UNIVERSITY OF IBADAN
DEPARTMENT OF PETROLEUM ENGINEERING
B. Sc. Final Degree Examinations First Semester 2015/2016 Session
TPE 418 BASIC RESERVOIR ENGINEERING TIME 3 HRS
Instructions: Answer all questions.

---

1. (a) List 3 uses and 3 limitations of the Material Balance Equation in oil reservoirs.

   (b) A well is producing from an undersaturated oil reservoir whose pressure is already below the bubble point. It was observed that GOR was becoming very high. Write an equation that demonstrates the impact of GOR under such conditions and List 3 ways by which the GOR could be controlled.

   (c) An undersaturated oil reservoir is producing at a gross liquid rate of 12000 bbl/d. Water cut is 25% while GOR is 800 scf/d. If the initial reservoir pressure was 3500 psia, and current reservoir pressure is 2000 psia, calculate the volume of water that must be injected to maintain the pressure at 2000 psia.

   PVT DATA:
   At 3500 psia, Boi = 1.25 rb/stb, Rsi = 510 scf/stb Bgi = 0.00086 rb/scf
   At 2000 Psia, Bo = 1.18 rb/stb, Rs = 385 scf/stb, Bg = 0.00106 rb/scf, Bw = 1.02 rb/stb

2. (a) Explain steady state, pseudo steady and unsteady state flow

   (b) For a reservoir with the following pressure history, calculate the water influx at the end of each year using the steady state equation. Assume water influx constant of 350 bbls/month/psi.

Time (yrs)	0	1	2	3	4
Pressure psia	3500	3330	3100	2980	2900

   (c) If the above aquifer is assumed circular and infinite, permeability is 1000mD, porosity is 20%, water viscosity of 1 cp, reservoir radius is 2500 ft, total compressibility of 7×10^{-6} psi^{-1}, calculate the water influx under unsteady state condition. Assume water influx constant (B) is 350 bbls/month/psi. State any other assumptions.

3. A small volumetric gas field has an area of 900 acres, initial pressure of 3250 psia, a porosity of 20 %, and connate water of 12%. The gas volume factor at 3250 psia is 262 scf/cu ft and at abandonment pressure of 750 psia is 94 scf/cu ft. Given that the net average productive thickness of the reservoir is 50 ft, calculate:

   (i) The initial in-place gas in scf
   (ii) The initial gas reserves in scf.
   (iii) Explain why the initial reserves depends upon the abandonment pressure selected.
   (iv) Explain why recovery will be lower if this reservoir was under strong water drive.

UNIVERSITY OF IBADAN
DEPARTMENT OF PETROLEUM ENGINEERING
B. Sc. Final Degree Examinations First Semester 2014/2015 Session
TPE 418 BASIC RESERVOIR ENGINEERING TIME: 3 HRS
Instructions: Answer all questions

Q1

a. The quality of a petroleum reservoir can be described by its __________, __________, __________
b. In undersaturated oil reservoirs, GOR control can be achieved by __________, __________ and __________
c. Complete mathematical description of a reservoir system requires the combination of at least 3 equations. List the equations. Flow equ., Equ. of state, Darcy
d. Reservoir pressure response during unsteady state flow can be described mathematically by __________
e. Rate sensitivity in some reservoirs may be due to __________, __________ or __________
f. Two limitations of the material balance equation are __________ and __________
g. Solutions to the general diffusivity equation require specifying rate and __________ conditions
h. While Darcy equation holds at low flow rates, the __________ equation is more appropriate in high rate gas wells.
i. Hydraulic diffusivity can be expressed as: $K/\phi\mu c$
j. When applied in the early life of an oil reservoir, the material balance equation will give:
   a. Optimistic estimates b. Pessimistic estimates c. Accurate estimates ~~d.~~ Zero estimates

Q2

(a) What is a reservoir drive? List 4 conditions that favor gascap drive.

(b) An undersaturated oil reservoir is producing at a gross liquid rate of 12000 bbl/d. Water cut is 25% while GOR is 750 scf/stb. If the initial reservoir pressure was 3500 psia, and current reservoir pressure is 2000 psia, calculate the volume of water that must be injected to maintain the pressure at 2000 psia.

