

**Carbon Energy**  
**(탄소에너지) (38523)**

**- 2021 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.**

For the sub-problems from 1-1 to 1-5, give the full names of the following abbreviations:

- 1-1. GOC [2 pts.]
- 1-2. OWC [2 pts.]
- 1-3. FWL [2 pts.]
- 1-4. NDC [2 pts.]
- 1-5. GOR [2 pts.]

**Problem 2.**

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

**Problem 3.**

Show your work how much 1 milli-Darcy (i.e., 1 mD) is equal to in  $\text{cm}^2$  [10 pts.].

**Problem 4.**

4-1. Show your work to derive the Archie's Equation [5 pts.].

4-2. 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 ( $\Omega\cdot\text{m}$ )	0.10
Saturation exponent, $n$	2.0	True formation resistivity ( $\Omega\cdot\text{m}$ )	40.0

**Problem 5.**

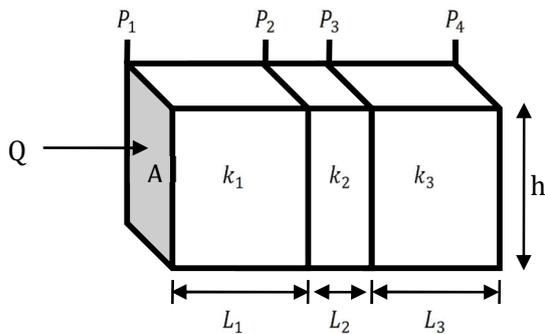
A reservoir is composed of serial four layers whose thickness are the same as  $h$ .

5-1. Calculate the average permeability  $k_{avg}$  for a linear flow system to the first decimal place [10 pts.]

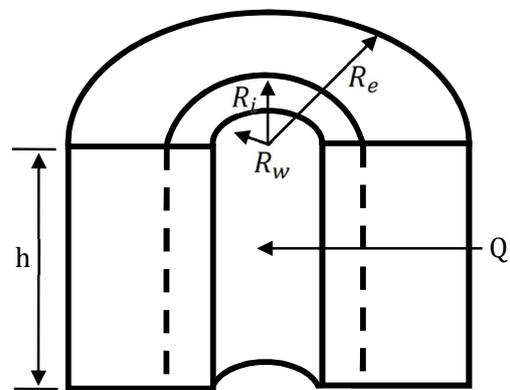
5-2. Calculate the average permeability  $k_{avg}$  for a radial flow system to the first decimal place. The radius of the production well is 6 in. and the effective radius of drainage area ( $r_e$ ) is 3,000 ft according the table below. Note that the production well is located in the center of the layer no.1 [10 pts.]

Layer no.	Length of each layer, ft	Horizontal permeability, md
1	200	25
2	300	50
3	500	100
4	2,000	200

(Tip: The left and right figures are schematics 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 6.**

Choose every drainage situation. You will gain 1 point for each correct answer you choose while losing 1 point for any 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 7.**

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.

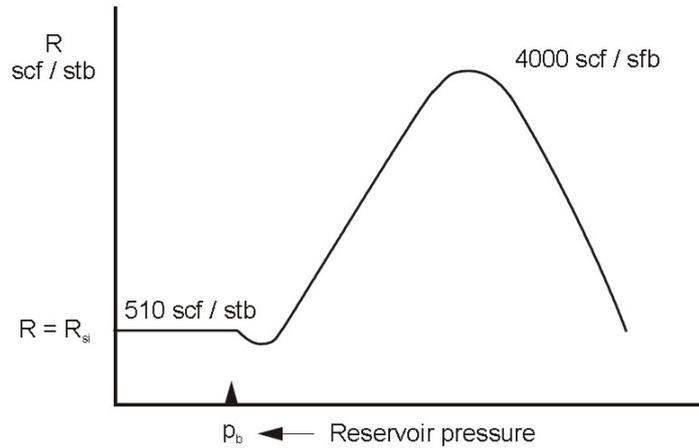
7-1. Oil formation volume factor ( $B_o$ ) [5 pts.]

7-2. Gas formation volume factor ( $B_g$ ) [5 pts.]

7-3. Solution gas/oil ratio ( $R_s$ ) [5 pts.]

**Problem 8.**

Below is the graph that depicts the producing gas oil ratio (R) as a function of the average reservoir pressure for a typical solution gas drive reservoir. Explain why R slightly decreases when the average reservoir pressure gets smaller than the bubble point pressure ( $P_b$ ). [5 pts.]



**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.

- (a) Wet gas [5 pts.]
- (b) Gas condensate [5 pts.]
- (c) Volatile oil [5 pts.]

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