The Geosynthetic Industry's use of a Porometer to Characterize Hydraulic Properties

Presented by
Sam Allen
TRI Environmental Group

Melissa Medlin
Solmax

Significance and Theory

Functions of a Filter
- Retain particles of the base soil
- i.e., prevent piping
- Allow free flow of water
- i.e., avoid clogging
- Survive construction
- i.e., be feasible for a site
Summary of Opening Size Test Procedures

Generally focused on largest opening size
• Equivalent Opening Size (EOS) Method (CW02215-77)
• Apparent Opening Size (AOS) (ASTM D 4751)
• Determination of the characteristic opening size (COS) (EN ISO 12956)
• Filtration Opening Size (FOS) (CAN CGSB 148.1 No.10)

Two Geotextile Samples

Same Largest Opening Size
But different smallest opening size, average opening size
**Apparent Opening Size**

- Washing/drying
- Glass bead maintenance
- Equipment issues
- 2-3 days/sample

**Permittivity**

- 2 hr soak
- 4 specimens – 5 measurements each
- O2 in water
- 2-3 hrs/sample

**HVAC**

- Breathing Masks

How do we measure opening size? Filtration? Breathability?
Recent Advances in Geotextile Filtration Design: Pore Opening Size Measurement using a Porometer or an Optical Test
IGS Technical Committee on Hydraulics

Porometer

Characteristic Flow Equation

\[ P = C_1 V + C_2 V^2 \]


Permittivity Testing

ASTM D4491, Procedure C

- Measurements of flow rate at 250 and 500 Pa pressure
- Resulting in two velocity and pressure values, \( V_{300} \), \( V_{500} \), \( P_{300} \), \( P_{500} \), which are used to calculate the two coefficients for the air flow test: \( P = C_1 V + C_2 V^2 \)
- Convert to water flow constants, \( C_{1W} \) and \( C_{2W} \), using:
  - \( 55.4 \) = ratio of dynamic viscosity of water to that of air at 20 °C
  - \( 833 \) = ratio of mass density of water to that of air at 20°C.
Permittivity Testing

ASTM D4491, Procedure C

- Calculate the constant head permittivity at 20 °C from the velocity at 490 Pa
  \[ V_{max} = \frac{C_{Air} \cdot V_{Water}}{C_{Water} \cdot V_{Air}} \]

- Calculate the geotextile constant head permittivity from the velocity at 50 mm of water head
  \[ \text{Permeability, } k_{in} = \frac{V_{max}}{\Delta h} \]

Porometers for Geotextiles

Pore Size Distribution
ASTM D 6767
Opening Size Testing


O = C / P
Recent Advances in Geotextile Filtration Design: Pore Opening Size Measurement using a Porometer or an Optical Test – IGS Technical Committee on Hydraulics

Geotextile AOS (O95 sieve size) From ASTM D 4751

<table>
<thead>
<tr>
<th></th>
<th>AOS (O95 sieve size)</th>
<th>Soil Loss (as %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>50 (corresponding to a size of 0.300 mm)</td>
<td>4.9</td>
</tr>
<tr>
<td>B</td>
<td>100 (corresponding to a size of 0.150 mm)</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Average Pore Size From ASTM D 6767

<table>
<thead>
<tr>
<th></th>
<th>Average Pore Size</th>
<th>Soil Loss (as %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.074 mm</td>
<td>4.9</td>
</tr>
<tr>
<td>B</td>
<td>0.092 mm</td>
<td>6.2</td>
</tr>
</tbody>
</table>
Porometer Efficiency

Apparent Opening Size – D4751

Procedure A: Glass Beads
- Washing
- Drying
- Static
- Oils
- 2-3 days/sample

Procedure B: Porometer
- No washing
- No Drying
- Static
- Oils
- 30-45 min./sample

Permittivity – D4491

Procedure A, B: Water
- 2 hr soak
- Water quality
- O₂
- Timers?
- 3-4 hrs/sample

Procedure C: Porometer
- No soaking
- No water quality issues
- 10-15 min./sample
Current Porometer Use for GS Measurements

- At least two independent service labs
  - Including Sageos
- At least 8 GT manufacturers
- Many Universities
- More users acquiring porometers

NOTES

- Full gradations often require evaluation using more than one wetting fluid.
- With permittivity and AOS, great utility with ...
  - Most wovens
  - Nonwovens between 135 and 500 gsm

NOTE – Important

- ASTM D4491 and ASTM D4751 results are governed by the hydraulic (permittivity) or (glass bead) versions.
- A correlation exercise is mandated if a porometer is used.

- Ongoing work to incorporate use porometer test results for filtration design.
  Sprague, J, Sack, R, Geotextile Filtration Design
  Based on Pore Size Distribution. GeoCongress 2020
Recent Advances in Geotextile Filtration Design: Pore Opening Size Measurement using a Porometer or an Optical Test
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Thank You!!