



# UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

SECOND SEMESTER EXAMINATIONS, MAY 2015

COURSE NO : PE 372  
COURSE NAME: **GATHERING OF OIL AND GAS**  
CLASS : PE III TIME: **3 HOURS**

Name: \_\_\_\_\_ Index Number: \_\_\_\_\_

## **SECTION A (0.5 Mark Each)**

**Answer ALL questions in this section. Circle the most appropriate answer.**

1. For efficient separation, the gas residence time must be equal or greater than the time required for the droplets to reach the liquid interface. (a) True (b) False
2. The retention times of between 30seconds and 3 minutes have been found to be sufficient for most two-phase separation applications. (a) True (b) False
3. In spherical two-phase separation when CO<sub>2</sub> presence is high, the minimum retention time applicable is 10 minutes. (a) True (b) False
4. Determining the correct chemical (demulsifier) to break emulsions is commonly done by petroleum engineers using a bottle test. (a) True (b) False
5. Liquid loading in a scrubber is much lower than that in separator (a) True (b) false
6. Inlet diverters increase the flowrate of fluids in the separators (a) True (b) false
7. In a separator, the water outlet is located at the top (a) True (b) false
8. Separators be designed effectively without considering the fluid properties (a) True (b) false
9. Irrespective of the size of the separator, every gas-liquid separator has four major components (a) True (b) false
10. All control valves have a variable opening or orifice. (a) True (b) False
11. Temperature control can only be achieved by using heat exchangers in the Petroleum Industry. (a) True (b) False
12. A flowline is a relatively small pipe made of steel, plastic, or fibre glass that conducts the produced fluids from the wing of a Christmas tree. (a) True (b) False
13. The assembly of pipework where different headers enter the flowlines via the isolation valves is called a manifold. (a) True (b) False
14. Proper separator design is important because a separation vessel is normally the initial processing vessel in any facility. (a) True (b) False
15. Separation is done only when product specification set limits on impurities (a) True (b) False

16. Separators are designed in a variety of configuration but its selection is based on obtaining the desired results at the minimum cost. (a) True (b) False
17. Vertical separators are commonly used in flow streams with low to intermediate gas-liquid ratios. (a) True (b) False
18. Horizontal separators are well suited for production containing sand and other sediment. (a) True (b) False
19. Depending on the mixture composition and the pressure and temperature, the inlet fluid to a separator can be present in:  
 (a) Single phase liquid (b) Single phase gas (c) Gas – liquid mixture (d) All the above (e) None of the above
20. Why is separation important in gathering of oil and gas? Because:  
 (a) Downstream equipment cannot handle gas liquid mixtures  
 (b) Product specifications set limits on impurities  
 (c) Measurement devices for gases or liquids are highly inaccurate when another phase is present.  
 (d) All the above (e) A and B
21. Separators are sometimes called "traps" because?  
 a. The ratio of gas rate to liquid rate is very high  
 b. The ratio of gas rate to water rate is very high  
 c. The ratio of gas rate to liquid rate is very low  
 d. The ratio of gas rate to water rate is very low  
 e. None of the above
22. The term “gas scrubbers” is used to designate separators that...  
 (a) Separate three-phase fluids (b) two-phase fluids (c) handle multiple separation (d) handle separation efficiently (e)None of the above
23. Separators are classified as three-phase if they separate  
 (a)Gas from the total liquid stream (b) the liquid stream into its crude oil and water components  
 (c) Fluid into gas, liquid and solid phase (d) all the above (e) none of the above
24. Exhibition of fabrication difficulties and limited capacity to absorb liquid surges is associated to...  
 (a) Horizontal Separators. (b) two-phase separators (c)spherical separators (d)centrifugal separators (e)none of the above
25. What is the limitation of centrifugal separators?  
 (a) Sensitive to flow rate (b) Sensitive to motion (c)fabrication difficulties (d)all the above  
 (e) None of the above
26. Mist extractors can be made of the following except?  
 (a) Wire mesh, (b) vanes (c) baffle plates (d) centrifugal force devices (e) packing
27. Foam presents no problem within a separator if the internal design assures..... for the form to “break”(a) Adequate pressure (b) adequate temperature (c) sufficient coalescing surface  
 (d)B and C (e) All the above

