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B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2005.

Third Semester

Industrial Biotechnology

IB 236 — PRINCIPLES OF CHEMICAL ENGINEERING

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Classify various types of Unit operations.

2. What are the objectives of Unit Processes?

3. Define Avogadro's Hypothesis.

4. Explain Dalton's Law.

5. Define an Ideal solution.

6. Distinguish between Conversion and Yield.

7. Define Latent heat.

8. Distinguish between Uniform flow and Non–uniform flow.

9. Define Power Number in Agitation.

10. Give the physical significance of Reynolds Number.

PART B — (5 × 16 = 80 marks)

11. (i) Describe the various steps to be followed in Material Balance calculation.
                                                                              (8)

    (ii) Estimate the consumption of 96% NaCl and 93% H_2SO_4 for the production of 500 kg of HCl if the conversion is 92%. Also calculate the amount of Na_2SO_4 produced during the process. HCl is produced according to the reaction : $2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$. Molecular masses of NaCl, H_2SO_4, Na_2SO_4 and HCl are 58.5, 98, 142 and 36.5 respectively.   (8)

12. (a) An absorber for removing benzene vapour from a vapour and gas mixture is irrigated with a wash oil which has a molar mass of 260 kg/kmol. The mean pressure in the absorber is 106.6 kPa and the temperature is 40°C. The flow rate of the vapour and gas mixture is 3600 m³/hr in the operating conditions. The concentration of benzene in the gas mixture at the inlet to the absorber is 2% by volume, and 95% of the benzene is absorbed. The benzene content in the absorbing oil entering the absorber is 0.2 mole percent. The flow rate of the absorbing oil is 1.5 times greater than the theoretical minimum value. Determine (i) the flow rate of wash oil in kg/hr and (ii) the concentration of benzene in the wash oil leaving the absorber.

The vapour pressure of benzene at 40°C = 25.65 kPa. The solubility of benzene in the wash oil is determined by Raoult's law and the solution behaves ideally. (16)

Or

(b) Nicotine is to be extracted with kerosene from a water solution containing 1% nicotine at 20°C. Water and kerosene are essentially immiscible. The equilibrium distribution of a solute between immiscible solvents is expressed by the distribution coefficient K, which is the ratio of the solute concentrations in the two phases. For the distribution of nicotine between kerosene and water

$$K = \frac{Y^*}{X} = \frac{\text{kg nicotine/kg kerosene in extract}}{\text{kg nicotine/kg water in raffinate}} = 0.90 .$$

(i) Determine the percentage extraction of nicotine if 100 kg of feed solution is extracted once with 150 kg of solvent.

(ii) Repeat for three ideal extractions using 50 kg solvent each. (16)

13. (a) (i) Describe the various steps to follow in Energy balance calculations across an equipment. (8)

(ii) Explain in detail about the effect of temperature on Heat of Reaction. (8)

Or

(b) A sample of petrol contains 15% H_2 and 85% C by weight. Calculate the amount of air needed for the combustion of 1 kg of the petrol. Find the volumetric composition of the dry products of combustion, if 15% excess air is supplied. (16)

14. (a) Derive the Bernoulli's equation for the steady flow of fluids. Give some applications of Bernoulli's equation. (16)

Or

(b) (i) Describe the various losses in fluid flow. (6)

(ii) Derive an equation for pressure loss in fluids flowing in pipes. (10)

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15. (a) A centrifugal pump takes brine from the bottom of a supply tank and delivers it into the bottom of the other tank. The brine level in the discharge tank is 50 m above that in the supply tank. The tanks are connected by 200 m of 18 cm pipe. The flow rate is 50 lt/s. The line between the tanks has two gate valves, four standard tees, and four ells. What is the energy cost for running this pump for a 24-h day?

Data : $\rho = 1180$ kg/m³, $\mu = 1.2$ mPa s, $f = 0.004$.

Energy costs Rs. 0.80/k Wh.

Overall efficiency of the pump and motor is 60%. (16)

Or

(b) (i) Classify fluid machinery with examples. (8)

(ii) Briefly explain the flow patterns in agitated vessels. (4)

(iii) How would you prevent swirling in agitated vessel. (4)

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