Gandhi Institute of Engineering and Technology University, Odisha, Gunupur
(GIET University)

B. Tech (Sixth Semester - Regular) Examinations, April 2025

22BCHPC36001 – Process Equipment Design

(Chemical)

Time: 3 hrs   Maximum: 70 Marks

(The figures in the right hand margin indicate marks)
Graph paper and databook are allowed with proper verification

PART – A   (2 x 5 = 10 Marks)

Q.1. Answer *ALL* questions

		CO #	Blooms Level
a.	What is the role of design Engineer in plant design?	CO1	K1
b.	What do you mean by 25% cut segmental baffle?	CO3	K1
c.	What is the q-line slope value of super saturated vapor feed?	CO2	K1
d.	What are the main factors considered when designing the diameter of an absorption tower?	CO2	K2
e.	Why is the choice of material important in storage tank design?	CO4	K2

PART – B   (15 x 4 = 60 Marks)

Answer *All* the questions

		Marks	CO #	Blooms Level

2. a. A feed mixture containing 50 mole % benzene and rest toluene is to be separated into an overhead product containing 93 mole % benzene and a residue of 3 mole % benzene at 1 std. atm. Feed is saturated liquid and is admitted to the column at the rate of 100 tons/day. A reflux ratio of 3.5 is to be used. Boiling point of benzene and toluene are 353 K and 383 K, respectively. Relative volatility for benzene-toluene system is 2.3. Vapor velocity can be taken as 1 m/s. Design a suitable sieve tray distillation column.   **15   CO2   K3**

(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. Design a horizontal shell & tube Heat Exchanger to heat 10000kg/hr of water to 66^{0}C by condensing the steam at 1.4bar absolute pressure on the shell side. The raw water is available at 21^{0}C. Brass tube (k= 85.5W/m. k) having 25.4mm outside diameter and 22.1mm inside diameter are to be used on a 37.5mm triangular pitch. Tubes should not be longer than 2500mm. To reduce pressure losses due to friction a low water velocity of 30.5cm/sec might be used. Effect of the tube fouling, shell side fluid distribution may be neglected. The condensing film coefficient is given by: **15   CO3   K3**

$\text{Nu}_{Condensation} = 0.725(\frac{g\rho^2 D_0^3}{\mu k \Delta t})^{1/4}$ Water film coefficient is given by: $\text{Nu} = 0.023(\text{Re})^{0.8}(\text{Pr})^{0.4}$

(OR)

b. Design a horizontal tube single effect evaporator to concentrate 6000 kg/hr of 8% (by weight) caustic soda solution to 20% (by weight). Steam is available at 1.9   **15   CO3   K3**

kg/cm^2. The pressure to be maintained in the vapour space of the evaporator is 400 mm Hg. The overall heat transfer co-efficient may be taken as 3000 kcal/ hr.m^2.°C. Boiling point elevation of the solution is 10°C. Enthalpy of the feed and product streams are 90 and 79 kcal/kg, respectively. Tubes of 50 mm OD (45 mm ID) and length of 150 cm are arranged in 75 mm square pitch.

4.a. Design a shell for storage vessel with at least two different thickness sheets: 15   CO4   K3
Data:

Tank diameter	25 m
Tank height	20 m
Specific gravity of liquid	0.8
Material	Carbon steel (Structural)
Permissible stress	142N/mm^2
Density	7.7
Modulus of elasticity	$2*10^5$

(OR)

b. 1) Design a shell, head and flange of a pressure vessel.   15   CO4   K3
Data:

Shell:
ID: 1200mm
Material: Stainless steel
Permissible stress (150^{0}C):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^{0}C): 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^{0}C): 58.7N/mm^2
Permissible stress (200^{0}C): 54.5N/mm^2

5.a. Draw a neat diagram of plate distillation column showing all the important accessories & different types of plates.   8   CO2   K2

b. Draw a neat diagram of storage vessel showing all the important accessories and tori spherical dished head.   7   CO4   K2

(OR)

c. Draw a neat diagram of Calendria evaporator showing all the important accessories and neat label.   8   CO3   K2

d. Draw a neat diagram of double pipe heat exchanger showing all the important accessories and with hair pin.   7   CO3   K2

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