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April-2011

Model Examination Questions
B.Tech Chemical Engineering

CH2357 PROCESS EQUIPMENT DESIGN– I 0 0 3 100

AIM

To integrate the various courses such as Chemistry, Engineering mechanism, Engineering Graphics, unit operation, Mechanics of solids Materials Technology for a comprehension approach to the design of the process equipments.

OBJECTIVES

To develop skill to design and install process equipments used widely in a chemical industry.

All Tables/ Chemical Engineers' Handbook/Data Books/Graph Sheets are permitted during the Examination/

UNIT I

9

Design and drawing considerations of

bolt, nut and screws,

welded and riveted joints,

flanged joints,

nozzles and reinforcements.

Pipe fittings.

UNIT II

9

Design and drawing considerations of vessel supports such as

bracket, saddle, skirt, etc.

Storage Tanks for solids, liquids and gases.

UNIT III **9**

General design and drawing consideration of vessels subjected to internal pressure, and external pressure. High pressure vessels.

UNIT IV **9**

Fundamental principles, equations, general design and drawing considerations of

cyclone separators,

centrifuges,

thickeners and

filtration equipments.

UNIT V **9**

General design and drawing considerations of

crystallizers,

agitated vessel, jacketed and coil heated vessels.

TOTAL = 45

TEXT BOOKS

1. R.S. Khurmi, “Machine design”.
2. M.V. Joshi and V.V. Mahajan, “Process Equipment Design”, MacMillan India Ltd.

REFERENCES

1. S.D. Dawande, “Process Design of Equipments”, Central Techno Publications, Nagpur, 2000.
2. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.
3. R.H. Perry, “Chemical Engineers’ Handbook”, McGraw-Hill.
4. W.L. McCabe, J.C. Smith and P. Harriot, “Unit Operation of Chemical Engineering”, McGraw-Hill, 2001.
5. Robert Treybal, “Mass Transfer Operations”, McGraw-Hill.
6. J.M. Coulson and J.Richardson, “Chemical Engineering”, Vol. 6, Asian Books Printers Ltd.

Model Examination
April 2013

CH2357 – Process Equipment Design – I

Duration: 3 hours **Max Marks: 100**

Set-1A

Part A

1. List out the types of standard flanges. Give a note of the salient features of these flanges. (7)
2. Explain the need and methods of reinforcement for openings. (7)
3. In the design of storage tanks, as per the standard design codes, the pressure acting on the bottom course of shell is calculated using the formula:

$$p = \rho g(H - 0.3)$$

Why is the number 0.3 subtracted from *H* ? (*H* is in meters) (6)

Part B

Draw to scale the **outline** of **self-supported conical roof storage tank** (showing the plate welding arrangements), and **sectional views** of the following details:

(i) Supporting rafters arrangement to the conical roof, (ii) bottom plate attachment with the shell,

(iii) details of manhole attached on the roof of the tank

Tank capacity: 1000 m^3, Diameter: 12.0 m; Height: 9.0 m.

Steel plates of 1.8 m width, 5 m long, 6 and 12 mm thick are available.

Cylindrical shell and bottom plates: 12 mm thick; Roof plate: 6 mm thick, roof plates are stiffened inside with rafters of 16 numbers. Rafters are made up of angles of 65 x 65 x 6 mm.

The storage tank is having one mole hole in the shell side and one on the roof, each of diameter 600 mm. There is a staircase to climb to the top of the tank.

Manhole details: Diameter of manhole: 600 mm.

Cover plate diameter – 750 mm; thickness – 16 mm.

Bolt circle diameter: 690 mm, No of bolts – 20, Bolt hole diameter – 18 mm

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Duration: 3 hours **Max Marks: 100**

Set-1 B

CH2357 –Process Equipment Design – I
Part A

1. List out the types of standard flanges. Give a note of the salient features of these flanges. (7)

2. Explain the need and methods of reinforcement for openings. (7)

3. In the design of storage tanks, as per the standard design codes, the pressure acting on the bottom course of shell is calculated using the formula:

$$p = \rho g(H - 0.3)$$

Why is the number 0.3 subtracted from *H* ? (6)

Part B

Draw to scale the **outline** of **self-supported conical roof storage tank** (showing the plate welding arrangements), and **sectional views** of the following details:

(i) bottom plate arrangement with the shell, (ii) roof plate attachment with the shell, (iii) shell manhole details

Tank capacity: 1000 m^3, Diameter: 9.0 m; Height: 16.5 m.
Steel plates of 1.5 m width, 5 m long, 6 and 12 mm thick are available.
Shell and bottom plates: 12 mm thick; Roof plate: 6 mm thick, roof plates are stiffened inside with rafters of 16 numbers. Rafters are angles of 65 x 65 x 6 mm.
The storage tank is having one mole hole in the shell side and one on the roof, each of diameter 600 mm. There is a staircase to climb to the top of the tank.

