D 4018

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2007.

Third Semester

Biotechnology

BT 1201 — PRINCIPLES OF CHEMICAL ENGINEERING

(Regulation 2004)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Explain Dalton's law.

2. What is the application of method of least squares?

3. Define the unit Newton.

4. Explain Molality.

5. Define Relative Saturation.

6. Explain Steady State.

7. Write any two methods for solving Material Balance problems.

8. Define Compressible and Incompressible fluid.

9. Explain Kinematic Viscosity.

10. What is NPSH? Explain.

PART B — (5 × 16 = 80 marks)

11. (a) Discuss Graphical Representation for correlating the data obtained from experimental analysis. (16)

Or

(b) (i) Write a note on Graphical Integration. (8)

(ii) Explain Graphical Differentiation. (8)

12. (a) (i) 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

$$2NaCl + H_2SO_4 = Na_2SO_4 + 2HCl\,.$$ (8)

(ii) Acetylene is produced by the treatment of Calcium Carbide with water $CaC_2 + 2H_2O = Ca(OH)_2 + C_2H_2$. Estimate the period of service that can be derived from 1 kg of pure Carbide in an Acetylene Lamp consuming 1 litre of gas per minute at 30°C and 100 kPa. (8)

Or

(b) (i) Explain Molal Humidity, Percentage Humidity, Dew point and wet bulb temperature. (8)

(ii) The temperature of air in a room is 40.2°C and the total pressure is 101.3 kPa abs. The air contains water vapour with a partial pressure p_A = 3.74 kPa. Calculate the humidity, the saturation humidity and percentage humidity, the percentage Relative Humidity. At 40.2°C the vapour pressure of water = 7.415 kPa (8)

13. (a) (i) Prove Cp – Cv = R. (4)

(ii) Explain the Following

(1) Adiabatic Flame Temperature (2)

(2) Heat of Dissolution (2)

(3) Standard Heat of Formation and Standard Heat of Combustion. (4)

(iii) Calculate the change in enthalpy ΔH° for the reaction

$$CH_4(g) + 2O_2(g) = CO_2(g) + 2H_2O(g)$$

The enthalpies of formation of $CH_4(g)$, $CO_2(g)$, $H_2O(g)$ are – 74.9, – 393.5 and – 241.8 KJ/mol, respectively. (4)

Or

(b) (i) Pure ethylene is heated from 30°C to 250°C at a constant pressure. Calculate the heat added per kilo mole if

$$C_p = 2.83 \times 28.601 \times 10^{-3} T - 87.26 \times 10^{-7} T^2 \text{ kCal/K}$$ (4)

(ii) An approximate equation for C_p (cal/g mol K) of gaseous HCl is, $C_p = 6.6 + 0.93 \times 10^{-3} T$. Calculate the heat required to raise the temperature of 1 g mol of gas from 100 to 200°C. (4)

(iii) Using the heat of formation values for the reactions below at 25°C in standard state, calculate the standard heat of formation of propylene gas(Δ H in kcal / gmol)

(1) $C_3H_6(g) + H_2(g) \rightarrow C_3H_8(g)$ $\Delta H = -29.6$

(2) $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$ $\Delta H = -530.6$

(3) $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ $\Delta H = -68.3$

(4) $C(\text{graphite}) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -94.05$ (8)

14. (a) (i) What is 'U' tube manometer and derive the equation for measuring the pressure difference? (6)

(ii) Briefly discuss Inclined manometer and Differential manometer. (6)

(iii) A U – tube mercury manometer is used to measure the pressure difference between 2 points across a pipe through which water is flowing. When the manometer reading is 40 cm, calculate the pressure difference. (4)

Or

(b) (i) Derive Bernoulli's Theorem. (8)

(ii) Oil of specific gravity 0.9 and kinematic viscosity of 0.00033 m^2/sec flows through a tube of inside diameter 75 mm and length 1.5 km at a rate of 25×10^3 kg/hr. Calculate the pressure loss due to frictional effects. (8)

15. (a) (i) Explain particulate and bubbling fluidization. (4)

(ii) Derive the equation for calculating minimum fluidization velocity. (6)

(iii) Estimate the minimum fluidization velocity for a bed of particles fluidized by water. Take

Diameter of the particle = 120×10^{-6} m

Density of the particle = 2500 kg/m^3

$\epsilon_{mf} = 0.45$, Density of the water = 1000 kg/m^3,

Viscosity = 0.9 MPa.s (6)

Or

(b) (i) Write briefly the principle and operation of a centrifugal pump. (8)

(ii) Derive the equation for the isothermal and adiabatic compression of gas. (8)