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VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN

[AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY, CHENNAI]

Elayampalayam – 637 205, Tiruchengode, Namakkal Dt., Tamil Nadu.



**Question Paper Code: 9008**

B.E. / B.Tech. DEGREE SUPPLEMENTARY EXAMINATIONS – FEB. / MAR. 2020

Third Semester

Biotechnology

U15BT301 – BIOPROCESS CALCULATION

(Regulation 2015)

Time: Three Hours

Maximum: 100 Marks

Answer ALL the questions

PART – A

(10 x 2 = 20 Marks)

1. Find the equivalent weight of  $\text{CO}_3$  radical
2. How many moles of  $\text{H}_2\text{SO}_4$  will contain 64 kg of S?
3. Define Dew point of Vapour.
4. Define Molal humidity.
5. What is Key component?
6. State the principle behind flash distillation.
7. Define Bypass.
8. Consider a binary system contains the components A and B adopted for a separation process with respect to the boiling point difference. Determine the degrees of freedom for the given system.
9. Define limiting reactant.
10. How much joule of heat is given out when a piece of iron of mass 50g and specific heat capacity of 460 J/Kg K cools from  $80^\circ\text{C}$  to  $20^\circ\text{C}$ ?

PART – B

(5 x 13 = 65 Marks)

11. a) Calculate the vapour pressure of water at 363 K if the vapour pressure at 373 K is 101.3 kPa. The mean heat of vaporization in this temperature range is 2275 KJ/ Kg.

(OR)

- b) A group of Aqwa leven is interested in preparing 500ml of 1 normal, 1 molar and 1 molal solution of  $H_2SO_4$ . Assuming the density of  $H_2SO_4$  solution to be 1.075 gm/cm<sup>3</sup>, calculate the quantities of  $H_2SO_4$  to be taken to prepare the above solutions.

12. a) A mixture of benzene vapor and nitrogen gas at 101.3 kPa and 295 K contains benzene vapor to the extent that it exerts a partial pressure of 15 kPa. The Vapor pressure of benzene is given by Antoine equation  $\ln P_s = 16.26205 - [3799.887 / (T - 46.854)]$ .

Determine the following:

- i. Mole fraction of benzene
- ii. Molal Humidity
- iii. Absolute humidity
- iv. Molal saturation Humidity
- v. Absolute saturation humidity
- vi. Mass of benzene in 100m<sup>3</sup> of the mixture

(OR)

- b) Explain the crystallization process with an example of any biological sample.

13. a) 10,000 kg/h of solution containing 20% methanol is continuously fed to a distillation column. Distillate is found to contain 98% methanol and waste solution from the column carries 1% methanol. All percentage is by weight. Calculate:

- i. The mass flow rates of distillate and bottom product
- ii. The percentage loss of methyl alcohol

(OR)

- b) The  $NH_3$ -air mixture containing 0.2 kg  $NH_3$  per kg air enters into absorption system where ammonia is absorbed in water. The gas leaving the system is found to contain 0.004 kg  $NH_3$  per kg air. Find the percentage recovery of ammonia.

14. a) Propane is burned with excess air to ensure complete combustion. If 55 kg of  $\text{CO}_2$  and 15 kg of CO are obtained when propane is completely burned with 500 kg air, determine the following:
- The mass of propane burnt
  - The percent excess air
  - The composition of flue gas

(OR)

- b) Acetic acid is manufactured by the oxidation of acetaldehyde. 120 kgmol/h of acetaldehyde is fed to the reactor. The product leaving the reactor contains 15.5% acetaldehyde, 58.5% acetic acid and rest oxygen (mole basis). Calculate the percentage conversion of acetaldehyde.

15. a) Chlorinated diphenyl is heated from 303 K to 503 K in an indirectly fired heater at a rate of 3500 kg/h. Calculate the heat to be supplied to the fluid in the heater. The heat capacity of the fluid in this temperature range is given by the equation

$$C_p = 0.751 + 1.465 \times 10^{-3}T, \text{ kJ/kg.K}$$

(OR)

- b) Air containing 21% (mole)  $\text{O}_2$  and 79% (mole)  $\text{N}_2$  is to be heated from 300 K to 450 K. Calculate the heat required to be added if the air flow rate is 5  $\text{m}^3$  per minute using data given below.

$$C_{p\text{O}_2} = 26.01 + 11.76 \times 10^{-3}T - 2.35 \times 10^{-6}T^2, \text{ kJ/kgmol.K}$$

$$C_{p\text{N}_2} = 29.60 - 5.15 \times 10^{-3}T + 13.19 \times 10^{-6}T^2, \text{ kJ/kgmol.K}$$

PART - C

(1 x 15 = 15 Marks)

16. a) An aqueous solution of pyridine containing 27% by weight pyridine and 73% by weight water is to be extracted with chlorobenzene. The feed and solvent are mixed well in batch extractor and the mixture is then allowed to stand for phase separation. The extract phase contains 11% pyridine, 88.1% chlorobenzene and 0.9% water by weight. The raffinate contains 5% pyridine and 95% water by weight. Calculate
- The quantities of two phase
  - The weight ratio of solvent to feed based on 100 kg of feed

(OR)

- b) Which of the below examples represent changes in state functions?
- i. Work done to climb from the bottom (state 1) to the top (state 2) of a mountain.
  - ii. Change in gravitational energy of an object when it is raised from the bottom (state 1) to the top (state 2) of a mountain.
  - iii. Change in density of water in a pot when it is heated from 20°C (state 1) to 50°C (state 2).
  - iv. Amount of heat liberated from burning gas in a stove in order to realize a temperature change of the water in a pot from 20°C (state 1) to 50°C (state 2).
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