UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

SECOND SEMESTER EXAMINATIONS, MAY, 2015

COURSE NO: PE 380
COURSE NAME: **PETROLEUM OPERATIONS OF PROBLEM WELLS**
CLASS: **PE III** TIME**: 3 HRS.**

Name**:** _____ Index Number: _____

SECTION A: ANSWER ALL (30 MARKS)

1. Which of the following may rule out the use of sand consolidation technique application in a formation?
   a. No prior history of sand production
   b. High temperatures
   c. Uniform permeability
   d. Thin formation
2. Gravel packs have a slight initial cost advantage over consolidation and a greater statistical chance for success in most types of completion.
   a. True
   b. False
3. For all equipment failures, a rig assisted workover may be required to repair the damage.
   a. True
   b. False
4. Formation material filling the perforation tunnels leads to a significant increase in pressure drop across the formation near the well bore for a given flow rate.
   a. True
   b. False
5. Poorly consolidated sandstone formations usually have a compressive strength that is less than ……. pounds per square inch.
   a. 10,000
   b. 1,00
   c. 100,000
   d. 1,000
6. Compaction of the reservoir rock due to a reduction in pore pressure can result in surface subsidence.
   a. True
   b. False
7. The critical flow rate of a well may be determined by ……
   a. Slowly decreasing the production rate until sand production is detected.
   b. Slowly increasing the production rate until sand production is not detected.
   c. Slowly stopping the production rate until sand production is detected.

d. Slowly increasing the production rate until sand production is detected.

8. Choking the flow rate up to the critical flow rate where sand production does not occur or has an acceptable level can minimise sand production.
   a. True
   b. False
9. High reservoir fluid viscosity will apply a greater frictional drag force to the formation sand grains than will a reservoir fluid with a low viscosity.
   a. True
   b. False
10. Sand production may be influenced by high water cut
   a. True
   b. False
11. As the water cut increases, the relative permeability to oil increases.
   a. True
   b. False
12. According to Stein Hilchie's rule,if the sonic travel time (Tc) is less than …….. there should be no sand control.
   a. 90 µs/ft
   b. 99 µs/ft
   c. 95 µs/ft
   d. 94 µs/ft
13. The general procedure followed by most operators considering whether or not sand control is required, is to determine the hardness of the formation rock (i.e., the rock's compressive strength)
   a. True
   b. False
14. Always, limited number of perforations would be optimal for the option of sand consolidation technique
   a. True
   b. False
15. The design of a gravel pack system involves three primary stages except …….
   a. Correctly sizing the gravel
   b. Correctly sizing the gravel pack thickness
   c. Correctly positioning the liner and placing the gravel
   d. Correctly sizing the gravel pack height and positioning the liner
16. The minimum size of the formation sample required for sieve analysis is ……..... cubic centimetres.
   a. 20
   b. 10
   c. 15

d. 25

17. Which of the following techniques is used to remove damages
    a. Hydraulic fracturing
    b. Matrix acidizing
    c. Acid washing
    d. Bailer
18. Which of the following deals with issues of permeability reduction
    a. Acid fracturing
    b. Hydraulic fracturing
    c. Fracture Acidizing
    d. Hydrologic Fracturing
19. The purpose of fracture treatment is to increase the conduction of fluid into the wellbore.
    a. True
    b. False
20. At some pressure level, known as the ……, the formation fails and a fracture is initiated
    a. Fracture breakdown
    b. Formation pressure
    c. Pressure Fracture
    d. Breakdown pressure
21. After the fracture has a width of at least …… times the proppant diameter, proppant is then introduced to the fracture.
    a. 1.5
    b. 25.5
    c. 2.5
    d. 3.5
22. The magnitude and direction of stresses on a formation is not a function of depth and tectonic activity
    a. True
    b. False
23. Fracture will orient itself to be perpendicular to the maximum principal total stress
    a. True
    b. False
24. Due to tectonic effect, the magnitude of the horizontal stress may vary with direction
    a. True
    b. False
25. Which of the following is not a fracture geometry model
    a. Radial Fracture Model
    b. The KGD Model
    c. Perkins and Kern model

d. The PNK model

26. All of the models assume that the fracture is planar, that is, fracture propagates in a particular direction (perpendicular to the minimum stress), fluid flow is one-dimensional along the length (or radius) of the fracture except
    a. Radial Fracture Model
    b. The KGD Model
    c. Perkins and Kern,
    d. Pseudo-3D models
27. Which of the models assume respectively that the fracture height is large or small relative to length
    a. The KGD and PKN
    b. The radial fracture mode and KGD
    c. The Radial fracture model and PKN
    d. None of the above
28. The viscosity of the fracturing fluid controls the amount of fluid lost to the formation.
    a. True
    b. False
29. Those fracturing fluids that have low viscosity and high fluid-loss characteristics are……
    a. Viscosity controlled fluids
    b. Wall building fluids
    c. Reservoir controlled fluids
    d. Viscosity controlled fluids and Reservoir controlled fluids
30. Acids can be used as preflush before sand consolidation jobs and squeezing cementing
    a. True
    b. False

