Total No. of Questions : 12]

SEAT No. :

P1108

[Total No. of Pages : 4

[4659]-290

B.E. (Chemical)

CHEMICAL ENGINEERING DESIGN - II

(2008 Course) (Semester - I)

Time : 3 Hours] *[Max. Marks : 100*

Instructions to the candidates:

1) *Answer 3 questions from each section.*
2) *Answers to the two sections should be written in separate answer books.*
3) *Neat diagrams must be drawn wherever necessary.*
4) *Assume suitable data, if necessary.*
5) *Use of logarithmic tables slide rule, Mollier charts, electronic pocket calculator and steam tables is permitted.*

SECTION - I

Q1) a) The reactor is fitted with a flat blade disc turbine agitator 0.6m diameter, running at 120 rpm. The vessel is baffled and is constructed of stainless steel plate 10 mm thick.

The physical properties of the reactor contents are,

ρ = 850 kg/m^3, μ = 80mNs/m^2, k_f = 400 × 10^{-3} W/(m.K), C_p = 2.65 kJ/kg K.

Estimate the heat transfer coefficient at the vessel wall and the overall heat transfer coefficient in the clean condition, if the thermal conductivity of stainless steel as 16 W/(m. K) and jacket side heat transfer coefficient is 1606 W/m^{2}K. **[8]**

b) Describe the power curve with sketch. **[6]**

c) Explain the criteria for jacket selection in the reactor. **[4]**

OR

Q2) a) Discuss the factors to be considered in the selection of agitators. **[6]**

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b) Design a turbine agitator shaft and blade only with the following specifications for a vessel of 1500 mm diameter. **[12]**

Data:

Diameter of agitator: 500 mm

Internal pressure in the vessel : 0.5 N/mm^2

Speed: 200 rpm

Sp. Gravity of liquid in the vessel: 1.2

Viscosity of liquid in the vessel: 600 cp

Overhang of the agitator shaft between bearing and agitator is 1300mm

No. of Agitator blades (Flat): 6 nos.

Width of the blade: 75mm

Thickness of the blade: 8mm

No. of baffles at tank wall: 4nos.

Shaft material-commercial cold rolled steel

Permissible shear stress in the shaft: 55N/mm^2

Elastic limit in tension: 246 N/mm^2

Modulus of elasticty: $1.95 \times 10^5 N/mm^2$

Value of Power No: 4.5

Motor rating is 10 hp.

Q3) a) Write short notes: **[9]**

i) O'Connell's Correlation.

ii) Van Winkle's Correlation.

iii) Design variables in plate distillation column.

b) Explain determination of the total plate pressure drop for the plate column in distillation. **[7]**

OR

Q4) a) Calculate the plate efficiency for the plate column used for the distillation using Van Winkle's correlation with the following data: **[8]**

$\rho_L = 925$ kg/m^3, $\rho_v = 1.35$ kg/m^3

$\mu_L = 0.34 \times 10^{-3}$ Ns/m^2, $\mu_v = 10.0 \times 10^{-6}$ Ns/m^2

$D_{LK} = D_L = 4.64 \times 10^{-9}$ m^2/s, $h_w = 50$ mm,

FA (Fractional Area) = 0.076

Superficial vapour velocity = 1.62 m/s,

σ_L = liquid surface tension = 60×10^{-3} N/m

b) Explain the Smoker equation and derive the same. **[8]**

Q5) a) Explain Onda's Method for the prediction of the height of transfer units (HTU) with its correlation. **[8]**

b) Using Cornell's method, estimate the height of packing Z for the absorption column to absorb SO_2 in water at 20ºC with the help of following data: **[8]**

Number of transfer unit $N_{OG} = 8$

The liquid mass flow rate (L^*_w) = 16.7 kg/m^{2}s

Diffusivity $D_L = 1.7 \times 10^{-9}$ m^2/s and $D_v = 1.45 \times 10^{-5}$ m^2/s

Viscosity $\mu_v = 0.018 \times 10^{-3}$ Ns/m^2 and $\mu_L = 1 \times 10^{-3}$ Ns/m^2

Density ρ_L = 1000kg/m^3 and ρ_v = 1.21 kg/m^3

With 60% flooding condition, $K_3 = 0.85$, H_G Factor $(\psi_h) = 80$ and

At $L^*_w = 16.7$, H_L Factor $(\varphi_h) = 0.1$ Take Z = 8m as an initial estimate.

OR

Q6) a) Enlist the column internals in the packed column with their types. **[6]**

b) Calculate the column diameter and check the percentage flooding for a packed column for absorption using the following data: **[10]**

Gas flow rate G_m = 5000kg/h., $mG_m / L_m = 0.8$

Packing size 38 mm ceramic intalox saddles with packing factor $F_p = 170$ m^{-1}

Gas density = 1.21 kg/m^3, liquid density = 1000 kg/m^3

Liquid viscosity = 10^{-3} Ns/m^2,

At Design pressure drop = 20 mm H_2O / m of packing, Constant $K_4 = 0.35$

At flooding, $K_4 = 0.8$.

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SECTION - II

Q7) a) Describe the principle, construction and working of Decanter and its design with necessary expressions. **[8]**

b) Make a preliminary design for a vapor - liquid separator to separate a mixture of steam and water. Steam; flow rate = 2000kg/hr, Density = 2.16 kg/m^3 water; flow rate = 1000kg/hr, Density = 926.4/m^3

Operating pressure 4 bar. **[10]**

OR

Q8) Explain the following with neat sketches. **[18]**

a) Reflux Drum.

b) Knock out Drum.

c) Safety Devices in the process industries.

Q9) a) Calculate the discharge through a pipe of diameter 200mm when the difference of pressure head between the two ends of a pipe 500m apart is 4m of water.Take the value coefficient of friction 'f' is 0.009. Use Darcy - Weisbach formula. **[8]**

b) Explain the fluid dynamic parameters in pipeline design. **[8]**

OR

Q10) a) Discuss on pipeline network and Hardy Cross Method. **[8]**

b) Find the head lost due to friction in a pipe of diameter 300mm and length 50m, through which water is flowing at a velocity of 3 m/s using Darcy Formula.

Data: Kinematic viscosity of water = $\nu = 0.01 \times 10^{-4}$ m^2/s. **[8]**

Q11) a) Explain different types of pipe fittings with their sketches. **[8]**

b) Discuss the piping materials for corrosive services. **[4]**

c) Define Schedule Number and give its significance in piping. **[4]**

OR

Q12) a) How is proper selection of material important for piping? Explain with example. **[8]**

b) Discuss common ASTM and IS specifications for pipes. **[8]**

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