Manhole details: Diameter of manhole: 600 mm.
Cover plate diameter – 750 mm; thickness – 16 mm.
Bolt circle diameter: 690 mm, No of bolts – 20, Bolt hole diameter – 18 mm

Model Examination
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CH2357 –Process Equipment Design – I

Duration: 3 hours **Max Marks: 100**

Set-2 A

Part A

1. List out the types of heads for process vessels and discuss the salient features of these heads. (7)

2. For a given pressure and diameter, which of the following vessel requires less thickness? Why?
   (i) Sperical vessel (ii) Cylindrical vessel (4)

3. Why is the joint efficiency factor included in design formulae of thickness of pressure vessels? Give the values of joint efficiency factor (*J*) for typical radiography test requirements. (6)

4. What is a gasket? Give some examples? (3)

Part B

Draw the **sectional elevation** of an **agitated vessel**, and the details of support of the vessel. The inside diameter of the vessel is 2 m. The height of cylindrical portion (tangent to tangent) of the vessel is 2 m. Thickness of the vessel is 8mm. The vessel is having conical closure at the bottom and torispherical closure at the top. The apex angle of the cone is 120^o. Top closure is connected to the cylindrical portion by flange and bolt-nut connections. Conical bottom is permanently welded to the cylindrical portion of the vessel. There are two 150 mm diameter nozzles, one for inlet (at the top of the vessel) and the other for outlet (at the bottom most point), and two 300 mm openings at the top; one serves as a hand-hole, and with another one a sight-glass is attached. The vessel contents are agitated by **a 4-bladed flat blade turbine**. The impeller is placed at 300 mm above from the bottom of the cylindrical portion of the vessel. The impellers are attached to the drive assembly through a 40 mm diameter shaft. The vessel is supported on the ground by means a lug support. The lug support consists of 4 numbers of equally spaced I-beams of 80 (wide) x 120 (breadth) x 6 (thick) mm. OD of impeller is 800 mm. 4 numbers of baffles of 80 mm width are there inside the vessel, to avoid vortex formation.

Model Examination
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CH2357 –Process Equipment Design – I

Duration: 3 hours **Max Marks: 100**

Set-2 B

Part A

1. List out the types of heads for process vessels and discuss the salient features of these heads. (7)

2. For a given pressure and diameter, which of the following vessel requires less thickness? Why?
   (i) Sperical vessel (ii) Cylindrical vessel (4)
3. Why is the joint efficiency factor included in design formulae of thickness of pressure vessels? Give the values of joint efficiency factor (*J*) for typical radiography test requirements. (6)

4. What is a gasket? Give some examples? (3)

Part B

Draw the **sectional elevation** of an **agitated vessel**, and the details of support of the vessel. The inside diameter of the vessel is 2 m. The height of cylindrical portion (tangent to tangent) of the vessel is 2.5 m. Thickness of the vessel is 8mm The vessel is having hemispherical closure at the bottom and torispherical closure at the top. Top closure is connected to the cylindrical portion by flange and bolt-nut connections. Bottom closure is permanently welded to the cylindrical portion of the vessel. There are two 150 mm diameter nozzles for inlet and outlet connections, and two 300 mm openings at the top; one serves as a hand-hole, and with another one a sight-glass is attached. The vessel contents are agitated by **two numbers of 4-bladed axial flow impellers**. The impellers are attached to the drive assembly through a 40 mm diameter shaft. The vessel is supported on the ground by means a lug support. The lug support consists of 4 numbers of equally spaced I-beams of 80 (wide) x 120 (breadth) x 6 (thick) mm. OD of impeller is 600 mm. 4 numbers of baffles of 80 mm width are there inside the vessel, to avoid vortex formation.

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Duration: 3 hours **Max Marks: 100**

Set-3 A

Part A

1. List out the types of supports to process vessels. Give a note of the salient features of these supports. (7)

2. Mention the various standard codes for design of pressure vessels. (4)

3. Give the typical dimensions of manhole and inspection openings for process vessels. (4)

4. What are the characteristic dimensionless numbers involved in power calculations for agitation? (5)

Part B

Draw to scale the **sectional elevation** of a process vessel with **external jacket (conventional jacket with spiral baffle)** heating arrangement.
ID of vessel = 1000 mm
Height (tangent-to-tangent) = 1500 mm
Torispherical closures both at the top and bottom
Inlet nozzle size = 150 mm
Outlet nozzle size = 100 mm
Hand-hole size = 250 mm

Width of jacket (distance between jacket inside and vessel outside) = 80 mm.
In the jacket, baffles are there to provide uniform distribution of jacket side fluid.
The baffle bitch is 200 mm.

Height of jacketed portion = 1200 mm

Top head is connected to the shell through flanged connection, and bottom head is welded to the shell. The vessel is supported by four equally spaced legs, welded to the bottom head. The height of legs is 600 mm above the ground.