SECTION B: ANSWER ANY THREE QUESTIONS FROM THIS SECTION. (60) EACH QUESTION CARRIES EQUAL MARKS

1. a. Abookis well began production in 2009 and production rate was 1000 bbl/day, this was estimated to be sustained for five years. Unfortunately, just entering into the 3rd year of the production life of the well, production dropped drastically from 1000 bbl/day to 200 bbl/day. As a Petroleum Engineer, what would you consider doing in order to know what stimulation technique to use to remedy this situation? What is the approach in dealing with such a well which giving lower than the expected productivity? (10)

   b. Reservoir and well properties of the Abookis well have been made available by the well operators. The well is reported to have a well bore radius of 0.18 m and is confirmed damaged. The formation damage skin factor was determined through a pressure build up test by the Reservoir Engineer and it was reported to have given a value of Sd=20, The Engineer also estimated the extent of damage radius to be 0.5m. Calculate the increase in productivity available by removing the damage if the formation permeability is 15 mD and drainage radius is 305 m? (5)

   c. Discuss the impacts of sand production on the oil and gas production activities (5)

2. A gas reservoir has a permeability of 2 md. A vertical well of 0.300-ft radius draws the reservoir from the center of an area of 207 acres. If the well is hydraulically fractured to create a 2,000-ft long, 0.12-in. wide fracture of 300,000md permeability around the center of the drainage area, what would be the fold of increase in well productivity? As a Petroleum Engineer, what is the impact of this value? (10)

   b. Explain what wellbore storage is and state its effects on build-up tests (5)

   c. The productivity of fractured wells depends on two steps or two potentials mention and explain briefly what they involve. (5)

3. In well stimulation jobs, tests were carried out by the Production Engineer to ascertain whether it was worth doing matrix acidizing. The following values depicting the expected fold of increase in terms of Productivity Index (PI) have been obtained to help in the stimulation operation. It will require the same quantities of acidizing fluids, injection rate, pressure and etc. to carry out the operation. As a Petroleum Engineering student with the knowledge in Productivity Improvement, comment on each of the values and state whether the Engineers can go ahead to carry out the operation with respect to the three PI values given. Also state which of the values gives the best increase and why?.

   Given: Well A, $J_o = 0.5J_d$, Well B, $Jo = 3.0J_d$, and Well C, $Jo = 1.0J_d$ (10)

   b. Predict the formation breakdown pressure for a hydraulic fracturing operation due to take place in an almost 85 % sandstone formation at a depth of 18,200 ft. The formation whose Poisson's ratio of is 0.232 alsohas a Biot'sporo-elastic constant of 0.70. The average density of the overburden formation is 175 lb. /ft3. The pore pressure gradient in the sandstones is 0.385 psi/ft. If a tectonic stress of 2550 psi and a tensile strength of the sandstone formation is 1200 psi, from a systematic approach, calculate the breakdown pressure for the sandstone formation. (7)

   c. If the hydrostatic pressure drop is 9457 psi, using the data from question 3a, calculate the surface injection pressure in addition to the following data (3)

Specific gravity of fracturing fluid: 1.2 Viscosity of fracturing fluid = 20 cp
Tubing inner diameter= 3.0 in. Fluid injection rate: 10 bpm

4. In a design for acidizing operation, a 28 wt% HCl is needed to propagate wormholes 3ft from a 0.368-ft radius wellbore in a limestone formation (specific gravity 2.71) with aporosity of 0.15. The required designed injection rate is 0.15bbl/min-ft, the diffusion coefficient is 10^{-9} m^2 /sec, and the density of the 28% HCl is 1.14 g/cm3. In linear core floods, 1.5 pore volume is needed for wormhole breakthrough at the end of the core. Calculate the acidvolume requirement using (a) Daccord's model and (b) the volumetric model. (7)

b. Discuss the operation of hydraulic fracturing as a well stimulation method (6)

c. i. Paraffin and/or asphaltene plugging caused by …….. It can be prevented by ……..and can be removed by ……... (3)

ii. Residual cement plugging, which can be caused by operating at overpressured conditions. This damage can be prevented by …… and can be treated by ……. (2)

iii. Iron scales, which can be caused by using poor quality steel and damaging workover fluids. This type of plugging can be prevented by using ……..and can be prevented by ……... (2)

