**National Exams May 2018**

# 17-PET-A5-Petroleum Production Operations

**(Duration 3 hrs)**

**NOTES:**

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM.
   Any non-communicating calculator is permitted.

3. FOUR (4) questions constitute a complete exam paper.
   The first four questions as they appear in the answer book will be marked.

4. Each question is of equal value.

**Problem-1 (25 points)**

Based on the data obtained from a recent isochronal test, the following IPR relationship was developed.

$$q_L = 0.02\left[P_R^2 - P_{wf}^2\right]^{0.8}$$

Stabilized Test Data:

| $P_{WF}$, psig | $Q_L$, STBL/Day |
|---|---|
| 2800 | 1420 |

**a-) (10 points)** The well is producing 100% oil at the current reservoir condition. Determine the oil production rate, STBO/D, when the flowing bottomhole pressure is 1800 psig.

**b) (15 points)** If in the later stage of the reservoir life, the average reservoir pressure goes down to 2400 psi, determine the oil production rate from this reservoir when the flowing bottomhole pressure is 1800 psi Note that 40% water production is anticipated at this stage of the reservoir life.

**Problem-2 (25 points)**

Following data are pertinent to current reservoir condition:

| | | |
|---|---|---|
| Bubble Point Pressure: | 4600 | psig |
| Average Reservoir Pressure : | 4500 | psig |
| Wellbore Radius: | 0.5 | ft |
| Drainage Radius: | 3000 | ft |
| Water Cut, fw : | 0 | |
| Skin Factor, S' = | 8 | |

Stabilized Test Data:

| $P_{WF}$, psig | $Q_L$, STBL/Day |
|---|---|
| 4000 | 500 |

a-) (10 points) Determine the oil production rate under current reservoir condition when the flowing bottomhole pressure is 2000 psig.

b-) (15 points) After performing a hydraulic fracturing job, well started producing 25% water ($f_w$ = 0.25). A production test was conducted after the frac job and the following data were obtained:

| $P_{WF}$, psig | $Q_L$, STBL/Day |
|---|---|
| 3662 | 2000 |

Determine the anticipated Oil Production Rate (STBO/D) after the Frac Job at the flowing bottomhole pressure of 2000 psi. Is this a successful frac job? Explain!

**Problem-3 (25 points)**

Suppose that the IPR curve for a well is given by the following relationship:

$$q_L = 1407\left[1 - 0.2\frac{P_{wf}}{\bar{P}_r} - 0.8\left(\frac{P_{wf}}{\bar{P}_r}\right)^2\right]$$

The other relevant data are given as follows:

Wellhead pressure = 400 psig.
Average Reservoir Pressure = 4000 psig
Bubble Point Pressure = 4100 psi
Well Depth = 5000 ft
Tubing ID = 2.441 in.
GLR = 300 SCF/STBL
$f_w$ = 0.5

**a-) (10 points)** The desired oil production rate is 400 STBO/Day. Determine if the well will flow at the desired oil production rate.

**b-) (15 points)** If you would like to increase the oil production rate up to 600 STBO/Day. Determine if the GLR=300 SCF/STBL is sufficient for this well to produce at the desired rate. If not, how much additional gas needs to be injected into the tubing? (Note that the water cut (fw) and wellhead pressure are the same as in part a)

**4.(25 points)**

The following table summarizes the results obtained when designing the unloading valves for a gas lifted well.

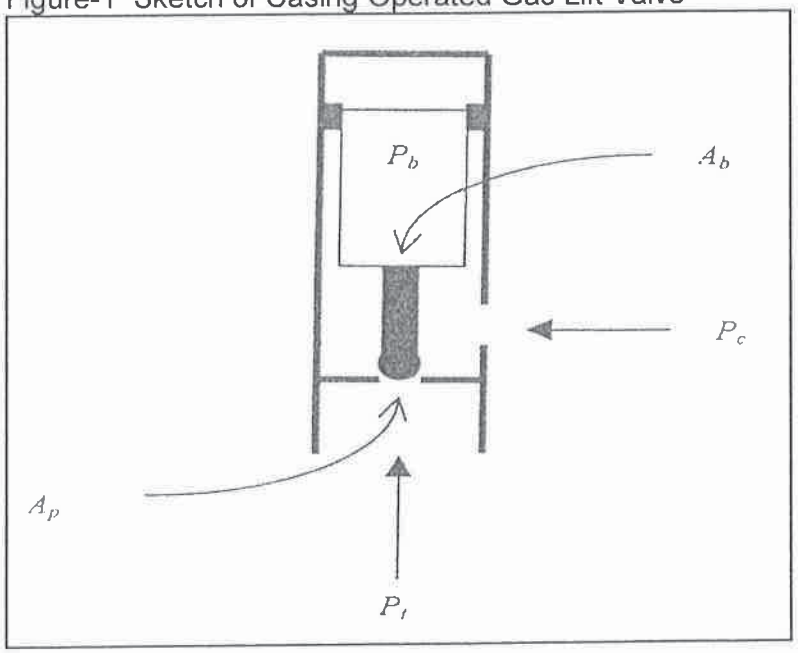
| Valve Number | Depth of Valve ft | Tubing Pressure (psi) Pt | Casing Opening Pressure (psi) Pvo |
|---|---|---|---|
| 1 | 1700 | 490 | 970 |
| 2 | 2600 | 600 | 968 |
| 3 | 3300 | 680 | 962 |
| 4 | 3850 | 750 | 953 |
| 5 | 4300 | 800 | 942 |

**a-) (10 points)** The ratio between the port area (Ap ) and the bellow area(Ab) R=Ap/Ab equals to 0.1534 for all the valves, calculate the bellow's nitrogen pressure, Pb, for valve number 3.

**b-) (10 points)** Calculate the valve closing pressure, Pvc, at depth for valve number 3.

**c-) (5 points)** Assuming the casing gas pressure gradient is constant and equal to 20 psi/1000 ft calculate the surface opening pressure, Pso, and the surface closing pressure, Psc, for valve number 3.

Figure-1 Sketch of Casing Operated Gas Lift Valve



**5. (25 points)**

Casing having an OD of 13.375 in. and an ID of 12.415 in. is to be cemented at a depth of 2500 ft. The hole size is 17 in. A 40 ft shoe joint will be used between the float collar and the guide shoe.

It is desired to place a 500 ft column of high strength slurry at the bottom of the casing. The high strength slurry is composed of Class A cement mixed using 2% calcium chloride and a water-cement ratio of 5.2 gal/sack.

The upper 2000 ft. of the annulus is to be filled with a low density slurry of Class A cement mixed with 16% bentonite and a 5% sodium chloride and a water-cement ratio of 13 gal/sack.

Specific gravity of Class A cement is 3.14.
Specific gravity of bentonite is 2.65.
Specific gravity of $CaCl_2$ is 1.96.
Specific gravity of NaCl is 2.16.

Compute the slurry volume and number of sacks required if the excess factor in the annulus is 1.75.

## NOMENCLATURE

$Q_L$ = Liquid production rate, STB/Day
$P_{wf}$ = Flowing Bottomhole pressure, psig
$P_R$ = Average Reservoir Pressure, psig
Pb = Bubble point pressure
$f_w$ = Water cut, fraction
GLR = Gas liquid ratio, SCF/STBL