



Dependable Products From People You Trust



Permeameter

Gas Permeameter - #120-85
Cement Permeameter - #120-87

Instruction Manual

Updated 5/29/2015
Ver. 2.2

OFI Testing Equipment, Inc.
11302 Steeplecrest Dr. · Houston, Texas · 77065 · U.S.A.
Tele: 832.320.7300 · Fax: 713.880.9886 · www.ofite.com

©Copyright OFITE 2015

Table of Contents

Intro.....	2
Description.....	2
Components	3
Specifications	3
Installation.....	4
Testing	5
Appendix	7
<i>Cement Preparation.....</i>	<i>7</i>
<i>Calculations</i>	<i>8</i>
<i>Flowrate Chart</i>	<i>9</i>
<i>Sample Data Sheet.....</i>	<i>10</i>
Warranty and Return Policy	11

Intro

Permeability is a measure of the ability of a fluid to flow through a porous media when subjected to a differential pressure and is mathematically equated by Darcy's Law.

The primary function of a well cement is to isolate/seal the casing from the well bore. This seal prevents the migration of fluids into the annulus and upwards to the surface. Therefore, it is imperative that a well cement exhibit very low permeability.

The permeability of a petroleum reservoir is one of the most influential factors governing the production capabilities of a producing formation.

Description

The OFITE Permeameter is utilized to measure the permeability of cement or core specimens one inch in diameter and one inch in length. The specimen is placed into a sleeve, which is then inserted into the "Modified Hassler" style test cell. Nitrogen at a constant flow rate is forced through the core and the differential pressure across the core is measured. The flowrate is measured with calibrated flowmeters. Viscosity is easily determined by the use of nitrogen property tables. These variables are incorporated into Darcy's law to calculate cement sample permeability.

Components

- #120-85-010 Digital Calipers
- #122-220 Core Sleeve, Rubber, 1" Long × 1" Diameter
- #122-222 Flowmeter, Low-Range
- #122-223 Flowmeter, High-Range
- #122-225 Core Sleeve Holder, Stainless Steel

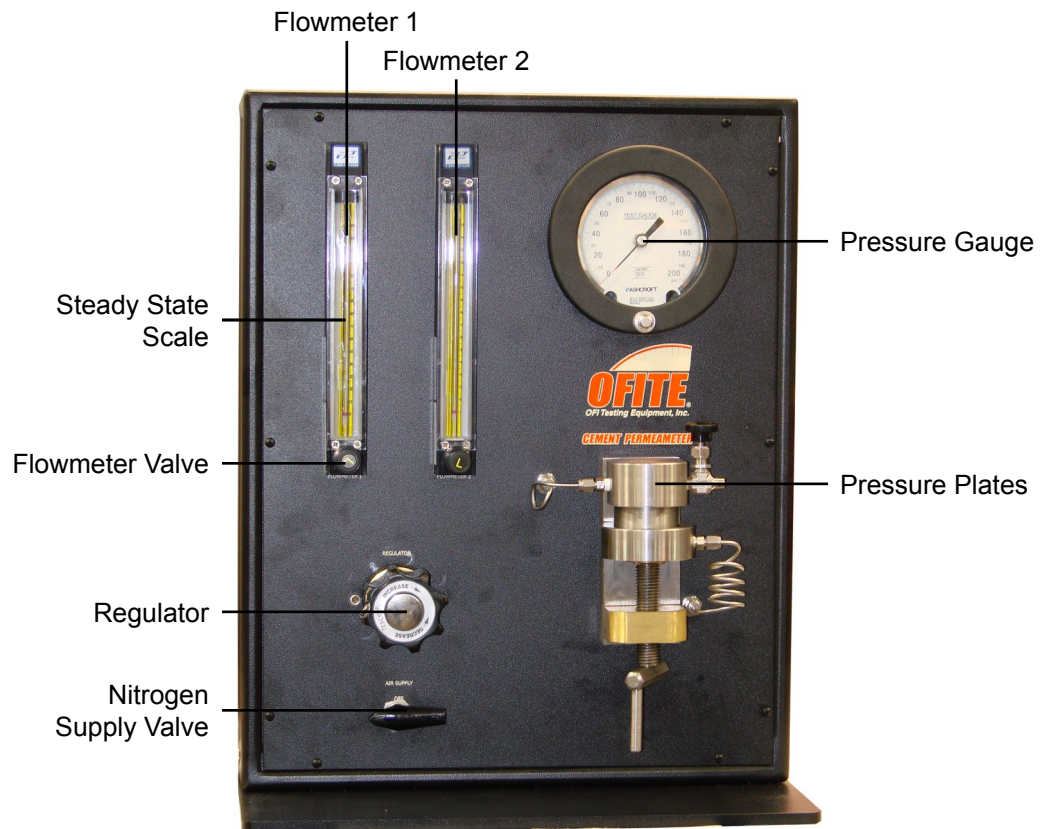
- #120-85-003 Cement Mold, Brass, 4 Gang (For #120-87 only)

