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**SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY**  
**DEPARTMENT OF PETROLEUM ENGINEERING**  
**2019/2020 RAIN SEMESTER EXAMINATION**  
**PET 504: PETROLEUM PRODUCTION ENGINEERING III**

**INSTRUCTION: ATTEMPT ANY 5 QUESTIONS (5 QUESTIONS IN ALL) TIME: 3 HRS DATE: 30/06/2021**

**QUESTION 1**

(a) The main aim of a petroleum production engineer is to keep the well's PI high, consistent with the economics. Discuss the process of doing so. (b) Write short notes on the following: (i) Hydraulic fracturing. (ii) Matrix acidizing. (c) Explain why  $r_w$  is not considered in well stimulation. (d) Using Vogel's method solve the followings: (i) Given that  $q = 100$  bopd at  $P_{wf}$  of 500psi and  $P_R$  of 1000 psi. Calculate the wells maximum potential and the production rate at 80% drawdown. (ii) A well producing under solution gas- drive conditions is tested at two different rates as follows: Test 1:  $q = 150$  bopd and  $P_{wf}$  is 1500 psi. Test 2:  $q = 250$  bopd and  $P_{wf}$  is 1000 psi. Using Vogel's equation, find PR and well potential. (e) Differentiate between continuous and intermittent gas lift installation. What are the four gas injection rates that are significant in continuous flow gas lift?

**QUESTION 2**

(a) A 50 ft producing section of pure limestone with a porosity of 0.15 has been acidized to increase the matrix permeability. The treatment consisted of 500 gallons of 15% HCL, spending time 15 sec and specific gravity of 1.075 pumped at a rate of 10 bbl/min. The wellbore radius is 4 inches. Calculate the depth of penetration of the unspent acid and the weight of limestone dissolved. (b) A pressure valve located at 6350ft has a dome pressure of 750psi and tubing pressure of 500psi at 6350ft. (i) calculate the casing pressure at 6350ft required to open the valve if  $AB = 1.0$  sq inch and  $AP = 0.1$  sq inch. (ii) what is the effect of tubing pressure in opening the pressure valve. (c) Explain briefly why it is difficult to use gas lift down to a well's economic limit. (d) what is the first and last valve in gas lift operation called.

**QUESTION 3**

A slotterliner has an outer diameter of 5.5 inches and a width of 0.025 the length per foot was measured at 12.4 in<sup>2</sup>/ft,

- a) determine the number of slots per foot required to achieve an optimum in flow area given that the required open area is 6%
- b) Determine the Maximum allowable tensile strength of the slotter liner if the tensile strength of pipe material is 100 and the inner diameter is 4 inches.
- c) List five key things to consider in developing the casing design for a well.
- d) Briefly explain five advantages of cased hole completion

**QUESTION 4**

- a) Explain any three major factors of sand production.
- b) What do you understand by chemical consolidation,
- c) The two main types of chemicals used in chemical consolidation are Thermosetting and thermoplastic resins. Explain in details the conditions for using the each of the resin types
- d) Explain the following sand production types (i) transient, (ii) continuous (iii) catastrophic

## QUESTION 5

(a) Rose-Felix oil servicing company have risen to the apex of international recognition in flow metering of oil and gas around the globe with an excellent job completion history. A successful presentation by Rose-Felix oil and gas to Agip oil company in Milan, Italy has earned the company a big contract to run measurement of the gases in their gas plant both at the Cryogenic operation unit, NGL Recovery unit and at the feeder system in Italy for a period of 5 years. The Agip Oil Company have set out their specifications ab-initio for any company that scales through their rigorous testing period to strictly use orifice meter equipped with pipe taps with 7 inches by 1.277 inches (3.628 inches) orifice with a line size of exact internal diameter of 6 inches Sch 80 (7.625 inches). The orifice plate has a surface roughness of 50 micro-inches and the ratio of orifice diameter to the diameter of meter bore lies between 0.15 to 0.70. The average downstream gauge pressure is 386 psig from the upstream tap with specific gravity of 0.605 and contract pressure base of 15.045 psia. Ambient temperature is 97 °F, Carbon dioxide is 22°F, Argon is 55°F, flowing temperature is 68°F, contract base temperature is 57°F, and Ammonia is 30°F. Average differential head is 64 inches of water, deviation factor is 0.862,  $S_{O_2}$  is 8.7%, expansion factor is 1.0042,  $b$  is 0.0527. As the Petroleum Engineer graduate representing Rose-Felix oil and gas company in Milan, calculate (i) The quantity rate of flow for 1 hour at base condition. (ii) The quantity rate of flow for the period of 1 week. (b)(i) Discuss 4 rules of thumb for sizing orifice installation (ii) Differentiate venturi meters with flow nozzles in natural gas measurement (c) Describe each orifice factor and discuss why they are needed (d) What are the five considerations that will guarantee measurement solutions for technical specifications in oil and gas metering project (e)(i) Explain the advantages of Helical-Turbine meters over PD meters. (ii) Differentiate between elbow meter and variable area meters. (f) What are the precautions to be taken to ensure an acceptable measurement for simultaneous metering of two-phase liquid (oil and gas). (g) What are the functions of strainer in LACT unit?

## QUESTION 6

(a)(i) (i) Describe the precision through which orifice meter works and support with diagram. (ii) What happens if a plate is out of beta ratio? (b)(i) How do you conduct oil and gas metering using pitot tube? (ii) Calculate the gas flowrate through a pitot tube which is controlled by a choke nipple. Flowing temperature is 60 °F, impact pressure is 10.7 psig, average differential head is 8.5 inches of water, specific gravity is 0.75, pipe ID is 3.465 inches,  $b$  is 0.0012, expansion factor is 0.8, static pressure is 120 psig, ambient temperature is 40°F. (c)(i) Define orifice constant and Differentiate it with pressure extension. (ii) What ensues if a meter factor is not within a specified range? (d) Calculate the volume of gas in (mmscf) to be measured in a certain gas plant with pipe bore ID of 7.5 inches, orifice plate size is 3.012 inches, base pressure is 16.01 psia, specific gravity is 0.7, flowing temperature is 87°F, Room temperature is 60 °F,  $Z$ -factor is 0.8,  $b$  is 0.002, expansion factor is 0.999, static pressure is 587 psig, differential pressure is 70 inches, discharge coefficient is 0.07, time is 20 hours. (e) An orifice plate is equipped with an L-10 square root chart. The maximum range of the static element is 800 psia while the maximum range of differential element is 210 inches of water. Calculate (i) Actual static pressure when the chart reading is 7.5 (ii) Chart reading when the actual differentials is 105 inches of water (iii) The meter constant  $M$ . (Hint:  $Q = C'Mh_u P_u$  where  $h_u$  = differential and  $P_u$  = static) assuming a square root chart. (f) (i) Orifice plates are mounted in cassettes. What are the demerits? (ii) Gas metering are less accurate than liquid metering by  $\pm 1.0$  of the mass. Explain why? (iii) Enumerate five needs for accurate measurement of oil and gas at custody transfer points. (g)(i) What is the major difference between flange type straightening vane and the pipe type. (ii) What are the factors which will affect the gas metering? (iii) What is the major difference between PD meter and Turbine meter?