Introduction to Energy Resources
(자원공학개론) (38523-01)

- 2019 Final Examination -

Student ID: **Name:**

Notice

- Fill your name in the following:

"I, _____, swear I solve all problems by myself in this final examination.
I will take any disadvantages if any dishonesty such as cheating is acted on my solution."

5 points will be deducted from your total score if you do not fill in your name above.

Problem 1.

List the five assumptions for Darcy's law [10 pts.].

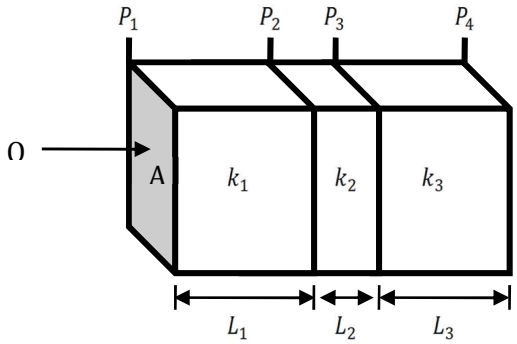
Problem 2.

Show your work that 1 Darcy (i.e., 1 D) is (approximately) equal to 9.869×10^{-9} cm^2 [10 pts.].

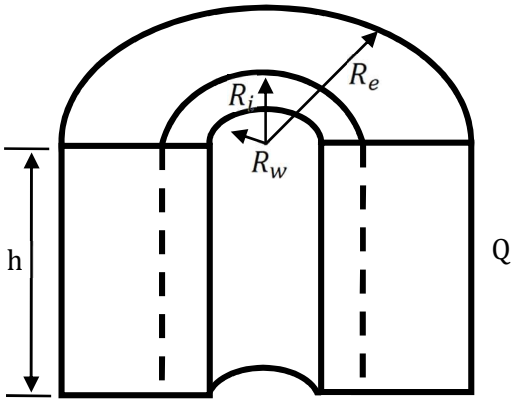
Problem 3.

A reservoir is composed of serial four layers whose thickness are the same. Calculate the average permeability for each case.

(Tip: The left and right figures are schematics for serial linear flow and radial flow systems, respectively.)



Serial linear flow composed of three layers



Serial radial flow composed of one production well and two serial layers.

3-1. Case 1: linear flow system [5 pts.]

3-2. Case 2: radial flow system. For Case 2, the radius of the production well is 6 in. and the effective radius of drainage area (r_e) is 2,000 ft. Also, the formation No. 1 is connected to the production well [5 pts.]

Formation No.	Length of formation, ft	Horizontal permeability, md
1	250	25
2	250	50
3	500	100
4	1,000	200

Problem 4.

Explain the Klinkenberg effect for gas permeability, in brief. [10 pts.].

Problem 5.

Select all drainage situations [10 pts.].

(a) Pressure maintenance or gas cycling by gas injection in a retrograde condensate reservoir

(b) Hydrocarbon (oil or gas) filling the pore space and displacing the original water of deposition in water-wet rock

(c) Gas injection in an oil or water wet oil reservoir

(d) Accumulation of oil in an oil wet reservoir

(e) Waterflooding an oil reservoir in which the reservoir is water wet

(f) Accumulation of condensate as pressure decreases in a dew point reservoir

(g) Evolution of a secondary gas cap as reservoir pressure decreases

(h) Waterflooding an oil reservoir in which the reservoir is oil wet

Problem 6.

Derive the Archie's Equation [5 pts.].

Problem 7.

7-1. Derive the equation for capillary pressure P_c for an oil/water system in a water-wet reservoir [10 pts.].

$$P_c = \frac{2\sigma_{ow}\cos\theta}{r},$$

where σ_{ow} is the interfacial tension between the wetting phase (i.e., water) and the non-wetting phase (i.e., oil), θ is the contact angle between the solid (e.g., rock) and the wetting phase, and r is the radius of capillary tube (e.g., pore),

7-2. Draw a graph that shows the relationship between the saturation of wetting phase (e.g., water) capillary pressure. What is the implication of capillary pressure that affects the thickness of the transition zone where the wetting phase (e.g., water) and non-wetting phase (e.g., oil) co-exist? [5 pts.]

Problem 8.

Define each formation volume factor. Also, draw the corresponding graph as a function of reservoir pressure [15 pts.].

(a) Oil formation volume factor (B_o)

(b) Gas formation volume factor (B_g)

(c) Solution gas/oil ratio (R_s)

Problem 9.

Draw the PVT diagrams for the following fluid types. Explain the phase behavior of each fluid type with the graph when the fluid pressure decreases from the initial reservoir pressure to the separator pressure [15 pts.].

(a) Dry gas

(b) Wet gas

(c) Gas condensate

(d) Volatile oil

(e) Black oil

---------- This is the End of the Final Examination ----------