 35 cm ³	N/A	134/50032/00
350 cm ³	5.84 cm ID x 13.94 cm D	N/A		134/50033/00
2000 cm ³	9.52 cm ID x 26.00 cm D	650 and 1300 cm ³		134/50034/00

Remote analysis modules only. Remote analysis units require connection to a control module or AccuPyc II 1345.

1 cm ³	1.14 cm ID x 1.1 cm D	0.1 cm ³		134/50041/00
10 cm ³	1.85 cm ID x 3.95 cm D	1.0 and 3.5 cm ³		134/50040/00
100 cm ³	4.62 cm ID x 6.18 cm D	10 and 35 cm ³	N/A	134/50042/00
350 cm ³	5.84 cm ID x 13.94 cm D	N/A		134/50043/00
2000 cm ³	9.52 cm ID x 26.00 cm D	650 and 1300 cm ³		134/50046/00

Control module only. Up to 6 analysis modules can be connected to a single control module.

N/A	N/A	N/A	N/A	134/50005/00
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AccuPyc II 1345 High Pressure (500 psi) Remote Analysis Instruments

Bundle includes Control module and 2-ft cable connected to Analysis module.

100 cm ³	4.62 cm ID x 6.18 cm D	10 and 35 cm ³	N/A	134/50037/00
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Remote analysis module only. Remote analysis unit requires connection to a control module or AccuPyc II 1345.

100 cm ³	4.62 cm ID x 6.18 cm D	10 and 35 cm ³	N/A	134/50049/00
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AccuPyc II 1345 Temperature-Controlled Instruments

10 cm ³	1.85 cm ID x 3.95 cm D	1.0 and 3.5 cm ³	Use with External Recirculating Bath 15-50 °C	134/50010/00
100 cm ³	4.62 cm ID x 6.18 cm D	10 and 35 cm ³		134/50020/00
10 cm ³	1.85 cm ID x 3.95 cm D	1.0 and 3.5 cm ³	Integral Thermoelectric Cooling 15-36 °C ±0.1 °C	134/50050/00
100 cm ³	4.62 cm ID x 6.18 cm D	10 and 35 cm ³		134/50051/00

AccuPyc II 1345 Temperature-Controlled Remote Analysis Instruments

Bundle includes Control module and 2-ft cable connected to Temperature-Controlled Analysis modules.

10 cm ³	1.85 cm ID x 3.95 cm D	1.0 and 3.5 cm ³	Integral Thermoelectric Cooling 15-36 °C ±0.1 °C	134/50035/00
100 cm ³	4.62 cm ID x 6.18 cm D	10 and 35 cm ³		134/50036/00

Remote analysis modules only. Remote analysis units require connection to a control module or AccuPyc II 1345.

10 cm ³	1.85 cm ID x 3.95 cm D	1.0 and 3.5 cm ³	Use with External Recirculating Bath 15-50 °C	134/50044/00
100 cm ³	4.62 cm ID x 6.18 cm D	10 and 35 cm ³		134/50045/00
10 cm ³	1.85 cm ID x 3.95 cm D	1.0 and 3.5 cm ³	Integral Thermoelectric Cooling 15-36 °C ±0.1 °C	134/50047/00
100 cm ³	4.62 cm ID x 6.18 cm D	10 and 35 cm ³		134/50048/00

Research grade helium or nitrogen is strongly recommended. High purity carbon dioxide, dry air, or argon may be used. A multigas option for up to four gases on one analysis unit is available.

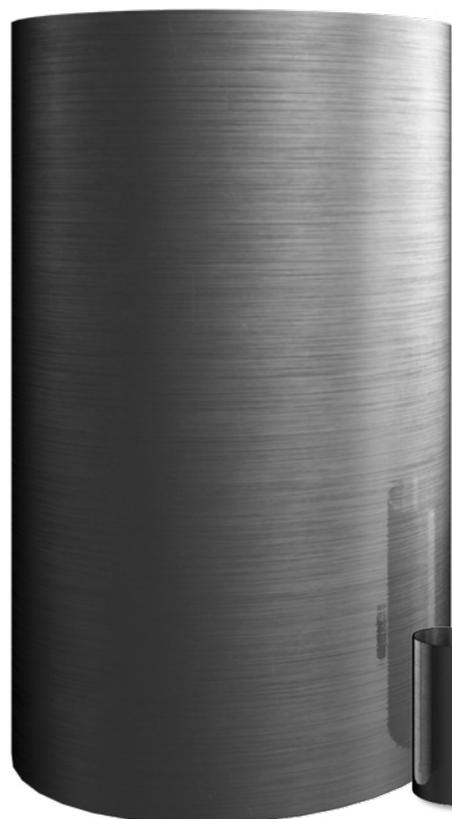
* Subject to environmental operating conditions

HARDWARE VERSATILITY

MULTIVOLUME KITS

A MultiVolume option allowing you to analyze smaller-sized samples with your current AccuPyc model is available for configurations listed below.

Each kit includes appropriate insert(s), reference standard(s), and sample cup(s).