Model Examination
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CH2357 –Process Equipment Design – I

Duration: 3 hours **Max Marks: 100**

Set-3 B

Part A

1. List out the types of supports to process vessels. Give a note of the salient features of these supports. (7)

2. Mention the various standard codes for design of pressure vessels. (4)

3. Give the typical dimensions of manhole and inspection openings for process vessels. (4)

4. What are the characteristic dimensionless numbers involved in power calculations for agitation? (5)

Part B

Draw to scale the **sectional elevation** of a process vessel with **external half-pipe coil** heating arrangement.
ID of vessel = 1000 mm
Height of the vessel (tangent-to-tangent) = 1500 mm
Torispherical closures at the top and conical closure at bottom. Apex angle of the cone is 120 mm.
Feed inlet nozzle size = 150 mm
Product outlet nozzle size (at the bottom most point of the vessel) = 150 mm
Hand-hole size = 250 mm

Diameter of half pipe = 50 mm; pitch of half-pipe coil = 200 mm.

Height of heating portion = 1200 mm

Top head is connected to the shell through flanged connection, and bottom head is welded to the shell. The vessel is supported by four equally spaced legs, welded to the bottom head. The height of the legs is 600 mm above the ground.

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Duration: 3 hours **Max Marks: 100**

Set-4 A

Part A

1. What are the common pressure ratings of ANSI flanges? (5)

2. The design of cylindrical pressure vessel is typically done using the following formula:

$$t = \frac{pd}{2fE} + C$$

What do the symbols *t*, *p*, *d*, *f*, *E*, and *C* mean for? (7)

3. List out the standard codes for design and fabrication of storage tanks. (4)

4. List out the types of impellers and mention the typical conditions under which they are used. (4)

Part B

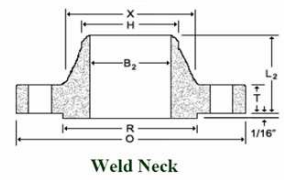
Draw to scale (the section elevation and side view) of a **horizontal cylindrical pressure vessel, supported by saddle supports**. Also show sectional elevation and plan of a manhole (of OD 24inch) opening and the support arrangements for its cover. The outer diameter of the vessel is 1.5 m, length of vessel (tangent to tangent distance) is 6 m, and thickness of the vessel is 12 mm.
One end of the vessel is closed with torispherical head and is welded permanently to the vessel. The other end of the vessel is closed with another torispherical head which is connected to the cylindrical portion of the vessel with flange and bolt-nut connections. The outer diameter of the flange is 1.8 m; thickness of flange is 30 mm. The bolt circle diameter of the flange is 1.65 m. There are 32 no of M20 bolts to connect this head with the vessel.
At the centre of the ends of the vessel, nozzles of 150 mm nominal size are available for providing inlet / outlet connections of streams.

On the vessel top at the middle length of vessel, there is a man-hole of nominal size 600 mm. The manhole flange is a welding neck raised face flange, and it is covered with a blind flange. Manhole opening is strengthened by the reinforcement pad of 150 mm with and 8 mm thickness. The dimensions of the manhole flange are given below:

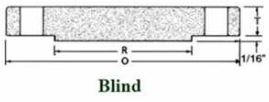
Nom. Pipe Size	O	T	T_J	R	X	#/Dia of Holes[a]	Bolt Circle Dia	B	B_2[b]	B_3	H	L	L_2	L_3[c]	r	D	Thr
24	32.00	1.81	1.88	27.25	26.12	20-1.38	29.50	24.25	23.25	24.25	24.00	3.19	5.94	4.38	0.50	2.50	3.25

Dimensions are in inches.

Dimensions of ANSI B16.5 class 150 psi flanges



Weld Neck



Blind

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Duration: 3 hours **Max Marks: 100**

Set-4 B

Part A

1. What are the common pressure ratings of ANSI flanges? (5)

2. The design of cylindrical pressure vessel is typically done using the following formula:

$$t = \frac{pd}{2fE} + C$$

What do the symbols *t*, *p*, *d*, *f*, *E*, and *C* mean for? (7)

3. List out the standard codes for design and fabrication of storage tanks (4)

4. List out the types of impellers and mention the typical conditions under which they are used. (4)

Part B

Draw to scale (the section elevation and the detailed view of the support) of a **vertical cylindrical process vessel, supported by skirt support**. The outer diameter of the vessel is 1.5 m, Height of vessel (tangent to tangent distance) is 15 m, and thickness of the vessel is 12 mm. The vessel is made up of three cylindrical segments of 5 m height each (tangent to tangent) and they are connected by means of flange and bolt-nut connections. The outer diameter of the vessel flange is 1.8 m; thickness of flange is 30 mm. The bolt circle diameter of the flange is 1.65 m. There are 32 no of bolt holes to use with M20 bolts on the vessel flange. Both ends of the vessel are closed with 2:1 semi-ellipsoidal heads and are welded permanently to the vessel.

Height of the skirt support is 1 m. At the centre of the ends of the vessel, nozzles of 100 mm nominal size are available for providing inlet / outlet connections of streams.