Environmental Geology – Darcy's Law and Hydraulic Conductivity

Fall 2019

Please address the following issues in the paper related to the laboratory work.

1. Describe the relationship between:
   Q and AH/L (the slope of the best-fit line is K)
   Q and K
   K and H
   Q and H/L

2. Use Excel to prepare the graphs above – use data from the constant-head permeameter. Mark those points where the Reynold's number indicates that the flow is not Darcian.

3. What influences K?

4. What are typical ranges of hydraulic conductivity and how do they differ for different types of sediment and properties of the clasts?

5. K can be expressed as gallons/day/ft^2 or as cm/sec. Use dimensional analysis to show that the dimensions of K are equivalent when expressed in either way.

6. Describe falling head and constant head permeameters.

7. How and why is Darcy's Law used?

8. What are the benefits and shortcomings of Darcy's Law?

9. Explain the significance of the Reynold's number.

10. When is Darcy's Law appropriate?

11. What defines porosity? What is the difference between primary and secondary porosity? How is porosity related to permeability? How is permeability related to hydraulic conductivity?

12. Compare the hydraulic conductivity calculated by the Hazen method to the values determined using Darcy's Law.

n.b.: The order of the topics listed above is probably not the best way to present your results. As usual, the paper must include a cover page, thesis statement, abstract, subheadings, reference list, figures, and must be well written (the usual issues will be assessed).

Environmental Geology – Darcy's Law and Hydraulic Conductivity (continued)

Equations and constants

Darcy's Law:

Constant Head Permeameter

$K = QL/AH$

Q = volumetric discharge ($cm^3 \cdot s^{-1}$)
ΔL = distance over which head is measured (cm)
A = cross sectional area (cm^2)
ΔH = change in head (cm)

Falling Head Permeameter

$K = d^2_t L/d^2_c t \cdot \mathit{ln}(h_0/h)$

K:	hydraulic conductivity (cm/s)
L:	sample length (cm)
h_0:	initial head in falling tube (cm)
h:	final head in falling tube (cm)
t:	time it takes for head to go from h_0 to h (cm)
d_t:	inside diameter of falling head tube (i.e. the manometer in cm)
d_c:	inside diameter of sample chamber (the Lexan tube in cm)

Temperature correction for K

$K_{15.5} = (\mu_T / \mu_{15.5}) K_T$

μ = viscosity
$K_{15.5}$ = temperature corrected value of K
K_T = temperature of fluid during the experiment

Reynold's number

$N_R = \rho v D/\mu$

ρ = density ($g \cdot cm^{-3}$)
v = discharge velocity ($cm \cdot s^{-1}$)
D = average grain size (cm)
μ = viscosity (poise: $g \cdot cm^{-1} \cdot s^{-1}$)

Miscellaneous notes

Area of a circle: πr^2 (π = pi = 3.14159)

Mean grain size diameter: 0.177 mm (fine sand – note: measurement in mm)
Inside radius of Lexan tube (sample chamber): 2.85 cm
Inside length of Lexan tube (sample chamber): 15.3 cm
Inside radius of manometer: 0.54 cm