Exam ta3440 Petroleum Engineering

April 6, 2006

Duration: 3 hours

Question 1:

1.a) Indicate the five stages of the oil or gas field development. Which stages imply the highest expenditure? Which stage generates most cash? [0.5]

1.b) Sketch the production profiles corresponding to: (a) high initial investment and (b) low initial investment. [0.5]

1.c) Sketch the pressure-temperature diagram for the hydrocarbon mixture. Then draw discuss a possible production path. [0.5]

Question 2: The oil material balance equation below consists of one term on the left and four terms on the right.

$$N_p\left[B_o+\left(R_p-R_s\right)B_g\right]=N\left[B_o-B_{oi}+\left(R_{si}-R_s\right)B_g\right]+mNB_{oi}\left(\frac{B_g}{B_{gi}}-1\right)$$

$$+NB_{oi}\left(1-m\right)\left(-\Delta P\right)\frac{c_wS_{wc}+c_f}{1-S_{wc}}+\left(W_e-W_p\right)B_w$$

2.a) Sketch the oil formation volume factor Bo, the solution gas oil ratio R_s and the gas formation volume factor B_g as a function of pressure including the bubble point pressure. [0.5]

2.b) Give the meaning of all the subscripts. [0.25]

2.c) Give the meaning of the remaining symbols that have been discussed during the lectures. [0.25]

2.d) Give the physical meaning of the term on the left. [0.5]

2.e) Relate the terms NB_{oi} and mNB_{oi} to the volume of gas and oil initially in place. [0.5]

2.f) Give the physical meaning of the first term on the right.[0.5]

Question 3: A well has a PI of 1 m^3/day/kPa. Initially the reservoir pressure is 26 MPa.

3.a) What is the production rate when the flowing bottomhole pressure is 25 MPa? [0.5]

3.b) The intake pressure curve for the well is shown in figure 2, for two tubing sizes (4 ½ and 5 ½ inch). Estimate the initial production rate for each size of tubing. [0.5]

3.c) The 5 ½ inch tubing is installed. If the PI stays constant, as the reservoir pressure drops, what is the lowest reservoir pressure at which the well will flow, with the chosen size of tubing? [0.5]

3.d) When the reservoir pressure reaches 24 MPa, the well is stimulated, increasing the PI by 50%. What is the increase in production rate in m^3/day? [0.5]

3.e) The stimulation costs $100 thousand. Estimate how quickly the extra production pays for the stimulation? Would you recommend carrying it out? [0.5]

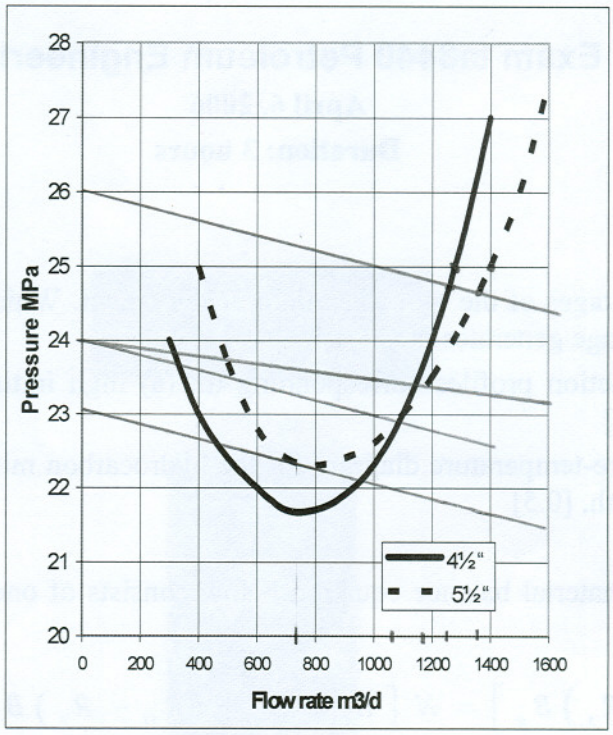

Figure 2: Pressure intake curves.

Question 4

4.a) Give at least 2 examples of product specifications for each of the following products: oil, gas and water. Explain the motivation of the definition of these product specifications. [0.5]

4.b) Give two typical examples of contaminants in produced gas. What is the reason for separating these from the gas? Give an example of a possible purification process and explain the process. [0.5]

4.c) What is commonly done to maximize the recovery of ethane, propane, butane and heavier hydrocarbons from natural gas liquids (NGL)? Make a schematic drawing of the process and explain the separation process. [0.5]

4.d) Make a schematic drawing of an oil, water and gas separator. Which elements are crucial for the functioning of the separator? [0.5]

Question 5:

5.a) Name 5 functions of drilling mud. [0.5]

5.b) Two wells have been drilled into an oil-water reservoir. One of them only penetrates the water layer, and pressure measurements at depths of 5300 and 5500 ft resulted in pressures of 2385 and 2475 psia. The other well only penetrates the oil layer, and pressure measurements at 4700 and 4950 ft resulted in pressures of 2158 and 2250 psia. What is the depth of the free water level? [0.5]

5.c) What is the NPV of the following cash flow at discount rates of 0 and 15%? [0.5]

Table 1: Undiscounted cash flow

Time (year)	1	2	3	4	5	6
Cash flow (10^6 $)	-4.2	-3.3	5.9	3.2	2.1	0.8