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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, 06th December, 2017

Program Name: B.Tech CERP	**Semester – V**
Course Name : Mass Transfer-I	**Max. Marks : 100**
Course Code :CHEG 214	**Duration : 3 Hrs**
No. of pages:2	

Note: Any missing data should be suitably assumed. State all the assumptions made. Draw a neat sketch using 'pencil' wherever applicable. Answering Part-C is 'compulsory' and be advised to answer it first.

Part A: Answer all the questions (4m *5 = 20 m)

1. Explain Total reflux, minimum reflux and optimum reflux conditions in a distillation column with suitable plots**.**
2. List the desirable characteristics of a packing material in a packed bed.
3. Derive an expression for minimum L/G ratio for continuous counter current Absorption where L and G are liquid and gas flow rates in kmoles.
4. a. Where and why liquid distributer, liquid collector and liquid re-distributer are used?
   b. Give one example each for maximum boiling azeotrope and minimum boiling azeotrope.
5. Define q-factor. Schematically represent five different q-lines corresponding to different phase conditions of feed to a distillation column.

Part B: Answer all the questions (8 m *5 = 40)

6. A liquid mixture of ethanol (96%) and water (4%) needs to be separated out. Identify the type the distillation needs to be employed and Explain the same with a neat sketch. Also mention the desired properties of the entrainer.
7. A benzene air mixture containing 12 mole % benzene is to be scrobbed in a packed column, operating at 43^{o}C and 1 atm pressure. The column is to be designed for treating 0.5782 kmol/m^2h, such that the exit gas will contain 1% benzene. The solvent for scrubbing is pure mineral oil which enters the top of the column at a rate of 27.72 kmol/ m^2 h. Determine the height of the tower (Z, meters) column assuming height of the transfer unit to be 1 m. The equilibrium concentration is given by y*= 0.263x, where x and y are molefractions in liquid and vapor.
8. 10 kmol FEED mixture of 40 mole% heptane and 60 mole % ethyl benzene is separated using a batch still (simple distillation) and the residue contains 15 mole% heptane. Using

graphical integration of Rayleigh's equation, Determine and report kmoles of Residue and the composition of Distillate.

Equilibrium data where x and y* are mole fractions:

x	0	0.1	0.2	0.25	0.35	0.5
y*	0	0.223	0.43	0.5	0.6	0.24
1/y*-x	Infinity	8.13	4.35	4	4	3.84

9. Differentiate between packed bed column and Plate column.
10. With a neat sketch, explain the PROCEDURE to determine the minimum reflux ratio using Ponchon-Savorit method.

Part –C Answer all the questions (20m *2 = 40)

11. A Fractionating column separates a FEED mixture entering at 5000 kmol /hour containing equimolar mixture of benzene (A) and Toluene (B) into an overhead product of 95 mole% A and a bottom product of 96 mole% B.
    Determine the flowrate of Distillate and residue in kmol.

    If the vapour pressure of pure benzene and toluene are 1460 and 584 mm Hg, determine relative volatility and compute VLE Data. Plot x-y diagram and draw diagonal line.
    If the FEED enters as 50% liquid and 50% vapor mixture, draw the q-line between the x-y diagram and diagonal line. Determine the minimum reflux ratio. If a reflux ratio of twice the minimum reflux ratio will be used, determine the number of IDEAL stages. Identify and report the optimum feed plate location. If plate efficiency is 50%, Determine the actual number of stages required, including reboiler.
12. Ammonia is separated from a gas by using water in a scrubber under atmospheric pressure. The initial content in the gas is 0.04 kmol NH_3/kmol inert gas. The recovery of ammonia by scrubbing is 90%. Pure water enters the tower.
    Equilibrium data where X and Y are mole ratios:

X	0.005	0.01	0.0125	0.015	0.02	0.023
Y	0.0045	0.0102	0.0138	0.0183	0.0273	0.0327

    a. Plot X-Y diagram and Mark Q (X_2, Y_2).
    b. Determine the MAXIMUM concentration of ammonia in the exit liquid
    c. Determine the ACTUAL concentration of ammonia in the exit liquid if accrual actual water used in 1,5 times the minimum.
    d. Mark P (X1,Y1) and draw the operating line equation for scrubbing.
    e. Determine the number of theoretical stages required.
    f. If the plate efficiency is 50%, determine the actual number of stages.

---Practice makes one perfect--