GUJARAT TECHNOLOGICAL UNIVERSITY
BE- SEMESTER–VI (NEW) EXAMINATION – WINTER 2024

Subject Code:2160503   **Date:25-11-2024**
Subject Name:Process Equipment Design -I
Time:02:30 PM TO 05:30 PM   **Total Marks:70**
Instructions:
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1	**(a)**	Define capacity of pump, total dynamic head and NPSH.	**03**
	(b)	Briefly discuss the standard pressure taps used in orifice meter.	**04**
	(c)	It is proposed to pump 10,000 kg/h of saturated toluene at 114°C and 1.1 atm a from the reboiler of a distillation tower to a second distillation unit without cooling. If the friction loss in the reboiler and pump is 7 kPa and density of toluene is 866 kg/m^3, how much liquid level in the reboiler is to be maintained to give a net suction head of 2.5 m? Calculate the power required to drive the pump if the pump is to elevate the toluene to 10 m to a second unit at atmospheric pressure. Assume friction loss in the discharge line to be 35 kPa. Pump efficiency is 62 %.	**07**
Q.2	**(a)**	State the functions of baffles in shell and tube heat exchanger.	**03**
	(b)	Explain the advantages and disadvantages of U-tube heat exchanger.	**04**
	(c)	Discuss in detail about the criteria of selection between kettle type and thermosyphon reboiler.	**07**

OR

	(c)	With neat sketch explain the process design of without phase change heat exchanger by using Tinker's flow model.	**07**
Q.3		Determine shell size, tube side coefficient, shell side coefficient and overall coefficient for a heat exchanger to sub-cool condensate from a methanol condenser from 95°C to 40°C. The flow-rate of methanol is 100000 kg/h. Brackish water will be used as the coolant, with a temperature rise from 25° to 40°C. Use one shell pass and two tube pass with the given data for calculation. Assume the overall heat transfer coefficient (U) = 600 W/m^2 C and F_t = 0.85, Heat capacity of methanol = 2.84 kJ/kg K and for water = 4.2 kJ/kg K, Choose 20 mm o.d., 16 mm i.d., 4.88 m long tubes (3/4 in. × 16 ft) of cupro-nickel. Allowing for tube-sheet thickness, take L = 4.83 m, Bundle diametrical clearance = 68 mm, Viscosity of water = 0.8 cP, Thermal conductivity of water = 0.59 W/m C, Use 25% cut baffles with baffle spacing = Ds/5, Density of methanol = 750 Kg/m^3, Viscosity of methanol = 0.34 cP, Thermal conductivity of methanol = 0.19 W/m C, Thermal conductivity of cupro-nickel alloys = 50 W/m°C. Take fouling coefficients for: methanol (light organic) = 5000 W/m^2°C & brackish water (sea water) = 3000 W/m^2°C	**14**

OR

Q.3	**(a)**	State the advantages and disadvantages of mixer-settler type extractor.	**03**
	(b)	With suitable industrial examples differentiate between continuous and dispersed phase for liquid-liquid extraction.	**04**

(c)	Discuss the design steps to determine the number of theoretical stages for a continuous counter current multistage extractor.	**07**

Q.4 **(a)** Differentiate between jet flooding and downcomer flooding. **03**

(b) Discuss the method to determine the optimum reflux ratio for distillation. **04**

(c) State and explain any three examples of selection of operating pressure in distillation column. **07**

OR

Q.4 **(a)** Determine the minimum reflux ratio for the saturated binary liquid mixture of benzene-toluene at standard atmospheric pressure based on the given data. Feed – 100 kmol/h, Mole fraction of benzene in feed – 0.4, Mole fraction of benzene in distillate – 0.99, Mole fraction of benzene in residue – 0.02, Average relative volatility – 2.25 **03**

(b) State the advantages and disadvantages of vacuum distillation. **04**

(c) Explain the design steps for a sieve tray distillation column. **07**

Q.5 **(a)** Why venturi scrubber is placed before the packed tower type absorber? **03**

(b) When shell and tube heat exchanger is used as falling film absorber? State any two advantages and industrial applications of falling film absorber. **04**

(c) Explain the design steps to determine the top and bottom diameter for a packed tower type absorber. **07**

OR

Q.5 **(a)** State the applications of pall ring, berl saddles and rasching rings. **03**

(b) Differentiate between countercurrent type and gas injection type of packing support used in packed column. **04**

(c) Determine diameter or width and Number of gas phase transfer unit for a vertical and horizontal cross flow spray tower type absorber based on the given data. Volumetric flow rate of boiler flue gas – 24,000 Sm^3/h, Pressure of gas – 150 mm WC (gauge), Temperature of gas – 80 to 90°C, SO_2 concentration in boiler flue gas - 4000 ppm, Desired concentration of SO_2 in the outgoing gas - 200 ppm, Solvent 1% lime solution. **07**

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