National Exams December 2017
98-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.

Note 3 sheets of graph paper follow the exam questions.

Problem-1 (25 points)

A well was tested for 10 hours at a rate of about 120 STB/D while the wellbore flowing pressure was recorded as 600 psi. After shutting the well in for 24 hours, the bottomhole pressure reached a static value of 1200 psi. The rod pump used in this well is considered undersized, and a larger pump can be expected to reduce wellbore flowing pressure to a level near 350 psi (bubble point pressure is 300 psi). Calculate the following:

a-) Productivity index J

b-) Absolute open flow based on constant productivity index

c-) Wellbore flowing pressure required to produce 150 STB/D

d-) Oil production rate for a wellbore flowing pressure of 350 psi.

e-) Draw the IPR curve and indicate the calculated quantities.

Problem-2 (25 points)

Average Reservoir Pressure :	P_R	= 4000 psig
Bubble Point Pressure	P_b	= 4200 psig
Wellbore Radius:	r_w	= 0.4 ft
Drainage Radius:	r_e	= 2000 ft
Skin Factor: .	S'	= 4.18

Stabilized Test Data

P_{WF}, psig	Q_{oil}, STB/Day
3000	1615

a-) (10 points) Construct the IPR curve for this reservoir under current conditions.

b-) (15 points) After performing hydraulic fracturing job, a production test was conducted and the following data were obtained:

P_{WF}, psig	Q_{oil}, STB/Day
3430	1100
2500	2470

Is this stimulation job successful? Explain!

Problem-3 (25 points)

It is hoped to flow a well at an oil production rate of 400 STBO/Day. The reservoir has a productivity index of 0.5 STBL/day/psi and the current static (average) reservoir pressure is 2800 psi. The well is equipped with a 4000 ft of 2 7/8 in (ID=2.441 in) tubing and the required wellhead pressure is 160 psi. The producing gas liquid ratio is 100 SCF/STBL and %50 water production is expected.

Other relevant information:
Bubble point pressure: 3000 psi
Gas Gravity: 0.65
Oil API Gravity: 35
Water Specific Gravity: 1.07
Average Flowing Temperature: 150 °F

a-) Will the well flow at the desired rate (i.e. 400 STBO/dav)?

b-) If you would like to increase the oil production rate up to 500 STBO/Day. How much gas (SCF/Day) you would need to inject into the tubing? Assume reservoir pressure, productivity index, water cut, wellhead pressure, and the gas/liquid ratio provided by the reservoir are all the same as in part a.

4- (25) points
The following oil well will be completed in an unconsolidated formation by using gravel packing scheme. Determine the anticipated producing capacity of this well for perforating densities of 8 shots per foot. Assume that there is no compacted zone around the perforations. Production test data showed that the liquid production rate is 2200 STB/day when the flowing bottomhole pressure is 2400 psi.

From DST and PVT Analysis:

$k_o = 100$ md

S' = 0

$\mu_o = 0.9$ cp

$B_o = 1.20$ *bbl / STB*

$\rho_o = 50$ *lbm / ft*^{3}

} *assume constant*

GOR = 1000 scf/STB

API = 35°

$P_R = 2800$ *psig*

$f_w = 0$

$p_b = 3000$ *psig*

$T_R = 180$ °F

$\gamma_g = 0.65$

COMPLETION DATA

$r_w = 4.25$ *in.*

$h = 40$ *ft*

Depth = 10000 ft.

Tubing I.D. = 2.441 in.

Perforation diameter = 0.5 in.

$r_e = 1200$ *ft.*

Screen diameter = 4.5 in.

$p_{wh} = 160$ psig

Gravel permeability = 40 darcies

Casing I.D. = 6.5 in.

Problem-5 (25 points)

The following well is going to be equipped with Electrical Submersible Pump (ESP) set at 6,000 ft from the surface. Assume that 50% of the free gas is separated at the pump. Assume that producing fluid flowing pressure gradient (psi/ft) in the 7in (ID) casing is given by:

$dP/dL = 0.0001*q_L$

q_L = the total liquid flow(production) rate, STBL/day
dP: Pressure drop, psi
dL: Unit length of casing, ft

Other relevant data:
Depth of Well : 7, 000 ft
Productivity Index, J = 1 bbl/day/psi
Average Reservoir Pressure= 1800 psi
Average Flowing Temperature: 200 °F
Desired Oil Production Rate: 1000 STBO/day
Oil Gravity = 35°API
Bo = 1.1 Bbl/STB
Gas Gravity = 0.65
$f_w = 0$
Gas Liquid Ratio = 400 SCF/STBL
Tubing Wellhead Pressure: 160 psi
Tubing ID = 2.441 in.

Determine the required pump horsepower.

NOMENCLATURE

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