P P SAVANI UNIVERSITY

Seven Semester of B. Tech. Examination

November 2022

SECH4011 Process Equipment & Design-II

17.11.2022, Thursday **Time: 10:00 A.M. To 12:30 P.M.** **Maximum Marks: 60**

Instructions:

1. The question paper comprises of two sections.
2. Section I and II must be attempted in separate answer sheets.
3. Make suitable assumptions and draw neat figures wherever required.
4. Use of scientific calculator is allowed.

SECTION – I

				CO	BTL
Q - 1	(i)	Define: Compressible and incompressible fluid.	**[10]**	**01**	**01**
	(ii)	Differentiate centrifugal pump and positive displacement pump.			
	(iii)	Define: capacity of pump and total dynamic head			
	(iv)	Write a note on power required by fan.			
	(v)	Write a note on power required by blower and adiabatic compressor.			
Q - 2	Calculate the pipe size based on following data. Fluid flowing through pipe is carbon monoxide. Discharge pressure of carbon monoxide required from the pipe is atmospheric.		**[10]**	**01**	**05**

Available pressure at inlet of pipe = 50 kPag

Length of pipe = 4 km

Flow rate of CO = 1500 kg/h

Temperature of gas = 50° C

No. of gate valves in pipe line = 2 (K_i = 0.17)

No. of 45° elbows = 3 (K_i = 0.35)

Nos. of 90° elbows = 6 (K_i = 0.75)

Viscosity of CO = 0.018 c_P

Molar mass of CO, M = 28

$$Re = \frac{4\dot{m}}{\pi D_i \mu} \quad \rho = \frac{pM}{RT}$$

$$\frac{\Delta p}{L} = 4.07 \times 10^{10} G^{1.84} \mu^{0.16} D_i^{-4.84} \rho^{-1}$$

$$\Delta p_{El} = \frac{K_i \rho v^2}{2}$$

Nominal Size	Schedule No.	ID of Pipe, mm	Δp_f, kPa	Remarks
100 mm (4 in)	SCH-40	102.26	1012.38	Very high
150 mm (6 in)	SCH-40	154.05	139.75	Higher
200 mm (8 in)	SCH-40	202.72	37.10	Reasonable
300 mm (12 in)	SCH-40	304.80	5.18	Very low

Q - 3 (i) Write steps for the design of multi stage counter current multistage extractor. **[10] 03 02**

(ii) Advantages and disadvantages of mixer settler extractor over other types of extractor.

SECTION – II

Q - 1 Design an orifice meter based on the following data. **[08] 01 05**

Name of fluid = Chlorine gas

Flow rate = 1500 Nm^3/h

Operating Pressure =1.2 atma

Operating temperature = 30°C

Viscosity of Chlorine gas at 30°C = 0.0145 mPa.s or cP

Inside diameter of pipe = 154 mm (6 in. SCH-40)

Specific heat ratio for Cl_2 gas = 1.355

$$C_o = 0.5959 + 0.0312\beta^{2.1} - 0.184\beta^8 + 0.0029\beta^{2.5}\left(\frac{10^6}{Re_D}\right)^{0.75}$$
$$+ 0.09 L_1 \beta^4 (1-\beta^4)^{-1} - 0.0337 L_2 \beta^3$$

$\beta = 0.5$, do/D = 0.5, do = 77 mm

$l_1 = l_2 = 0$, for first trial r = 0.8, Y = 0.9362, k = 1.355

for second trial r = 0.762, Y = 0.9241

Q - 2 (i) Explain different types of losses taking place in storage of volatile liquids. **[08] 03 01**

(i) Explain standard fixed roof storage tank.

OR

Q - 2 (i) List out different types of agitators and explain any two in detail. **[08] 02 01**

(ii) Explain agitator used for highly viscous fluid in detail with diagram.

Q - 3 It is desired to design A bracket support for a vertical cylindrical reaction vessel **[14] 03 05**

installed indoor. Following data are available.

Vessel diameter = 1.5 m
Vessel height = 2 m
Clearance from vessel bottom to foundation = 0.8 m
Weight of vessel with content = 4000 kg
Number of brackets = 6
Height of bracket from the foundation = 2 m
Diameter of the anchor bolt circle = 1.65 m

Distance between vessel wall and bracket end = 150 mm

Gusset plate are 140 M apart from each other

Web plate dimension for bracket height = 0.707

Channel size = 150 × 75 (Area = 21 cm^2)

Modulus of section = 19 cm^2 , radius of gyration = 2.2 cm

Weight = 170 N/m

Eccentricity = 7.5 cm

Base plate size extend 20 mm on either side of the channel

Permissible stress:

Tensile $\sigma_{tensile}$ = 140 N/mm^2

Compressive σ_{comp} = 128 N/mm^2
Bending σ_{bm} = 158 N/mm^2
Permissible bearing pressure of concrete = 5 N/mm^2
Assuming wind pressure = 1285 N/m^2

$$P = \frac{4Pw(H-F)}{nDb} + \frac{\sum W}{n}$$

$$Pav = \frac{P}{aB}$$

where, a = 140 mm
f_{max} = 0.7 Pav $(B^2/T^21)*(a^4/B^4+a^4)$

Gusset plate thickness:

$f_{max} = (3PC/T_2h^2)*(1/\cos\beta)$

$\beta = 48$

C = (Bolt circle diameter – O.D. of reactor)/2

h=145 mm

Channel design:

$f_{max} = (P/A)*(1 + a\,(le/r)^2)$
a = 1/7500 , le = l/2,

$fe = \sum \frac{we}{nZ}$

Where, e = (Bolt circle diameter – (OD of shell- thickness))/2

Fw = Pwl/2nZ

(f_c max /fc allow) + (fec + fw/fb allow)

Base plate column

B = 0.8W + 2 L2
C = 0.95d + 2L1
Take L1 & L2 20 mm
Bearing Pressure
$P_b = P/BC$

Maximum bending moment
$Mmax = P_bL^21/2$
Maximum bending stress
$f = 6M/t^2$

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CO : Course Outcome Number BTL : Blooms Taxonomy Level

Level of Bloom's Revised Taxonomy in Assessment

1: Remember	2: Understand	3: Apply
4: Analyze	5: Evaluate	6: Create