2000-cm³ nominal cell volume
650- and 1300-cm³ cups

100-cm³ nominal cell volume
10- and 35-cm³ cups

10-cm³ nominal cell volume
1- and 3.5-cm³ cups

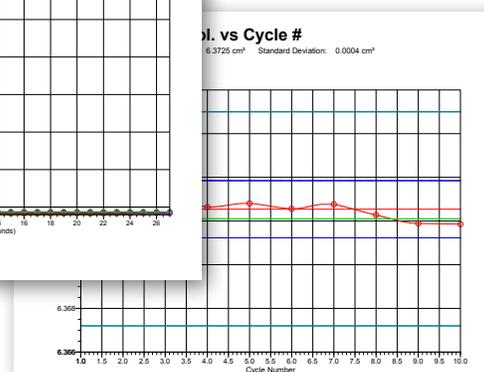
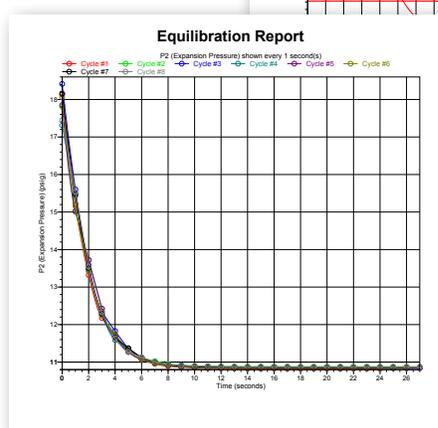
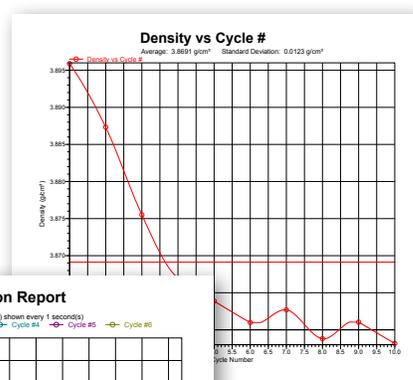
1-cm³ nominal cell volume
0.1-cm³ cup

SOFTWARE VERSATILITY

DATA PRESENTATION

The AccuPyc II can be operated with a full keyboard or an optional Windows[®] interface that provides exceptional reporting and archiving capability. Both versions include direct sample mass input from a balance and cycle-based displacement volume reporting. With the Windows interface, features such as time-based pressure equilibration reporting and additional calculations such as percent solids content and total pore volume are included. Operational status can also be continually monitored in a status window on the monitor screen.

- Combined Report
- Summary Report
- User-Defined Tabular Reports
- Volume vs. Cycle #
- Density vs. Time
- Total Pore Volume vs. Temperature
- Density vs. Cycle #
- Density at 60 °F
- Volume at 60 °F
- Options Report
- Equilibration Report
- Sample Log
- Specific Gravity



POROSITY SOLUTION

TOTAL PORE VOLUME/PERCENT POROSITY BUNDLE PHARMACEUTICAL APPLICATIONS

While skeletal and envelope volume measurements are each important on their own merit, their combination also allows you to accurately calculate percent porosity and total pore volume of a body.



TABLET PRESS

Pharmaceutical scientists realize that many of the physical, mechanical, and pharmacokinetics properties of tablets are influenced by the basic settings of a tablet press. Using the AccuPyc coupled with the GeoPyc, scientists are now able to determine quickly and easily the skeletal density, envelope density, total pore volume, percent porosity, and closed-cell pore volume of tablets produced with varying press settings.

GEOPYC ENVELOPE DENSITY ANALYZER

The GeoPyc utilizes a quasi-fluid displacement medium composed of non-hazardous microspheres having a high degree of flowability that do not wet the sample or fill its pores.

- Determines envelope volume and density of monolithic samples as well as bulk volume and density of powdered materials
- A variety of sample chambers is available to accommodate a wide range of sample sizes
- T.A.P. Density option – measures the packing volume and calculates the bulk density of granular and powdered samples

PHARMACEUTICAL RIBBONS

With the skeletal density measured by the AccuPyc included in the setup parameters for the envelope density, the GeoPyc will calculate and report the percent porosity and total pore volume of the ribbon. This information has proven to be useful in controlling the mechanical properties of the material, compression force settings on the roller compactor, and subsequent tablet press settings.

ACCUPYC/GEOPYC*



**included in porosity bundle*

SUPERIOR WORLDWIDE SUPPORT A
INSTRUMENT PERFORMANCE I

FOAM SOLUTION

FOAMPYC BUNDLE – DENSITY MEASUREMENTS FOR OPEN- AND CLOSED-CELL FOAMS

The AccuPyc II unit can be ordered initially with the FoamPyc application installed. If you have a standard AccuPyc, you can upgrade with a software enhancement. A FoamPyc option for measuring open- and closed-cell foam materials is available in the following configurations for the standard and temperature-controlled pycnometers:

- 10-cm³ nominal cell volume
- 100-cm³ nominal cell volume (for conformance to ASTM and ISO methods)

