B.E- VII

Process Engg. (26)

QP Code : 5919

BE/VII/CBGS/CHEM./PE

(3 Hours)

Total Marks: 80

N.B:

1. **Question No. 1 is compulsory.** Attempt **any three** questions from the rest of the five questions.
2. Draw neat sketches wherever required.
3. Assume suitable data if necessary and **specify the assumptions** clearly.
4. Answer to the sub-questions of an individual question should be grouped and written together i.e. one below the other.

Q.1. Answer the following questions very briefly and exactly (in 2 to 3 sentences) (each sub-question below carry equal marks) **(20)**

1. During Nitration reaction, why it is necessary to control the reaction temperature?
2. List out various specifications about "Process Vessel", those must be provided to vendor to get correctly manufactured / designed process vessel.
3. What is the meaning of "Reversible by-product" and why such by-products should be recovered and recycled back to the process?
4. The feed stream to a splitter contains 60 and 40 moles of component A and B respectively. The splitter divides the feed stream in stream 1 and stream 2, where split fraction of stream 1 is 0.3. Then calculate the moles of A and B in stream 1 and 2 respectively.
5. Inlet temperature of the gas being compressed by a stage compressor is 298 K and compression ratio is 2.45. C_p and C_v values of the gas are 1.005 and 0.718 kJ/KgK respectively. What will be the outlet temperature of gas after each compression stage?
6. If material factor, pressure factor and design factor for the heat exchanger are 1, 0.25 and 1 respectively, then calculate overall material and pressure factor i.e. MPF for this heat exchanger.
7. What is the meaning of "Fire Point"?
8. In case of designing the control structure for the process, what is the degree of freedom and what is its significance?
9. What is the limitation of "steam" to be used as utility?
10. What is the significance of "relative volatility" in distillation operation?

Q.2. (a) The bubble point feed to distillation column contains 20 gmol/s acetone and 330 gmol/s of water and residue from the column contains 2 gmol/s of acetone and 328 gmol/s of water. Vapor pressure of acetone and water at 368 K is 2784 and 643 mm Hg respectively. The column has extra feed space of 1.5 m and disengagement space is 3 m each at top and bottom. Height of support is 1.5 m. Tray efficiency is 80% and tray spacing is 18 inch. Then evaluate, no. of trays, reflux ratio and total height of column. **(12)**

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(b) Determine the updated bare module cost of only tray stack (diameter of tray stack is 1.22 m) in distillation column designed in Q.2 (a), in year 2016 considering the following data. (08)

L_0 =10 ft, D_0 = 2 ft, C_0 = Rs.11700, α =0.97, β = 1.45, UF = 3.12, F_m = 1.7, F_s = 1, F_t = 1.8, MF = 1

Q.3. (a) Discuss the common features of Liquid phase catalytic reduction process and develop the preliminary process system (PPS) block diagram for the manufacture of mono p-amino phenol. Also discuss the safety aspects related to the process. (14)

(c) Write short note on event tree analysis of accidents.

Q.4. (a) In a plant there are four streams. We have to exchange heat amongst these four streams using a heat exchanger network. For this find out minimum heating load, minimum cooling load & pinch temperatures of the hot and the cold stream. Data for process stream as follows:

Assume ΔT_{min} = 20°C.

Streams	FCp (kW/°C)	Tin (°C)	Tout (°C)
1	5	150	60
2	16	90	60
3	6	25	100
4	5	20	125

(b) Define the concept of pinch temperature. Also explain how we can evaluate minimum heating and cooling load from temperature-enthalpy curve. (05)

Q.5. (a) We have to design the control structure for the flash column in order to maintain, the desired production rate, fixed liquid level in the column and also to maintain the pressure and temperature in the column. The heat to the flash column is being supplied by steam. The feed to the flash column is separated in vapour and liquid stream from the column. In order to maintain above desired conditions, explain, which parameters related to this operation should be controlled. Further draw the control structure accordingly. (10)

(b) Discuss in detail the points to be considered while deciding "Input-Output Structure of Flowsheet". (10)

Q.6. A feed to the flash column consist of 25 moles/s of pentane, 40 moles/s of cis-2-butene and 35 moles/s of n-butane. The pressure is 1530 mm Hg and temperature is 300 K. Assuming intermediate boiling component as key component and its recovery in vapor stream from flash column as 35%, carry out mass balance and calculate component flow rates in vapor and liquid stream from flash column. Also with the help of bubble point equation, verify whether assumption of overhead recovery of key component as 35% is correct or not. (20)

Data:

Component	Antoine Constants			Boiling point (K)
	A	B	C	
Pentane	15.8333	2477.07	- 39.94	309
Cis-2-butene	15.8171	2210.71	- 36.15	276.7
n-butane	15.6782	2154.90	- 34.42	272.5