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

IV B.Tech I Semester Examinations,MAY 2011
CHEMICAL PROCESS EQUIPMENT DESIGN
Chemical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. Write in detail about calculation of shell-side coefficients in respect of design of a shell and tube heat exchanger. [16]

2. (a) Give the classification of reactors. Explain the different types of reactors with schematic diagrams.
   (b) Assuming a stoichiometry A → R, for the first order reaction gas reaction we calculate the size of plug flow reactor needed for a given duty (99% conversion of a pure A feed) to be V = 32 liters. In fact, however, the reaction stoichiometry is A → 3R. With this corrected stoichiometry, what is the required reactor volume? [8+8]

3. Write short notes on using schematic diagram
   (a) Weeping
   (b) Flooding
   (c) Coning
   (d) Excessive entrainment. [16]

4. Discuss how compensation for opening and branches is provided for a process vessel. [16]

5. Write the design calculations in respect of evaporators for calculating
   (a) Calendria sheet thickness
   (b) Tube sheet thickness. [8+8]

6. A high pressure natural gas is flowing through the tubes and due to some problem, the exchanger tube ruptures near the tube sheet. Assume complete break near the tube sheet and isothermal flow. Estimate the flow rate of natural gas, relieving through the relief valve assembly of heat exchanger. Following data is available. Pressure in heat exchanger tubes P_1 = 75 kg/cm^2 (g). Relief valve set pressure P_2 = 27.2 kg/cm^2 (g) on shell side. Molecular weight of natural gas M = 18.7. Compressibility factor Z = 0.9. Internal diameter of exchanger tubes is = 15.6 mm. Outer diameter of exchanger tubes is = 26.7 mm. Tube length is = 6.10 m; Gas temperature = 38^0 C. Friction factor f = 0.026 for complete turbulence. [16]

7. Write short notes on:
   (a) Shrink fit construction of high pressure vessel.

(b) Strains in shell of high pressure vessels. [16]

8. Write short notes on the following as materials of construction:

(a) Copper and its alloys.

(b) Aluminum and its alloys. [16]

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

IV B.Tech I Semester Examinations,MAY 2011
CHEMICAL PROCESS EQUIPMENT DESIGN
Chemical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. Write notes on inspection and tests that are carried out during pressure vessel manufacture and after completion of fabrication. [16]

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

3. Discuss agitated thin film evaporator with the help of a schematic diagram. [16]

4. The oxidation of Nitric oxide according to the equation: $2NO + O_2 \rightarrow 2NO_2$ is a third-order reaction. The rate constant is $k_c = 26500$ liter^2/gmol^2-sec at 30^0C. Assume the ideal gas law to apply. A reactor is charged with a mixture containing 18.42 vol% NO, 10.53 vol% O_2 and 71.05 vol% nitrogen. The initial pressure is 760 mm Hg. Assuming an isothermal batch reaction at 30^0C, how much time is required to reach 90% conversion and (b) what is the total pressure and composition at that point? [16]

5. Discuss the design of vessels for storage of gases. [16]

6. A tubular exchanger 889 mm ID contains eight hundred and twenty eight 19 mm OD tubes 3.66 m long on a 25 mm square pitch. Standard 25 % baffles are spaced 305 mm apart. Liquid benzene at an average bulk temperature of 15.6^0C is being heated in the shell side of the exchanger at the rate of 45,360 kg/h. If the outside surfaces of the tubes are at 60^0C, estimate the individual heat transfer coefficient of the benzene. Properties of benzene are listed in the table below:

μ at 15.6^0 C	0.70 cP
μ at 60^0 C	0.38 cP
cp	1.716 KJ/K$g.^0$C
K	0.1592W/m-^{0}C

[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. 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. (a) Discuss the economics in material selection.

   (b) Discuss the materials standards and specifications of major importance to the chemical process industries. [8+8]

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

IV B.Tech I Semester Examinations,MAY 2011
CHEMICAL PROCESS EQUIPMENT DESIGN
Chemical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. Discuss the choice between plates or packed column for distillation/absorption.[16]
2. Discuss how expansion provision is made in a shell and tube heat exchangers. [16]
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. What is the purpose of a protective coating? Categorize and discuss them. [16]
5. Natural gas with a sp.gr 1.20 at 43000 kPa and 45^0C is being blown down to 102000 kPa. The flow rate could be from 95 m^3/day to 39m^3/day. The drop through the pressure reducing regulator is 3100 kPa leaving 1000 kPa for the pipe. The pipe length is 140m upstream of the regulator and 8.7 m downstream. Determine the upstream and downstream pipe sizes. Value of $\psi = 0.6$. M - Molecular weight of gas = 20. [16]
6. Discuss the effect of non condensables on heat transfer in evaporators. [16]
7. Develop the performance equation for the following reactors from material balances
   (a) Continuous stirred tank reactor
   (b) Batch reactor. [8+8]
8. What are the main sources of load to be considered for the safe design of pressure vessels? Discuss in detail how design is to be made to withstand the worst combination of loading without failure. [16]

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

IV B.Tech I Semester Examinations,MAY 2011
CHEMICAL PROCESS EQUIPMENT DESIGN
Chemical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (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]
2. What is a piping and instrumentation diagram? Discuss the objectives and the general considerations of a piping and instrumentation diagram. [16]
3. Write in detail about calculation of tube-side pressure drop calculation of a shell and tube heat exchanger. [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 the design of "calendria with vertical tubes" in respect of standard vertical short tube evaporator. [16]
6. Discuss the reflux considerations in the design of distillation column. [16]
7. What is elastic instability? Discuss how it is taken care in design of a component. [16]
8. Discuss in detail the important fluid dynamics considerations that affect pipeline design. [16]

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