PVT DATA:

At 3500 psia, Boi = 1.22 rb/stb, Rsi = 510 scf/stb Bgi = 0.0100 rb/scf
At 2000 Psia, Bo = 1.15 rb/stb, Rs = 405 scf/stb, Bg = 0.0106 rb/scf, Bw = 1.02 rb/stb

Q3

a) Explain what you understand by steady, semi-steady and unsteady state flow in porous media
b) Given the following data for a reservoir, estimate the STOIIP and Water Influx constant in bbls/month/psi, assuming steady state water encroachment. (Bw = 1.02 rb/stb)

Time (years)	Pressure (psia)	Np (stb)	Wp (bbl)	Gp (MMscf)	Bo (rb/stb)	R s (scf/stb)	Bg (Cu ft/scf)
0	3000	0	0	0	1.350	500	0.0059
1	2850	6,625,800	120,000	3890	1.302	395	0.0083
2	2760	13,156,000	310,000	12150	1.250	350	0.0090

Note: All the terms have the usual connotations

$N = A h \phi$

Q4 Explain why higher oil recovery factors are usually obtained in watr drive reservoirs.

a) Explain why higher oil recovery factors are usually obtained in watr drive reservoirs.

b) The following data are given for an oil Field:
Area = 26,700 acres, Net productive thickness = 49 ft, Porosity = 8%, Average Sw = 45%, Initial reservoir pressure, pi = 2980 psia, Abandonment pressure, pa = 300 psia, Bo at pi = 1.68 bbl/STB, Bo at pa = 1.15 bbl/STB, Sg at pa = 34%, Sor after water invasion = 20%. Calculate the following:

i) Initial oil in place
ii) Oil in place after volumetric depletion to abandonment pressure
iii) Oil in place after water invasion at initial pressure
iv) Oil reserves by volumetric depletion to abandonment pressure
v) Oil reserves by full water drive

Q5

a) Explain why recovery from hydraulic gas reservoirs would be lower than from volumetric reservoirs.

(b) The following data are given for a gas field:
Area = 160 acres, Net productive thickness = 40 ft, Initial reservoir pressure = 3250 psia, Porosity = 22%, Connate water = 23%, Initial gas FVF = 0.00533 Cu.ft/SCF, Gas FVF at 2500 psia = 0.00667 Cu. ft/SCF, Gas FVF at 500 psia = 0.03623 Cu. ft/SCF, Sgr after water invasion = 34%, Find the following:

i) Initial gas in place
ii) Gas in place after volumetric depletion to 2500 psia
iii) Gas in place after volumetric depletion to 500 psia
iv) Gas in place after water invasion at 3250 psia
iv) Gas in place after water invasion at 2500 psia
v) Gas in place after water invasion at 500 psia
vi) Gas reserves by volumetric depletion to 500 psia
vii) Gas reserves by full water drive; i.e. at 3250 psia
ix) Gas reserves by partial water drive, i.e. at 2500 psia
x) List two ways of increasing gas production in water drive reservoirs.

Note: All terms and abbreviations in this paper have the usual connotations

UNIVERSITY OF IBADAN
DEPARTMENT OF PETROLEUM ENGINEERING
B. Sc. Final Degree Examinations First Semester 2013/2014 Session
TPE 418 BASIC RESERVOIR ENGINEERING TIME: 3 HRS
Instructions: Answer all questions

1. (a) Explain why higher recovery factors should be expected in volumetric than in hydraulically-controlled gas reservoirs.

(b) A small gas reservoir has an initial pressure of 3200 psi and temperature of 220 °F. The pressure-production history and gas volume factors are as follows:

Time (Years)	Pressure Psia	Cumulative Gas Production MMSCF	Gas Volume factor, cu ft/scf
0	3200	0	0.0052622
1	2925	79	0.0057004
2	2525	221	0.0065311
3	2125	452	0.0077360

i. Calculate the initial gas in place at the end of each year, assuming volumetric behavior and explain why the calculations suggest a water drive

ii. Show that a water drive exists by plotting the cumulative production versus P/Z

iii. If the actual volume of gas in place is 1018 MMSCF, estimate the volume of water encroached at the end of each year, assuming there was no appreciable water production.

iv. It was assumed that the water influx can be described by the steady state model with water influx constant of 350 bbls/month/psi, is this assumption correct or not?

(40 marks)

2. (a) Write short notes on the following:
   i. Maximum Efficient Rate.
   ii. Characteristics of solution gas drive
   iii. Gas equivalent of produced oil.

