PIPING QUESTIONNAIRE

Questions related to Codes & Standards :-

1. What is the ASME Code followed for design of Piping Systems in process piping (Refineries & Chemical Industries)?

(i) B 31.1
(ii) B 31.3
(iii) B 31.5
(iv) B 31.9

Answer (ii)

2. Which American Institute Standard does Piping Engineer refer ?

Answer:-

A. The American Petroleum Institute (API)
B. The American Iron & Steel Institute (AISI)
C. The American Society for Testing and Materials (ASTM)
D. The American National Standard Institute (AISI)
E. The American Welding Society (AWS)
F. The American Water Works Association (AWWA)
G. The American Society for Mechanical Engineers (ASME)

3. What is the different ASME 31 Code for Pressure Piping?

Answer :-

A.	ASME B 31.1	-	Power Piping
B.	ASME B 31.2	-	Fuel Gas Piping
C.	ASME B 31.3	-	Process Piping
D.	ASME B 31.4	-	Pipeline Transportation System for liquid hydrocarbon & other liquid.
E.	ASME B 31.5	-	Refrigeration Piping.
F.	ASME B 31.8	-	Gas transmission & distribution piping system.
G.	ASME B 31.9	-	Building Services Piping
H.	ASME B 31.11	-	Slurry transportation Piping System.

4. What are the different sections of ASME Code? Where these sections are referred?

Answer :-

A. ASME Section I : Rules for construction of power boiler.
B. ASME Section II : Materials.
- Part A - Ferrous Materials.
- Part B - Non - Ferrous Materials.
- Part C - Specification for electrodes & filler wire.
- Part D - Properties.

C. ASME Section IV : Rules for construction of Heating Boiler.
D. ASME Section V : Non – destructive Examination.
E. ASME Section VI : Recommended rules for care & Operation of heating boiler.
F. ASME Section VII :Recommended guidelines for care of power boiler.
H. ASME Section VII :Rules for construction of pressure vessels. (Division I & II)
I. ASME Section IX :Welding & Brazing questions.

5. Which American Standard is referred for selection of following piping element?
A. Flanges B. Butt Welded fittings C. Gasket D. Socket & Threaded fittings
E. Valves F. Pipes

Answer :-

A. Flanges :-
I. ASME B 16.1 : Cast Iron pipes flanges & flanged fittings.
II. ASME B 16.5 : Carbon steel pipes flanges & flanged fittings (Up to 24")
III. ASME B 16.47 : Large Diameter steel flanges (above 24")

B. Butt welded fittings :-
I. ASME B 16.9 : Steel butt welding fittings.
II. ASME B 16.28 : Butt – welded short radius elbows & returns bends.

C. Gasket :-
I. ASME B 16.20 / API – 601 : Metallic gasket for pipe flanges – spiral wound, Octagonal ring joint & Jacketed flanges.
II. ASME B 16.21 : Non Metallic Gasket.

D. Socket & Threaded fittings :
I. ASME B 16.11 : Forged steel socket welding & threaded fittings.

E. Valves :-
I. ASME B 16.10 : Face to face & end to end dimension of valves.
II. ASME B 16.34 : Flanged & butt welded ends steel valves (pressure & Temperature ratings) except Ball, plug & Butter fly valves.

F. Pipes :-
I. ASME B 36.10 : Welded & Seamless wrought iron pipes.
II. ASME B 36.19 : Stainless steel pipes.

Questions related to Materials :-

1. What is the ASTM Code for the following ?
A. Pipes :-
I. Carbon Steel II. Alloy Steel III. Stainless Steel IV. Nickel Steel.
B. Tubes :-
I. Carbon Steel II. Alloy Steel III. Stainless Steel IV. Nickel Steel.

C. Wrought Iron Fittings :
I. Carbon Steel II. Alloy Steel III. Stainless Steel IV. Nickel Steel.

D. Forged Fittings :
I. Carbon Steel II. Alloy Steel III. Stainless Steel IV. Nickel Steel.

E. Cast Fittings :
I. Carbon Steel II. Alloy Steel III. Stainless Steel IV. Nickel Steel.

F. Plates :
I. Carbon Steel II. Alloy Steel III. Stainless Steel IV. Nickel Steel.

Answer :