28. To properly design separators the following factors must be determined.  
 (a) Corrosive tendencies of fluid (b) Gas flow rates (c) source of the fluid (d) A and B (e) All the above
29. What type of mist extractor(s) should be considered when paraffin is an actual or potential problem in separation?  
 (a) Plate type (b) Packing type (c) Wire mesh type (d) A and B (e) All of the above
30. In the gravity settling section of a separator, the velocity where the drag forces acting on the liquid droplet are equal to the buoyant forces is called. (a) Coalescing velocity (b) settling velocity (c) interface velocity (d) stall velocity (e) gas-liquid velocity
31. For most three-phase separator applications, retention times  
 (a) Determine the volume of the liquid collection section (b) are dependent upon API gravity (c) are lower for horizontal separators (d) range between 3 minutes and 30 minutes (e) A, B, and D
32. A special two-phase gas-liquid separator that is designed to handle large gas capacities and liquid slugs is called (a) cyclone mist extractor (b) filter separator (c) slug catcher (d) horizontal double-barrel separator (e) wire-mesh mist extractor
33. Scrubbers (a) are two-phase separators (b) are usually installed upstream of production separators (c) protect compression equipment from liquid carryover (d) all of the above (e) A and C only
34. The inlet diverter  
 (a) abruptly changes the direction of flow by absorbing the momentum of the liquid  
 (b) uses the inertia of the incoming fluid to achieve an initial free liquid separation  
 (c) lowers the temperature of the incoming fluid  
 (d) lowers both the specific gravity and viscosity of the oil  
 (e) is sized so that liquid droplets greater than 100 to 140 microns fall to the gas-liquid interface
35. Liquid carryover can be an indication of (a) high liquid level (b) level control valve failure (c) improper design (d) all of the above (e) A and C only
36. Which of the following can cause crude oil to foam in a separator?  
 (a) CO<sub>2</sub> (b) completion and workover fluids that are incompatible with the wellbore fluids (c) impurities other than water (d) A and B (e) all of the above
37. Which of the following factors affect gas-liquid separation?  
 (a) Gas and liquid flow rates (minimum, average, and peak)  
 (b) physical properties of the fluids, such as specific gravity and compressibility  
 (c) operating and design pressures and temperatures (d) foaming tendencies of the crude oil (e) all of the above
38. The term(s) given to pressure vessel designed to separate and remove free water from a mixture of crude oil and free water is(are) (a) Three-phase separator (b) free-water knockout (c) two-phase separator (d) A and B (e) all of the above
39. Three-phase separators  
 (a) experience the same operating problems as two-phase separators  
 (b) may develop problems with emulsions (c) have two liquid outlets (d) B and C (e) all of the above

40. The inlet diverter in a three-phase separator
- (a) extends below the oil–water interface
  - (b) promotes the coalescence of water droplets that are entrained in the oil continuous phase
  - (c) assures liquid does not fall on top of the gas–oil or oil–water interface
  - (d) B and C (e) all of the above
41. The oil–water interface is maintained by
- (a) liquid interface level controller (b) bucket and weir (c) bubble tube (d) A and B
  - (e) all of the above
42. The bucket and weir design
- (a) eliminates the need for a liquid interface controller
  - (b) prevents gas blowby (c) requires two interface level control valves
  - (d) requires one level control valve and one interface level control Valve
  - (e) none of the above
43. The inlet diverter
- (a) contains a down-comer that directs the liquid flow below the oil–water interface
  - (b) forces the inlet mixture of oil and water to mix with the water continuous phase in the bottom of the vessel
  - (c) promotes the coalescence of water droplets that are entrained in the oil continuous phase
  - (d) none of the above (e) all of the above
44. The inlet diverter
- (a) contains a down-comer that directs the liquid flow below the oil–water interface
  - (b) forces the inlet mixture of oil and water to mix with the water continuous phase in the bottom of the vessel
  - (c) promotes the coalescence of water droplets that are entrained in the oil continuous phase
  - (d) none of the above (e) all of the above
45. Which of the following criteria are important when sizing a three-phase separator?
- (a) gas capacity (b) oil and water retention times (c) settling water droplets from the oil phase (d) rising oil droplets from the water phase (e) all of the above
46. In the absence of laboratory data, what maximum water droplet size is suggested to settle through the oil phase?
- (a) 500 microns (b) 200 microns (c) 100 microns (d) it doesn't matter (e) none of the above
47. Common vessel internals include
- (a) coalescing plates (b) sand jets and drains (c) vortex breakers (d) inlet diverters
  - (e) level controllers (f) all of the above (g) A, B, and E
48. Agents absorbed at the water–oil interface to lower the interfacial tension are called (a) emulsions (b) surfactants (c) coalescers (d) demulsifiers (e) B and D
49. The most efficient method to determine the chemicals to best treat an emulsion is accomplished by (a) a bottle test (b) electrostatic coalescence (c) heating (d) agitation (e) injection
50. The stability of an emulsion is dependent on the following factor(s)
- (a) Water salinity, (b) Age of the emulsion, (c) Agitation (d) B and C (e) all of the above

