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SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

THIRD SEMESTER B. TECH DEGREE EXAMINATION (S), FEBRUARY 2023

FOOD TECHNOLOGY

(2020 SCHEME)

Course Code: **20FTT201**

Course Name: **Principles of Chemical Engineering**

Max. Marks: **100** **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. Explain the different steps for solving material balance problems.
2. Explain i) mole fraction
   ii) weight fraction
   iii) volume fraction, of solute concentration in solutions.
3. What are the different methods used for calculating the heat of reaction?
4. How is the heat capacity of solids calculated using Kopp's rule?
5. Write the differential form of continuity equation for two-dimensional steady flow of incompressible fluid.
6. State Newton's Law of viscosity.
7. Write the expression for head loss due to sudden expansion.
8. Explain the terms maximum velocity and average velocity for a flow of fluid in a circular pipe.
9. What is "hydraulic mean radius?
10. What is the function of volute in a centrifugal pump?

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) An aqueous solution of K_2CO_3 is prepared by dissolving 43 kg K_2CO_3 in 100 kg water at 293 K. The density of the solution is 1.3 kg/L. Find the molarity, normality and molality of the solution (4)

    b) Convert the following empirical equation into SI units

    $$h = (0.026\ G^{0.8}\ k^{0.67}\ Cp^{0.5}) / (D^{0.2}\ \mu^{0.47})$$

    where h is heat transfer coefficient in Btu/hr $ft^2\ ^0F$
    G is mass velocity of liquids in lb/ft^2 s
    k is thermal conductivity in Btu/ft.hr. ^0F.
    Cp is specific heat in Btu/lb^OF (10)

D is diameter of tube in ft
μ is viscosity of liquid in lb/ft s

OR

12. A hot solution of Ba $(NO_3)_2$ from an evaporator contains 30.6 kg of Ba $(NO_3)_2$ per 100 kg of water and goes to a crystallizer where the solution is cooled and Ba $(NO_3)_2$ crystallizes. On cooling 10% of the original water present evaporates. For a feed solution of 100 kg, calculate the yield of crystals and water evaporated if the solution is cooled to 290 K. Solubility of Ba $(NO_3)_2$ is 8.6 kg per 100 kg total water at 290 K (14)

MODULE II

13. a) Coal is burnt to a gas of the following composition by mole: CO2 – 9.2, CO – 1.5, O_2 – 7.3, N_2 – 82%. Compute the enthalpy difference for this gas between the bottom and the top of the stack if the temperature at the bottom is 550 K and at the top is 200 K.
Cp of CO_2 is $8.448 + 5.757 \times 10^{-3} T - 21.59 \times 10^{-7} T^2 + 3 \times 10^{-10} T^3$ J/mol K (8)
Cp of CO is $6.865 + 0.8024 \times 10^{-3} T - 0.736 \times 10^{-7} T^2$ J/mol K
Cp of N_2 is $6.895 + 0.7624 \times 10^{-3} T - 0.7 \times 10^{-7} T^2$ J/mol K
Cp of O_2 is $7.104 + 0.7851 \times 10^{-3} T - 0.5528 \times 10^{-7} T^2$ J/mol K
b) State and explain Hess's law of constant heat summation. (6)

OR

14. a) Carbon monoxide combines with chlorine in the presence of a suitable catalyst to form phosgene according to the following reaction.

$$CO\ (g) + Cl_2\ (g) \longrightarrow COCl_2\ (g).$$

(10)

After reaction, the products contained 12 moles of phosgene, 3 moles of chlorine and 8 moles of carbon monoxide. Calculate the following:
i. The percent excess reactant used
ii. The percent conversion of the limiting reactant

b) Explain the terms
i. Heat capacity at constant volume (4)
ii. Heat capacity at constant pressure.

MODULE III

15. a) Define hydrostatic equilibrium. Express mathematically the condition of hydrostatic equilibrium. (10)
b) With the help of a neat sketch, explain the principle and applications of an inclined manometer. (4)

OR

16. a) Derive an expression for the estimation of pressure drop in a centrifugal field. (4)

b) With the help of shear stress-shear rate diagram, explain the classification of fluids. Discuss their important characteristics (10)

MODULE IV

17. a) Discuss the velocity profiles for laminar and turbulent fluid flow through a pipe. What is the relationship between skin friction and wall shear in a pipe? (10)

b) Discuss the boundary layer formation during laminar and turbulent fluid flow. (4)

OR

18. a) Prove for laminar flow of Newtonian fluids through a pipe, $u/u_{max} = 1 - (r/r_w)^2$ (8)

b) Define Fanning's friction factor. How is it related to the pressure drop? (6)

MODULE V

19. a) Water flows through a Venturi meter which has a diameter at the inlet of 1.2 m and a diameter of 0.6 m at the throat. The difference in pressure between the main and the throat is measured by a differential mercury gauge, which shows a deflection of 5.1 cm. Find the discharge through the meter and also calculate the velocity of water at the throat. Take the coefficient of discharge of the meter as 0.98. (10)

b) Differentiate centrifugal and positive displacement pumps. (4)

OR

20. a) Explain the various pump characteristics. (6)

b) Compare the merits and demerits of Orifice meter and Venturi meter in the measurement of flow. (8)

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