(b) An oil reservoir has gas cap whose size is unknown. Water injection was undertaken. The material balance equation when there is no water production is expressed as:

$$N = \frac{N_p[B_t + B_g(R - R_{si})] - W_i B_w}{(B_t - B_{oi}) + (B_g - B_{gi}) m B_{oi} / B_{gi}}$$

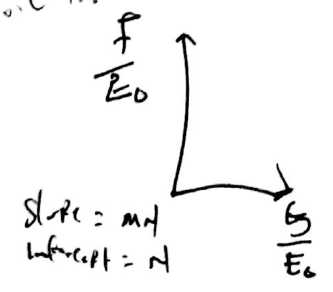
Where $Bt = Bo + (Rsi - Rs)Bg$ and Wi is the water volume injected given in STB.

Pressure Psia	Rs scf/stb	Bo rb/stb	Np MMstb	Rp scf/stb	Wi MMstb	Bg rb/scf	Bt rb/stb
1850	690	1.363	-	-	-	0.00124	1.363
1600	621	1.333	310	1100	159.4	0.00150	1.437
1300	535	1.300	550	1350	261.4	0.00190	1.594
1000	494	1.258	590	1800	312.0	0.00250	1.748

-F1 = 635.97
-F2 = 1566.65
-F3 = 2668.54

Using graphical technique, calculate the initial oil in place and the size of the gas cap when the PVT and production data are as given. The bubble point pressure is 1850 psia. Assume Bw = 1.0 rb/stb.

(40 marks)



FACULTY OF TECHNOLOGY
DEPARTMENT OF PETROLEUM ENGINEERING
B.Sc DEGREE FINAL EXAMINATIONS
FIRST SEMESTER EXAMINATIONS 17TH MAY, 2011 TIME: 8.00AM

COURSE: ~~DRILLING II~~ TPE 418

Basic Reservoir Engg

INSTRUCTIONS: ANSWER ALL QUESTIONS TIME ALLOWED: 3HRS

1. (a) Write short notes on any two natural reservoir drive mechanisms.

   (b) The planimetered areas for reservoir Egg-yoke are given in the following table. Given the average reservoir porosity as 25%, Sw = 15%, Bo = 1.35 rb/stb and Bg = 0.00132 rb/scf, calculate the hydrocarbon volumes for oil and gas initially in place. Use the trapezoidal method (For a map scale: 1 sq. in = 20 acres).

Contour (ftss)	Area (sq. in)
-7200	5
-7250 (GOC)	8.5
-7300	10
-7350	12.5
-7400 (OWC)	15

   (c) What is the oil recovery factor attained if 2 MMstb was recovered from Egg-yoke?

2. (a) State the necessary conditions for the application of the general material balance equation. Write the general MBE as an equation of a straight line. Express clearly each term of the equation using the usual notations. What is the significance of the straight line form of the MBE? $F = N[E_o + mE_g + E_{fw}]$

   allows interpolation & extrapolation of values from the line

   (b) The Mango head Field is a volumetric undersaturated reservoir. The initial reservoir pressure is 3685 psi. The following additional data is available: pb = 1500psi, Swc = 0.24, Bw = 1.0, cw = 3.62 x 10-6 psi^{-1}, cf = 4.95 x 10-6 psi^{-1}

Volumetric average pressure (psia)	Bo (bbl/STB)	Np (MSTB)	Wp (MSTB)
3685	1.3102	0	0
3605	1.3116	364.613	0
3515	1.3128	841.591	0.805
3360	1.3150	1691.887	5.008
3188	1.3170	2575.33	8.000

   Calculate the initial oil-in-place by using the MBE.

   (c) How can you detect water influx into an undersaturated reservoir assumed to be volumetric at initial development using any appropriate form of the Havlena and Odeh plots? *N.B: The reservoir is still above the bubble point.*

Gas 3. (a) When the p/Z versus Gp points for a gas reservoir is extrapolated to zero pressure, what can be obtained from the plot? This linear extrapolation is valid

volumetric depletion

only under certain assumptions. State any three of the assumptions. What effect does water influx have on gas recovery in gas reservoirs? Support your answer with an illustration.

(b) The production data for a gas field is given in the following table. Assume volumetric behaviour and calculate the following

(i) Determine the initial gas in place

(ii) What percentage of the gas will be recovered at a p/Z of 1000?

