GG455 Laboratory

Experiment 4: Darcy’s Law and Constant Head Experiment

This experiment is designed to illustrate the validity of Darcy’s law according to the equation:

\[ Q = -KA \frac{dh}{dl} = -KA \frac{h}{L_s} \]

in which \( Q \) = discharge (L³/T); \( K \) = hydraulic conductivity (L/T); \( A \) = cross sectional area (L²); \( dh/dl \) = hydraulic gradient (dimensionless); \( L_s \) = distance between the two manometers (L); and \( h \) = difference between head at the two manometers (L).

Procedure:

Given \( L_s = 6.35 \) cm and \( A = 31.67 \) cm²:

1. Measure the distance between the marks outlining the potential locations of the constant-head tank
2. Divide this distance to about 10 intervals
3. For the current location of the tank, adjust the flow to the tank and open the outflow valve wide open. Make sure water will not overflow from the constant head tank
4. Make sure that tubes are void of air bubbles
5. When the flow stabilizes, measure the difference in the head level between the two manometers (h)
6. Measure the flow rate \( Q \) a few times by collecting a volume of water and measuring the time for collection. You will use the average \( Q \) for calculations. Keep an eye also on h
7. Calculate the ratio \( Q \) (average)/h
8. Carefully change the height of the constant head tank and repeat steps 3 and 7 for the 10 or so intervals. Close the in- and out-flow valves before the change. Open the valves and wait for the flow to stabilize before measuring \( Q \) and h
9. Check if the ratio \( Q \) (average)/h is roughly constant

Report:

1. Compile data collected
2. Draw a diagram of the apparatus
3. Use Darcy’s law to estimate the hydraulic conductivity for each test and estimate the average conductivity value. Discuss potential reasons for variability in conductivity, if any.
4. Make a plot of \( y = Q \) (average)/A (cm/sec) versus \( x = h/L_s \) (dimensionless). Is Darcy's law valid? Why?
5. Use the plot to calculate the hydraulic conductivity. How does it compare with those estimated in step 3 above?

Due in one week