Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – II • EXAMINATION – SUMMER • 2014

Subject code: 1723001 **Date: 16-06-2014**

Subject Name: Advance Mass Transfer

Time: 02:30 pm - 05:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 A multicomponent distillation column should be designed in such a way, that a concentrate stream of Ethane could be separated from a feed stream containing 6 hydrocarbons. Calculate the required theoretical number of stages by FUG method, when R = 1.25Rmin. **14**

Separation requirements:
Mole fraction of Propylene in the Distillate: 0.025
Mole fraction of Ethane in the Bottoms: 0.050
Operating conditions:
Pressure: p = 27.3 bar
Feed quality: liquid at the boiling temperature (q = 1)
Average plate efficiency coefficient: E = 0.75
Feed composition:

Components in the Feed stream	mol-%	ŬFeed
Methane	5.0	7.356
Ethane (LK)	35.0	2.091
Propylene (HK)	15.0	1.000
Propane	20.0	0.901
i-Butane	10.0	0.507
n-Butane	15.0	0.408

Mole flow-rate for a Feed of 100 kmol/h:
Assumption: The non-key components are completely separated.

Q.2 **(a)** Discuss the Process design steps of Falling film absorber. **07**

(b) Write a Shot note on Thermally coupled Distillation Column. **07**

OR

(b) Discuss the use of heat pump with refrigerant in distillation column for energy saving. **07**

Q.3 By using Lewis Matheson method, calculate the composition of vapour entering top most tray of the column for following case. **14**

(a) Distillation columns details:

Component	Feed, Mole%	Distillate mole %	Residue mole %
n-Butane	37	95	16.3
i-Pentane	32	05	41.6
n-Pentane	21		28.5
n-Hexane	12		13.6

(b) F = 4750 kmol/hr , D = 1250 and feed is saturated liquid

(c) Operation Pressure = 2 atm ab

(d) Reflux ration R =3

(e) Vapour pressure of components:

ln Pv = A ï (B/T+C) , where Pv is in mmHg & Temp. in K

Component	A	B	C
n-butane	15.6782	2154.9	-34.42
i- pentane	15.6338	2348.67	-40.05
n-pentane	15.8333	2477.07	-39.94
n-hexane	15.8366	2697.55	-48.78

OR

Q.3 Explain the stepwise procedure multicomponent batch distillation with constant overhead composition. **14**

Q.4 Predict the Fractional solute removal and pressure drop in a venturi scrubber based on the following data. **14**

(1) Volumetric flow rate of boiler flue gas = 24000 Nm^3/h
(2) Discharge pressure of gas from venture = Atmospheric
(3) Temperature of gas = 90°C
(4) SO_2 concentration in boiler flue gas = 4000 ppm
(5) Solvent = 1% lime solution
(6) Solvent to gas ratio = 1.4 L/m^3
(7) Throat velocity of gas phase = 100 m/s
(8) Average molar mass of flue gas = 29.48 kg/kmol
(9) Equilibrium mass of SO_2 per 100 mass of H_2O = 0.035

Assume that no Chemical reaction is taking place between lime and SO_2 due to presence of 1% lime in solution. Also assume the average temperature of scrubber is 50°C.

Reliable pressure drop equation for venturi scrubber is,

$$\varphi P = 2.584*10^{-3}\ V_G J_G\ A_{th}\ (L\hat{o}/\ G\hat{o})^{0.78}$$

OR

Q.4 **(a)** Explain the method of selection of operating pressure in distillation column. Also define light key and heavy key components. **07**

(b) Discuss the criteria for selection of Spray tower, Venturi scrubber and Tray tower as absorbers. **07**

Q.5 **(a)** Describe the advantages and disadvantages of microfiltration. **07**

(b) Discuss the Applications of Super heated Steam dryer in detail. **07**

OR

Q.5 Write advantages and disadvantages of superheated steam dryer over hot air dryer. **14**

****