Name:

Enrolment No:

UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2021

Programme Name: B. Tech in Applied Petroleum Engineering, Spl. Gas **Semester : IV**
Course Name : Mass Transfer **Time : 03 hrs.**
Course Code : CHCE 2017 **Max. Marks : 100**
Nos. of page(s) : 2

Instructions: The exam will be OPEN BOOK and OPEN NOTES exam. The students are allowed any textbooks, photo-copied and hand-written notes. The students will need graph papers

SECTION A [30]

<table>
<tr><th>S. No.</th><th></th><th>Marks</th><th>CO</th></tr>
<tr><td>Q1.</td><td>a. What is the significance of “Chemical Potential” in mass transfer operations? Answer in detail.</td><td>[5]</td><td>CO1</td></tr>
<tr><td></td><td>b. Starting from $N_A = N. X_A + J_A$, show that $j_A = \rho_A (v_A – v)$
Here, N, N_A and J_A are the molar fluxes in kmol/m^2.sec and j_A and j_B are mass fluxes in kg/m^{2}sec. ρ_A is the density and v_A, v are the velocities.</td><td>[10]</td><td>CO1</td></tr>
<tr><td>Q2.</td><td>A solution containing 60% A and 40% C is fed to a co-current extractor at 120 kmol/hr. Solvent B is added to the process at 200 kmol/hr.
a. Calculate the amount of C removed for the above condition.
b. Calculate the amount of C removed if the process is converted to a 2 staged cross current process with 100 kmol/hr of B added to each stage. Write what do you infer from both the results.
The equilibrium data is as below
<table>
<tr><td>X (kmol of C per kmol of A)</td><td>0.05</td><td>0.2</td><td>0.3</td><td>0.45</td><td>0.5</td><td>0.54</td></tr>
<tr><td>Y (kmol of C per kmol of B)</td><td>0.25</td><td>0.4</td><td>0.5</td><td>0.65</td><td>0.7</td><td>0.74</td></tr>
</table>
<i>Instruction: Please plot the graph using the same graph paper</i></td><td>[15]</td><td>CO2</td></tr>
</table>

SECTION B [30]

<table>
<tr><td>Q3.</td><td>a. Explain how heat and mass transfer are simultaneously affecting the process of drying and humidification.
b. If a solid is partially soaked in water, how will the process of drying occur? Please explain in terms of movement of water molecules.</td><td>[15]</td><td>CO3</td></tr>
<tr><td>Q4.</td><td>Crude with 0.8% H_2S fed at 1500 Kmol/hr is treated in a packed column with ethanolamine solution containing 0.02% H_2S. The optimum liquid rate is 2.5 times the minimum liquid flowrate. If the packed column of diameter 2 m is filled in random with 2.5 in glass saddle packings, calculate the height of the packing required to separate 98% of H_2S from the crude. The mass transfer coefficient for the process K_Ga = 1450 Kmol/hr. m^3 and equilibrium condition follows the equation $y^* = 1.5x$. The minimum liquid flowrate for the process is 1090 Kmol/hr.</td><td>[15]</td><td>CO4</td></tr>
</table>

SECTION-C [40]

Q5. 55% Butane and 45% Hexane mixture is separated in a distillation column operated at 1 atm pressure and 45°C. The Distillate is removed at 450 kmol/hr and has composition of 90% and the bottom has 92%. The optimum reflux is 2 times the minimum reflux. The feed condition is an equal mixture of vapor and liquid.

a. Calculate the Real number of trays required for the process if the efficiency is 68%.
b. Calculate the optimum feed tray location
c. Feed flowrate needed for the process.
d. What should be done to increase the purity of the product?

The equilibrium data is as below

y*	0.21	0.37	0.51	0.64	0.72	0.79	0.86	0.91	0.96	0.98
x	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	0.95

The x, y data are in mole fraction*

[40] **CO4**