

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 $R = 1.25R_{min}$. **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-%	$\dot{U}_{Feed}$
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 ratio $R = 3$
 (e) Vapour pressure of components:

$\ln P_v = A - (B/T + C)$, where P_v 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 = $24000 \text{ Nm}^3/\text{h}$
- (2) Discharge pressure of gas from venturi = 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,

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

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**