## SECTION B

### Answer ALL questions in this section

1. Given the following data;

Gas flow rate:	12 MMSCFD at 0.8 specific gravity
Oil flow rate:	300 BOPD at 60° API
Operating pressure:	1,200 psia
Operating temperature:	80 °F
Droplet size removal:	150 microns
Retention time:	3 min
Compressibility factor Z:	0.78
Gas viscosity ( $\mu$ ):	0.06

(a) Estimate the drag coefficient  $C_D$  required to design a standard two phase separator. ***The answer should be given in 3 decimal places*** (8 marks)

(b) As a Production Engineer in an oil and gas production company, advice management on the type of separator (vertical or horizontal) that would be suitable for treating crude oil with the above data. Advice management using the results obtained from designing **two phase** vertical and horizontal separators. (24 marks)

**NB: Use the following API 12J standard size diameters (24, 30, 32, 34, 36, 38, 40 and 42) as a guide in your separator design.**

(c) State three conditions that must exist for an emulsion to be formed. (3 marks)

The following formulae apply for sizing separators:

#### **Vertical Separation Design**

1. Gas Capacity constraint:

$$d^2 = 5,040 \left[ \frac{TZQ_g}{P} \right] \left[ \left( \frac{\rho_g}{\rho_l - \rho_g} \right) \frac{C_D}{d_m} \right]^{1/2}$$

2. Liquid capacity constraint:

$$d^2 h = \frac{t_r Q_l}{0.12}$$

3. Seam-to-seam length:

$$L_{ss} = \frac{h + 76}{12} \text{ or } L_{ss} = \frac{h + d + 40}{12}$$

4. Slenderness ratio: ( $12 L_{ss}/d$ ).

#### **Horizontal Separation Design**

1. Gas capacity constraint

$$L_{eff} d = 420 \frac{TZQ_g}{P} \left[ \left( \frac{\rho_g}{\rho_l - \rho_g} \right) \frac{C_D}{d_m} \right]^{1/2}$$

2. Liquid capacity constraint

$$d^2 L_{eff} = \frac{t_r Q_l}{0.7}$$

3. Seam-to-seam length

$$L_{ss} = L_{eff} + \frac{d}{12} \quad \text{for gas capacity}$$

$$L_{ss} = \frac{4}{3} L_{eff} \quad \text{for liquid capacity}$$

4. Slenderness ratio

( $12 L_{ss}/d$ ).

Drag Coefficient

$$v_t = 0.0204 \left[ \left( \frac{\rho_l - \rho_g}{\rho_g} \right) d_m \right]^{1/2}$$

$$v_t = 0.0199 \left[ \left( \frac{\rho_l - \rho_g}{\rho_g} \right) \frac{d_m}{C_D} \right]^{1/2}$$

$$C_D = \frac{24}{Re} + \frac{3}{Re^{1/2}} + 0.34$$

2. Calculate  $Re = 0.0049 \frac{\rho_g d_m v}{\mu}$

**S.A. MARFO**