Kentucky Method 64-107-05
Revised 01/04/05
Supersedes 64-107-03
Dated 02/11/03

FALLING-HEAD WATER PERMEABILITY OF FILTER FABRIC: DETERMINATION OF PERMEABILITY COEFFICIENT AND FLOW RATE AT A GIVEN CHANGE IN WATER HEAD

1. SCOPE: This procedure provides for (1) determination of coefficient of water permeability for filter fabrics and (2) flow rate of water through a fabric determined by a falling head permeameter test.

2. APPARATUS:

   2.1. Falling-head fabric permeameter (50.8 mm. diameter Plexiglas standpipe with a cross-sectional area of 20.27 cm^2 above a fabric sample placed over a 25.4 mm orifice; the cross-sectional area of flow through the test fabric is 5.07 cm^2) (Figure 1).

   2.2. Water Supply

   2.3. Fabric thickness gauge that meets the requirements outlined in ASTM D1777 71.60 mm diameter pressure foot weighing 454 gms.

   2.4. Celsius thermometer

   2.5. Stopwatch

   2.6. Rubber gaskets to fit flanges in falling-head fabric permeameter.

3. SAMPLE PREPARATION:

   3.1. Cut a 76.2 mm x 152.4 mm fabric sample to fit flanges of permeameter.

   3.2. Measure thickness of fabric sample according to the procedure outlined in ASTM D1777, record on data sheet (Attachment 1).

   3.3. Place fabric layer on bottom flange of permeameter. Attach a rubber gasket of appropriate thickness around fabric.

   3.4. Place top section of permeameter over fabric and gasket. Fasten flanges securely with clamps or bolts.

3.5. Fill stand pipe with water.

3.6. Open water release valve for a few seconds to saturate filter fabric. Close valve.

4. TEST PROCEDURE:

4.1. The object of this procedure is to determine the time required for water to travel through the fabric filter as the height of the water column is reduced from h_o to h_1.

4.2. The values recommended for h_o and h_1 are 20 cm and 10 cm respectively. This low head level is suggested to provide flow within or close to the laminar range.

4.3. An elapse time (t) for the (h_o-h_1) condition should be determined according to the following procedure.

4.3.1. Raise water level in standpipe until it reaches the desired starting height of h_o (20 cm). Use pipette for fine adjustment of pressure head level to exactly h_o.

4.3.2. Record temperature of water in system.

4.3.3. Open water release valve and start stopwatch simultaneously.

4.3.4. Stop stopwatch when water level reaches the desired lower level of h_1 (10 cm).

4.3.5. Record time (t) on data sheet.

4.3.6. Repeat above procedures four times.

5. CALCULATIONS: Permeability Coefficient:

The coefficient of permeability, k, is computed using the following equation:

$$k = \left(\frac{aL}{At}\right)\left(\ln \frac{h_o}{h_i}\right)$$

where: a = cross-sectional area of standpipe (cm^2)
L = thickness of fabric sample (cm)
A = cross-sectional area of flow through fabric (cm^2)
T = time in seconds for head of water in standpipe to drop from h_o to h_i

$h_o h_i$ = heads between which the permeability is determined (20 cm and 10 cm respectively)

For the apparatus described in this test procedure a = $\Pi (1)^2$ and A = $\Pi (0.5)^2$, therefore Equation 1 becomes:

$$k = \left(\frac{4L}{t}\right) \left(\ln \frac{h_o}{h_i}\right)$$

6. FLOW RATE: Flow rate is defined as the flow per unit area through a filter fabric for a given drop in the head of water above the fabric.

The equation for flow rate (FR) follows:

$$FR = \frac{Q}{tA}$$

where: t = time in seconds required for head to drop from h_o to h_i
Q = volume of flow passing through the fabric
A = cross-sectional area of flow through fabric (cm^2)

By the continuity equation Q = a (h_o - h_i) where a = cross-sectional area of the permeameter standpipe/tank, h_o = original height of water above the fabric (e.g. 20 cm), and h_i = final height water (e.g. 10 cm). For this test procedure a = 20.26 cm^2 and the area of flow is A =5.07 cm^2

Substituting these values, Equation 3 becomes:

$$FR = \left(\frac{a}{A}\right) \left(\frac{h_o \quad h_i}{t}\right) = \frac{4(h_o h_i)}{t}$$

7. REPORTING RESULTS: Report k and FR as the average of the five values obtained from this Test Procedure. The calculated values of "k" are corrected to $k_{20\ ^oC}$, the permeability coefficient at 20 ^oC, using the following equation:

$$k_{20\,^oC} = k \frac{u_t}{u_{20\,^oC}}$$

where: u_t = viscosity of water at temperature of water in system (See Attachment 2),
$u_{20\,^oC}$ = viscosity of water at 20 ^oC=10.09 millipoises.

APPROVED _____
Director
DIVISION OF MATERIALS

DATE _____01/04/05_____

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Revised 01/04/05
Supersedes 64-107-03
Dated 2/11/03

Attachments

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