EPS-443 – Properties of Petroleum Reservoirs
Fall Semester 2005

Course Logistics

Class Information:

Section: GX
Time: S, T 9:00-9:50
Location: B 55 Lab 113
Web page: www.kau.edu.sa/hnaji

Instructor:

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Required Text:

1. Petrel User's Manual
2. Ahmed, T., "Reservoir Engineering Handbook," Second Edition, GPP.
3. Ahmed, T., "Advanced Reservoir Engineering," First Edition, GPP.

Supplemental Texts:

Craft, B.C., M. Hawkins, Revised by Ronald E. Terry: "Applied Petroleum Reservoir Engineering," Second Edition, Prentice Hall, 1991.

Course Description

A closer look at the geological and geophysical parameters required for building 3D geological models of petroleum reservoirs. Wells location maps, well logs, seismic sections, and contour maps. Use of Schlumberger software packages; Neurascanner, Neuralog, Interactive Petrophysics, and Petrel. Basic concepts of petroleum reservoir simulation. A closer look at the simulation process. Data gathering and input for reservoir simulators. Analysis of simulation results. Term project.

Course Objectives

The course aims at preparing students to understanding reservoirs, gather geological and geophysical parameters necessary for building 3D geological models of petroleum reservoirs. The student will know his exact role in the process of reservoir simulation. He will be acquainted with the software packages used in the industry.

Sample Exams

EPS-443: Properties of Petroleum Reservoirs
Midterm Exam
Second Semester 1425

Name: **SS#:**

1. A 1.015 gas-saturated water sample exists at 3000 psia and 160F. Calculate the following:

   - Water formation volume factor
   - Water viscosity
   - Gas solubility

2. Draw a typical phase diagram of a volatile oil sample.

3. Draw typical liquid-shrinkage curves for the different oil systems.

4. A hydrocarbon sample with the following composition:

Component	Mole Fraction
C1	0.25
C3	0.25
C7+	0.5

Classify the above sample.

5. Use Ahmed correlation to find the critical properties (T_c and P_c) of the C_{25} fraction. Compare your calculated values to those of Katz-Firoozabadi.

6. A proposed gas well is being evaluated. Well spacing is 640 acres and it appears that the entire 640 acres is productive. Geological estimates indicate 30 ft of net effective pay, 15% porosity, and 30% interstitial water saturation. The initial pressure is 3000 psia and the reservoir temperature is 150 °F. The abandonment pressure is estimated to be 500 psia. The gas gravity is expected to be 0.6. Base temperature and pressure are 60 °F and 14.65 psia, respectively. Estimate the gas reserve.

7. A sandstone core which came from a 1500 acre-ft reservoir was tested using restored natural state method (simulates initial reservoir conditions). The following data was generated:

Core length	= 8	cm
Core diameter	= 2.5	cm
Weight of oil extracted	= 2.33	gm
Weight of water extracted	= 1.25	gm
SG_o	= 0.80	
SG_w	= 1.05	

Calculate original oil in place (OOIP) of this Middle East sample. Use Marhoun correlations when needed. Operating conditions are 3000 psia and 200 °F. Specific gravity of the dissolved gas is 0.70.

Properties of Petroleum Reservoirs
EPS-443 Final Exam
Fall 2003

Name: **SS#:**

1. Permeability is considered a measure of the cross-sectional area of a pore. Use this observation to answer the following questions:

a. Is capillary pressure greater in a high permeability reservoir or a low-permeability reservoir? Justify your answer.

b. Is the transition zone thicker in high permeability reservoir or a low-permeability reservoir?. Justify your answer.

2. In an oil reservoir, reservoir pressure is maintained by the bottom water drive. Does this concept applies to a gas reservoir?. Justify your answer. Mention two techniques to increase production from a gas reservoir.

3. In the same order that we have taken in the class, write down all input data required to conduct a reservoir simulation study.

