Petroleum Production Systems
(석유생산시스템) (G17702)

- 2019 Final Examination -

Student ID: **Name:**

Notice

- Fill your name in the following:

"I, _____, swear I solve all problems by myself in this final examination.
I will take any disadvantages if any dishonesty such as cheating is acted on my solution."

5 points will be deducted from your total score if you do not fill in your name above.

Problem 1.

Define each formation volume factor and draw the corresponding graph as a function of reservoir pressure.

(a) Oil formation volume factor (B_o) [2 pts.]

(b) Gas formation volume factor (B_g) [2 pts.]

(c) Solution gas/oil ratio (R_s) [2 pts.]

Problem 2.

Draw the PVT diagrams for the following fluid types. Explain the phase behavior of each fluid type with its PVT diagram when the fluid pressure decreases from the initial reservoir pressure to the separator pressure [15 pts.].

(a) Dry gas

(b) Wet gas

(c) Gas condensate

(d) Volatile oil

(e) Black oil

Problem 3.

A well produces 12,000 STB/D of oil at a producing gas/oil ratio (GOR) of 1,500 scf/STB. The oil gravity is 38°API and the gas gravity is 0.82. What are the oil and gas production rates and densities in SI units? [3 pts.]

Problem 4.

For single-phase pipe flow, derive the general expression for the pressure drop per unit length d*p*/d*s* by combining Mass Balance, Momentum Balance, and Equation of State [10 pts.].

Problem 5.

Explain flow regimes in horizontal flow and those in vertical flow. What are the main differences between the former and the latter? [10 pts.]

Problem 6.

A tubing intake curve for single-phase flow displays a monotonically increasing relationship between flow rate and FBHP. This is intuitively correct: An increase in flow rate, at a given FTHP, requires an increase in FBHP. However, a tubing intake curve for multiphase flow typically displays a minimum, as shown below. At low flow rates, an increase in rate corresponds to a decrease in FBHP. Explain this seemingly counterintuitive behavior [10 pts.].

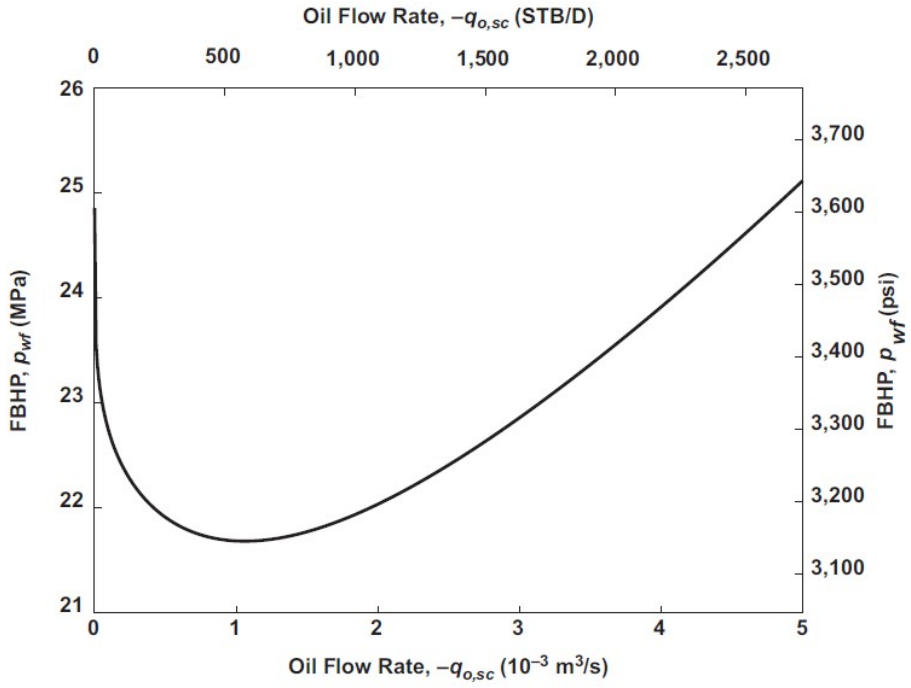


Fig. 4.8—Tubing intake curve for varying production rate.

Problem 7.

Answer the following questions on flow through restrictions.

(a) What is the meaning of restriction? [3 pts.]

(b) Why is the temperature at the throat of a gas choke lower than at the entrance? [3 pts.]

(c) Why is it often desirable to operate a wellhead choke in the critical regime? [3 pts.]

