

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VI (NEW) EXAMINATION – WINTER 2018****Subject Code:2160503****Date:20/11/2018****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.

MARKS

- Q.1** (a) Describe effect of increase in reflux ratio on number of theoretical stages and utility requirement with graph. **03**
- (b) Discuss selection criteria between kettle type and thermosyphon reboiler. **04**
- (c) Explain use of baffles, tie rods, spacers, tube side pass partition plate, shell side pass partition plate, tube sheet and expansion joints in shell and tube heat exchanger. **07**

- Q.2** (a) Explain merits and demerits of hot oil over saturated steam as a heating medium. **03**
- (b) Discuss Tinker's flow model with neat figure. **04**
- (c) Discuss step wise design procedure for shell and tube heat exchanger without phase change. **07**

OR

- (c) In vertical thermosyphon reboiler recirculation ratio is fixed by trial and error method. Discuss in detail that, how to find or fix the recirculation ratio in the following conditions: **07**
1. $\Delta P_{av} > \Delta P_t$
 2. $\Delta P_{av} \ll \Delta P_t$
 3. $\Delta P_{av} \approx \Delta P_t$

- Q.3** (a) Discuss steps to prevent flooding and weeping in distillation column. **03**
- (b) Discuss importance of gas distributor, liquid distributor, liquid redistributor and structured and random packing in packed column operation. **04**
- (c) Discuss merits and demerits of vacuum distillation over atmospheric distillation with appropriate example. **07**

OR

- Q.3** Calculate overall heat transfer coefficient for kettle type reboiler, which vaporizes 7160 kg/hr of n-butane at 5.84 bar. Also check that actual heat flux is less than the critical heat flux or not. n-butane is available at saturated liquid condition at given pressure. Saturated steam available at 1.7 bar pressure and 115.2 °C temperature is to be used as a heating medium. Use following data for calculation purpose. Properties of n-butane are given at 5.84 bar pressure. **14**

Latent heat of vaporization of n-butane	326 kJ/kg
Boiling point of n-butane	56.1 °C
Critical pressure of n-butane	38 bar
Steam side heat transfer coefficient	8000 W/m ² °C
Steam side fouling coefficient	5000 W/m ² °C
n-butane side fouling coefficient	10000 W/m ² °C
Surface tension	9.7 X 10 ⁻³ N/m
Density of liquid n-butane	550 kg/m ³
Density of vapor n-butane	12.6 kg/m ³
Type of tube	U-tube
Nominal length of tube	4.8 m
Outside diameter of tube	30 mm

Inside diameter of tube	25 mm
Tube pitch	Square
Tube pitch to Outside diameter tube ratio	1.5
Thermal conductivity of tube material	55 W/m°C
Constant K_b for square pitch	0.44

- Q.4** (a) List factors affecting selection of trays in tray column. Discuss any one of them in detail. **03**
- (b) Discuss selection criterion between horizontal and vertical condenser. **04**
- (c) Discuss stepwise procedure for determination of minimum reflux ratio in binary distillation system. **07**

OR

- Q.4** (a) List important industrial application of liquid-liquid extraction. **03**
- (b) Differentiate between jet flooding and downcomer flooding. **04**
- (c) Discuss stepwise design procedure for horizontal and vertical gravity decanter. **07**

- Q.5** Estimate minimum reflux ratio and minimum number of ideal stages needed for the butane-pentane splitter defined by the compositions given in table below. Also investigate effect of reflux ratio on ideal stages. The column is operated at a pressure of 8.3 bar. The feed is at its boiling point. Top and bottom temperatures are 65 °C and 120 °C respectively. **14**

Component	Feed, kmol/hr	Distillate, kmol/hr	Bottom, kmol/hr
Propane	5	5	?
i-Butane	15	15	?
n-Butane	25	24	?
i-Pentane	20	?	19
n-Pentane	35	?	35

Relative volatilities at top and bottom are listed in table below.

Component	Top	Bottom
Propane	5.5	4.5
i-Butane	2.7	2.5
n-Butane	2.1	2
i-Pentane	1	1
n-Pentane	0.84	0.85

OR

- Q.5** (a) State the merits and demerits of falling film absorber. **03**
- (b) Explain function of downcomer and discuss the different types of downcomer used in distillation column. **04**
- (c) Explain concept of NPSH in pumping system. Distinguish between $(NPSH)_A$ and $(NPSH)_R$. If $(NPSH)_A$ is less than $(NPSH)_R$, then suggest corrective action to make $(NPSH)_A$ greater than $(NPSH)_R$. **07**

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