4. List three relative permeability models that can be used in a simulation study.

5. Define the productivity index of a wellbore?. Write its descriptive equation?. Define its terms.

Properties of Petroleum Reservoirs
EPS-443 Final Exam
Fall 2002

Name: **SS#:**

1. Fill in the table by giving ranges for porosity values:

Rock Type	**Porosity Range**	**Typical Value**
SS		
LS		
DL		

2. Write down the definition of porosity?. If a sandstone core came from a 1500 acre-ft reservoir was tested using restored natural state method (simulates initial reservoir conditions), and the following data was generated:

Core length	= 8 cm
Core diameter	= 2.5 cm
Weight of oil extracted	= 2.33 gm
Weight of water extracted	= 1.25 gm
SG_o	= 0.80
SG_w	= 1.05
B_o	= 1.48 RB/STB

Use your definition of porosity to calculate the original oil in place (OOIP).

3. Write down Darcy's Law for linear & radial flow of oil. Use both laws to find out the oil flow rate in the field.

Field data - 1 well

acre spacing	= 160 acres
formation thickness	= 25 ft
oil viscosity	= 2.3 cp
well diameter	= 8 inches
pressure at external radius	= 3600 psi
wellbore pressure	= 2200 psi

Laboratory test data on a core from above reservoir

linear-horizontal flow test	
pressure difference across sample	= 30 psi
cross-sectional flow area	= 3 in^2
core length	= 6 in
oil viscosity	= 0.8 cp
oil flow rate	= 1.0 BOPD

4. Draw the typical curves for the oil-water and oil-gas relative permeabilities.

5. Draw typical curves for oil-water & oil-gas capillary pressures.

EPS-443: Properties of Petroleum Reservoirs
Mid-Term Exam
Spring 2004

Name: **SS#:**

Problem #1: A gas sample with 0.8 specific gravity was supplied to you. Use the given charts and equations to find its physical properties at a pressure of 1500 psia and temperature of 200 EF:

1. The pseudo-critical pressure and pseudo-critical temperature (P_{pc} & T_{pc}).

2. The pseudo-reduced pressure and pseudo-reduced temperature (P_{pr} & T_{pr}).

3. The gas deviation factor (Z).

4. Gas compressibility (C_g) using the following equation

5. Gas density (D_g) using the following equation

6. Gas formation volume factor (B_g) using the following equation

7. Gas viscosity (μ_g) at atmospheric pressure using the chart:

Problem #2: A 40E API oil sample with solution gas/oil ratio of 800 SCF/STB at the bubble-point pressure. From what you know, find the following physical properties at a pressure of 4500 psia and temperature of 150 EF Knowing that the gas specific gravity is 0.72:

1. Bubble-point pressure

Standing proposed a mathematical correlation for determining the bubble-point pressure of crude oil systems.

$$P_b = c\left(\frac{R_{sb}}{\gamma_g}\right)^{0.83} - 25.48$$

where:

$$c = (18.2)10^{-0.0125\,API + 0.00091\,T}$$

and

R_{sb} = solution gas-oil ratio at a pressure higher than or equal to the Pb, SCF/STB
($_g$ = average specific gravity of total surface gases (air=1)
API = oil API gravity (water=10)
T = system temperature, EF
p = system pressure, psia.

2. Solution Gas-Oil Ratio

Standing proposed a mathematical correlation for determining the solution gas-oil ratio as a function of pressure. He presented the following expression:

$$R_{so} = \gamma_g \left[\left(\frac{p}{18.2} + 1.4 \right) 10^a \right]^{1.20482}$$

where

$$c = \frac{10^{0.0125\,API - 0.00091\,T}}{18.2}$$

and

R_{so} =solution gas-oil ratio at pressure p and temperature T, SCF/STB
γ_g = average specific gravity of total surface gases (air=1)
API = oil API gravity (water=10)
T = system temperature, EF
p = system pressure, psia.

Problem #3: A 1.015 gas-saturated water sample exists at 3000 psia and 160F. Calculate the following:

- Water formation volume factor
- Water viscosity
- Gas solubility
- Isothermal compressibility