Code No: 07A70803 **R07** **Set No. 2**

IV B.Tech I Semester Examinations,NOVEMBER 2010
CHEMICAL PROCESS EQUIPMENT DESIGN
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. Discuss the different types of materials available for process equipment and their accessories. [16]

2. (a) Develop design equation for a steady state plug flow reactor.
   (b) A liquid phase reaction with first order kinetics A→ R is to be carried out in plug flow reactor. What size of plug flow reactor would be needed for 80% conversion of a feed stream of 1000 mole A/hr at C_{AO} = 1.5 mole/lit? Take k = 20.0 hr^{-1}. [8+8]

3. Discuss the design of following heads and closures used for closing the ends of a cylindrical vessel:
   (a) Conical sections.
   (b) Flat plates and formed heads. [16]

4. Explain the construction and working principle of centrifugal separators used to separate vapor from liquid. [16]

5. How is increased heat recovery achieved in case of 2-4 tubular exchangers? Give the thermal design calculations of a 2-4 exchanger. [16]

6. Calculate the stresses created in the pressure vessel shell due to
   (a) Internal pressure.
   (b) Weight of the vessel and contents.
   (c) Offset piping.
   (d) Wind. [16]

7. A column is to be designed to separate a mixture of ethyl benzene and styrene. The feed will contain 0.5 mol fraction styrene, and a styrene purity of 99.5 percent is required, with a recovery of 85 per cent. Estimate the number of equilibrium stages required at a reflux ration of 8. Maximum column bottom pressure 0.20 bar.
   Antoine equation, ethyl benzene, In $p = 9.386 - \frac{3279.47}{T-59.95}$
   Antoine equation, styrene, In $p = 9.386 - 3328.57\frac{3279.47}{T-63.72}$
   P bar, T Kelvin. [16]

8. What is economic pipe diameter? Discuss any general equation that can be used to estimate the economic pipe diameter for any particular situation. [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: 07A70803 **R07** **Set No. 4**

IV B.Tech I Semester Examinations,NOVEMBER 2010
CHEMICAL PROCESS EQUIPMENT DESIGN
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. Discuss the design of pipelines installed below sea water. [16]

2. (a) The space time necessary to achieve 80% conversion in a CSTR is 5 hours. Determine the reactor volume necessary to process 2 m^3 / min. What is the space velocity for this system?
   (b) Define order of reaction. Enlist various methods for determination of order and rate constant of a reaction. Describe one method in detail. [8+8]

3. Discuss forced circulation evaporator with the help of a schematic diagram. [16]

4. Write notes on the following materials used for constructing high pressure vessels:
   (a) Creep resistance steels.
   (b) Non ferrous alloys. [8+8]

5. Discuss in detail design of tanks. [16]

6. Give the design calculations for the heating and cooling of a gas using a shell and tube heat exchanger. [16]

7. Acetone is to be recovered from an aqueous waste stream by continuous distillation. The feed will contain 10 percent w/w acetone. Acetone of at least 88 per cent purity is wanted, and the aqueous effluent must not contain more than 50 ppm acetone. The feed will be at 20^0C. Estimate the number of ideal stages required below an acetone concentration of 0.04 (more volatile component), using the Robinson - Gilliland equation. The equilibrium data available for the acetone- water system of Kojima et al. will be used. [16]

x	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55
y	0.00	0.6831	0.7301	0.7716	0.7916	0.8304	0.8124	0.8201	0.8269	0.8376	0.8387	0.8455
T^0C	100.0	74.80	68.53	65.26	63.59	62.60	61.87	61.26	60.75	60.35	59.95	59.54

x	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
y	0.8532	0.8615	0.8712	0.8817	0.8950	0.9118	0.9335	0.9627
T^0C	59.12	58.71	58.29	57.90	57.49	57.08	56.68	56.30

8. Discuss the role of alloy steels as material of construction in chemical process industries. [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: 07A70803 **R07** **Set No. 1**

