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

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: VI**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 22CH6PCPED **Max Marks: 100**
Course: Process Equipment Design

Instructions:
1. Answer Unit I and Unit IV are compulsory. Answer any ONE full question from choosing Unit II and Unit III.
2. Missing data, if any, may be suitably assumed & stated.
3. Perry's Chemical Engineers Handbook, IS 4503 and IS 2825 Unfired Pressure Vessel Codebooks are permitted to use.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

				CO	*PO*	Marks
			UNIT – I			
1	a)	If you are a design engineer working in a chemical company and want to design chemical equipment, explain the various steps followed to obtain the final design.		*CO3*	*PO4*	**08**
	b)	Discuss the various pressure vessel enclosures employed to fabricate pressure vessels, with equations.		*CO3*	*PO4*	**06**
	c)	How are flanges classified? Explain.		*CO3*	*PO4*	**06**
			UNIT – II			
2		Design a 1-2 shell and tube heat exchanger required to cool 75,000 kg/h of ethylene glycol from 120 °C to 100 °C using toluene as the coolant. Toluene is heated from 25 °C to 60 °C. Use steel tubes 14 BWG thickness having an OD of ¾ inch and tubes of 8 feet in length which are laid in a triangular pitch of one inch. The shell contains 25% cut segment baffles spaced 152 mm apart.				
	a)	Determine the physical properties of the two fluids at average temperature to design the heat exchanger.		*CO1*	*PO2*	**05**
	b)	Estimate the mass flow rate of cold fluid and corrected LMTD for the given temperatures. What are the heat transfer area and number of tubes required for the given duty?		*CO2*	*PO4*	**15**
	c)	Calculate the clean overall heat transfer coefficient. Comment on the validity of the design.		*CO2*	*PO4*	**15**
	d)	Estimate the shell thickness and shell diameter.		*CO2*	*PO4*	**10**
	e)	Determine the pressure drops across the shell and tube sides.		*CO2*	*PO4*	**10**
	f)	Draw the sketch of the sectional front view of the STHE.		*CO4*	*PO2*	**05**

			UNIT - III			
	3		A continuous distillation column is to be designed for the separation of an equimolar mixture of n-heptane and n-octane. The top and bottom products should have 98% purity and the column is to be operated slightly above the atmospheric pressure, with operating reflux ratio of 2.5. Feed is admitted as a saturated liquid to the column. The feed rate to the column is 9000 kg/h. The plate spacing may be assumed to be 0.45 m and the overall efficiency of the distillation column is about 75%. VLE data for the system is as follows: Mole fraction, *x*: 0.0, 0.13, 0.22, 0.32, 0.57, 0.69, 0.92, 1.0 Mole fraction, *y*: 0.0, 0.24, 0.37, 0.50, 0.74, 0.83, 0.96, 1.0			
		a	Make overall material balance, find the total number of plates in the column and calculate the height of the column.	*CO2*	*PO4*	**15**
		b	Calculate the diameter of the fractionating column.	*CO2*	*PO4*	**10**
		c	Calculate the condenser and re-boiler loads by assuming the steam is available at 2 bar pressure.	*CO3*	*PO4*	**10**
		d	Establish plate specifications and bubble cap design.	*CO3*	*PO4*	**10**
		e	Design the diameter of gas and residue outlet nozzles.	*CO3*	*PO4*	**10**
		f	Draw the schematic of the distillation column designed.	*CO2*	*PO4*	**05**
			UNIT – IV			
	4	a	An evaporator drum, cylindrical in shape, 1.7 m internal diameter, and 1.9 m height is to be designed for internal operating pressure of 400 mmHg and 90°C. The vessel is to have a tori-spherical head (100-06). Outside pressure is atmospheric. The vessel will be fully radiographed. Material: stainless steel, IS: 1570-1961: 15Cr90Mo55. Estimate the thickness of shell and Tori-spherical head based on internal pressure.	*CO3*	*PO4*	**10**
		b	Pressure vessel of internal diameter 150 cm operates at 0.05 kg/mm^2. The vessel must be provided with a nozzle 10 cm internal diameter. The nozzle is welded to the shell wall and does not project inside the vessel. Permissible stress of the material is 10.20 kg/mm^2. Corrosion allowance is 1 mm and welded joint efficiency is 85%. Estimate the reinforcement required for the nozzle.	*CO3*	*PO4*	**10**

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