B E sem-VII (CBSGS) chemical process Engg
process Engineering.
1/12/16

Q.P. Code : 814002

(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. Answer the following questions briefly and exactly (each sub-question below carry equal marks) **(20)**

1. What specifications related to pump must be specified by process engineer to get correctly manufactured/designed pump?
2. List out the information that can be predicted from PFD.
3. How high temperature may adversely affect the nitration process?
4. What kind of trade off analysis need to be carried out in case if by-product formed in process is reversible in nature?
5. With the help of proper diagram, write and explain general material balance equation for splitter.
6. In case of staged compression, the inlet temperature of gas to each compression stage is 298 K. Then calculate outlet temperature of gas after each compression stage. Assume appropriate necessary data if any required.
7. What are the applications of N_2 as utility in chemical processes?
8. List out only the various risk analysis techniques used in process industries for ensuring the safety.
9. Based upon degree of freedom analysis, how the number of controllers required in any process are decided?
10. What major information can be predicted by process engineer after carrying out energy balance around the process?

Q.2. (a) Discuss the common features of chlorination process and develop PPS for manufacture of mono-chlorobenzene from benzene and chlorine gas as raw materials. **(10)**

(b) Discuss in detail the points to be considered while deciding whether the process should be carried out batch wise or continuous. **(10)**

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Q.3. (a) An absorption column is used to recover 99.2% of acetone from the inlet gas mixture containing 94.3% gmol/s air, 5 gmol/s acetone and 0.7 gmol/s formaldehyde. Water is used as solvent to recover acetone. Then estimate required flow rate of solvent for different four conditions of column pressure and water temperature as given below and explain how the required flow rate of solvent varies w.r.t. different operating conditions. **(10)**

Different operating conditions:

P (column) (mm Hg)	T (water) (K)
750	300
750	330
7500	300
7500	330

Antoine Constants:

Compound	A	B	C
Acetone	16.6513	2940.46	-35.93
Formaldehyde	16.4775	2204.13	-30.15
Water	18.3036	3816.44	-46.13

(b) Consider a distillation column with feed of 20 gmol/s benzene, 40 gmol/s o-xylene and 30 gmol/s of toluene at 760 mm Hg and 383 K. When 98% benzene is recovered in distillate, the ratio of benzene (lk) to o-xylene (hk) in distillate is 100. Then calculate the number of trays required and flow rate of benzene and o-xylene only in distillate and bottom stream from distillation column. Vapour pressure of benzene and o-xylene at operating conditions are 1750.46 and 276.22 mm Hg respectively. **(10)**

Q.4. (a) An ideal gas is being compressed from 200 kPa to 5000 kPa using staged compressor. Molar flow rate of gas is 500 gmol/s. Find the number of stages and work to compress the gas. Also evaluate all intermediate pressures, gas outlet temperature after each compression stage and heat duty for intercooler if the gas enters the compressor at 320 K. C_p of gas is 29.09 J/gmol K. **(10)**

(b) A process vessel has diameter and length of 0.88 m and 5.84 m respectively. Calculate its updated bare module cost in present year. Necessary data in base year and present year is as below: **(10)**

L_o = 1.22 m, D_o = 0.91 m, α = 0.81, β = 1.05, C_o = Rs. 65000, MF = 4.23, F_m = 1, F_p = 1.2, **CI** in base year = 395, **CI** in present year = 1125.

Q.5. (a) For the process stream data given below, determine $Q_{H,min}$, $Q_{C,min}$ and pinch temperature for ΔT_{min} = 20 °C. **(10)**

Streams	MCp (kW/ °C)	Tin (°C)	Tout (°C)
1	10	250	120
2	40	200	100
3	30	90	150
4	60	130	190

(b) Discuss the applications of the following utilities: (i) Compressed air (ii) Vacuum **(05)**

(c) Discuss in brief major accidents that may occur in chemical industries **(05)**

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10-2

Q.6. (a) Write the steps involved in HAZOP procedure. **(10)**

(b) In a particular process, the feed stream to the reactor is being heated by exchanging heat with hot reactor effluent. The objective is to maintain the constant temperature of feed to the reactor in order to maintain the conversion at desired level. Draw a simple block diagram to show this and further draw and explain the most appropriate control strategy to achieve the said objective. **(10)**
