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Question Paper Code: 96903

B.E./B.Tech. DEGREE EXAMINATION, MAY 2022

Sixth Semester

Chemical Engineering

19UCH603– Process Equipment Design

(Regulations 2019)

Duration: Three hours Maximum: 100 Marks

PART A - (10 x 1 = 10 Marks)

1. Which of the following is NOT a type of heat exchanger? CO1- R

   (a) Recuperator (b) Regenerator (c) Mixer (d) none of the above

2. The two fluids are not mixed and kept separated as they both flow through heat exchanger in CO1- R

   (a) Transfer type heat exchanger or recuperator

   (b) Storage type heat exchanger or regenerator

   (c) Direct contact type heat exchanger or mixer

   (d) none of the above

3. Which one of the following is not a type of evaporator? CO1- R

   (a) Forced Circulation (b) Natural Circulation

   (c) Nucleate Boiling (d) Gasketed evaporators

4. One of the most common solvents used for crystallization is CO1- U

   (a) oil (b) alcohol (c) water (d) sulphuric acid

5. What is the soluble component called in absorption equipment? CO1- U

   (a) Solute (b) Solvent (c) Liquid phase (d) Solution

6. At what conditions will the solute is absorbed more per stage or packing segment? CO1- R

   (a) When L/G ratio is increased
   (b) When L/G ratio is decreased
   (c) When L/G ratio is negligible
   (d) When L/G ratio is reduced to very low level

7. Which of the following ammonolysis is an exothermic reaction? CO1- R

(a) Phenols (b) Alcohols (c) Aldehyde (d) All of the mentioned

8. Process tank has a scraper which aid in which kind of products? CO1- R

(a) Viscous (b) Dry (c) Powder (d) Milk

9. Hazard identification mainly focus on _____ CO1- U

(a) Chemical source and concentration (b) Chemical exposure

(c) Chemical analysis (d) Chemical pathway

10. What is the first stage of risk assessment? CO1- R

(a) Exposure assessment (b) Hazard identification

(c) Toxicity study (d) Risk characterization

PART – B (5x 2= 10 Marks)

11. What are the parts of a heat exchanger? CO1- R

12. State Evaporation. CO1- R

13. List out the choice of solvent for absorption. CO1- U

14. Write the formula for mean residence time and variance. CO1- R

15. Write the basic formula for determining pipe wall thickness. CO1- R

PART C - (5 x 16 = 80 Marks)

16. (a) 14500Kg/hr of nitrobenzene is to be cooled from 400K to 317K by heating up 40000Kg/hr of benzene from 305K to 345K. there are two heat exchangers available and these are to be operated in parallel, each with a shell dia of 45cm I.D fitted with 166 tubes of 19mm O.D, 15mm I.D,5m long. The exchangers are 2-2 shell and tube type. The tubes are arranged on a 25mm square pitch with 15cm baffle spacing. There are two phases on the shell side counter current is used. Assuming that benzene is flowing through the tube and heat transfer coefficient on the tube side is 1050W/m^2K. find the order of scale resistance that could be allowed if the heat exchangers are used. CO3 -Ana (16)

Data: For Nitrobenzene, Cp= 2.387KJ/Kg K, $\mu = 7 \times 10^{-4}$ Kg/ms, K= 0.151W/mK

Or

(b) 1-2 shell and tube heat exchanger is to be used to cool nitrobenzene from 400K to 317K with the help of the benzene entering at 300K and leaving at 333K. Benzene is flowing at the rate of 20000kg/hr to the tubes and the tube side coefficient is 1050W/m^2K. Nitrobenzene is flowing through the shell at a rate of 7250kg/hr. The shell inside dia is 450mm fitted with 170 tubes of 19mm O.D and 15mm I.D and 5m long. The tubes are arranged on a 25mm square pitch and baffle spacing is 150mm. fouling factor is to be provided 9×10^-4 m^2K/W. check the suitability of this exchanger.
Data: For Nitrobenzene, Cp= 2.387KJ/Kg K, μ = 7×10^-4 Kg/ms, K= 0.151W/mK, viscosity correction factor is 1, LMTD correction factor= 0.9. CO4- E (16)

17. (a) Calculate the boiling point elevation of a solution and the driving force for heat transfer using the following data: Solution boils at a temperature of 380K and the boiling point of water in vapor space is 373K. Temperature of condensing steam is 399K. CO2 -App (16)

Or

(b) A solution containing 20% solids is to be concentrated to a level of 50%solids. Steam is available at a pressure of 0.9 Mpa(saturation temperature=393K). Feed rate to the evaporator is 30,000kg/hr. The evaporator is working at reduced pressure such that the boiling point is 323K. Overall heat transfer coefficient is 2.9KW/m^2K. Estimate the steam economy and heat transfer surface for i) Feed introduced at 293K ii) Feed introduced at 308K.
Data: Specific heat of feed =4.98Kj/Kg.K, latent heat of condensation steam=2202KJ/Kg, latent heat of vaporization of water at 323K=2383Kj/Kg CO3 -Ana (16)

18. (a) A mixture containing of benzene and toluene with 40% benzene and 60% toluene is to be separated in a fractionating column to give product containing 96% benzene and bottom product containing 95% toluene. Feed is a mixture of two third vapor one third liquid. Find the number of theoretical stages required if the reflux ratio of 1.5 times the minimum used Data:
Relative volatility = 2.5 CO2- App (16)

Or

(b) Design a suitable distillation column and determine the Rectifying, Stripping and Feed stage section. CO5- C (16)

19. (a) It is proposed to operate a batch reactor for converting A into R. This is liquid phase reaction with stoichometry A→R. Find the time required to drop the concentration of A from CAo=2.3mol/l to CAf=0.3mol/l. CO1 -U (16)

C_A	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.3	2.0
-rA	0.1	0.3	0.5	0.6	0.5	0.25	0.1	0.06	0.05	0.045	0.042

Or

(b) Determine the size of the plug flow reactor required to achieve 80% conversion of feed stream of 1000mol/hr at CAo=1.5mol/l. CO1 -U (16)

CA	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.3	2.0
-rA	0.1	0.3	0.5	0.6	0.5	0.25	0.1	0.06	0.05	0.045	0.042

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20. (a) List out the safety measures which should maintain in designing process equipment CO1- U (16)

Or

(b) List out the Product certification for Indian as well as Foreign industry. CO1- U (16)