GLY-4822

Assignment 4

1. Write the porosity \( n \) in terms of the total volume \( V_T \) and the pore volume \( V_p \).

2. What is the pore volume in terms of the total volume and the solids volume \( V_s \)?

3. Use the results of 1 and 2 to show that

\[
    n = 1 - \frac{V_{solids}}{V_{total}}
\]  

(1)

4. The solid density \( \rho_s = \frac{M_{solids}}{V_{solids}} \) and the bulk density \( \rho_b = \frac{M_{solids}}{V_{total}} \). Use these to show that

\[
    n = 1 - \frac{\rho_b}{\rho_s}
\]  

(2)

5. Explain the volumetric water content.

6. What are the pressures (relative to atmospheric pressure taken as 0 at the water surface) 1 and 2 meters down in a swimming pool? What are the pressure heads (in meters of water) at that depth?

7. If the water surface is taken as the elevation datum, what are the elevation heads 1 and 2 meters down in the pool?

8. What are the total heads 1 and 2 meters below the surface of the pool?

9. The following table contains data obtained from a 10-cm long, 2.54 cm diameter column of glass beads of approximate size 186 \( \mu \)m. Use the data to compute the hydraulic conductivity \( K \).

<table>
<thead>
<tr>
<th>dh/dx (cm)</th>
<th>Q (ml s(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.35</td>
<td>0.11</td>
</tr>
<tr>
<td>2.35</td>
<td>0.19</td>
</tr>
<tr>
<td>3.75</td>
<td>0.3</td>
</tr>
<tr>
<td>5.1</td>
<td>0.4</td>
</tr>
</tbody>
</table>

10. Use the approximate Kozeny-Carman equation

\[
    k = \frac{n^3}{(1-n)^2} \frac{d_m^2}{180}
\]  

(3)
to estimate the intrinsic permeability of the bead pack. Then convert the intrinsic permeability to hydraulic conductivity using the following equation:

\[
K = k \frac{P_w g}{\mu}.
\]  

(4)

The bulk viscosity \( \mu \) is the kinematic viscosity \( (10^{-6} \text{ m}^2 \text{ s}^{-1}) \) times the density. Compare this Kozeny-Carman estimate of the hydraulic conductivity (based on crude estimates of \( n \) and grain size) with the estimate obtained by direct measurement in Question 9.