IV B.Tech I Semester Examinations,NOVEMBER 2010
CHEMICAL PROCESS EQUIPMENT DESIGN
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. What is entrainment in a distillation column? How does it affect the separation efficiency of a column? [16]
2. Discuss the common methods for fabrication of the components of pressure vessels. [16]
3. Write in detail the classification of shell and tube heat exchangers. [16]
4. In an existing system where the condensate load is 2000kg/hr, the pipeline size is 25mm. the supply pressure is 34 kg/cm^2. Density of steam at return line pressure is = 5.85 kg/m^3. Enthalpy of a condensate at supply pressure = 476 kJ/kg. Enthalpy of a condensate at return line pressure = 356 kJ/kg. Latent heat of steam at return line pressure = 900 kJ/kg. Estimate the velocity of condensate through the pipeline. [16]
5. What do you mean by ovalisation of storage tank? How does it occur? [16]
6. Discuss any four popular non destructive testing methods used for testing of fabricated equipment. [16]
7. Explain how thermo compression results in large savings in steam consumption in a single stage evaporator. [16]
8. The liquid phase reaction A + B$\leftrightarrow$ R + S, k_1 = 7 lit/mol.min for forward reaction, k_2 = 3 liter/mol.min for reverse reaction, is to take place in a 120 liter steady-state mixed reactor. Two feed streams, one containing 2.8 mol A/liter and the other containing 1.6 mol B/liter, are to be introduced in equal volumes into the reactor, and 75% conversion of limiting component is desired. What should be the flow rate of each stream? Assume a constant density throughout. [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: 07A70803 **R07** **Set No. 3**

IV B.Tech I Semester Examinations,NOVEMBER 2010
CHEMICAL PROCESS EQUIPMENT DESIGN
Chemical Engineering

Time: 3 hours Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. Write short notes on
   (a) Pipe diameter for steam.
   (b) Pipe supports. [8+8]
2. Write short notes on:
   (a) Sieve plates
   (b) Bubble cap plates. [8+8]
3. Discuss the design of following heads and closures used for closing the ends of a cylindrical vessel:
   (a) Torispherical heads.
   (b) Hemispherical heads. [16]
4. What is a refractory? What are the functions of a refractory? What is the primary method of selection of refractory? Discuss with examples. [16]
5. Discuss the constructional features of high pressure vessels. [16]
6. Discuss about the evaporators used for evaporating heat sensitive materials. [16]
7. In an electricity generating facility, steam leaves a turbine and is piped to a condensing unit. After condensation occurs, it is desired to further cool the (distilled) water by means of a shell- and - tube exchanger. The water enters the heat exchanger at 43.33^0C with a flow rate of 21.41 kg/s. The heat will be transferred to raw water from a nearby river. The raw water is available at 18.33^0C, and the mass flow rate is 18.89 kg/s. It is proposed to use a heat exchanger that has a $17\frac{1}{4}$ - in.-ID shell and $\frac{3}{4}$ in.-OD, 18-BWG tubes that are 16 ft long. The tubes are laid out on a 15/16 in. triangular pitch. The tube fluid will make four passes. The shell contains baffles that are spaced 1 ft apart. Determine the outlet temperature of the distilled water and the pressure drop for each stream.

	Units	Distilled water at 40^0C	Raw water at 20^0C
C_p	J/g-^{0}C	4.1784	4.1878
P	Kg/m^3	994.141	1000.14
k	W/m-^{0}C	0.628	0.597
Pr		4.34	7.02
α	m^2/s	1.514 x 10^{-7}	1.431 x 10^{-7}
v	m^2/s	0.066 x 10^{-5}	0.101 x 10^{-5}

For $\frac{3}{4}$ inch OD 18-BWG tubes

(a) Outer Diameter = 0.01905 m.

(b) Inner Diameter = 0.01655 m.
From tube count table number of tubes for 6 tube passes is 178. [16]

8. What is the volume of the plug flow reactor used for the non-elementary homogeneous gas phase reaction A$\rightarrow$3R having the rate $-r_A = kC_A{}^2$. The feed consists of 50% inerts and 50% A at 200^0C and 5 atmospheres, and is flowing at 1 liter/sec. The initial concentration of A is 0.0625 moles/liter and the required conversion is 90%. The reaction rate constant is 0.01 liter/mole-sec at 200^0C. [16]

⋆⋆⋆⋆⋆