(d) Why does critical choke flow not occur for single-phase oil? [3 pts.]

(e) Why are the expressions for critical flow over a choke much more approximate than for critical flow over an orifice? [3 pts.]

Problem 8.

Consider single-phase oil flow under semi-steady-state conditions toward a well in the center of a circular reservoir with parameters given in the Table below. What is the PI expressed in SI units and in field units? [10 pts.]

Property	Value	Units
B_o	1.12	-
H	35	ft
k_o	84	mD
$p_{R,av}$	5,600	psi
r_e	2,100	ft
r_w	0.33	ft
R_{sb}	145	scf/STB
S	0	-
T_R	230	°F
γ_{API}	29	ºAPI
γ_g	0.78	-
μ_o	2.54	cp

Problem 9.

Derive an expression for the steady-state PI of a vertical well located at a distance *D*/2 from a vertical sealing fault in a circular homogeneous isotropic reservoir with a large drainage radius. How do you interpret your result if D approaches zero? [10 pts.]

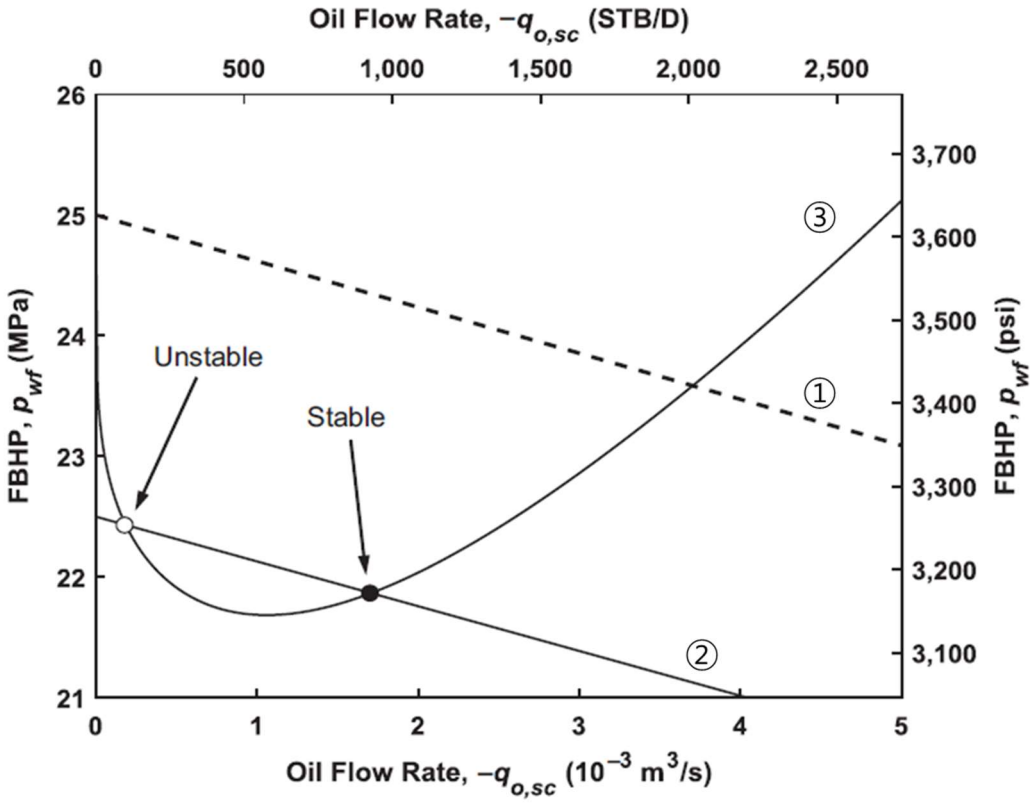
Problem 10.

The figure below shows effects of a drop in reservoir pressure.

- The straight-line ① is the IPC (inflow performance curve) under the original reservoir condition.

- The straight-line ② is the IPC (inflow performance curve) after depletion of the average reservoir pressure.

- The curve ③ is the VLP (Vertical Lift Performance) of given production facilities.



(a) Explain the reason why the relationship between reservoir pressure decline and production decline is usually disproportional. [2 pts.]

(b) What causes the occasional appearance of two intersections between upstream and downstream performance curves? [2 pts.]

(c) Prove which of the corresponding operating points is the physically realistic one mathematically [5 pts.].

(d) Why is nodal analysis not of any help in indicating which of the points is physically realistic? [2 pts.]

---------- This is the End of the Final Examination ----------