INTERNATIONAL

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Standard Test Method for Permeability of Rocks by Flowing Air[1]

This standard is issued under the fixed designation D 4525; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of the coefficient of specific permeability for the flow of air through rocks. The procedure is to establish representative values of the coefficient of permeability of rocks or well-indurated soils.

1.2 This test method is limited to permeability values greater than 0.9869 nm^2(1.0 microdarcy), and is limited to rocks free of oil or unctuous matter.

1.3 The values stated in SI units are to be regarded as the standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 2434 Test Method for Permeability of Granular Soils (Constant Head)[2]

D 3877 Test Methods for One-Dimensional Expansion, Shrinkage, and Uplift Pressure of Soil-Lime Mixtures[2]

2.2 *American Petroleum Institute Standards:*

RP-27 Recommended Practice for Determining Permeability of Porous Media[3]

RP-40 Recommended Practice for Core Analysis Procedure[3]

3. Summary of Test Method

3.1 The permeability of a rock sample is measured by flowing dry air through the specimen and measuring the pressure, the flow rate, and pressure differential of the air. Three or more tests are performed on a sample at different mean air pressure values. The permeability values are plotted as a function of the reciprocal mean pressure; those points lying on a straight line are extrapolated to a value corresponding to an infinite mean air pressure to obtain an equivalent permeability value for liquids.

4. Significance and Use

4.1 This test method is designed to measure the permeability to air of a small sample of rock. By extrapolation, this test method also determines an equivalent of the liquid permeability. This parameter is used to calculate the flow through rock of fluids subjected to a pressure differential.

5. Apparatus

5.1 *Permeameter*—The permeameter shall have a specimen holder; a pressure transducer or gage, or manometers, for measuring the air pressure differential across the ends of the specimen; a means for measuring the flow rate of the air; and a means for providing dry air to the flow stream (see Fig. 1).

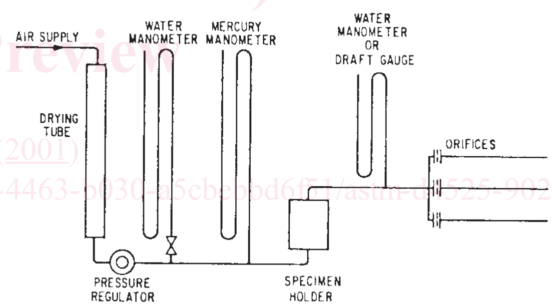

FIG. 1 Air Permeameter

5.1.1 *Specimen Holder*—The specimen holder shall have a diameter of at least ten times the diameter of the largest particle of the specimen. Where suitable, the preferred diameter is 2.54 cm. The entrance and exit flow ports shall be sufficiently large to prevent pressure loss at maximum flow rate. The length shall be 1.3 to 1.7 times the diameter.

5.1.2 *Preferred Apparatus*—In the preferred form, the specimen holder shall be an elastomer sleeve and have means for confining the sleeve and compressing it against the specimen so as to prevent bypassing of air under pressure between the sleeve and the specimen. The holder shall also have a means for confining the ends of the sample. In the preferred form, the end confining plugs will have two ports each, one for the flow of air, and the other for a static pressure line to

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.12 on Rock Mechanics.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] Available from American Petroleum Institute, 2101 L St., NW, Washington, DC 20037.

measure pressure at the end faces of the specimen, as in Fig. 2. This type of holder is suitable for many types of flowing fluids and allows the simulation of overburden stress on the specimen.

5.1.3 *Alternative Apparatus*—An elastomer bushing may be used to confine the specimen, as in Fig. 3. This holder is suitable for confining well-indurated specimens of a fine to moderate texture. This holder allows rapid operation; it cannot be used for simulating overburden stress.

5.1.3.1 Alternatively, a rigid bushing may be cast around the specimen (see Fig. 4). The casting material shall be one that will adhere well to both the specimen and the bushing, without penetration of the specimen beyond the superficial pores. Epoxies, polyesters, and sealing wax are suitable for this purpose. This method of mounting samples is particularly well suited for testing less well-indurated specimens. This technique is not applicable for tests requiring the simulation of overburden stress.

5.1.4 The flow rate of the air shall be sensed downstream from the specimen by means of calibrated orifices (Fig. 1), rotameters (Fig. 5), or a bubble meter (Fig. 6).

5.1.5 The preferred method of sensing pressure to obtain the pressure differential across the specimen is by means of pressure transducers located at the ends of the specimen. The transducers must operate over a range of 0 to 50 kPa (0 to 0.5 atmospheres) with a resolution of 250 Pa (0.0025 atmospheres) or better. Alternatively, the sensors may be connected to the end faces of the specimen with static lines, or placed in sufficiently large flow lines to cause less than 250 Pa (0.0025 atmospheres) loss of head at maximum flow rate. Pressure must be sensed between the downstream end of the specimen and the orifice if such a flow sensor is utilized.

