QP Code: RM21BTECH431 | Reg. No | | | | | | | | | | | AY 21

GIET UNIVERSITY, GUNUPUR – 765022

B. Tech (Sixth Semester Regular) Examinations, May – 2024

21BCHPC36001 – Process Equipment Design

(Chemical)

Time: 3 hrs | Maximum: 70 Marks

(The figures in the right hand margin indicate marks)

Data Books are allowed

PART – A **(2 x 5 = 10 Marks)**

Q.1. Answer ***ALL*** questions	CO #	Blooms Level
a. What are criteria for absorbent selection?	CO1	K2
b. What is the q-line slope value for partial vapour feed?	CO1	K1
c. Name the different types of multi effect evaporator.	CO3	K1
d. Why reflux ratio is necessary in distillation column?	CO3	K2
e. Why nozzle reinforcement is required in pressure vessel?	CO4	K1

PART – B **(15 x 4 = 60 Marks)**

Answer ***ALL*** questions	Marks	CO #	Blooms Level
2. a. An ethanol-water solution containing 60% wt ethanol at 27^0C is to be continuously rectified at 1 atm pressure in a bubble cap tray distillation column, at a rate of 5500kg/hr to provide a distillate containing 96% wt ethanol & a residue containing 1.5% wt ethanol. Feed is saturated liquid. The distillate is totally condensed to a liquid and the reflux returned at bubble point. A reflux ratio of 2 times the minimum will be used. Vapor velocity 1m/s is used. Overall tray efficiency 60% may be taken. Boiling point of methanol is 65^0C. Equilibrium data is:	15	CO2	K3

x	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
y	0	0.37	0.56	0.67	0.73	0.75	0.77	0.81	0.86	0.92	1.0

Calculate:

i. Height of the tower
ii. Diameter of the tower
iii. Number of actual plate used

(OR)

b. A counter current packed tower is used to separate ammonia from coke oven gas by employing water as solvent. Inlet gas contains 25% ammonia at a rate of 158 kmol/hr. Outlet gas liquid contain 1.5% and 18% ammonia after recovery (all are in mole%). Calculate the packing height required if mass transfer co-efficient is 135 kmol/hr.m^2. Equilibrium relation is: y = 2.6x, where x & y are mole fractions of ammonia in liquid and gas phase.	15	CO2	K3
3.a. A 1-2 heat exchanger is to supply hot water receiving heat from flue gas at 240^0C and cooled to 220^0C. 500kg/sec of water at 300K enters the tubes at a velocity of 5m/sec and leaves at 370K. Gas inlet pressure may be taken as	15	CO3	K3

1atm. Calculate the number of tubes, shell ID and length of exchanger.
Data:
Tubes: ID = 2.12cm, OD = 2.54cm, P_T = 3.175cm (Square Pitch)
U_d = 1200kcal/hr.m^2, F_T = 0.95.

(OR)

b. An evaporator is to be fed with 5800kg/hr of solution containing 15% solute by weight. The feed at 40^0C is to be concentrated to a solution containing 48% by weight of the solute under an absolute pressure of 1.03kg/cm^2. Steam is available at an absolute pressure of 3 atm. Overall heat transfer co-efficient is 1550kcal/hr.m^2 ^{0}C. Calculate heat transfer area that should be provided & steam requirement. The data given as: 15 CO3 K3

Temp	Enthalpy in Vapor	Enthalpy in Liquid
40	613.5	40.5
100	639.2	100.0
134	651.4	134.4

4.a. Design a storage vessel with column supported roof. 15 CO4 K3

Data:

Tank diameter	9m
Tank height	11m
Specific gravity of liquid	0.85
Material	Carbon steel (Structural)
Permissible stress	142 N/mm^2
Density	7.7
Modulus of elasticity	$2*10^5$

(OR)

b. Design a shell, head and flange of a pressure vessel. 15 CO4 K3

Data:

Shell:
ID: 1200mm
Material: Stainless steel
Permissible stress (150^0C):130 N/mm^2
Internal pressure: 0.3 N/mm^2

Head:
Type: Flanged & dished
External diameter: 1200mm
Crown radius: 1200mm
Kunckle radius: 72mm
Material: Same as shell

Flanges:
Material: Carbon steel
Permissible stress (250^0C): 95 N/mm^2
Gasket: Asbestos
Nominal diameter: 1200mm
Inside diameter of flange: 1202mm
Outside diameter of flange: 1315mm
Outside diameter of stainless steel lining ring (raised face): 1240mm
Bolt circle diameter: 1270mm
Thickness of flange: 45mm
Number of Bolt: 48

Bolts:
Material: Hot rolled carbon steel
Permissible stress (50^0C): 58.7N/mm^2
Permissible stress (200^0C): 54.5N/mm^2

5.a.	Draw a neat diagram of packed bed absorption column showing all the important accessories & different types packing arrangements.	8	CO2	K2
b.	Draw a neat diagram of double heat exchanger showing all the important accessories.	7	CO3	K2
	(OR)			
c.	Draw a neat diagram of horizontal tube evaporator showing all the important accessories.	7	CO3	K2
d.	Draw a neat diagram of pressure vessel showing all the important accessories and torispherical dished head.	8	CO3	K2

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