Exam AES1340

Applied Reservoir Engineering

examination 18 April 2013
14:00-17:00

Name:
Student number:

Use separate sheets to write your answers and clear derivation with name and student number indicated at the top. Also present them in the logical order from answer 1 to the last answer. An answer without derivation or explanation will receive a lower score than a complete answer.

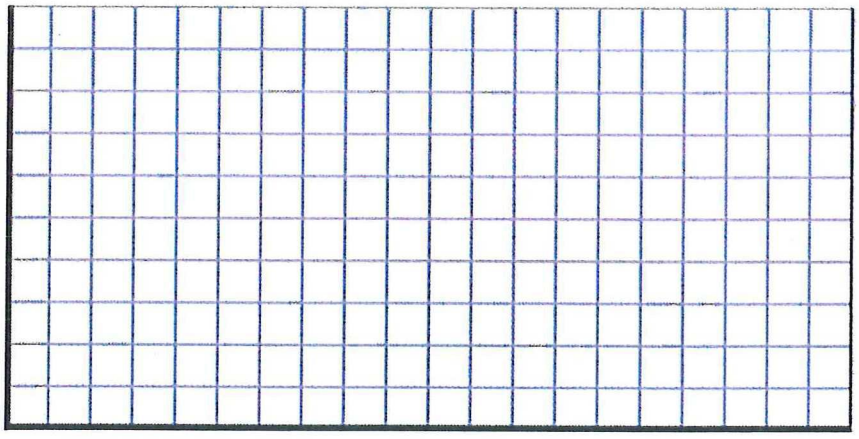
Question 1:

a) Your company has discovered a new field with 200 million barrels (mln bls) STOIP and an integrated team has studied development options for two years. They present the preferred option to management with an ultimate recovery of 75 mln bls. Management likes the plans but the financial director still needs to consider if the company can afford this development. Under which category will you book the 75 mln bls under the SPE classification system?
b) Sketch the future changes in classification of these volumes over the life time of the field, and explain why any change occurs.
c) What is the difference between proved and possible reserves?

Question 2:

Consider the following set of production data:

year	cum oil (1000 bls)	rate (b/d)
1	0	500
2	183	2000
3	913	4500
4	2555	4172
5	4078	3584
6	5386	3434
7	6639	2916
8	7704	2829
9	8736	2470



a) What is the expected UR at an abandonment rate of 500 b/d?
b) What principle have you used and why is that justified? Would you consider your result optimistic or pessimistic?
c) In year 9 you do an aggressive infill campaign which unfortunately will not raise ultimate recovery but will accelerate production. How can you create a forecast for the new oil rate over time?

Question 3:

a) Write down the Havlena & Odeh material balance equation (MBE) and describe in words what the terms represent.

b) To what would this equation reduce if you consider a waterflood without any pressure decline? Describe what this equation means.

Question 4:

Consider a gas reservoir, which is being depleted under pressure depletion with no sign of any aquifer.

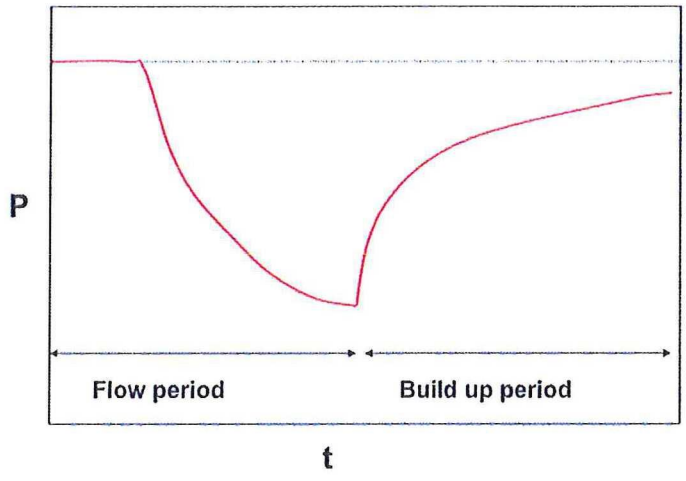
a) How can you derive the ultimate gas recovery of such a reservoir from early performance data? Describe the methodology and the key factors that influence your end-of-life condition.

b) Pressure decline has created significant earthquakes and the government wants to shut your field down. What alternative methods do you have to raise recovery factors? Illustrate in a graph how you can derive the expected recovery for an alternative method.

