Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII (NEW) EXAMINATION – SUMMER 2024

Subject Code:3173617 Date:28-05-2024

Subject Name:Principles of Process Equipment Design

Time:02:30 PM TO 05:00 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.**

			Marks
Q.1	(a)	Define Equivalent length of pipe and Number of velocity heads.	03
	(b)	What is the need for design?	04
	(c)	Explain the process design of pump.	07
Q.2	(a)	Mention the design equation for power required in blower and in adiabatic Compressor.	03
	(b)	What is the difference between PFD and P&ID diagrams?	04
	(c)	Find out the power required for a turbo blower for the following duty. Fluid: Atmospheric air Capacity = 1000 Nm^3/h Discharge pressure = 2 atm a Also find the discharge temperature of air.	07
		OR	
	(c)	A three stage reciprocating compressor is used to compress 306 Sm^3/h of methane from 0.95 atm a to 61.3 atm a. The inlet temperature is 26.7 °C. Specific heat ration of methane, k = 1.31. Calculate (a) Power required for compression, if mechanical efficiency is 80 percent and (b) Discharge temperature of gas after 1st stage.	07
Q.3	(a)	What do you mean by Optimum Pipe Size?	03
	(b)	What are the different types of baffles used in shell and tube Heat exchanger? Explain it with suitable figures and also mention the functions of baffles.	04
	(c)	Explain the general design method for shell and tube heat exchanger with suitable equations.	07
		OR	
Q.3	(a)	Define: Reflux ratio. How to determine reflux ratio for binary distillation?	03
	(b)	Describe Tinker's flow model in detail.	04
	(c)	Explain the design of Vertical Thermo syphon Reboiler.	07
Q.4	(a)	Explain in detail about NPSH.	03
	(b)	Write down the criteria of selection between kettle type reboiler and thermosyphon reboiler.	04

(c) Feed mixture to a distillation column contains 30% n-hexane, 32% n-propane, 20% n-butane and 18% n-pentane (by mole). Total flow rate of the feed is 100 kmol/h. If butane and pentane are selected as light key and heavy key components, respectively then (a) fix the operating pressure of distillation column and (b) find the product compositions. **07**

OR

Q.4 **(a)** Explain degree of completion of reaction. **03**

(b) Define (a) Light key (b) Heavy key (c) Adjacent key (d) split key **04**

(c) Butyl acetate formation is carried out in a batch reactor at 90°C with sulphuric acid as a homogeneous catalyst. The feed contained 4.97 moles of n-butanol per mole of acetic acid and the catalyst concentration is 0.032% by mass as H_2SO_4. Rate equation for this reaction is $-r_A = kC^2_A$. **07**

Where, C_A = Concentration of acetic acid in mol/cm^3 ,

k = 17.4 cm^3/(mol.min)

Density of the reaction mixture at 90°C can be assumed constant and equal to 0.75 g/cm^3. Calculate the time required to obtain conversion of 50%.

Q.5 **(a)** Explain Jet flooding and Down comer flooding. **03**

(b) Explain FUG method for Multicomponent distillation with suitable equation. **04**

(c) Explain in detail about factors affecting the performance of bubble column reactor. **07**

OR

Q.5 **(a)** Mention the criteria of selection between tray tower and packed tower. **03**

(b) Explain Advantages and disadvantages of batch reactor over continuous flow reactor. **04**

(c) Explain in detail about process design of bubble column reactor. **07**

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