Name:

Enrolment No:

UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, July 2020

Programme Name: B. Tech in Applied Petroleum Engineering, Spl. Gas **Semester : IV**
Course Name : Mass Transfer **Time : 3 hrs.**
Course Code : CHCE 2017 **Max. Marks : 100**
Nos. of page(s) : 3

Instructions: The exam will be <u>OPEN BOOK and OPEN NOTES</u> exam. The students are allowed any and all textbooks, photo-copied and hand-written notes.

Please make necessary assumptions and mention them whenever and wherever necessary

SECTION A [30]

S. No.		Marks	CO
Q1.	2000 kg of water containing 20% dye is treated with 1000 kg of activated carbon to purify the water in a counter-current adsorption column. The equilibrium data is as follows: X (kg dye/kg carbon): 0, 0.05, 0.1, 0.2, 0.4, 0.5 Y (kg dye/kg water): 0, 0.03, 0.05, 0.11, 0.26, 0.36		
	a) Calculate the number of stages needed for the process if the final concentration of dye in water should not be more than 5%.	**10**	**CO2**
	b) If the real column is only 85% efficient, calculate the number of real stages required	**5**	**CO2**
	c) What do you think will happen if the process is conducted co-currently? Do you expect different separation? Give reasons. (maximum 150 words)	**5**	**CO1**
	d) For the above process, if the separation process has to be improved, what necessary steps will you take and why? (maximum 200 words)	**10**	**CO1**

SECTION B [30]

Q2.	A 500 kg wet solid is being dried in a tray drier for 10 hr at a critical rate of drying of 1 kg moisture/m^2.hr. The final moisture content is found to be 5%. The critical and equilibrium moisture contents are 10% and 0.5% respectively. The falling rate of drying is linearly related to the free moisture content. The drying surface is 1 m^2/30 kg dry weight.		
	a) Calculate the initial moisture content of the solid.	**10**	**CO4**
	b) Calculate the final moisture content if the drying is continued for another 4 hrs.	**5**	**CO4**
	c) Explain the rate of drying of solids from the molecular movement of water perspective. (maximum 250 words)	**15**	**CO3**

SECTION-C [40]

Q3. Consider the schematic below, where the first column is a distillation column run at 1 atm pressure. A feed containing 50% methane and 50% butane is fed under saturated liquid condition to the column at 1500 Kmol/hr. Post separation, product specification required is 98% methane at the top and 99% Butane at the bottom.

The vapor phase residue stream containing Butane [99.5% Butane + 0.5% H_2S (1% methane in residue is ignored)] is sent to a packed-bed absorption column. Here the butane is treated with amine to remove 95% H_2S from the stream. The column is 3 m in diameter and is packed with 1.5" ceramic Berl saddle packings.

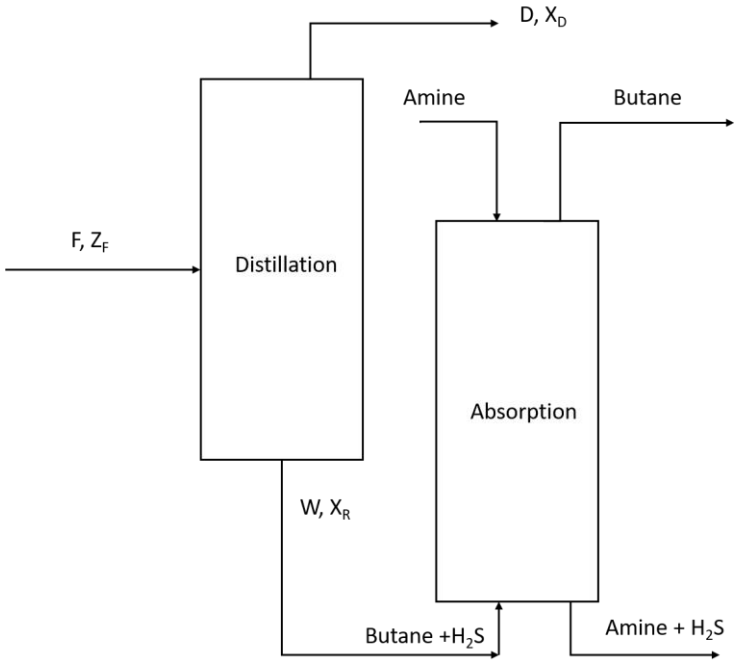
Calculate:

a) Number of stages required for the distillation column to meet the product specification if the reflux ratio is 2.3.
b) Optimal feed location for the feed mixture.
c) Real number of stages required for the distillation column if the column efficiency is only 80%
d) The total packing height required for the absorption column to meet the product requirement, if the overall mass transfer coefficient is $K_G.a$ = 200 kmol and the equilibrium relation is given by y=0.6x.

The equilibrium data is as follows (in mole fractions):

X	0	0.13	0.22	0.32	0.46	0.57	0.69	0.82	0.92	1.0
Y*	0	0.24	0.37	0.5	0.65	0.74	0.83	0.91	0.96	1.0

*** make necessary assumptions and mention them*



[40] **CO4**