KOYA UNIVERSITY

Faculty of Engineering
Department: Chemical Engineering
Level: 3
Total Mark: 100

Final Examination
Fall Semester (2024-2025)

Course Title: Unit Operation
Course Code: KOU20441
Time Allowed: 120 minutes
Attached Sheet: Non

Answer All Questions

Q1) A packed tower operating at 101 kPa, recovers 95% of solute gas initially is presented at low concentration in an inert gas. The inert gas rate is 0.076 kmol/m ^{2}.s and the tower is supplied with solute free liquid at the rate of 0.23 kmol/m^2.s. Calculate the height of the tower given:

$y_A^* = 1.15 * x_A$

$KOL.a = 66 + KOG.a$

Where KOG.a and KOL.a are in kmol/m^3.h

(20 Marks)

Q2) Drive an expression for the diffusion of an ideal gas in unsteady state conditions.

(20 Marks)

Q3) A continuous rectifying column handles a mixture consisting of 40 per cent of benzene by mass and 60 per cent of toluene by mass at the rate of 4 kg/s, and separates it into a product containing 98 per cent of benzene by mass and a liquid containing 97 per cent toluene by mass. The feed is vapor at its boiling-point.

(a) Calculate the mass flows of distillate and waste liquor.

(b) If a reflux ratio of 3.5 is employed, how many plates are required in the rectifying part of the column?

X (mole fraction)	0.11	0.23	0.32	0.41	0.52	0.61	0.73	0.81	0.92
Y (mole fraction)	0.24	0.438	0.55	0.64	0.738	0.803	0.875	0.917	0.967

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Given:

$M.wt_{benzene}$ = 78 kg/kgmol,

$M.wt_{toluene}$ = 92 kg/kgmol

(30 Marks)

Q4) 1000 kg/hr of an aqueous feed containing 28.6 kg of solute B/100 kg of solution is to be treated counter-currently with solvent S in order to reduce the solute concentration to 9.1 kg solute B/100 kg solution. A five stages mixer-settler is available. If the solvent contains 4.75% solute by mass, what solvent flowrate should be used and what is the final extract composition. The equilibrium relationship is Y = 2/3 X where Y and X are mass ratios in extract and raffinate respectively.

(30 Marks)