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BLP-530 Gas Porosimeter

Part No. 127-20

Instruction Manual

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Ver. 4.0

OFI Testing Equipment, Inc.

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Intro

The OFITE BLP-530 Gas Porosimeter was designed to rapidly and accurately measure the effective porosity of a core sample. Porosity is defined as the percentage of void within a solid media. Effective porosity is the percentage of void within a solid media in which the pore spaces are interconnected. It is imperative to accurately measure the effective porosity of a petroleum reservoir when estimating the amount of recoverable oil within a producing formation. The BLP-530 was engineered to precisely measure the effective porosity of a core sample.

Description

A sample is placed into an airtight sample holder and pressure is applied to a reservoir of known volume. After the pressure has stabilized, a valve is opened, which permits the gas within the reservoir to expand into the sample holder. After equilibrium is reached, the new pressure of the system is measured and recorded. The effective porosity of the core specimen may be calculated by the use of Boyle's Law ($P_1V_1 = P_2V_2$) in conjunction with the bulk volume of the sample. The variables V_1 and V_2 are constants, which are dependent upon the geometry of the unit and the effective porosity of the core.

Features

- Precision regulator for accurate pressure control
- Digital display of pressure
- Vacuum gauge and connection port for evacuation
- Lock in feature allows for rapid measurements of samples
- Unit is compact and virtually maintenance free
- Calibration sample included with unit
- Air relief valve prevents over pressurization
- Can test core samples 1.5" (3.81 cm) in diameter by 2" (5.08 cm) long
- Size: 24" x 22" x 20" (61 x 55.9 x 50.8 cm)
- Weight: 150 lbs (68.1 kg)

Requirements:

- Helium or Nitrogen source (500 PSI / 3,448 kPa minimum)
- 220 Volt, 50 Hz power source

Components

#120-27-004 DP-15 Diaphragm (0 - 200 PSI)
#127-00-262 Valve
#127-20-004 O-ring for Test Cell
#127-20-020 Calibration Block

Setup



Note

1. Carefully remove the instrument from the wooden crate and place it on a countertop.
2. Connect a nitrogen air supply (500 PSI / 3,448 kPa) to the port on the back of the instrument panel.
3. Connect the vacuum pump to the port located on the front panel with the hoses and connectors supplied with the unit.

OFITE uses ¼" NPT female connections.

4. Make sure the unit is turned off. Plug the unit into a grounded electrical outlet. The electrical socket is located on the back of the unit. A 120/220 VAC, 50/60 Hz power source is recommended. Apply electrical power to the vacuum pump in the same manner.
5. The o-ring (Part #127-22) contained within the sample holder should be periodically checked and replaced when needed. Applying a thin film of typical bearing grease to the o-ring will facilitate installation and prolong the life of the o-ring.



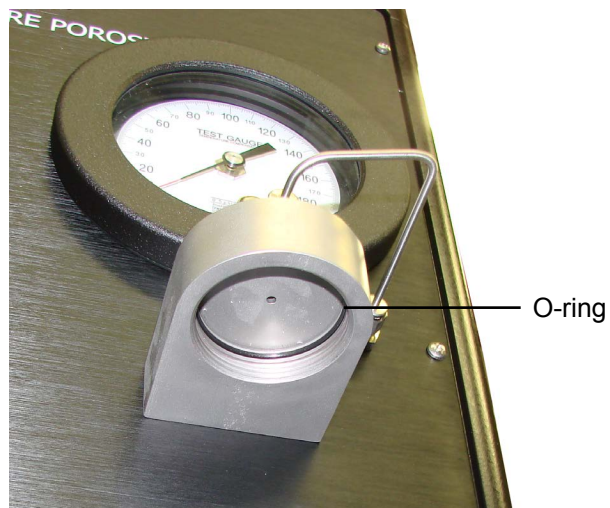
Operation

Testing Without a Vacuum

1. Before starting a test, place all valves in the vertical position. Make sure the regulator on the front panel is rotated fully counter-clockwise.
2. Turn the unit on and allow it to warm up for 5 to 10 minutes. After the unit warms up, the display should read zero.
3. Measure and record the diameter and length of the core with the calipers included with the unit.
4. Unscrew the sample holder and insert the core specimen. Screw the sample holder back into place just until it stops.
5. Turn the "P2 Test" valve to the "Off" position.
6. Rotate the regulator clockwise until the pressure reads approximately 180 PSI (1,242 kPa).
7. Turn the "P1 Lock In" valve to the "Off" position.
8. Allow P_1 to stabilize and record this value.