Necessary Equations and Graph

$$\Delta p_f = \frac{518\rho^{0.79} q^{1.79} \mu^{0.207}}{1000 D^{4.79}} L,$$

$$s_d = \left(\frac{k}{k_d} - 1\right) ln\left(\frac{r_d}{r_w}\right)$$

$$\frac{J_d}{J_o} = \frac{\frac{k_d}{k} ln\left(\frac{r_e}{r_w}\right)}{\frac{k_d}{k} ln\left(\frac{r_e}{r_w}\right) + ln\left(\frac{r_d}{r_w}\right)}$$

$$\sigma_v = \frac{\rho H}{144}$$

$$\sigma_h' = \frac{\upsilon}{1-\upsilon}\sigma_v'$$

$$P_p = P_{pg} \times \mathrm{H}$$

$$P_{bd} = 3\sigma_{h,min} - \sigma_{h,max} + T_0 - P_p$$

$$\sigma_{h,max} = \sigma_{h,min} + \sigma_{tect}$$

$$\sigma_{h,min} = \sigma_h' + \alpha P_p$$

$$r_e = \sqrt{\frac{A}{\pi}}$$

$$v_h = \pi\varphi(r_{wh}^2 - r_w^2)(PV)_{bt}$$

$$V_h = \frac{\pi\varphi D_h^{\,2/3} q_h^{\,1/3} r_{wh}^{\,d_f}}{bN_{AC}}$$

$$N_{AC} = \frac{\varphi\beta\gamma_a}{(1-\varphi)\gamma_m}$$

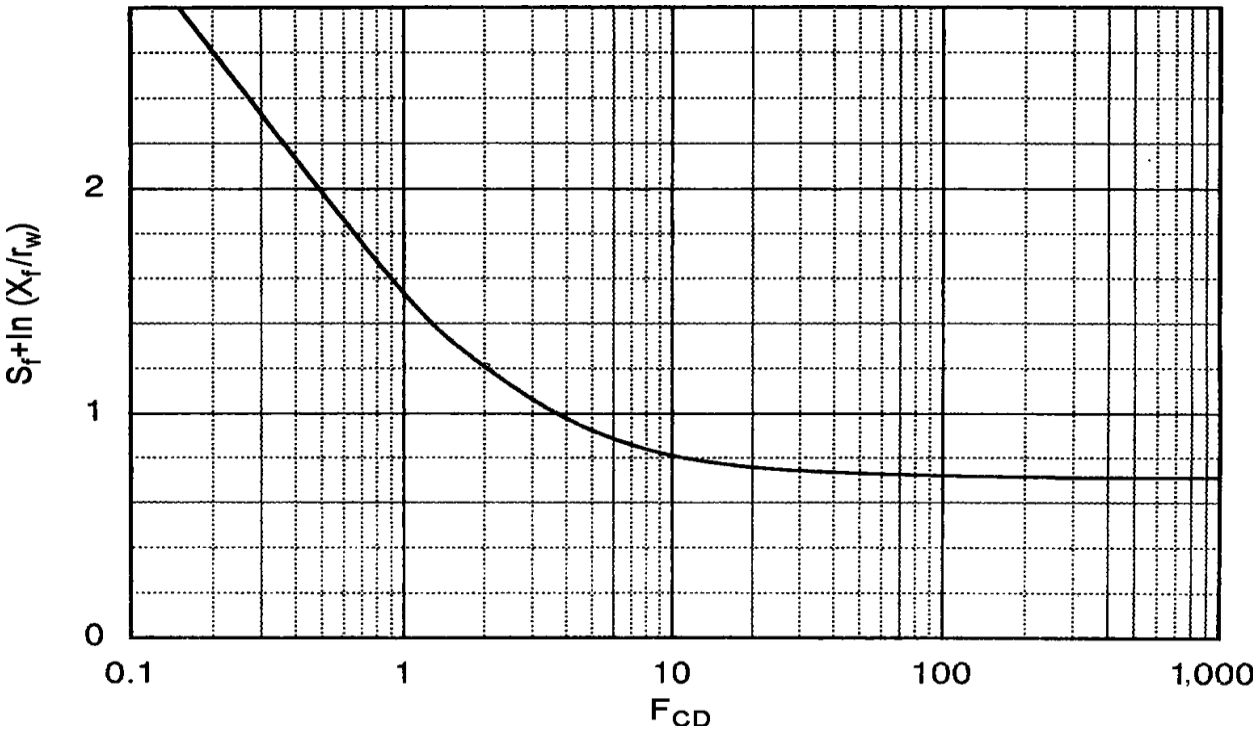
$$\beta = C_a \frac{v_m MW_m}{v_a MW_a}$$

$$q = \frac{kh(P_e - P_{wf})}{141.2B\mu(ln\frac{r_e}{r_w} + S_f)}$$

$$\frac{J}{Jo} = \frac{ln\frac{r_e}{r_w}}{(ln\frac{r_e}{r_w} + S_f)}$$

$$F_{CD} = \frac{k_f w}{k x_f}$$

Relationship between fracture conductivity and equivalent skin factor (Cinco-Ley and Samaniego, 1981).



Examiner: O. Kakra Dankwa