Reg. No. : | | | | | | | | | | |

Question Paper Code: 96903

B.E./B.Tech. DEGREE EXAMINATION, APRIL 2024

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   CO1- R
    heat exchanger in

    (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   CO1- R
    segment?
    (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   CO3 -Ana   (16)
          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.
          Data: For Nitrobenzene, Cp= 2.387KJ/Kg K, $\mu = 7 \times 10^{-4}$ Kg/ms, K=
          0.151W/mK

                                    Or

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(b)   1-2 shell and tube heat exchanger is to be used to cool nitrobenzene   CO4- E   (16)
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, $\mu = 7\times10^{-4}$ Kg/ms,
K= 0.151W/mK, viscosity correction factor is 1, LMTD correction
factor= 0.9.

17.   (a)   Calculate the boiling point elevation of a solution and the driving   CO2 -App   (16)
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.

Or

(b)   A solution containing 20% solids is to be concentrated to a level of   CO3 -Ana   (16)
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

18.   (a)   A mixture containing of benzene and toluene with 40% benzene and   CO2- App   (16)
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

Or

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(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)