(iii) If 200 Mstb of liquid hydrocarbons is recovered in the stock tank, calculate the Gas Equivalent (GE) volume if the liquid has a molecular weight of 138 and 45°API.

$\Rightarrow N = 200 \times 10^3$

$M_o = 138$

45°API

p/Z (psia)	G_p (bscf)
6553	0.393
6468	1.642
6393	3.226
6329	4.260
6246	5.504
6136	7.538
6080	8.749

$\gamma = 0.8017$

4. (a) Briefly discuss any two aquifer models (excluding the van Everdingen & Hurst model). State whether the models are steady state or unsteady state models.

(b) A wedge reservoir-aquifer system with as encroachment angle of 60° has the following boundary pressure history:

Time (days)	Boundary pressure (psi)
0	2850
365	2610
730	2400
1095	2220
1460	2060

Given the following aquifer data:

h = 120 ft, $c_f = 5 \times 10^{-6}$ psi^{-1}, $c_w = 4 \times 10^{-6}$ psi^{-1}, $\mu_w = 0.7$ cp, k = 100 md, Ø = 12%, T = 140°F, reservoir area = 40,000 acres, aquifer area = 980,000 acres

Calculative he cumulative water influx as a function of time by using the van Everdingen and Hurst method after 1460 days.

37 169211

UNIVERSITY OF IBADAN

B. Sc. (Petroleum Engineering) Degree Examination

PPE 418 Basic Reservoir Engineering; October 12, 2004 Time: 3 Hrs.

Instruction: Answer all Questions

Q1

(a) Write short notes on the following:

i. Mechanics of primary oil recovery

ii. Uses of the material balance equation

iii. Developed reserves

(b) Given the following data for an oil reservoir below bubble point, determine the original oil in place and the water influx constant. State clearly any assumptions made.

Date	Pressure (psia)	Np (mmstb)	Rp (scf/stb)	Wp (mm bbls)	Bo (rb/stb)	Bg (rb/scf)	Rs (scf/stb)
1-1-70	2720	0		0	1.373	1.322	490
1-1-74	1720	9.004	990	0.024	1.284	1.623	417
1-1-76	160[illegible]	11.620	980	0.360	1.270	1.743	387

Q2

(a) Explain why initial calculations of gas in place are likely to be in greater error during the early life of depletion type reservoirs.

(b) Using volumetric method, the initial volume of gas in a reservoir is calculated to be [illegible] MMM scf underlying 2250 productive acres, at an initial pressure of 3500 psia and [illegible]. The pressure-production history is:

Pressure (psia)	Cumulative Gas Production (MMM scf)
3500	0
[illegible]	75

(c) Assuming no water influx, estimate the initial volume of gas in place using the pressure production history. Explain the possible conclusions that can be made from the differences in the values obtained from the two methods.

Q3

(a) Explain how you would recognize a condensate gas reservoir at the time of discovery and how you would control GOR during production from such reservoirs.

(b) Calculate the daily gas production including the condensate and water gas equivalents for a reservoir with the following daily production:

Separator gas production = 9 MM scf

Condensate production = 142 stb

Stock tank gas production = 40 M scf

Fresh water production = 15 bbl

Bottom hole temperature = 198 oF

Initial reservoir pressure = 6000 psia

Current reservoir pressure = 2000 psia

Water vapour content at 6000 psia and 198 oF = 0.86 Bbl/MM scf

Condensate gravity = 50 oAPI

University of Ibadan

DEPARTMENT OF PETROLEUM ENGINEERING

B.Sc. DEGREE EXAMINATIONS FIRST SEMESTER 2004/2005 SESSION

TPE 418 Basic Reservoir Engineering: Material Balance **Time Allowed: 3hrs**

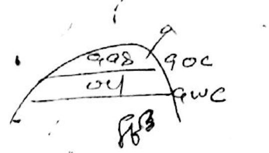
INSTRUCTIONS: Answer ALL Questions

1. (a) Discuss the technical role of a reservoir Engineer in an oil producing company.

   (b) Given the following Planimeter readings obtained for a reservoir, estimate the initial oil and gas in place. Use Trapezoidal rule and assume that porosity = 0.29, S_{wi} = 0.23, B_{oi} = 1.1098 rb/stb and B_{gi} = 0.00859 rb/scf. Planimeter constant = 1.544 acres/p.u.