5.1.5.1 Manometers may be utilized to measure the pressures of the flowing air. Both a mercury and water manometer must be provided, with a high-pressure cutoff valve to the water manometer as in Fig. 1, to provide the range of differential pressures required. The manometers must be 20 cm or more in height.

5.1.5.2 Alternatively, pressure gages with a range of 0 to 50 kPa (0 to 0.5 atmospheres) and a resolution of 250 Pa (0.0025 atmospheres) may be used to measure the pressure of the flowing air.

5.1.6 The dimensions of the column for drying the flowing air shall be a 2.54-cm inside diameter by a 30-cm or more length. The columns shall be filled with silica gel or anhydrous calcium sulfate, with indicator. There shall be a screen of 50 mesh on the downstream end of the filter to prevent particulate matter from reaching the specimen under test.

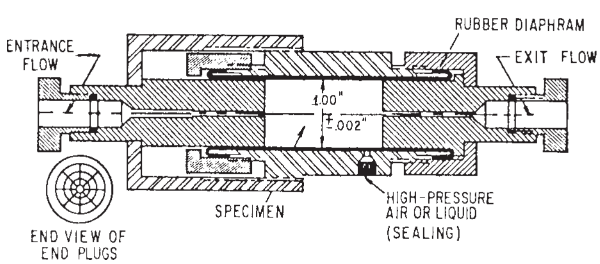

FIG. 2 Hassler Type Specimen Holder

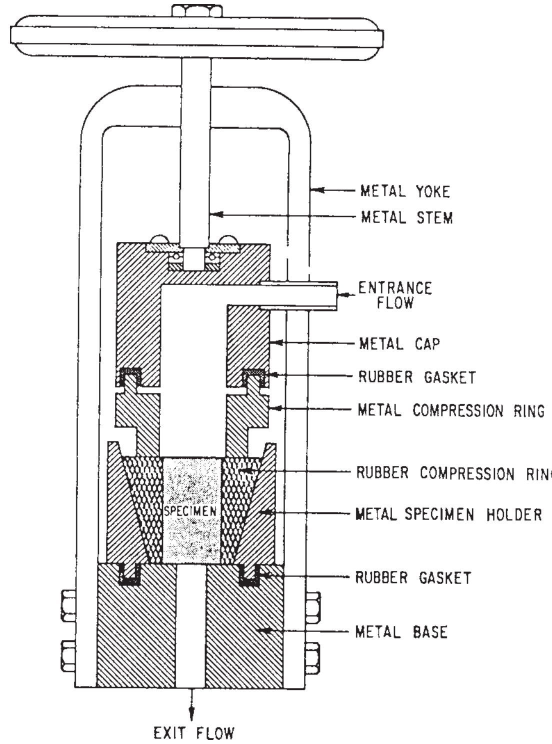

FIG. 3 Fancher-Type Specimen Holder

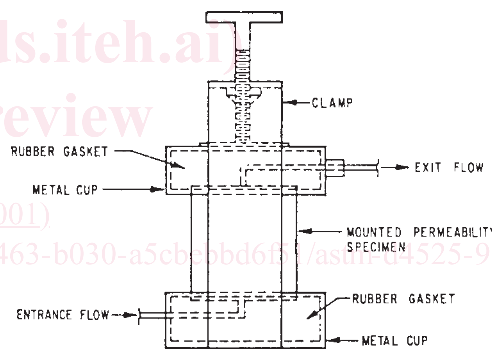

FIG. 4 Compression Cell for Ring-Mounted Specimens

5.1.7 *Compressed Air Source*, with a regulator and gage, shall supply air pressure up to ½ atmosphere for the flow system.

5.1.7.1 The air shall be clean and free of particles that can plug the pores of the sample.

5.1.7.2 A compressed air supply with a separate regulator and gage, or a hydraulic pressure source with gage, shall supply pressure for seating the sleeve when that option for holding the specimen is used. A seating pressure of 700 kPa (7 atmospheres) or more shall be used for seating. Pressures up to 100 MPa (1000 atmospheres) may be required for simulating in situ stress.

5.1.8 *Small Vacuum Source*, for expanding the sleeve-type holder is required for specimen insertion when that holder option is utilized.

5.2 *Drilling Machine*, with a diamond bit and coolant circulating system to drill specimens from rock samples.

5.3 *Required Miscellaneous Implements*, including a stop watch for use with bubble meter, a metric scale graduated in