Sample Holder



Operation

Testing Other Samples

9. Make sure the three-way valve is in the “TEST” position.
10. Allow the gas to expand into the test chamber by turning the “P2 Test” valve to the vertical position.
11. Allow P_2 to stabilize and record this value.
12. The values P_1 , P_2 , D (diameter), and L (length) can be inserted into the Porosimeter Spreadsheet and the sample porosity will be calculated automatically.
13. Turn the three-way valve to “VENT” and remove the sample.

Once the unit has been set up, it is easy to test numerous specimens. To test numerous specimens, follow the procedures listed below. It is recommended to label and measure each core before performing a test.

1. Place a new specimen into the sample holder and screw it in just until it stops.
2. Place the three-way valve into the “TEST” position.
3. Return the “P2 Test” valve to the “OFF” position.
4. Turn the “P1 Lock In” valve to the vertical position for a few seconds. Return the “P1 Lock In” valve to the “OFF” position. Allow the pressure to stabilize and record P_1 .
5. Allow the gas to expand into the test chamber by turning the “P2 Test” valve to the vertical position. After stabilization, record P_2 .
6. Place the three-way valve into the “VENT” position and remove the core specimen.
7. Repeat steps 1 - 6 until all of the specimens have been tested.

Operation

Testing With a Vacuum



When core specimens have very low porosity (less than 2%), it may be necessary to fully evacuate a core using the supplied vacuum pump before conducting a porosity test.

Only use the vacuum to evacuate core samples of very low porosity. Using the vacuum on core samples with normal porosity can produce inaccurate readings.

1. Follow steps 1 through 4 on page 4 to prepare the unit and sample core for testing.
2. Make sure the “P1 Lock In” valve is in the vertical position, the “P2 Test” valve is in the “OFF” position and the three-way valve is in the “Vacuum” position.
3. Turn the vacuum pump on and evacuate the core until the vacuum gauge shows a steady reading.
4. Switch the three-way valve to the “Test” position.
5. Proceed with testing as normal.

Calculations

In the equations below, V_1 and V_2 are constants. Each Porosimeter has different V_1 and V_2 values. The values for each unit are located on the nameplate attached to the back of the unit. See the "Calibrating the Porosimeter Constants" section on page 10.

Core Bulk Volume $V_B = \frac{\pi D^2 L}{4}$

Where:
 V_B = Bulk Volume
 D = Diameter
 L = Length

Core Grain Volume $V_G = V_2 - V_3$

Where:
 V_G = Core Grain Volume
 V_2 = Constant of the Porosimeter

$$V_3 = \frac{P_1 V_1}{P_2}$$

Where:
 P_1 = Initial Pressure Value
 P_2 = Final Pressure Value and Expansion
 V_1 = Constant of Porosimeter

Porosity (Φ) $\Phi = \frac{(V_B - V_G) 100}{V_B}$

Example:

L	=	2.65 cm	D	=	2.54 cm
P_1	=	182.6 PSI	P_2	=	71.5 PSI
V_1	=	58.64 cc	V_2	=	161.18 cc
V_B	=	$\frac{\pi D^2 L}{4}$	=	$\frac{\pi 2.54^2 (2.65)}{4}$	= 13.43 cc
V_3	=	$\frac{P_1 V_1}{P_2}$	=	$\frac{182.6 (58.64)}{71.5}$	= 149.76 cc
V_G	=	$V_2 - V_3$	=	161.18 - 149.76	= 11.42 cc
Φ	=	$\frac{(V_B - V_G) 100}{V_B}$	=	$\frac{(13.43 - 11.42) 100}{13.43}$	= 14.93%

A spreadsheet in MS Excel format has been provided to simplify the calculation of porosity.

1. Enter the length and diameter of the core into the cells outlined by the red boxes.
2. Enter P_1 and P_2 into the appropriate cells.
3. Bulk volume, grain volume, and effective porosity are automatically calculated.

CORE INFORMATION		
Length	<input type="text" value="1.0025"/> IN	2.54635 cm
Diameter	<input type="text" value="1.0046"/> IN	2.551684 cm
Bulk Volume		13.02 cm ³
P_1	<input type="text" value="187"/> PSI	
P_2	<input type="text" value="72.9"/> PSI	
Grain Volume		10.94 cm ³
Effective Porosity		15.99%

Maintenance

Calibrating the Porosimeter Constants (V_1 and V_2)

The constants V_1 and V_2 have been calculated for each new Porosimeter. These values are located on the nameplate attached to the back of the Porosimeter. In the event that any plumbing or fittings are replaced, it will be necessary to recalibrate the Porosimeter. This is achieved by solving two equations simultaneously.

First, a pressure (P_1) is exerted on the volume of the system (V_1) with the "P2 Test" valve closed. Then this valve is opened and the gas is allowed to expand into the empty sample chamber, which creates a new pressure (P_2) that is a function of the entire volume of the system (V_2).