$HCIIP = c \times \phi . h (1 - S_w) A$

Contour (ft.ss)	Area (P.U.)
-8000	7
-8050	310
-8100(GOC)	445
-8150	567
-8200(OWC)	718



2. (a) Write the general material balance equation for oil reservoirs as a straight line equation and discuss its uses and limitations.

   (b) Derive the general material balance equation for gas reservoirs.

   (c) Given the following pressure-production history for a gas reservoir, estimate the revenue expected from gas sales. Assume reservoir temperature = 160 oF, gas gravity = 0.675 (air =1), Gas price = N15/scf. Gas recovery factor = 0.78, abandonment pressure = 500 psia.

Reservoir Pressure, *Psia*	3000	2500	2000	1500
Cumulative gas produced *(MMMscf)*	0	150	329	511

3. (a) Explain the following terms and their significance in the oil industry
   - (i) Gas cycling.
   - (ii) Rate sensitive reservoirs
   - (iii) Mechanics of primary oil recovery
   - (iv) Developed reserves

   (b) Using an appropriate mathematical expression, explain why GOR control is important when producing from an undersaturated oil reservoir whose pressure is below the bubble point. What practical techniques are available for achieving successful GOR control?

4. (a) Explain the basic differences between steady state and unsteady state flows.

UNIVERSITY OF IBADAN

B.SC. (Petroleum Engineering) Degree Examinations **First Semester 1997/98 Session** **2/9/98**

TPE - 425 Reservoir Engineering I **Time - 3 Hours only** **Answer ALL questions**

1 (a) Define the term petroleum reserves. Differentiate between developed and undeveloped reserves.

(b) The following data were obtained for a reservoir. Make the Area-depth plot. Estimate the initial oil in place, free gas in place and solution gas.

CONTOUR (ft.ss)	AREA (Acres)
-7050	0
-7100	50.91
-7150*	197.99
-7200	322.30
-7250**	468.88
-7300	630.76

* GOC , ** OWC

Porosity = 22%, Water saturation = 13%, Net/Gross = 0.65, Boi = 1.32 rb/stb, Bgi = 221 scf/cu. ft. and solution GOR = 320 scf/stb.

2 (a) Derive from first principles, the general material balance equation for gas reservoirs. What modifications would you make in order to apply the expression to gas condensate reservoirs? What are the limitations of the material balance equation?

(b) A well drilled into a gas cap for gas recycling purposes is found to be an isolated fault block. After injecting 50 MMscf, the pressure increased from 2500 to 3500 Psia. Deviation factors for the gas are 0.9 at 3500 and 0.8 at 2500 Psia and the bottom hole temperature is 160 oF. What is the cubic feet of gas storage space in the fault block? If the porosity is 16%, connate water saturation is 24% and average sand thickness is 12 feet, what is the areal extent of the fault block? Under what conditions would you recommend gas cycling? What are the advantages and disadvantages of gas cycling?

3 (a) Write short notes on any four of the following:

- Mechanics of primary oil recovery
- Uncertainty in reserves estimation
- Rate-sensitive reservoirs
- Characteristics of solution gas drive

- Reservoir drive indices

(b) Estimate the average petrophysical parameters for a sand with the following data

Well Number	1	2	3	4
Porosity (%)	18	22	20	15
Water Saturation (%)	8	13	12	9
Sand thickness (ft)	120	130	117	165

The following data are available for E2 reservoir

Reservoir data

P_i = 2720 psia, B_{oi} = 1.373 rb/stb, S_w = 0.25, porosity = 0.22, radius = 5600 ft, C_w = 4.5 * 10^{-6}/psi, C_f = 3 * 10^{-6}/psi, m = 0, P_b = [illegible]

Aquifer Data

Thickness = 72 ft, water viscosity = 0.37, encroachment angle = 140 degrees, permeability = 33 mD, C_w = 4.5 * 10^{-6}/psi, C_f = 3 * 10^{-6}/psi

PVT data

Pressure (psia)	Bo rb/stb	Bg rb/scf	Rs scf/stb
1957	1.3135	1.418	479
1720	1.2843	1.623	[illegible]
1607	1.2703	1.743	[illegible]
1462	1.2525	1.923	[illegible]
1268	1.2286	2.232	300

Production data

Time (years)	Press. (Psia)	Np (MMstb)	Rp (scf/stb)	Wp (bbls)
2	1957	4.995	1070	0.000
4	1720	9.004	990	0.024
6	1607	11.62	950	0.360
8	1462	14.18	972	0.980
10	1268	16.45	1018	1.994

It appears from seismic evidence that the relative aquifer size might correspond to re/rw = 9. Part of the recorded production appears to have originated from a second reservoir and a closer analysis of the production data suggests that some of the listed Np -values may be somewhat too large. Perhaps the following data are more reliable: T = 2 years, Np = 4.146 MMstb; T = 4 years, Np = 8.373 MMstb. Analyse the data and estimate the initial oil in place. State clearly your assumptions.