Question 5:

Consider well test analysis using type curves

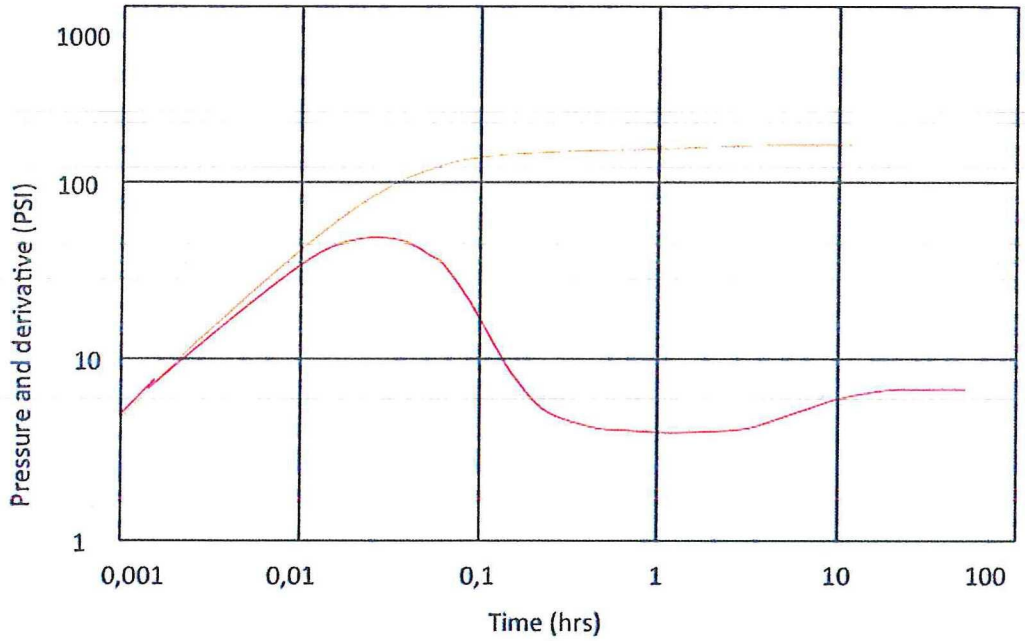
a) Consider the well test data as sketched: what would your best approach be to analyze this data: what to plot against what (be specific on which values you will use).



b) What is the equation for the derivative-curve in type-curve matching? Indicate the key aspect of this curve under purely radial flow.

c) Consider the plot below and derive the permeability.

d) Towards the end the curve changes. What is the most likely explanation for this?



Independent data

flow rate drawdown	1000 b/d	Note that
Bo	1.22	1 bls = 0.156 m^3
viscosity	1 cP	1 cP = 0.001 Pa.s
Porosity	30%	1 bar = 14.5 psi = 100,000 Pa
Total compressibility	2 10^{-5}/psi	
well radius	0.1 m	
Reservoir height	30 m	

Question 6:

A new field has been discovered and proves to be mixed to oil-wet. You need to model the initial conditions and the subsequent waterflood of this field.

a) Which capillary pressure curve(s) do you need to use in the process?

b) Sketch the capillary pressure curve(s) and illustrate how the process of waterflooding for different parts of the reservoir progresses in this sketch.

Question 7:

a) What key vertical well patterns can be considered for a field development? Indicate the injector/producer ratio.

b) What will be your main argument to choose between one or the other?

c) How can you adjust the pattern step-wise by drilling more vertical wells? Describe under which conditions you would do this.

d) Describe the advantages and disadvantages for horizontal wells

Question 8:

a) Describe the key principle of Dykstra Parson's method to derive production in a non-communicating layered system.

b) Derive the formula for x_f for a particular layer.

c) What happens when $x_f>1$ and describe how you proceed in the analysis.

d) What is the difference with a Buckley Leveret analysis and how can both be integrated?

Question 9:

In steam flooding the Marx-Langenheim method solves the following equation:

$$m_s H_s = (\rho C)_1 (T_s - T_r) * h \frac{dA}{dt} + 2 \frac{k(T_s - T_r)}{\sqrt{\pi \alpha_2}} \int_0^t \frac{1}{\sqrt{(t - t_k)}} \frac{dA_k}{dt_k} dt_k$$

a) Describe the key terms of this equation.

b) What is the significance of the integral on the right hand side and why is there a root in the denominator?

c) Why is a steamflood above 150 bar useless?

d) Why do operator like to keep the pressure for a steamflood as low as possible?

Question 10:

a) Sketch and describe what a type III phase behavior of a surfactant system is?

b) Why is this type III phase behavior so important?

c) What is the role of Alkaline in an ASP flood?

d) What is (are) the key concern(s) of using alkaline?