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# Permeameter

**Air Permeameter - #120-85**  
**Cement Permeameter - #120-87**

# Instruction Manual

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Ver. 2.1

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## ***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***

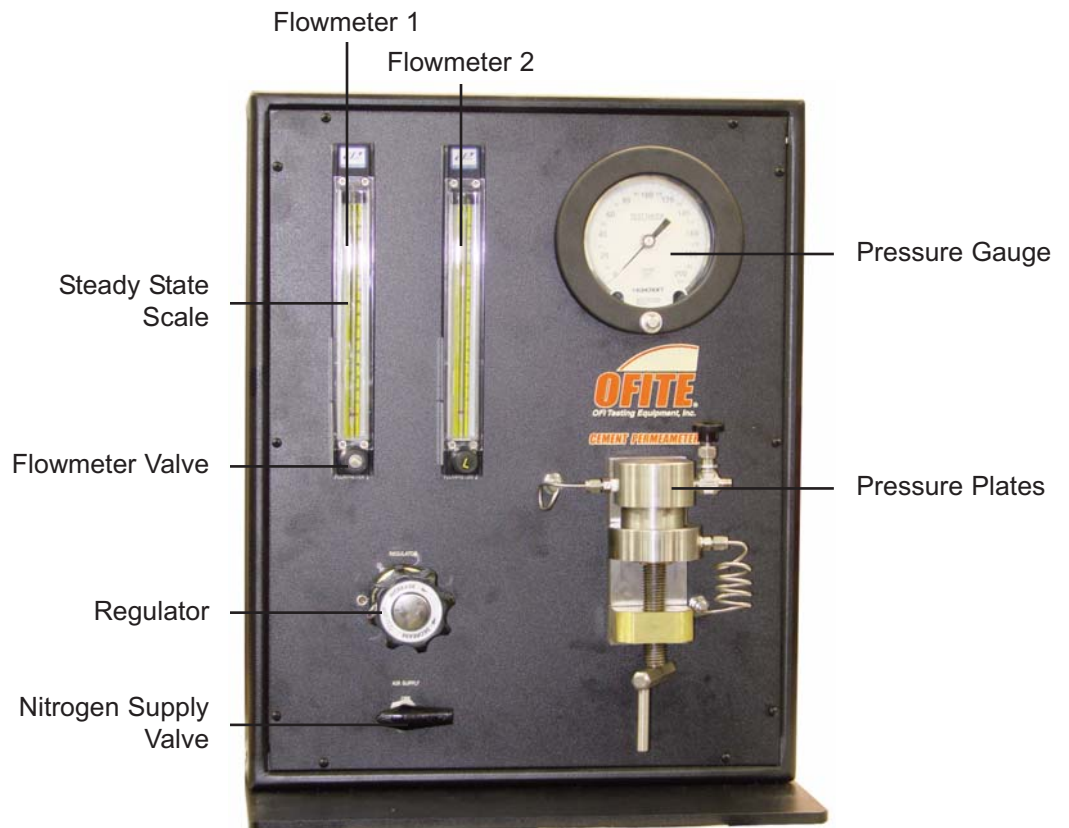
#122-222	Low-Range Flowmeter
#122-223	High-Range Flowmeter
#122-224	Valve
#171-44	¾" Rubber Foot; Qty: 4

## ***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

# 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.



Specimen



Specimen Holder



Specimen in Holder



Sleeve



Holder in Sleeve

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.