(b) Given a reservoir having the following pressure history and reservoir data calculate the water influx at 400 and 600 days assuming (i) steady state model and (ii) unsteady state model. What conclusion(s) can you derive from the results?

Time (days)	0	100	200	300	400	500	600
Boundary Pressure (psia)	3795	3780	3770	3740	3695	3680	3625

Aquifer/Reservoir Data
Porosity = 0.21, Permeability = 540 md, thickness = 60 ft., Viscosity = 0.25 cp, effective compressibility = 0.0000007/psi Encroachment angle = 180° Aquifer area = 250000 acres, reservoir area = 1216 acres.

N_e V_w

Steady

UNIVERSITY OF IBADAN

FACULTY OF TECHNOLOGY

B. Sc. (PETROLEUM ENGINEERING) DEGREE EXAMINATIONS

FIRST SEMESTER 2005/2006 SESSION

TPE 418: Reservoir Engineering IV

Instructions: Answer ALL Questions *Time: 3 hrs*

---

1. a) Write short notes on the following:
   I. Rate sensitive reservoirs
   II. Elements of a petroleum reservoir
   III. Solution gas drive.
   IV. Gravity segregation

   b) Given the following data for an oil reservoir, estimate the initial [illegible] in place.
   Initial reservoir pressure = 5000 psig
   Initial reservoir temperature = 220 oF
   Boi = 1.355 rb/stb
   Bob = 1.391 rb/stb
   Average Reservoir pressure = 3600 psig
   Bo at 3600 psig = 1.375 rb/stb
   Connate water = 16 %
   Average Porosity = 27%
   Cumulative Oil produced = 1.25 mmstb
   Water influx = 0 bbl
   Rock compressibility = 5.0 * 10^{-6} psi^{-1}
   Water compressibility = 3.6 * 10^{-6} psi^{-1}
   State clearly any other assumptions made.

2. a) Differentiate between undersaturated and saturated oil reservoirs.

   b) Explain why fractional recovery could be high in oil reservoirs producing under water drive, but low in case of gas reservoirs producing under water drive.

   c) Given the following data obtained by planimetering SAM reservoir, estimate the stock tank oil in place and Free gas initially in place. Assume porosity = 24%, Water saturation = 16% Boi = 1.52 rb/stb and Bgi = 1084 scf/bbl.

Contour (ft.ss)	AREA (acres)
5950	0
6000 (GOC)	250
6050	410
6100	550
6150 (OWC)	700
6200	980

Note: Boi, Bgi, Gp, scf, etc bear the usual connotations.

a) Derive an expression for the general material balance equation for a gas reservoir. Explain the limitations of the equation

b) The pressure- production history and gas volume factors of a gas reservoir are as follows:

Pressure (psia)	Gp (MMscf)	Bg (cu ft/scf)
3200	0	0.0052622
2925	79	0.00570004
2525	221	0.0065311
2125	452	0.0077360

i) Calculate the initial gas in place using the production data at the end of each of the production intervals, assuming volumetric behavior.

ii) Explain why the calculations of part i above indicate a water drive and show that a water drive actually exits by plotting the cumulative production versus p/z

4

a) Explain what you understand by steady, pseudo-steady and unsteady state flow in porous media.

b) An aquifer has an area of 40,000 acres. The oil area is 890 acres. Porosity = 23 %, rock and water compressibility is 4 * 10^{-6} and 3 * 10^{-6} vol/vol/psi respectively. Aquifer thickness is 60 ft and permeability = 100 md. Water viscosity = 0.3 cp. Assuming the aquifer - reservoir system is circular and concentric estimate the water influx at the end of 200, 400 and 800 days given the following pressure history. State clearly any assumptions.

