Exam AES1340

Applied Reservoir Engineering

examination 14 April 2011
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 answer 7. An answer without derivation or explanation will receive a lower score than a complete answer.

Question 1:

a) What should an operator have to do to book proven developed reserves?

b) What are contingent resources?

c) Consider an oil field of 1000 mln blls where the facilities are build and in operations. You booked 300 mln blls proven reserves at the start of the project. After 5 years you have produced 80 mln blls, but decline curves and monitoring efforts indicate that you may not get all the remaining 220 mln blls. They are not really certain about a volume of 40 mln, and it would likely need some extra wells.
Would you change your reserves booking and if so, how?

Question 2:

a) Write down the Havlene MBE formulation and describe the key terms.

b) If in your water injection project, you expected pressure to stay constant but it is declining, what is the most likely cause. What would be your next step?

c) If in your water injection project, you expected the pressure to decline slowly, but instead it declines much less, what is the most likely cause. What would be your next step?

Question 3:

a) In a gas development, would injection of nitrogen help in gas recovery? Explain.

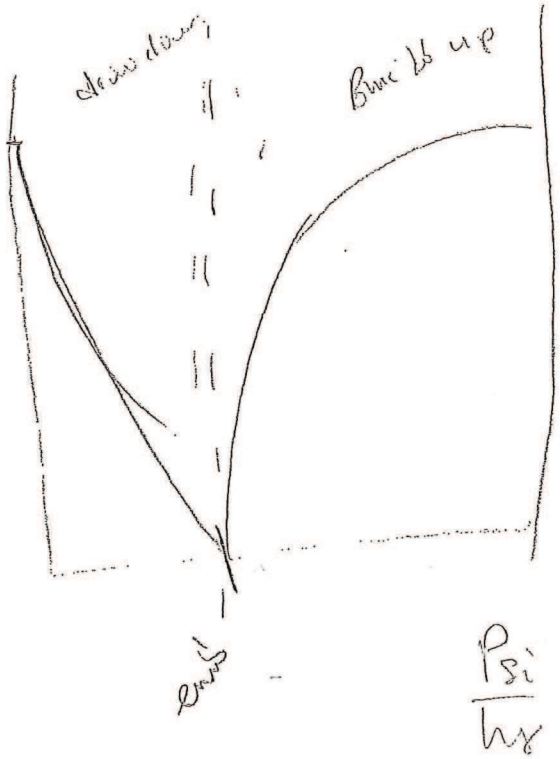
b) If it would be beneficial, what would be against doing this? How would you mitigate? If it would not be beneficial, what would you do instead?

Question 4:

a) Given the following data, do a Horner analysis of the build-up and derive the permeability. Be clear on the equations you use.

time [hrs]	pressure [psi]
0	
0,012063	3571,266
0,053179	3393,69
0,111658	3347,114
1,033557	3269,431
2,170113	3246,75
20,08747	3175,08
100,2102	3099,767
145,2064	3079,677
210,4066	3059,009
238,09	3052,02
238,0911	3076,184
238,1007	3235,929
238,1772	3463,19
238,2972	3501,14
238,6471	3534,143
239,5877	3564,652
242,1166	3593,926
250,3407	3626,894
275,3619	3665,466
292,0977	3679,472
351,4874	3706,722
402,4049	3718,97

end of drawdown



Known parameters in SI units

q	0,006944	m3/s
Bo	1,2	
μ	0,002	Pa/s
h	75	m
c	1,00E-09	1/Pa
rw	0,1	
Gamma	0,5772	
1 psi =	6896,5	N/m2

$P_{average}$ if reservoir is already producing.

for an infinite reservoir $P = P_i$; for a finite reservoir $P_{average}$ indicate magnitude of reservoir

5:16 b) What are the two key aspects you can take away from p^* (no need to derive the value !)

5:11 c) What is a radius of investigation, provide formula and where do you use it for?

$r_{inv} = 0.029\sqrt{\frac{kt}{\phi \mu c_t}}$ it's valid only when flow regime is transient

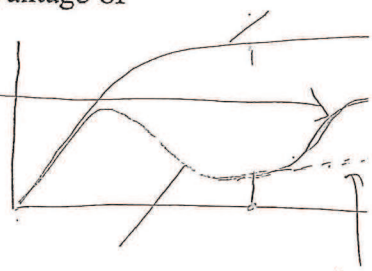
r_{inv} is the drainage radius.

Question 5: Lec 02 Lec 02

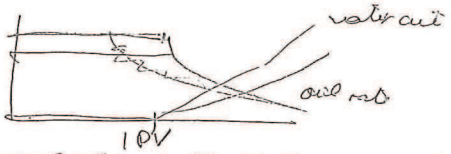
5:17 a) Sketch the principles of a diagnostic log-log analysis of a well test. Indicate which two curves you use. Δp and $t\frac{dp}{dt}$.

b) Why can you use one set of axis for both curves and what is the advantage of doing so?

5:18 c) Sketch the expected shapes in case your well is very close to a fault:



indicate a deviation



Question 6: Lec 3a

a) Consider a symmetry element of a 5-spot. Sketch the expected the anticipated water cut as function of PV injected and argue your profile through the use of stream lines.

b) How do you convert a 5-spot into a 9-spot. How would it influence you answer under a) add producer with decrease with water cut decrease the drawdown to improve production

Question 7: Lec 3b $\Delta p = P_R - P_{wf}$ 18 (2) = drawdown. 20 20 MPa

7:10 a) In a dipping reservoir, you inject at the bottom and you produce at the top. Where do you expect to find residual oil saturations? bottom

6:16 b) If the reservoir is very layered with no communication between the layers, how would you calculate the Dykstra Parson coefficient? $V(DP_{wf})_{lin} = \frac{k_{ro} - k_{ro1}}{k_{ro}}$

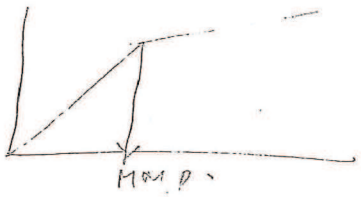
c) Can you use the Dykstra Parson analysis in this case. If not, indicate in principle how you would modify the analysis? streamline. Because in this Dykstra it considers crossflow + PL displacement between layers

Question 8: EOR

9:7 a) Derive the equation for the maximum Oil-Steam-Ratio in a steam injection project

b) What is the first step in a steam injection project concerning the oil producers? Steam breakthrough is the 1st concern for the producer mitigation: decrease the drawdown of the well.

producer producer to avoid water + gas override



Question 9: EOR

10:11 a) At 100 bar and standard temperature, is CO2 a gas or a liquid? liquid

miscible m

10:08 b) What is MMP and how do you determine it?

10:11 c) What are the 3 key advantages of a CO2 flood (from a subsurface perspective)
can be stored, miscible w/ oil at low P, recovery higher than other gases.

d) How can you improve the sweep of a CO2 flood? WAG

e) What are key concerns in a CO2 flood? corrosion.
gas migration

fill thin beds w/ oil, inject gas, initially oil recovery will ↑ fast as → immiscible displacement
then after some time, gas will dissolve in oil → miscible displacement

plateau the change in slope = MMP
low values, 1 curve)