Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. - SEMESTER – VI • EXAMINATION – SUMMER 2015

Subject code: 160503 **Date:08/05/2015**

Subject Name: Process Equipment Design I

Time: 10.30AM-01.00PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 (a) Carbon dioxide is to be conveyed from the top of the stripper of ammonia plant to urea plant. Calculate the pipe size required based on following data. **10**

(i) Flow rate of CO_2 = 1000 t/day
(ii) Total length of pipe = 800 m
(iii) Available pressure at inlet of pipe = 24 kPa g
(iv) Discharge pressure of CO_2 from pipe required = atmospheric
(v) No. of butterfly valve in pipeline = 1
(vi) No. of 90o elbows in pipeline = 8
(vii) Temperature of gas = 60°C
(viii) Viscosity of CO_2 gas = 0.016 cP
(ix) Equivalent number of velocity heads for butterfly valve =0.24
(x) Equivalent number of velocity heads for 90° elbows = 0.75
(xi)MOC of Pipe = Carbon Steel

Pipe	ID of Std. Pipe
500 mm NB	387.55 mm
600 mm NB	438.15 mm
500 mm NB	488.95 mm
600 mm NB	590.55 mm

(b) For the specified location of the pump calculated value of $(NPSH)_A$ is coming less than $(NSPH)_R$. Suggest all possible solutions to make$(NPSH)_A$ greater than $(NPSH)_R$. **04**

Q.2 (a) In design of vertical thermosyohon Reboiler recirculation ratio is determined via trial and error calculation. In these case calculations one of the following hypothetical conditions arises for the assumed value of recirculation ratio. **07**

(i) $\Delta P_{av} \approx \Delta P_t$
(ii) $\Delta P_{av} >> \Delta P_t$
(iii) $\Delta P_{av} < \Delta P_t$

Discuss how to find or fix the recirculation ratio in each of the above condition.

(b) Discuss the Process design of Horizontal and Vertical Settlers in details. **07**

OR

(b) Discuss criteria for choice of solvent for liquid-liquid extraction. **07**

Q.3 10900 kg/h of nearly pure saturated methyl ethyl ketone (MEK) vapor at 13.73 kPa g is to be condensed and cooled to 60 $^{\circ}$C by cooling water which is available in plant at 32 $^{\circ}$C. Assme Uc = 800 **14**

W/m^2 °C and Usub = 200 W/m^2 °C. Calculate the % excess heat transfer area for the given condenser.

(1) Latent heat of condensation of MEK at condensation temperature, 83.87°C = 438.27 KJ/Kg

(2) Specific heat of MEK liquid = 2.298 KJ/Kg °C

(3) No. of tube side pass = 4 , for 4 passes k_1 = 0.175, n_1 = 2.285

(4) Tube OD = 19.05 mm , Tube ID = 15.748 mm , Tube length = 1.83 m

(5) Viscosity of water = 0.72 cP,

(6) Thermal conductivity of water = 0.6228 W/m °C

(7) Mean temperature of condensate film = 71.22 °C

(8) Physical properties of MEK liquid condensate at 71.22 °C,

Viscosity = 0.31 cP, density = 805 kg/m^3, Thermal conductivity = 0173 W/m °C

(9) For subcooling zone h_{osub} = 283.77 W/m^2 °C

(10) dirt factor for organic vapor = 10000 W/m^2 °C

(11) dirt factor for cooling water = 4000 W/m^2 °C

(12) Thermal conductivity of SS 304 material = 16.3 W/m °C

OR

Q.3 **(a)** Discuss the Advantages and disadvantages of plate heat exchanger over shell and tube heat exchanger. **07**

(b) Write short note on Tinker's flow model in shell and tube heat exchanger design. **07**

Q.4 Explain and write all equations involved in following condition for Sieve tray tower. **14**

(a) Pressure drop across tray tower
(b) Checking of weeping condition
(c) Checking of Down comer flooding
(d) Checking of liquid entrainment

OR

Q.4 A mixture of benzene and toluene containing 40 mole% of benzene is to be separated to give a top product of 90 mole% benzene and a bottom product with not more than 10 mole% benzene. Using an average value of 2.4 for the volatility of benzene relative to toluene, calculate the following using McCabe-Thiele Method: **14**

1. The minimum reflux ratio(Rm),
2. No. of theoretical stages when R=2.5Rm
3. Feed Tray location

Feed entering the column is liquid and at its boiling point.

Q.5 Explain design procedure for Absorption tower for finding the height (Cornell's method) and diameter of column. **14**

OR

Q.5 **(a)** Discuss the criteria of selection among the different types of the equipment used as absorbers or scrubbers. **07**

(b) Discuss about the different flow pattern of liquid in column with neat sketch. **07**

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