Exam Petroleum Engineering (TA3440)
25 AUGUST 2008   9:00 – 12:00

Instructions

- This exam consists of 10 questions, some of which are divided in sub-questions. The rating of each question is indicated behind the question in brackets. In total 10 points can be earned.

- If you cannot answer a sub-question and can therefore not proceed to the next sub-question, guess the answer and proceed anyway.

- State your assumptions and explain your answers.

- The exam is 'closed book'.

- **Exams written with pencil cannot be accepted!**

Questions

1.

    a. Sketch carefully the schematic pressure-temperature diagram for hydrocarbon mixtures and indicate therein the main types of hydrocarbon reservoirs. [0.5]

    b. Explain the concept of retrograde condensation. [0.25]

    c. Draw in the diagram a typical production path for a black oil reservoir. [0.25]

2.

    a. State Dalton's Law of partial pressures. How is it used to determine the composition of the liquid and gas phases in a separator? [0.5]

    b. A new separator system is to be designed. State one main criterion for optimising the composition of the liquid output stream. State one main criterion for optimising the composition of the gas output stream. What is the disadvantage if too many light components are kept in the liquid phase? [0.3]

    c. Give three factors which determine the size of a separator. [0.25]

    d. Give two reasons for using a vertical separator rather than a horizontal separator. [0.2]

3. List and briefly define three major components of a long-term gas contract. [0.7]

4. Explain why maintaining a steady production rate from a gas reservoir can be difficult, and give at least two ways one might maintain production at a constant rate in spite of these difficulties. [0.7]

5. Figure 1 below depicts an intake performance curve (IPC) for the tubing in combination with an inflow performance relationship (IPR) for the reservoir.
   a. What are the closed-in and flowing bottomhole pressures for this well? [0.5]
   b. What is the PI for this well? [0.5]
   c. If we stimulate the well with acid to improve the inflow performance, how will the IPR change? Sketch the IPR (qualitatively) in the figure. [0.5]
   d. If we do not stimulate the reservoir, and the reservoir pressure drops to 24 MPa, what will be the production rate of the well? [0.5]
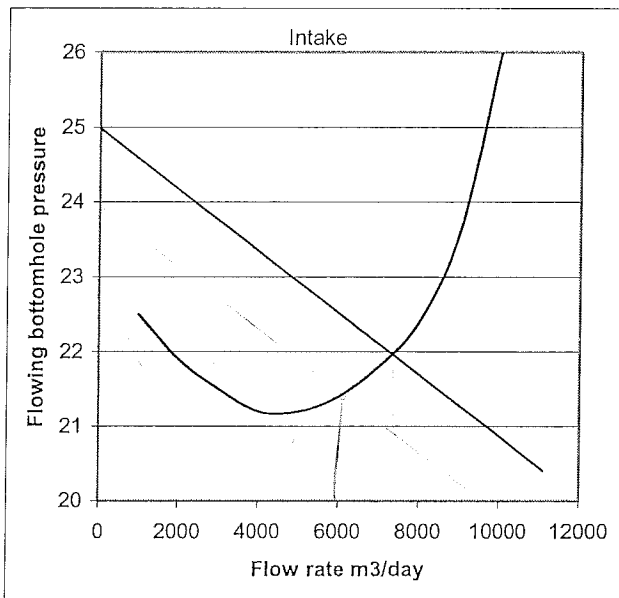

Figure 1: Intake pressure curve. Pressures in MPa.

6. Why does drilling mud need to have a certain viscosity? What is a disadvantage of very viscous mud? [0.5]

7. 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? [1.0]

8. Table 1 depicts the drilling costs, facilities costs and expected production for a heavy-oil development project. Use an oil price of 20 $/bbl, a discount rate of 15%, a 40% royalty, a variable Opex of 4.5 $/bbl and neglect fixed opex and taxes.

a. Is the real oil price (August 2008) higher or lower than 20$/bbl? [0.1]

b. Why is the expected production initially going up, but later in the field life going down? [0.5]

c. How many years does it take before the project becomes economical? [1.0]

Table 1: Heavy oil development project data			
Time (year)	Drilling costs $	Facilities ($)	Production (bbl/d)
1	$55 * 10^6$	$70 * 10^6$	0
2	$55 * 10^6$	$30 * 10^6$	15,000
3	$55 * 10^6$		35,000
4	$55 * 10^6$		55,000
5			40,000
6			31,000
7			23000
8			16000
9			10000
10			5000

9. In petroleum engineering the oil flow rate q_o of a an oil-water mixture flowing through a horizontal cylindrical core is expressed by Darcy's law as:

$$q_o = \frac{kk_{ro}A\Delta p}{\mu_o L} \quad ,$$

where L is the length of the core, A it's cross-sectional area, and Δp the pressure drop. What are the parameters k, k_{ro} and μ_o and what are their dimensions in SI units? Show that the equation is dimensionally consistent. [0.5]

10. List 5 elements of an HSE management system. [0.75]