Pressure (psia)	3600	3450	3380	3300	3280
Time (days)	0	100	200	400	800

University of Ibadan
DEPARTMENT OF PETROLEUM ENGINEERING
B.Sc. DEGREE EXAMINATIONS FIRST SEMESTER 2008/2009 SESSION

TPE 418 Basic Reservoir Engineering **Time Allowed: 3hrs**
INSTRUCTIONS: Answer **ALL** Questions

---

1. (a) Discuss the major technical duties of a reservoir engineer in an oil producing company.
(b) Given the following planimeter readings obtained for a reservoir, estimate the initial oil and gas in place. Use Trapezoidal; rule and assume that porosity = 0.29, Swi = 0.23, Boi= 1.112 rb/stb and Bgi = 0.0086 rb/sscf. Planimeter constant = 1.544 acres/.p.u.

Contour (ft.ss)	**Area (P.U.)**
-7000	9
-7050	270
-7100 (GOC)	365
-7150	447
-7200 (OWC)	628

2. (a) Derive the general MBE for gas reservoirs and discuss its uses and limitations
(b) Given the following pressure-production history for a gas reservoir, estimate the revenue expected from gas sales. Assume reservoir temperature = 160°F, gas S.G = 0.67 (air =1), Gas price = N8/scf. Recovery factor =0.8, abandonment pressure = 500 psia.

Reservoir Pressure, Psia	3000	2500	2000	1500
Cumulative gas produced, mmscf	0	150	329	511

Gas

3. (a) With illustrations, explain the causes and characteristics of the following:
(i) Edge-Water drive (ii) Bottom-Water drive
(iii) Solution gas drive (iv) Rate sensitive reservoirs

(b) An undersaturated oil reservoir is producing at an oil rate of 12000 bbl/d. Water cut is 15% while GOR is 800scf/stb. If the initial reservoir pressure was 3500 psia, and current reservoir pressure is 2000 psia, calculate the volume of gas that must be injected to maintain the pressure at 2000 psia. Assume the following PVT data:
At 3500 psia, Boi = 1.25 rb/stb, Rsi = 510 scf/stb Bgi = 0.00086 rb/scf
At 2000 Psia, Bo = 1.18 rb/stb, Rs = 385 scf/stb, Bg = 0.00106 rb/scf

4. (a) Explain what you understand by steady state, pseudo-steady and unsteady state flow.
(b) Given a reservoir having the following pressure history and petrophysical data, calculate the water influx at 400 and 600 days assuming (i) steady state model and (ii) unsteady state model. What conclusion(s) can you derive from the results?

Time (days)	**0**	**100**	**200**	**300**	**400**	**500**	**600**
Pressure, Psia	**3795**	**3780**	**3770**	**3740**	**3695**	**3680**	**3625**

Aquifer/Reservoir Data
Porosity = 0.21, Permeability = 540 md, thickness = 60 ft., water viscosity = 0.25 cp, effective compressibility = 0.0000007/psi. Encroachment angle =180° Aquifer area = 77824 acres, reservoir area = 1216 acres.

UNIVERSITY OF IBADAN
DEPARTMENT OF PETROLEUM ENGINEERING
B. Sc. Final Degree Examinations First Semester 2011/2012 Session
TPE 418 BASIC RESERVOIR ENGINEERING TIME 3 HRS
Instructions: Answer all questions

---

1. (a) List 3 uses and 3 limitations of the Material Balance Equation in oil reservoirs.

   (b) A well is producing from an undersaturated oil reservoir whose pressure is already below the bubble point. It was observed that GOR was becoming very high. Write an equation that demonstrates the impact of GOR under such conditions and List 3 ways by which the GOR could be controlled.

   (c) An undersaturated oil reservoir is producing at a gross liquid rate of 12000 bbl/d. Water cut is 25% while GOR is 800 scf/d. If the initial reservoir pressure was 3500 psia, and current reservoir pressure is 2000 psia, calculate the volume of water that must be injected to maintain the pressure at 2000 psia.

   PVT DATA:
   At 3500 psia, Boi = 1.25 rb/stb, Rsi = 510 scf/stb Bgi = 0.00086 rb/scf
   At 2000 Psia, Bo = 1.18 rb/stb, Rs = 385 scf/stb, Bg = 0.00106 rb/scf, Bw = 1.02 rb/stb

2. (a) Explain steady state, pseudo steady and unsteady state flow

   (b) For a reservoir with the following pressure history, calculate the water influx at the end of each year using the steady state equation. Assume water influx constant of 350 bbls/month/psi.