Specifications

- "Modified Hassler" cell accommodates specimens of 1" length and 1" diameter
- Instrumentation gauge displays driving pressure
- All Hassler components are fabricated from 316 Stainless Steel
- Unit conforms to API Specification 10 guidelines
- Permeability Range: .01mD - 1D

Installation

1. Carefully remove the OFITE Permeameter from the packing crate and place it on a flat, stable surface.
2. Connect the unit to a 200 PSI (1,379 kPa) nitrogen source. The nitrogen line is attached to the back of the unit via a ¼" NPT female fitting.
3. Connect the unit to an appropriate power outlet.



Testing

1. Place a dry specimen into the rubber specimen holder and place the specimen holder into the sleeve.

If you are testing cement permeability, refer to “Cement Preparation” on page 7 for instructions for preparing a specimen.

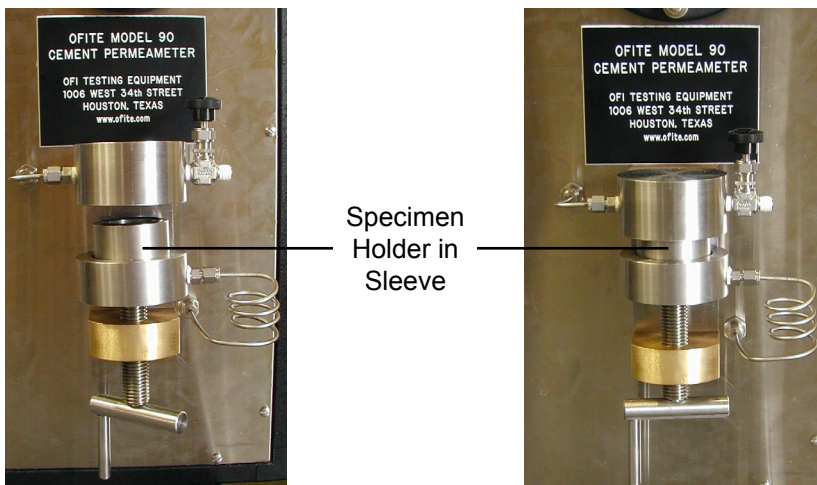


2. Place the sleeve between the pressure plates on the permeameter.



Make sure the face of the core does not come in contact with the surface of the pressure plates.

3. Using your hand, screw the bottom plate upwards as tight as possible to insure a good seal between the specimen and the rubber specimen holder.





Tip

4. Turn the pressure regulator fully counter-clockwise and open the “Nitrogen Supply” valve.
5. Open the valve on Flowmeter 1 by turning it fully counter-clockwise.

Flowmeter 2 is much more sensitive than Flowmeter 1. If Flowmeter 1 does not register any appreciable flowrate at 180 PSI (1,249 kPa), close the valve on Flowmeter 1, open the valve on Flowmeter 2, and take all subsequent readings from Flowmeter 2.

