U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

August 2024 Supplementary Examinations

Program: B.E. **Semester: VI**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 19CH6DCPED **Max Marks: 100**
Course: Process Equipment Design

Instructions: 1. Answer any one full question, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. Use of Perry's Chemical Engineering handbook, IS 4503, and IS 2825 code books is allowed.
4. Use of psychometric chart and other data sheets is allowed.

			UNIT – I	CO	PO	Marks
1			A crystallizer industry is planning to buy an evaporator for their new product manufacture. For this purpose, the single effect evaporator is used to concentrate 36,000 kg/h of a solution from 10% to 50% solids. Steam is available at 205 kN/m^2 and the evaporator-vacuum space is maintained at 13.5 kN/m^2. The feed to the evaporator is at 294 K. The overall heat transfer coefficient is 3.27 kW/m^2 K. The specific heats of 10% to 50% solutions are 3.76 and 3.14 kJ/kg, respectively. The height of the evaporator body above the calandria may be at least 3 m to minimize entrainment. The calandria has vertical tubes of 5 cm ID, with thickness of 2.5 mm, and 2 m height spaced on a triangular pitch of 6.25 cm. The cross-sectional area of the down comer should be at least 75% of the total cross-sectional area of all the tubes to ensure rapid circulation. For the construction of evaporator, mild steel is used, which has an allowable stress of 9.5 kg/mm^2. Constant *k* may be assumed as 2.857 for the flange design.			
	a)	Design the evaporator to determine the heat load, amount of steam required, and economy of evaporator.	*CO1* *CO2*	*PO2* *PO4*	**30**
	b)	Find the number of tubes required and diameter of calandria, vapor drum of evaporator, and total height of the evaporator.	*CO3*	*PO3*	**20**
	c)	Determine the thickness of calandria, vapor drum, flange, top tori spherical head and bottom conical head, assuming conical angle to be 45°.	*CO4* *CO5*	*PO12* *PO8*	**20**
	d)	Estimate the diameter of feed inlet and steam inlet nozzles.	*CO4*	*PO12*	**10**

		e)	Draw the schematic of the evaporator designed.	*CO6*	*PO3*	**20**
			UNIT – II			
	2		It is desired to separate 10 kg/s of a saturated vapour mixture of acetic acid and water containing 40 mol % of acetic acid (CH_3COOH) by a fractional distillation column. The distilled product contains 98 mol % of water and the residue contains 98 mol % of acetic acid. The reflux ratio of 2 times the minimum reflux is employed. The column is operating at 1.05 atm.			
		a)	Estimate the minimum reflux ratio using the McCabe-Thiele method.	*CO1*	*PO2*	**10**
		b)	Determine the number of plates required for a bubble cap distillation column assuming 60% of tray efficiency, and calculate the height of the column.	*CO1* *CO2*	*PO2* *PO4*	**10**
		c)	Calculate condenser and re-boiler loads.	*CO2*	*PO4*	**10**
		d)	Determine the diameter of the column.	*CO3*	*PO3*	**20**
		e)	Design the dimensions of the plate and bubble cap, assuming a 100 mm bubble cap diameter.	*CO4*	*PO12*	**20**
		f)	Calculate the diameter of gas and liquid nozzles.	*CO4* *CO5*	*PO12* *PO8*	**10**
		g)	Draw a neat schematic diagram of the sectional front view.	*CO6*	*PO3*	**20**

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