

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh Semester B.Tech Degree Examination (Regular and Supplementary), December 2020

Course Code: CH405**Course Name: CHEMICAL ENGINEERING DESIGN II**

Max. Marks: 100

Duration: 3 Hours

Instructions:

1. Graph sheets may be provided
2. Missing data may be assumed suitably
3. The following materials are allowed in the examination:
 - i. Perry's Chemical Engineers Hand book (original print and attested photocopies), McGraw-Hill Int. Edn.
 - ii. Steam Table (original print), IS Codes, Psychrometric chart.
 - iii. Attested copies of relevant equations and charts for design of sieve tray from 'Mass Transfer Operations' by Robert E. Treybal (pages 169, 532 to 538), McGraw-Hill Int. Edn

The attestation must be done by the concerned faculty engaging the subject with official seal.

Answer any two full questions, each carries 50 marks.

Marks

- 1 a) A double-effect long tube evaporator is to concentrate a 10% solution of Sodium Hydroxide to 40%. The feed is fed at 38°C and carries 5000 kg/hr of NaOH. Steam is available at 113°C and a vacuum of 710 mm Hg may be maintained in the last effect. Heat transfer coefficients may be assumed to be 6240 and 3400 W/m²K in the 1st and 2nd effects respectively. Radiation losses and losses by entrainment may be neglected. Design an evaporator for the purpose. Also sketch the sectional elevation of the designed evaporator. (50)
- 2 a) 1000 kg/hr of a mixture containing 60 mole percent acetic acid and 40 mole percent water is to be fractionated to a distillate containing 95 mole percent water and a residue containing 97 mole percent acetic acid using a total condenser and feed is 40% vapour. The enthalpy-concentration data for the water - acetic acid at 1 atm pressure are as follows: (50)

x	0	0.188	0.308	0.45	0.52	0.582	0.675	0.726	0.795	0.856	0.913	0.958	1.0
y	0	0.306	0.447	0.60	0.658	0.711	0.78	0.824	0.867	0.904	0.941	0.971	1.0
T, °C	118.3	110.6	107.8	105.2	104.3	103.5	102.8	102.1	101.5	100.8	100.5	100.2	100

- i) Design a sieve tray tower operating at 1 atm. meeting all the hydrodynamic considerations. (40)
- ii) Give a neat sketch of the distillation column (10)
- 3 a) A cooling tower operates in the counter current mode, process hot water entering at 48°C and the cold water leaves at 8°C approach to the wet-bulb temperature. The entering air has a humidity of $0.001 \text{ kg}/(\text{kg dry air})$ and wet-bulb temperature of 18°C . The cross-sectional area of the tower is 7 m^2 . Determine the height of the fill required for a tower operating with a liquid loading of $1700 \text{ kg-H}_2\text{O}/(\text{h})(\text{m}^2)$ and an air loading of $1950 \text{ kg-air}/(\text{h})(\text{m}^2)$. The overall mass transfer coefficient, $K_Y a$ is $2500 \text{ kg}/(\text{m}^3)(\text{h})$. (25)
- b) A plant manufactures flue gas containing CO_2 by burning with air in a dryer. Then the flue gases are cleaned & cooled. They contain 15% CO_2 , 6% O_2 and 79% N_2 . The gases are at 25°C , 912 mm Hg pressure. They are to be scrubbed with 30% MEA solution to bring down the CO_2 content to 2% CO_2 . Solvent, 50% in excess enters the column at 25°C and containing 0.058 mol of CO_2/mol of MEA solution. The scrubber is to be operated at 25°C and 912 mm Hg. Determine number of transfer units and the diameter required for a packed column to handle 100 tons per day of flue gases. The equilibrium data is as follows. (25)

Mol CO_2/mol MEA, X	0.058	0.060	0.062	0.064	0.066	0.068	0.072
Mol $\text{CO}_2/\text{mol}(\text{O}_2+\text{N}_2)$, Y	0.00618	0.01423	0.0328	0.0654	0.1213	0.2047	0.3411

(2 x50= 100 Marks)