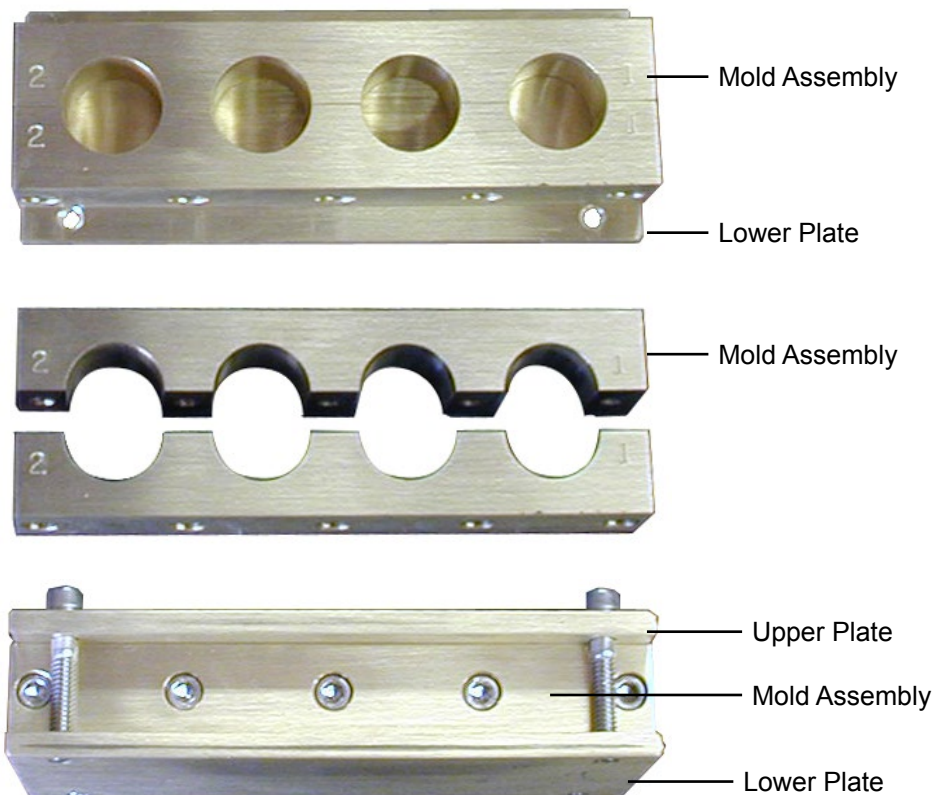
6. Turn the regulator clockwise until the steady state scale reading (center of float) on the Flowmeter registers 10. Record the inlet pressure (P1) from the pressure gauge.
7. Continue opening the regulator. Record the inlet pressure at every increment of 10 units on the steady state scale. A sample data sheet is available on page 10.

Appendix

Cement Preparation

A four-gang brass mold is supplied with the Cement Permeameter (Part No. 120-87) that can make cement samples one inch diameter by one inch long.

1. Lightly grease the internal surfaces of the mold assembly and the upper and lower plate to prevent the cement from adhering to the surface. Place the mold assembly on top of the lower plate
2. Prepare the cement mixture to be tested according to the procedures as outlined in API Specification 10.
3. Carefully pour the cement into the molds. Place a puddling rod into each mold and tap the bottom to remove any entrapped air. Wipe any excess cement from the mold assembly.
4. Place the upper plate on top of the mold assembly. Clamp the plates together using the four screws provided.
5. The mold assembly should be cured in either a heated water bath or an HTHP Curing Chamber.
6. After the samples have cured remove the four screws that hold the upper and lower plates together. Then remove the five screws that hold the mold assembly together. The cement specimens can now be tested in the permeameter.