Analysis Prior to Recutting					
Cycle#	P1 Pressure (psig)	P2 Pressure (psig)	Volume (cm ³)	Volume Deviation (cm ³)	Elapsed Time (mm:ss)
1	4.052	2.387	1.3772	0.1295	6:27
2	4.018	2.368	1.1658	-0.0819	8:40
3	4.013	2.364	1.2618	0.0141	10:55
4	4.085	2.407	1.2386	-0.0091	13:09
5	4.072	2.400	1.1889	-0.0588	15:19
6	4.082	2.404	1.3808	0.1331	17:52
7	4.001	2.357	1.3046	0.0568	20:10
8	4.006	2.361	1.2285	-0.0192	22:16
9	4.062	2.394	1.2038	-0.0439	24:36
10	4.070	2.399	1.1274	-0.1204	26:37
Average Volume: 1.2477 cm ³			Standard Deviation: 0.0806 cm ³		

Cycle#	P1 Pressure (psig)	P2 Pressure (psig)	Volume (cm ³)
1	0.974	0.565	5.0834
2	2.113	1.224	5.4949
3	3.069	1.784	4.7258
4	4.087	2.380	4.2183
5	5.015	2.927	3.6335
6	6.047	3.537	3.1133
7	6.997	4.098	2.8279
8	7.995	4.686	2.6318
9	8.991	5.272	2.4875
10	9.930	5.827	2.2975
11	10.945	6.426	2.1864
12	11.920	7.000	2.1253
13	13.023	7.651	2.0076
14	13.995	8.223	1.9763
15	14.973	8.800	1.9202

WEIGHING SOLUTION

ANALYTICAL BALANCE BUNDLE

The AccuPyc weighing solution bundle provides one-touch transfer of mass data from the analytical balance directly to the AccuPyc's Windows software. Direct transfer eliminates user error associated with manual entry of mass data.

- Seamless device compatibility
- One-touch mass data transfer to AccuPyc for automatic calculation of density
- Includes 120 X 0.01 mg electronic analytical balance with calibration weight



ASSURES YOU CONSISTENT
FOR YEARS TO COME

TEMPERATURE-CONTROL SOLUTION

ACCUPLYC II TEC – DENSITY TESTING FOR SEMI-SOLID MATERIALS

This AccuPyc solution can be closely correlated ($< 0.15\%$ difference) to results obtained with ASTM Test Method D70-09. The ASTM method is burdensome and time consuming. Our approach offers an expedited, more robust, operator-independent method, with results in minutes.

- Reproducible results in minutes, virtually eliminates operator error
- Integral solution with software for bituminous material testing includes results for specific gravity, volume, and density. As well as reported density corrected to 60 °F.
- Peltier thermoelectric control (15 to 36 °C) provides excellent temperature control/stability and sample handling
- Optional 3.3 cm³ disposable sample cups limit cross-contamination and minimize cleaning of sample chamber between analyses



ASPHALT ANALYSIS

Asphalt Sample	Average Density AccuPyc II TEC Solution (n=11) (g/cm ³)	%Relative Standard Deviation (n=11)	ASTM Method D70-09 Density (g/cm ³)	%Difference Between Methods
Sample A	1.01906	0.03	1.01758	0.1453
Sample B	1.02543	0.03	1.02536	0.0067
Sample C	1.01821	0.07	1.01848	0.0263
Sample D	1.02563	0.09	1.02576	0.0125

Samples varied in composition and viscosity



If your research work requires an analytical device, technique, or configuration that is not commercially available, talk to us about modifications to our standard instrument designs. There are no charges associated with the initial consultation and our research into the feasibility of your project.

Call us here: 770.662.3636 | email: CEP@micromeritics.com

HIGH-PRESSURE SOLUTION

ACCUPYC II HP – DENSITY DETERMINATIONS IN A HIGH-PRESSURE ENVIRONMENT

This pycnometer can provide high-speed, high-precision volume measurements and density determinations in an elevated pressure environment (i.e. intact or crushed shale core samples).

- Operates at a higher pressure of 500 psi to provide a better diffusion of the gas into the rock
- Optional stainless-steel sample cup with a volume of 100 cm³.
 - Aluminum cup 46.2 mm (1.82 in.) diameter x 61.8 mm (2.43 in.) long
 - S.S. cup 48 mm (1.89 in.) diameter x 62.5 mm (2.46 in.) long
- Sample cup can accommodate a 48 mm (1.85 in.) diameter core of up to 60 mm (2.40 in.) in length



LARGE VOLUME SOLUTION

CORE PYC – DENSITY OF INTACT CORE SAMPLES

With a large-volume sample chamber, this pycnometer has been designed to address the specific needs of operations that require pore volume knowledge of intact drilling cores. This instrument improves sampling statistics by eliminating the need to break a core into many smaller pieces and run multiple analyses to obtain volume results. The CorePyc eliminates the need to run multiple analyses on large cores.

- Large sample chamber with a volume of approximately 2000 cm³
- Sample chamber can accommodate a 95-mm (3.74 in.) diameter core of up to 278 mm (10.9 in.) in length

FOCUSED ON YOUR SOLUTION



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