Carbon Energy
(탄소에너지) (38523)

- 2022 Final Examination -

Student ID (학번): **Student Name (성명):**

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 ≈ 9.869×10^{-9} cm^2 [10 pts.].

Problem 3.

Derive Equation (2) from Equation (1). [10 pts.]

In Darcy Unit:
$$\mathrm{Q}\left(\frac{\mathrm{cc}}{\mathrm{sec}}\right) = -\frac{k(\mathrm{D})A(\mathrm{cm}^2)}{\mu(\mathrm{cp})}\frac{dp(\mathrm{atm})}{dl(\mathrm{cm})} \quad (1)$$

In Field Unit:
$$\mathrm{Q}\left(\frac{\mathrm{bbl}}{\mathrm{day}}\right) = -(\mathrm{constant})\frac{k(\mathrm{D})A(\mathrm{ft}^2)}{\mu(\mathrm{cp})}\frac{dp(\mathrm{psi})}{dl(\mathrm{ft})} \quad (2)$$

Problem 4.

4-1. Calculate the volumetric oil flow rate Q (bbl/day) if the reservoir extent area A = 60 acres [5 pts.].

4-2. Calculate the volumetric oil flow rate Q (bbl/day) if the reservoir extent area A = 120 acres [5 pts.].

- Reservoir thickness h = 10 ft
- Reservoir permeability k = 150 md
- Well radius = 5.5 in
- Bottomhole pressure at a production well = 1,000 psia
- Current reservoir pressure = 2,500 psia
- Oil viscosity = 2 cp

Problem 5.

5-1. See Figure 4(a). Show your work to solve the Darcy's Equation for the downward flow from ① to ② [5 pts.].

5-2. See Figure 4(b). Show your work to solve the Darcy's Equation for the upward flow from ① to ② [5 pts.].

Problem 6.

6-1. Show your work to derive the Archie's Equation [5 pts.].

6-2. Show your work to calculate water saturation (S_w) under the following condition [10 pts.].

Cementation factor, *m*	2.0	Porosity (%)	40.0
Empirical constant, *a*	1.0	Resistivity of formation water (Ω·m)	0.10
Saturation exponent, *n*	2.0	True formation resistivity (Ω·m)	40.0

Problem 7.

A reservoir is composed of serial four layers whose thickness are the same as h.

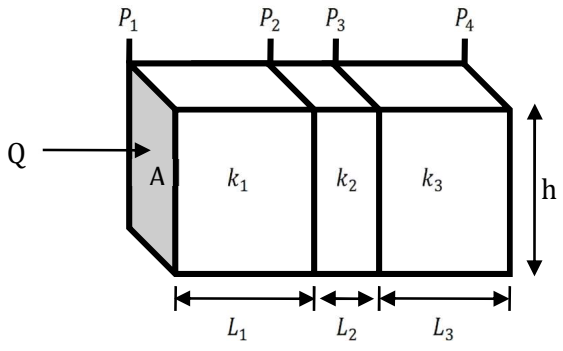
7-1. Calculate the average permeability $\underline{k}_{avg}$ for a linear flow system to the first decimal place [5 pts.]

Layer no.	Length of each layer, ft	Horizontal permeability, md
1	100	25
2	200	50
3	300	100
4	1,000	200

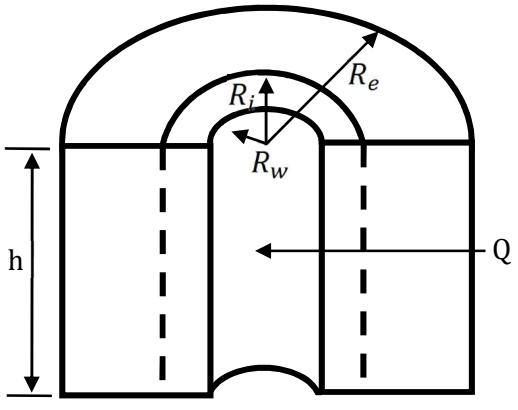
7-2. Calculate the average permeability $\underline{k}_{avg}$ for a radial flow system to the first decimal place. The radius of the production well is 6 in. and the effective radius of drainage area (r_e) is 1,000 ft according the table below. Note that the production well is located in the center of the layer no.1 [5 pts.]

Layer no.	Radius from the center of the well, ft	Horizontal permeability, md
1	100	25
2	200	50
3	300	100
4	1,000	200

(Example: The left and right figures are schematic diagrams for a serial linear flow system with three layers and a radial flow system with two layers, respectively.)



Serial linear flow composed of three layers



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

Problem 8.

Choose every drainage situation. You will gain 1 point for each correct answer you choose while losing 1 point for each incorrect answer you choose. You will gain 0 point if you do not choose any situation as your own answer.

(a) Accumulation of oil in an oil wet reservoir

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

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

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

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

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

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

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

(i) Decrease in capillary pressure

Problem 9.

Define the following formation volume factors. Also, draw graphs of three formation volume factors as a function of reservoir pressure. You MUST draw the graphs with a bubble point pressure (P_b), their conventional ranges, and their units.

9-1. Oil formation volume factor (B_o) [5 pts.]

9-2. Gas formation volume factor (B_g) [5 pts.]

9-3. Solution gas/oil ratio (R_s) [5 pts.]

9-4. Calculate how much the reservoir volume is occupied by 100 STB of oil where Bo = 1.1 rb/STB, Bg = 0.003 rb/scf, R_s = 510 scf/STB, and R = 5,000 scf/STB. [5 pts.]

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