

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VII (NEW) EXAMINATION – WINTER 2023****Subject Code:3170502****Date:14-12-2023****Subject Name: Process Equipment Design****Time: 10:30 AM TO 01:00 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 weeping, entrainment and flooding with reference to distillation column.	03
	(b) Discuss in brief the various heating and cooling media used in shell and tube heat exchanger.	04
	(c) A rotameter tube have an internal diameter of 40 mm at top and 25 mm at the bottom. The maximum diameter of float is 25 mm. Water flows through the rotameter. Calculate the flow rate in the rotameter at tube diameter of 36 mm. Data: - Mass of float = 23.25 gm Density of water = 992.2 kg/m ³ Volume of float, $V_f = 3.338 \text{ cm}^3$, $C_D = 0.775$ Angle made by tapered tube with vertical plane is 2 degree.	07
Q.2	(a) Give the full names for TEMA, ASME and BEM heat exchanger.	03
	(b) How to fix the operating pressure in distillation column. Explain with example.	04
	(c) It is proposed to pump 10000 kg/h of saturated toluene at 114 °C and 1.1 atm a from the reboiler of a distillation column to a second distillation unit without cooling. If the friction loss in the line between the reboiler and pump is 7 kPa and the density of toluene is 866 kg/m ³ , how much liquid level in reboiler be maintained to give a net positive suction head of 2.4 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
	OR	
	(c) Explain the function of followings in shell and tube heat exchanger (1) Baffles (2) tube sheet (3) tie rod (4) spacers (5) sealing strip	07

Q.3	Scrubber is used for absorbing acetone vapor from air-acetone mixture by using pure water as solvent. The temperature in scrubber is 25 °C and scrubbing is isothermal. Operating pressure is near atmospheric. A mixture of air acetone vapor containing 6% by volume of acetone is passed through the scrubber. The mixture contains 1400 m ³ /h of air. The scrubber is required to absorb 98% of acetone. The phase equilibrium equation is $y=0.3x$. Calculate (a) the minimum solvent rate required for given absorption. (b) Top diameter of packed bed tower considering actual solvent rate = 1 m ³ /h. Base your design 66% flooding. Use the data: Density of water = 1000 kg/m ³ , Viscosity of water = 1 cP, Molecular Weight air = 29, Use 25 mm polypropylene packing, Packing factor $F_p = 170 \text{ m}^{-1}$	14
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$$G_w = \left(\frac{K \rho_G \rho_L g}{F_p \phi \pi_L^{0.2}} \right)^{1/2}$$

OR

- Q.3** (a) State the various types of liquid distributors used in packed tower. Explain any one in detail. **03**
 (b) State the various equipment used as absorber. What are the selection criteria for packed tower. **04**
 (c) Write a short note on Tinker's flow model. **07**
- Q.4** (a) Write a short note on selection of tray type in tray column. **03**
 (b) Discuss the advantages and disadvantages of Vacuum distillation. **04**
 (c) Discuss the design of downcomers in tray column. **07**
- OR**
- Q.4** (a) Discuss the design procedure of condenser in details. **10**
 (b) State the various types of shell and tube heat exchanger. Discuss their advantages over each other. **04**
- Q.5** (a) How to fix the design pressure (Internal and external) and design temperature for mechanical design of pressure vessel? **03**
 (b) What is welding joint efficiency factor? Discuss the radiography test to examine the quality of welding joint. **04**
 (c) Write a brief note on types of heads or closures for various equipments. **07**
- OR**
- Q.5** (a) What is static and rotary equipments? Explain with examples. **03**
 (b) Discuss the various classes of Pressure vessels. **04**
 (c) A cylindrical vessel 14 ft ID and 0.3125 inch has ring stiffeners located at 40 in spacing and it is subjected to an external pressure of 15 psi at a temperature of 700 °F. the material of both the vessel and stiffeners is carbon steel with a yield stress of 30000 – 38000 psi. Modulus elasticity of carbon steel is $170 \times 10^3 \text{ N/mm}^2$. **07**
 (1) Is $t_s = 0.3125$ in adequate for a design with factor of safety of 4 ?
 (2) What is the allowable external pressure for a factor of safety of 3?
 (3) What is the thickness for same ID vessels based on a factor of safety 3?
 (4) Determine the stiffener ring requirements for the vessel in (3)?

$$P_c = \frac{2.42 E (t/D_0)^{5/2}}{(1 - \mu^2)^{3/4} [(L/D_0) - 0.45(t/D_0)^{0.5}]}$$

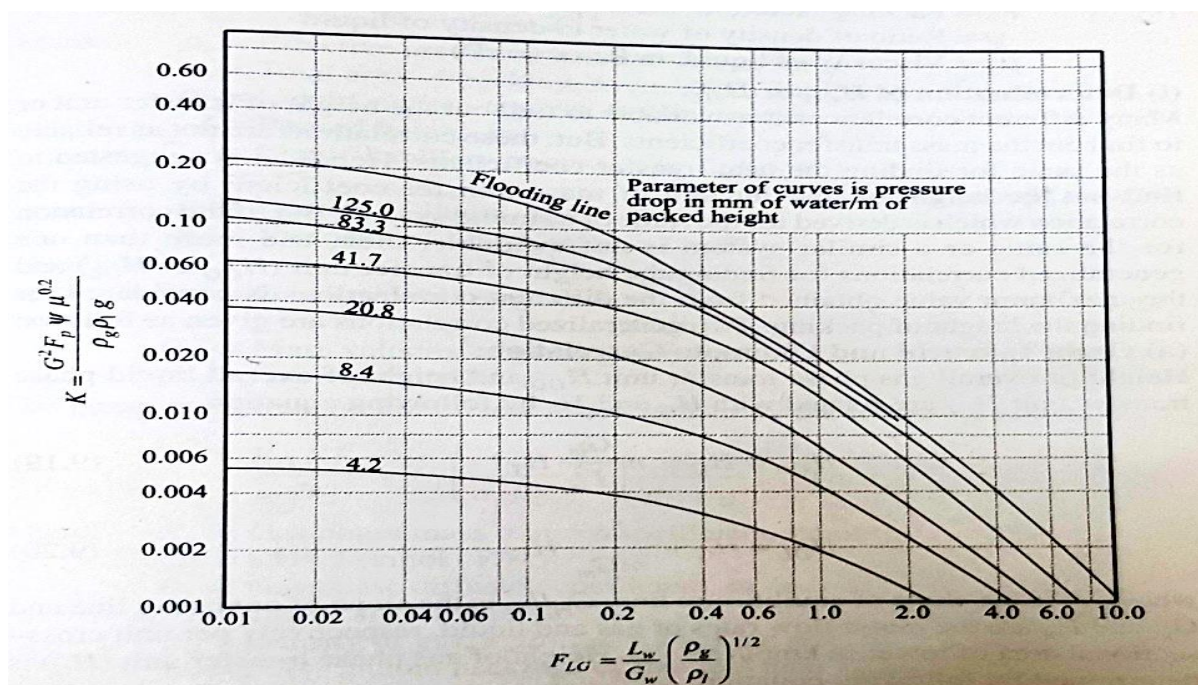


Fig 1 : Generalized flooding and Pressure-drop Correlation for packings.