Appendix

Calculations

Permeability is calculated via Darcy's Law, which is stated mathematically:

$$K = \frac{2000P_o Q \mu L}{A(P_i^2 - P_o^2)}$$

Where:

- K = Permeability (md)
- P_o = Outlet Pressure (atm) - Use atmospheric pressure.
- P_i = Inlet Pressure (atm)
- Q = Flowrate (cc/sec)
- μ = Viscosity (cP) - The viscosity of nitrogen is 0.01756 cP at ambient conditions.
- L = Specimen Length (cm)
- A = Cross Sectional Area (cm²)

A spreadsheet is provided to assist in the permeability calculations. All of the specimen information should be entered in the red boxes. Choose either the Flowmeter 1 table or the Flowmeter 2 table and enter the inlet pressures (PI) in the red boxes that correspond to the flowmeter scale readings. Permeability is automatically calculated and plotted on the chart. The chart should be linear as Darcy's equation assumes laminar flow. Any data which deviates from linear is invalid.

The screenshot shows a spreadsheet with the following data:

CORE INFORMATION

- Length: 1 IN (2.54 cm)
- Diameter: 1 IN (5.06 cm²)
- Viscosity of Nitrogen: 0.01756 cp
- PI: 0.5 PSIG (1.03 atm)
- Po: 14.7 PSIG (1.00 atm)
- Flowrate: 24.1 cc/min (0.40 cc/sec)
- K = Permeability: 102.26 md

HIGH FLOWMETER TUBE (FLOWMETER 1)

SCALE	Q (ML/MIN)	2000QPoLu	(Pi ² -Po ²)A	PI (PSIG)	PI (atm)	K (MD)
10	17.6	26.17	1.09	1.50	1.10	24.09
20	22.9	34.05	1.67	2.25	1.15	20.40
30	25.3	37.61	2.26	3.00	1.20	16.51
40	31.1	46.24	3.13	4.00	1.27	14.77
50	41.3	61.40	3.80	4.75	1.32	16.15
60	49.6	73.74	4.50	5.50	1.37	16.39
70	55.9	83.11	5.22	6.25	1.43	15.92
80	63.2	93.96	5.97	7.00	1.48	15.73
90	70.9	105.41	7.55	8.50	1.58	13.96
100	81.0	120.43	8.66	9.50	1.65	13.90
110	89.7	133.36	9.53	10.25	1.70	14.00
120	98.5	146.44	11.02	11.50	1.78	13.26
130	111.4	165.62	12.92	13.00	1.88	12.82
140	124.5	185.10	14.92	14.60	1.99	12.41
150	139.2	206.96	15.61	15.00	2.02	13.26

The chart titled "PERMEABILITY" plots (Pi²-Po²)A on the y-axis (0.00 to 20.00) against 2000QPoLu on the x-axis (0.00 to 200.00). The data points form a nearly straight line passing through the origin, indicating laminar flow.

Appendix

Flowrate Chart

The chart below shows the correlation between the Flowmeter reading and the flowrate. The Scale Reading is determined by observing the center of the float in the flowmeter. Use the corresponding flowrate (Q) in the equation on page 8.

Flowmeter 1		Flowmeter 2	
Scale Reading	Flowrate (cc/min)	Scale Reading	Flowrate (cc/min)
150	139.20	150	30.97
140	124.50	140	27.77
130	111.40	130	25.08
120	98.50	120	21.87
110	89.70	110	19.17
100	81.00	100	17.31
90	70.90	90	15.30
80	63.20	80	12.85
70	55.90	70	10.94
60	49.60	60	9.65
50	41.30	50	7.98
40	31.10	40	5.41
30	25.30	30	5.11
20	22.90	20	4.05
10	17.60	10	2.94

Appendix

Sample Data Sheet

Specimen _____

Specimen Length _____ in

Specimen Diameter _____ in

N₂ Viscosity _____ cP

Flowmeter 1		Flowmeter 2	
Scale Reading	Flowrate (P _i)	Scale Reading	Flowrate (P _i)
150		150	
140		140	
130		130	
120		120	
110		110	
100		100	
90		90	
80		80	
70		70	
60		60	
50		50	
40		40	
30		30	
20		20	
10		10	

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.