Time (yrs)	0	1	2	3	4
Pressure psia	2500	2330	2100	1980	1900

   (c) If the above aquifer is assumed circular and infinite, permeability is 1000mD, porosity is 20%, water viscosity of 1 cp, reservoir radius is 2500 ft, total compressibility of 7×10^{-6} psi^{-1}, calculate the water influx under unsteady state condition. Assume water influx constant (B) is 350 bbls/month/psi. State any other assumptions.

3. A small volumetric gas field has an area of 800 acres, initial pressure of 3250 psia, a porosity of 19.2 %, and connate water of 13%. The gas volume factor at 3250 psia is 262 scf/cu ft and at abandonment pressure of 750 psia is 94 scf/cu ft. Given that the net average productive thickness of the reservoir is 50 ft, calculate:
   (i) The initial in-place gas in scf
   (ii) The initial gas reserves in scf.
   (iii) Explain why the initial reserves depends upon the abandonment pressure selected.
   (iv) Explain why recovery will be lower if this reservoir was under strong water drive.

(b) Given a reservoir having the following pressure history and reservoir data, calculate the water influx at 400 and 600 days assuming (i) steady state model and (ii) unsteady state model. What conclusion(s) can you derive from the results?

Time (days)	0	100	200	300	400	500	600
Boundary Pressure (psia)	3795	3780	3770	3740	3695	3680	3625

Aquifer/Reservoir Data

Porosity = 0.21, Permeability = 540 md, thickness = 60 ft., Viscosity = 0.25 cp, effective compressibility = 0.0000007/psi, Encroachment angle = 180° Aquifer area = 250000 acres, reservoir area = 1216 acres.

$(P_i - P)\Delta t$

W_e V_w

Steady

and

UNIVERSITY OF IBADAN

Department of Petroleum Engin ring

PPE 418 Reservoir Engineering I Time: 1 hr. Instructions: Answer all Questions

The following readings were obtained when a reservo r map was planimetered. Use both Trapezoidal rule and Simpson's first rule to estimate the stock tank oil initially in place given that the reservoir thickness is 200 ft, Porosity i 23%, Sw = 12%, and oil formation volume factor is 1.53 rb/stb. Explain the difference, if an between the two results.

Contour (ft. ss)	Area (acres)
-6800	37
-6850**	152
-6900	306
-6950	524
-7000	825
-7050**	987

* Gas oil contact ** Oil water co ict

$\frac{7758}{B_{oi}}$

h h conversio to

$\underset{stb}{STOII} = \frac{rb}{B_{oi}} = \frac{r}{B_{gi}}$

comp

2. An undersaturated oil reservoir is producing oil at a rate of 10,00 bbl/d. Water cut is 27% while GOR is 850 scf/d. If the initial reservoir pressure was 3500 psia, and current reservoir pressure is 2000 psia, calculate the volume of gas that must be injec d to maintain the pressure at 2000 psia.

PVT DATA:

At 3500 psia, Bo = 1.25 rb/stb, Rs = 510 scf/stb Bgi = 0.00086 rb/scf

At 2000 Psia, B = 1.18 rb/stb, Rs = 385 scf/stb; Bg = .00106 rb/scf

scf = rb/scf

scf × s

An aquifer has the follwing petrophysical parameters and bou dary pressure history. Calculate the cumulative water influx at 500 days for re/rw = 8.0 case.

Petrophysical parameters

Aquifer area = 28850 acres, Reservoir Area = 451 acres, Porosity = 0.24, Thickness = 0 ft.

Rock compressibility = 4 x 10⁻⁶ psi⁻¹, Permeability = 2000 md. Water viscosity = 0.3 cp

Water compressibility = 3.0 x 10⁻⁶ psi⁻¹

$N_p R_s = R_s - R_s$

Time (days)	0	100	200	300	400	500
Pressure (psia)	3600	3500	3470	3430	3400	3380

$STOIIP = \frac{N}{B_o}$

$\boxed{N_p B_o = N}$

$\frac{N_p}{B_o}$

$\frac{G_p}{N_p} = 850$

$G_p = 850 \times 10,0$

$\frac{scf}{stb}$ $\frac{scf}{day}$

$\frac{scf}{day} = \frac{stb}{day} \times \frac{scf}{stb}$

$N_p [B_o + (R_{si} - R_s) B_g$

$N_p [B_o + (R_p - R_s) B_g]$

Scanned by CamScanner