



UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA
FIRST SEMESTER EXAMINATIONS, MAY, 2018

COURSE NO: P276

COURSE NAME: RESERVOIR ENGINEERING I

CLASS: PE II

TIME: 3 HRS.

Name: _____ Index Number: _____

Answer question 1 and any other 2 questions

- 1) i. What is the difference between Instantaneous GOR and Solution GOR?
ii. Give the equation relating instantaneous GOR equation and the Solution GOR
iii. Under what circumstances are the two the same?
iii. Outline the main difference(s) between a wet-gas reservoir and a gas condensate reservoir? **(10 marks)**
- b) The Jubilee field is a combination-drive reservoir. The volume of the bulk oil zone is 100,000 ac-ft while the volume of the bulk gas zone is 20,000 ac-ft. The current reservoir pressure is estimated at 2600 psi and the oil, gas and water production at this pressure are 5MMSTB, 6MMMscf and 0.3MMbbl respectively. The other reservoir production data and PVT information are given as:

	Initial Reservoir Condition	Current Reservoir Condition
P, psi	3200	2600
B _o , bbl/STB	1.40	1.35
R _s , scf/STB	650	550
B _w , bbl/STB	1.00	1.00
W _e , MMbbl	0.00	3.00
B _g , bbl/scf	0.0011	0.0019

Assuming that formation and water compressibility are negligible, calculate the initial oil in place. **(10 marks)**

- 2a) Calculate cumulative gas produced and cumulative gas-oil ratio at each pressure when the production data on a depletion-drive reservoir is given as:

p, psi	GOR, scf/STB	N _p , MMSTB
2100 (p _i)	1340	0
1800	1936	7.24
1500	3584	12.03

(5 marks)

b) The production history and the PVT data of a gas-cap-drive reservoir are given below:

p psi	N_p MSTB	G_p MMscf	B_t bbl/STB	B_g bbl/scf
5000	—	—	1.630	0.00075
4500	492	765	1.680	0.00079
3000	1015	2409	1.796	0.00080
2500	1322	3901	1.911	0.00083
2000	1350	3986	1.920	0.00086

The initial gas solubility R_{si} is 977 scf/STB. Estimate the initial oil and gas in place.

(15 marks)

3a) The UMaT Petra field has a volumetric gas reservoir with the following characteristics:

$$A = 3550 \text{ acres} \quad h = 45 \text{ ft} \quad \Phi = 0.15 \quad S_{wi} = 20\%$$

$$T = 155^\circ\text{F} \quad p_i = 3600 \text{ psi}$$

P	Z
3600	0.80
2600	0.82
1000	0.88
400	0.92

Calculate:

- i) Gas initially in place.
- ii) Cumulative gas productions and recovery factors at 2600, 1000 and 400 psi.
- iii) Recoverable Reserves to an abandonment pressure of 400 psi.

(10 marks)

b) A 2000-acre jubilee field has a water-drive gas reservoir with the following characteristics:

Initial bulk reservoir volume, G	= 415.3 MM cu ft
Average Porosity	= 0.172
Average connate water	= 0.25
Initial pressure	= 3200 psia
Initial Gas Formation Volume factor, B_{gi}	= 0.005262 cu ft/SCF
Final pressure	= 2925 psia
Final Gas Formation Volume factor, B_{gf}	= 0.005700 cu ft/SCF
Cumulative water production, W_p	= 15200 STB
Water formation Volume factor, B_w	= 1.03 res.bbl/STB
Gas produced, G_p	= 935.4 MM SCF

Calculate the water influx, W_e

(10 marks)

4 a) The following pressures and cumulative production data are available for a natural gas reservoir:

Reservoir pressure psia	Gas deviation factor, z	Cumulative gas production, Gp MMMscf
2080	0.759	2.0
1885	0.767	6.8
1620	0.787	14.0
1205	0.828	23.6
888	0.866	31.0
645	0.900	36.2

i) Estimate the initial gas in place using the MBE equation

ii) Estimate the recoverable reserves at an abandonment pressure of 500 psia. Assume $z_a = 1.00$, temperature of 180°F, reservoir rock has a porosity of 12%, the initial water saturation is 30%, the reservoir thickness is 35 ft and reservoir area of 2000 acres.

(10 marks)

b) i. Explain Petroleum Reserves?

ii. List and explain the main three types of reserves

iii. Under what conditions can the existing change?

(10 marks)

Equations

$$F = N [E_o + m E_g + E_{f,w}] + (W_e + W_{inj} B_w + G_{inj} B_{ginj})$$

where:

$$F = N_p [B_o + (R_p - R_s) B_g] + W_p B_w$$

$$\text{or } F = N_p [B_t + (R_p - R_{si}) B_g] + W_p B_w$$

$$E_o = B_t - B_{ti}$$

$$\text{or } E_o = (B_o - B_{oi}) + (R_{si} - R_s) B_g$$

$$E_g = B_{oi} [(B_g/B_{gi}) - 1]$$

$$\text{or } E_g = B_{ti} [(B_g/B_{gi}) - 1]$$

$$E_{f,w} = (1 + m) B_{oi} \left[\frac{S_{wi} c_w + c_f}{1 - S_{wi}} \right] \Delta p$$

$$N = \frac{N_p [B_t + (R_p - R_{si}) B_g] - (W_e - W_p B_w)}{(B_t - B_{ti}) + m B_{ti} \left[\frac{B_g}{B_{gi}} - 1 \right] + B_{ti} (1 + m) \left[\frac{S_{wi} c_w + c_f}{1 - S_{wi}} \right] \Delta p}$$

$$P.V = \frac{N B_{oi} (1 + m)}{1 - S_{wi}}$$

$$N = \frac{N_p [B_o + (R_p - R_s)B_g] - (W_e - W_p B_w) - G_{inj} B_{ginj} - W_{inj} B_w}{(B_o - B_{oi}) + (R_{si} - R_s)B_g + mB_{oi} \left[\frac{B_g}{B_{gi}} - 1 \right] + B_{oi} (1 + m) \left[\frac{S_{wi} c_w + c_f}{1 - S_{wi}} \right] \Delta p}$$

$$N = \frac{N_p B_o}{(B_o - B_{oi}) + B_{oi} \left[\frac{S_{wi} c_w + c_f}{1 - S_{wi}} \right] \Delta p} \quad G = \frac{G_p B_g - (W_e - W_p B_w)}{B_g - B_{gi}}$$

$$\Delta G_p = (\text{GOR})_{\text{avg}} \Delta N_p$$

$$G_p = \sum (\text{GOR})_{\text{avg}} \Delta N_p$$

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