B.E (chem) sem-III 28/11/13. 11.00 - 2.00 CBSGS
(P.E)

Q. P. Code: 24241

Time: 3 Hours **Total Marks: 80**

N.B.: (1) Question No.1 is compulsory.
(2) Attempt any **Three** out of remaining questions.
(3) Assume any suitable data if necessary and indicate it clearly.
(4) Draw neat sketches wherever required.
(5) Answer to the sub-questions of an individual question should be grouped and written together i.e. one below the other.

Q.1. (a) Explain in brief the purpose of each of the following process engineering activities: **(04)**

(1) To conduct Mass balance around the process flow sheet
(2) Deciding equipment specifications
(3) To carry HAZOP study of the process
(4) Interact with market analysers

(b) What are the common characteristics of PFDs? **(04)**

(c) Explain that, when the vapour recovery system (VRS) should be installed on purge stream, when on gas recycle stream and when on flash vapour stream. **(04)**

(d) Fire hazard is one of the major accidents in chemical process industries. What are the various types / classes of fire? What is the concept of fire triangle? **(04)**

(e) In liquid phase catalytic reduction process, what precautions should be taken when H_2 is used as reducing agent? **(04)**

Q.2. (a) Discuss the common features of Nitration process. **(05)**

(b) Draw PPS (block diagram) for manufacture of monochloro benzene (MCB) from benzene using Cl_2 as chlorinating agent **(05)**

(c) With a suitable example, describe the "Fault Tree Analysis" (FTA), a safety redundancy technique. **(10)**

Q.3. (a) Consider the feed to distillation column, whose composition and other related data is given below. Feed temperature is 340 K and Pressure is 11250 mm Hg. The key component to be recovered in distillate is propylene and that in residue is trans-2-butene. The recovery of propylene in distillate is 99.5% and that of trans-2-butene in residue is 99%. Then carry out the mass balance and calculate molar composition of distillate and residue. **(14)**

Component	Composition in feed (gmol/s)	Antoine Constants		
		A	B	C
Propylene	90	15.893	1875.3	- 22.91
Trans-2-butene	20	15.821	2213.6	- 33.11
Cis-2-butene	30	15.816	2209.8	- 36.21
1-butene	12	15.897	2189.4	- 30.52
Ethylene	10	15.833	1427.2	- 14.31
Propane	8	15.725	1872.8	- 25.10

(b) It is proposed to use as absorption column to recover acetone from gas mixture containing 100 gmol/s of air, 10 gmol/s of acetone and 3 gmol/s of formaldehyde. If water is to be used as solvent for this operation, then estimate solvent flow rate at each of the following conditions and conclude how solvent flow rate changes for different operating conditions:

Condition No.	1	2	3	4
$P_{(Column)}$ (atm)	3	3	15	15
$T_{(water)}$ (K)	350	380	350	380

Component	Antoine Constants		
	A	B	C
Acetone	16.6513	2940.46	- 35.93
Water	18.3036	3816.44	- 46.13

Q.4. (a) The shell and tube heat exchanger is used to heat 7060 kg/h of liquid 'A' from 75 to 120 K by cooling liquid 'B' from 160 to 120 K. The overall heat transfer coefficient is 255 W/m^2K. The specific heat capacities of liquid 'A' and 'B' are 2010 J/kgK and 2386 J/kgK respectively. Then calculate heat transfer area required, flow rate of liquid 'B' and bare module cost of heat exchanger in present year. (10)

Data: C_o = Rs. 3,25,000; S_o = 37 m^2; α = 0.65; F_m = 3.1; F_p = 0.1; F_d = 1; MF = 3.29; CI in present year = 1125; CI in base year = 389

(b) The pump is used to pump the chemical at the rate of 600 m^3/day. Density of chemical is 1100 kg/m^3. The inlet and exit pressures for the pump are 200 and 500 kPa respectively. The efficiency of pump and associated motor are 70% and 90% respectively. Then calculate, break horse power of the pump and its bare module cost in present year. (10)

Data: C_o = Rs. 42,250; S_o = 2000 watt; α = 0.36; F_m = 1; F_p = 1.5; MF = 3.38; CI in present year = 1125; CI in base year = 389

Q.5. (a) Consider the process system where there are multiple hot and cold streams are involved. In order to design heat exchanger network for this system, evaluate $Q_{H,min}$, $Q_{C,min}$ and pinch temperature at ΔT_{min} = 25 °C. Process stream data is as below: (12)

Stream	1	2	3	4
T_{in} (°C)	150	90	25	20
T_{out} (°C)	60	60	100	125
MC_p (kW/°C)	2.5	8	3	2.5

(b) During sulphonation process where liquid SO_3 is used as sulphonating agent, why it is required to maintain temperature in SO_3 evaporator equal to boiling point of SO_3 and not below it? Draw and explain the proper control strategy for SO_3 evaporator to achieve this objective. (08)

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Write short notes on the following; each carry equal marks: (20)

(a) Batch v/s Continuous process

(b) Major utilities used in chemical process industries

(c) Different types of Flexibilities that may be involved in process and their effect on process

(d) Reaction information that must be known while synthesizing any chemical manufacturing process

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