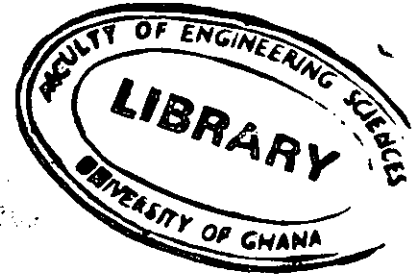




UNIVERSITY OF GHANA
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B.Sc ENGINEERING SECOND SEMESTER EXAMINATION: 2015/2016
SCHOOL OF ENGINEERING SCIENCES
FPEN 302: SEPARATION PROCESSES (2 Credits)

INSTRUCTIONS

ANSWER FOUR QUESTIONS

EQUILIBRIUM CURVE FOR METHANOL/WATER SYSTEM IS PROVIDED.

TRIANGULAR DIAGRAM FOR ACETONE-MIK-WATER IS PROVIDED.

TIME ALLOWED: TWO (2) HOURS

1. An expression for the number of ideal stages, N , in a system with straight operating and equilibrium lines for the removal of a component from a liquid feed using clean air, can be derived from the Kremser equation as

$$N = \frac{\ln[(y_a - y_a^*)/(y_b - y_b^*)]}{\ln[(y_a - y_b)/(y_a^* - y_b^*)]}$$

- a) On a y - x diagram, draw the operating and equilibrium lines for such a system and indicate all the quantities involving y 's in the equation above on the diagram.
- b) The denominator defines the absorption factor A . Show that the number of ideal stages can be related to the absorption factor as

$$A^N = \frac{y_a - y_a^*}{y - y_b^*}$$

- c) In terms of the slopes of the operating and equilibrium lines, define the absorption factor, A .
2. Ammonia is stripped from a dilute aqueous solution by countercurrent contact with air in a column containing nine sieve trays. The equilibrium relationship is $y_e = 0.85x_e$ and when the molar flow of air is 1.4 times that of the solution, 95% of the ammonia is removed.

- a) Draw a column showing all the inflows and outflows and their corresponding mole fractions
 - b) Calculate the number of ideal stages present in the column, analytically.
 - c) What is the stage efficiency of the column?
3. a) State two laws that can be used to relate phase compositions in vapour-liquid equilibrium in dilute systems

b) A soluble gas is absorbed in water using a packed tower. The equilibrium relationship may be taken as $y_e = 0.08x_e$. Terminal compositions are as follows:

Mol. fraction	Top	Bottom
x	0	0.075
y	0.0015	0.008

If $H_x = 0.35$ m and $H_y = 0.45$ m, what is the height of the packed section of the column?

$$H_{Oy} = H_y + m \frac{V}{L} H_x ; N_{Oy} = \frac{y_b - y_a}{\Delta y_{LM}}$$

(Note: All symbols have their usual meanings)

4. a) State the three assumptions usually made in the application of the McCabe-Thiele method of analysis in distillation and other stagewise operations.

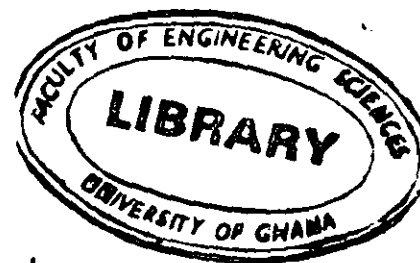
b) A plant must distill a mixture containing 60 mol percent methanol and 40 percent water. The overhead product is to contain 96 mol % methanol and the bottom product 3.0 mol%. The feed is saturated vapour. The reflux ratio at the top of the column is 1.4, and the reflux is at its bubble point. Calculate

- i. The molar ratio of the product to feed
- ii. The minimum number of plates
- iii. The number of plates using a total condenser and a reboiler, assuming an average Murphree plate efficiency of 72 percent.
- iv. Indicate the feed tray.

5. A mixture containing 50% weight percent acetone and 50% weight water is contacted with an equal amount of methyl isobutyl ketone (MIK).

- a) What will be the amounts and compositions of the extract and raffinate phases?
- b) What fraction of the acetone can be extracted?
- c) What fraction of the acetone could be extracted if the fresh solvent were divided into two parts and two successive extractions are made?





Methanol/Water Equilibrium Graph