Important



Specimen Holder in Sleeve





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.**

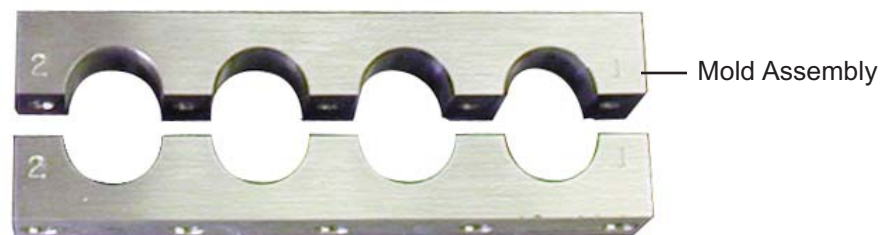
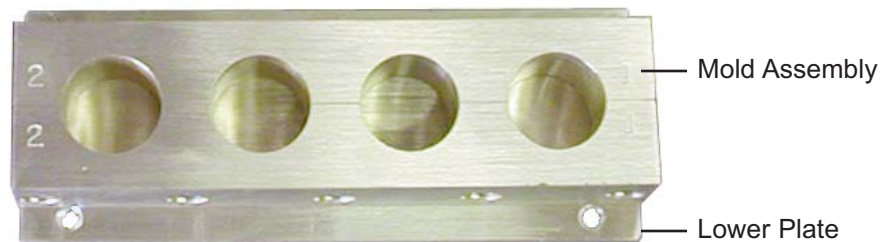
6. Turn the regulator clockwise until the steady state scale reading (center of float) on the Flowmeter registers 10. Record the inlet pressure (P1) from the pressure gauge.
7. Continue opening the regulator. Record the inlet pressure at every increment of 10 units on the steady state scale. A sample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

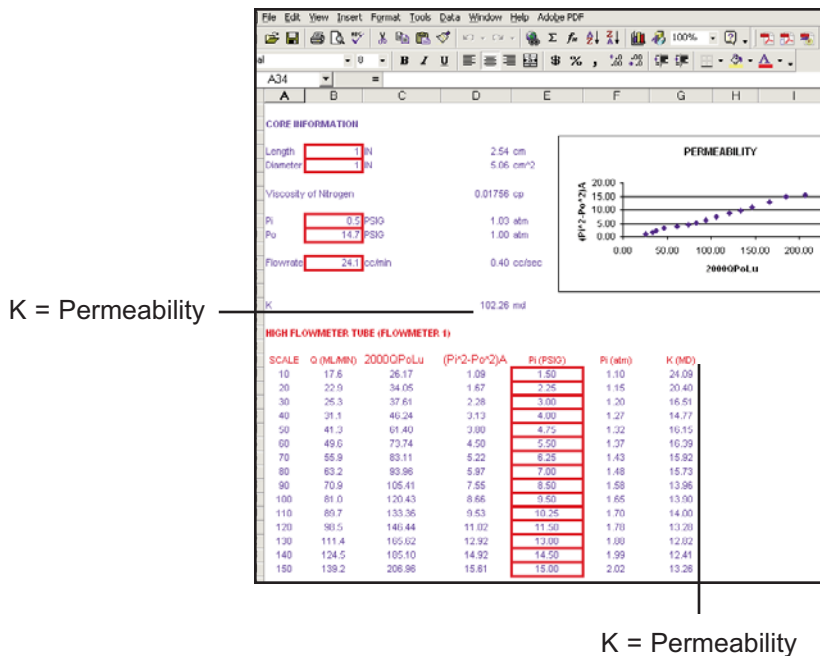
Permeability is calculated via Darcy's Law, which is stated mathematically:

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

Where:

- K = Permeability (md)
- P<sub>o</sub> = Outlet Pressure (atm) - Use atmospheric pressure.
- P<sub>i</sub> = Inlet Pressure (atm)
- Q = Flowrate (cc/sec)
- μ = Viscosity (cP) - The viscosity of nitrogen is 0.1756 cP at ambient conditions.
- L = Specimen Length (cm)
- A = Cross Sectional Area (cm<sup>2</sup>)

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 (P<sub>i</sub>) 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.



# 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  
 N<sub>2</sub> Viscosity \_\_\_\_\_ cP

Flowr		Flowr	
Scale Reading	Inlet Pressure (P <sub>1</sub> )	Scale Reading	Inlet Pressure (P <sub>1</sub> )
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	