Secondly, the above procedure is repeated with a calibration block (included with each unit) of known volume (V_B) inserted into the sample chamber. This yields pressure (P_3) from the system with the "P2 Test" valve closed and the pressure (P_4) from the expansion of the gas into the sample chamber with a block of known volume. Simultaneously solving the two equations in mathematical form is stated below.

From Boyle's Law $P_1V_1 = P_2V_2$

Empty Reservoir

1. $V_2 = V_1 + V_R$

Reservoir with Block

$$V_2 = V_1 + (V_R - V_B)$$

Applying Boyle's Law

2. $P_1V_1 = P_2V_1 + P_2V_R$

$$P_3V_1 = P_4V_1 + (P_4V_R - P_4V_B)$$

Combining the equations and solving for V_1 yields:

3.
$$V_1 = \frac{P_2V_BP_4}{P_4P_1 - P_2P_3}$$

Once V_1 is obtained, V_R can be calculated from equation 2.

4.
$$V_R = \frac{P_1V_1 - P_2V_1}{P_2}$$

Knowing V_1 and V_R allows the calculation of V_2 from equation 1.

INITIAL CALIBRATION OF POROSIMETER TO DETERMINE THE CONSTANTS V_1 AND V_2

P_1	181.3	PSI
P_2	66	PSI
P_3	185.9	PSI
P_4	84.9	PSI
V_B	33.54	CC
V_1	60.18	CC
V_2	165.31	CC

Warranty and Return Policy

Warranty:

OFI Testing Equipment, Inc. (OFITE) warrants that the products shall be free from liens and defects in title, and shall conform in all respects to the terms of the sales order and the specifications applicable to the products. All products shall be furnished subject to OFITE's standard manufacturing variations and practices. Unless the warranty period is otherwise extended in writing, the following warranty shall apply: if, at any time prior to twelve (12) months from the date of invoice, the products, or any part thereof, do not conform to these warranties or to the specifications applicable thereto, and OFITE is so notified in writing upon discovery, OFITE shall promptly repair or replace the defective products. Notwithstanding the foregoing, OFITE's warranty obligations shall not extend to any use by the buyer of the products in conditions more severe than OFITE's recommendations, nor to any defects which were visually observable by the buyer but which are not promptly brought to OFITE's attention.

In the event that the buyer has purchased installation and commissioning services on applicable products, the above warranty shall extend for an additional period of twelve (12) months from the date of the original warranty expiration for such products.

In the event that OFITE is requested to provide customized research and development for the buyer, OFITE shall use its best efforts but makes no guarantees to the buyer that any products will be provided.

OFITE makes no other warranties or guarantees to the buyer, either express or implied, and the warranties provided in this clause shall be exclusive of any other warranties including ANY IMPLIED OR STATUTORY WARRANTIES OF FITNESS FOR PURPOSE, MERCHANTABILITY, AND OTHER STATUTORY REMEDIES WHICH ARE WAIVED.

This limited warranty does not cover any losses or damages that occur as a result of:

- Improper installation or maintenance of the products
- Misuse
- Neglect
- Adjustment by non-authorized sources
- Improper environment
- Excessive or inadequate heating or air conditioning or electrical power failures, surges, or other irregularities
- Equipment, products, or material not manufactured by OFITE
- Firmware or hardware that have been modified or altered by a third party
- Consumable parts (bearings, accessories, etc.)

Returns and Repairs:

Items being returned must be carefully packaged to prevent damage in shipment and insured against possible damage or loss. OFITE will not be responsible for equipment damaged due to insufficient packaging.

Any non-defective items returned to OFITE within ninety (90) days of invoice are subject to a 15% restocking fee. Items returned must be received by OFITE in original condition for it to be accepted. Reagents and special order items will not be accepted for return or refund.

OFITE employs experienced personnel to service and repair equipment manufactured by us, as well as other companies. To help expedite the repair process, please include a repair form with all equipment sent to OFITE for repair. Be sure to include your name, company name, phone number, email address, detailed description of work to be done, purchase order number, and a shipping address for returning the equipment. All repairs performed as "repair as needed" are subject to the ninety (90) day limited warranty. All "Certified Repairs" are subject to the twelve (12) month limited warranty.

Returns and potential warranty repairs require a Return Material Authorization (RMA) number. An RMA form is available from your sales or service representative.

Please ship all equipment (with the RMA number for returns or warranty repairs) to the following address:

OFI Testing Equipment, Inc.
Attn: Repair Department
11302 Steeplecrest Dr.
Houston, TX 77065
USA

OFITE also offers competitive service contracts for repairing and/or maintaining your lab equipment, including equipment from other manufacturers. For more information about our technical support and repair services, please contact techservice@ofite.com.