Registration No. :

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B. Tech
PCCH 4303

Fifth Semester Examination – 2013
PROCESS EQUIPMENT DESIGN
BRANCH : CHEM
QUESTION CODE : C-415
Full Marks – 70
Time : 3 Hours

Answer Question No. *1* which is compulsory and any **two** from the rest.
The figures in the right-hand margin indicate marks.
Assume suitable notations and any missing data wherever necessary.

FOLLOWING BOOKS ARE ALLOWED :
1. PROCESS EQUIPMENT DESIGN- M V JOSHI
2. CHEMICAL ENGINEERING, VOLUME – VI- COULSON and RICHARDSON
3. INDIAN STANDARD CODE (IS: 803-1976)
4. STEAM TABLE
5. DATA TABLE (APPENDIX - PROCESS HEAT TRANSFER-D Q KERN)

1. Answer the following questions : 2×10

    (a) How to obtain equilibrium data from relative volatility ?

    (b) Reflux is the deciding factor for number of plates to be used in a distillation column. Explain.

    (c) Why partial condenser is equivalent to one theoretical stage in distillation operation ?

    (d) Is the corrosion allowance necessary ? If no then when and if yes how much ?

    (e) What is the role of baffles in a shell and tube heat exchanger ?

    (f) Define "pass" and "partition" in a shell and tube heat exchanger.

    (g) Why LMTD correction factor F_T is used in multi-pass heat exchangers ?

    (h) Which materials are used for cladding and bonding for low cost materials ?

P.T.O.

(i)   Which equipment is known as condenser-cooler ?

(j)   How wall thickness changes w.r.t. BWG number ?

2. (a) Design a storage vessel with column supported roof.

Data :

Tank diameter	19
Tank height	25
Sp. Gr. of liquid	1.2
Material	Carbon Steel (structural)
Permissible stress	142 N/mm^2
Density	7.7
Modulus of elasticity	2 × 10^5

Design : (a) Shell, (b) Bottom, (c) Column supported roof.   15

(b) Draw a neat diagram of storage vessel.   10

3. (a) A feed mixture containing 55 mol % benzene and rest toluene is to be separated into an overhead product containing 98 mol % benzene and a residue of 2 mol % benzene at 1 std atm. Feed is saturated vapor and is admitted to the column at the rate of 4000 kg/hr. A reflux ratio of 2.5 times of minimum is to be used. Boiling point of benzene and toluene are 353 K and 383 K respectively. Relative volatility for benzene-toluene system is 2.6. Overall efficiency of the tower is 75%. Vapor velocity can be taken as 1 m/sec.

Design a suitable bubble cap tray distillation column.   15

(b) Draw neat sketch of distillation column showing all necessary auxiliary equipments.   10

4. (a) Design a vertical tube single effect evaporator to concentrate 7000 kg/hr of 5% (by weight) caustic soda solution to 30% (by weight). Steam is available at 1.6 kg/cm^2. The pressure to be maintained in the vapor space of the evaporator is 500 mm Hg. The overall heat transfer co-efficient may be taken as 2000 Kcal/hr.m^2.^{0}C. Boiling point elevation of the solution is 8°C. Enthalpy of the feed and product streams are 82 and 72 Kcal/kg respectively. Tubes of 50 mm OD (45 mm ID) and length of 150 cm are arranged in 75 mm square pitch.   15

(b) Draw a neat sketch of vertical tube evaporator with specifications.   10

5. (a) Crude oil at the rate of 15050 kg/hr is to be heated from 25°C to 60°C by heat exchange with the bottom product from a distillation unit (both fluids are heavy organics). The product at 13500 kg/hr is to be cooled from 145°C to 105°C. For this purpose 396 tubes with 1 in. OD and BWG number 14 are used in 1.25 in. square pitch. Design a 1-2 shell and tube heat exchanger. What are the both side allowable pressure drop values in N/m² ?   15

Average properties are :

	Product (outside the tube), "hot"	Crude (inside the tube) "cold"
C_p, kJ/kg.°C	2.15	1.96
μ, cP	4.9	2.7
ρ, kg/m³	880	830
κ, W/m.°C	0.119	0.137

(b) Draw a neat sketch of 1-2 shell and tube heat exchanger.   10

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