Exam AES1340

Applied Reservoir Engineering and Simulation (Part 1)

19 June 2007
9:00-12:00

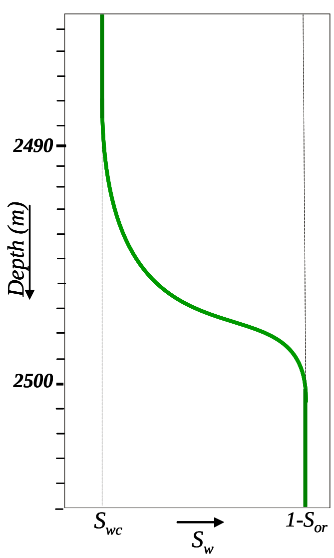
Name:
Student number:

Question 1:

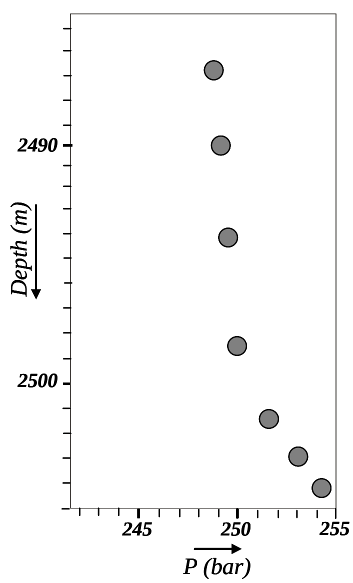
a) In a well drilled in a reservoir with a constant permeability, the water saturations as plotted in Graph 1 have been found. Please indicate which part is the transition zone and why.

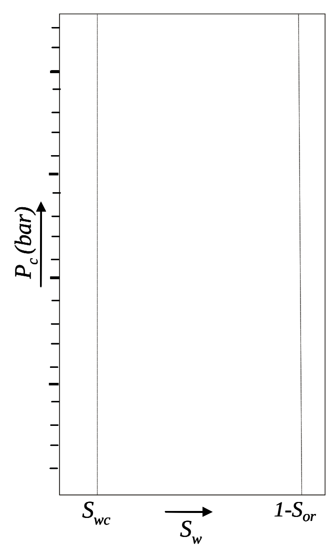
b) Assuming a density of 1000 kg/m^3 for water, 650 kg/m^3 for oil and g of 10 m/s^2, construct the capillary pressure curve for this rock type in Graph 2.

c) Assume that in question (1a), the rock permeability is 100 mD. Plot in Graph 1 what you would expect the water saturation to be if there was a thief zone of 1000 mD at the depth of 2496 m to 2497 m.



Graph 1



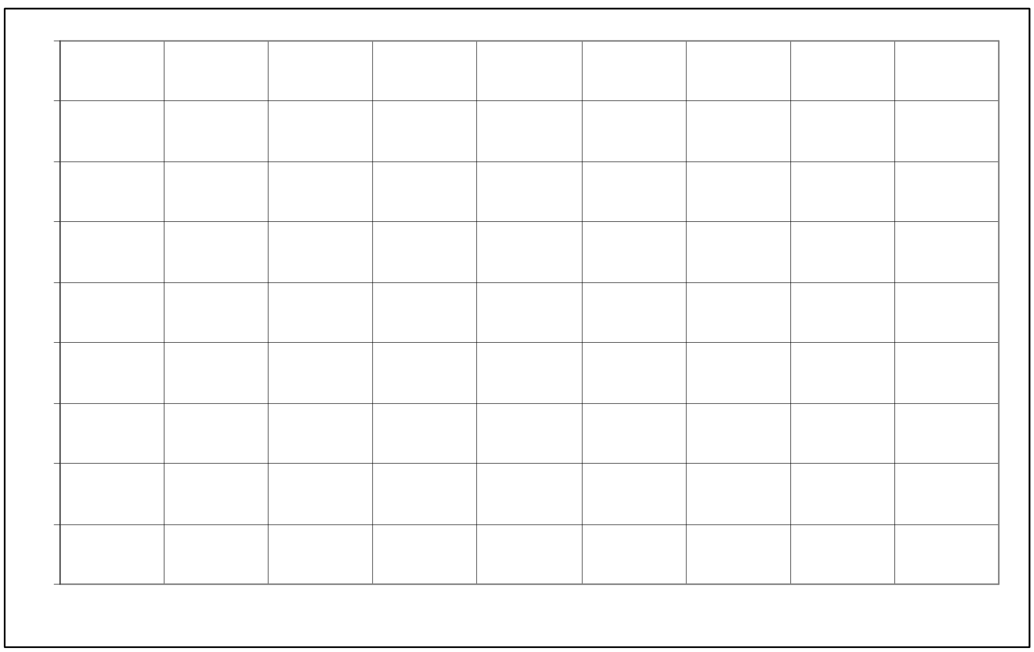


Graph 2
Distance between thick marks is 50 bars

Question 2:

a) Given a gas reservoir with an initial pressure of 300 bar and a GIIP of 10 billion m^3 (1 billion is 10^9), what would be the gas recovery factor for this gas reservoir when the pressure has been depleted to 60 bar. The Z factor at reservoir temperature as function of pressure is given in the table below. Please use Graph 3 to illustrate your derivation.

P [bar]	***Z***
50	0.946
60	0.937
100	0.908
150	0.893
200	0.902
250	0.929
300	0.968



Graph 3

b) Assuming the same abandonment pressure of 60 bar but with a strong water influx, what would now be the maximum gas recovery factor? Assume a residual gas saturation of 30%. Illustrate your result in Graph 3.

Question 3:

a) Write down the linearised oil material balance in the format of Havlena & Odeh, using the individual elements as given below and explain the individual terms.

$$\begin{cases} F = N_p\left(B_o + \left(R_p - R_s\right)B_g\right) + W_p B_w \\ E_o = \left(B_o - B_{oi}\right) + \left(R_{si} - R_s\right)B_g \\ E_g = B_{oi}\left(\dfrac{B_g}{B_{gi}} - 1\right) \\ E_{f,w} = -\left(1+m\right)B_{oi}c_e dP \end{cases}$$

b) How would you simplify the equation under a pure solution gas drive (no gas cap, no aquifer influx), ignoring rock compressibility?

c) How would you derive the STOIIP under these conditions?

Question 4:

a) How does wellbore storage influence the pressure response in a drawdown test?

b) How does wellbore storage influence the pressure response in a build-up test?

c) How would you avoid well bore storage?

Question 5:

a) How do you derive the permeability and initial reservoir pressure from a build up well test using the Horner plot?

b) Explain in which time period this method is valid and how you could check this.

Question 6:

a) Write down the Darcy equation and indicate which terms you could influence to improve ultimate oil recovery and why.

b) Give the three most important methods to achieve above and explain the main concept of each recovery method in 4 or 5 lines.

Question 7:

a) For steam flooding Marx-Langenheim have derived the following heat balance:

$$m_s H_s = h(\rho c)_1 \Delta T \frac{dA_s}{dt} + 2\Delta T \sqrt{\frac{\lambda_2 (\rho c)_2}{\pi}} \int_0^t \frac{1}{\sqrt{t-t'}} \frac{dA_s}{dt} dt'$$

b) Describe in words the meaning of the left hand side term and the first and second term on the left side (also the meaning of the integral).

c) What conditions will favor a heat efficient displacement.