A.	**Pipes :-**	
I.	**Carbon Steel :**	ASTM A53 Gr. A/B, ASTM A 106 Gr. A/B/C, ASTM A333 Gr. 1/ Gr. 6
II.	**Alloy Steel :**	ASTM A 335 Gr. P1/P2/P5/P7/P9/P11/P12/P22.
III.	**Stainless Steel:**	ASTM A312TP304/TP304L/TP304H/TP308/ TP310/ TP316/TP316L/TP316H/TP317/TP321/TP321H/ TP347/TP347H/ TP348/ TP348H.
IV.	**Nickel Steel :**	ASTM A333Gr. 3/Gr.8
B.	**Tubes :-**	
I.	**Carbon Steel :**	ASTM A178/179/192, ASTM A334 Gr. 1/6.
II.	**Alloy Steel :**	ASTM A 161T1, ASTM A213T1/T2/T5/T7/T9/T11/ T12/T22
III.	**Stainless Steel:**	ASTM A213 TP 304/TP304L/TP304H/TP310/ TP316/ TP316L/TP316H/TP317/TP321/ TP321H/TP347/ TP347H/ TP348/ TP348H, ASTM A608 HK40.
IV.	**Nickel Steel :**	ASTM A334Gr. 3/ Gr.8
C.	**Wrought Iron fittings:-**	
I.	**Carbon Steel :**	ASTM A234 Gr. WPA/B, ASTM A420 Gr. WPL6.
II.	**Alloy Steel :**	ASTM A234 WP1/WP5/WP7/WP9/WP11/WP12/WP22
III.	**Stainless Steel:**	ASTM A403 WP304/WP304L/WP304H/WP309/WP310 /WP316/WP316L/WP316H/WP317/WP321/WP321H /WP347/WP347H/WP348.
IV.	**Nickel Steel :**	ASTM A420WPL6/WPL8.
D.	**Forged Fittings:-**	
I.	**Carbon Steel :**	ASTM A 181, ASTM A105, ASTM A350 LF1/2.
II.	**Alloy Steel :**	ASTM A 182F1/F2/F7/F9/F12/F22.
III.	**Stainless Steel :**	ASTM A182F6/F304/F304L/F304H/F310/F316/F316L / F316H/F321/ F321H/F347/F347H/F348.
IV.	**Nickel Steel :**	ASTM A350 LF3, ASTM A522.
E.	**Cast Fittings :-**	
I.	**Carbon Steel :**	ASTM A216, ASTM A352 LCB/C.
II.	**Alloy Steel :**	ASTM A217 WC1/WC6/WC9/C5/C12.

III.	**Stainless Steel :**	ASTM A217 CA15, ASTM A296 CA15, ASTM A351 CF8/ CF3 / CH20 / CK20/ CF 8M / CF 3M / CF 8C / HK 40.
IV.	**Nickel Steel :**	ASTM A352LC3.

F. Plates :-

I.	**Carbon Steel :**	ASTM A285, ASTM A515, ASTM A516.
II.	**Alloy Steel :**	ASTM A387 Gr.2/Gr.5/Gr.7/Gr.9/Gr.11/Gr.12/Gr.22.
III.	**Stainless Steel:**	ASTM A240 TP410/ TP405/TP430 /TP304/TP304L / TP309/ TP310S/ TP316/ TP316L/ TP317/ TP321/ TP347/ TP348.
IV.	**Nickel Steel :**	ASTM A203 Gr. D/Gr.E. ASTM A353.

2. What is the basic difference between pipe specification A106 Gr. A/ Gr.B / Gr. C?

Answer :-

Difference is due to the Carbon content.

% of carbon content in :-

I. ASTM A 106 Gr. A – 0.25%
II. ASTM A 106 Gr. B – 0.30%
III. ASTM A 106 Gr. C – 0.35%

3. What is the difference between pipe specification ASTM A312 TP 304 & ASTM A312 TP34L, ASTM A312 TP 316 & ASTM A 312 TP 316L?

Answer :

Difference is due to the Carbon content. The Letter "L" denotes lower percentage of carbon. % of carbon content in :-

I.	ASTM A312	TP 304	-	0.08%
II.	ASTM A312	TP 304L	-	0.035%
III.	ASTM A312	TP 316	-	0.08%
IV.	ASTM A 312	TP 316L	-	0.035%

Questions related to Pipe Fittings :

1. How can flanges be classified based on Pipe Attachment?

Answer :

Flanges can be classified based on pipe attachment as :-

Slip on .	-	The slip – on type flanges are attached by welding inside as well as outside. These flanges are of forged construction.
Socket Weld	-	The Socket Weld flanges are welded on one side only. These are used for small bore lines only
Screwed	-	The Screwed – on flanges are used on pipe lines where welding cannot be carried out.
Lap joint	-	The lap joint flanges are used with stub ends. The stub ends are welded with pipes & flanges are kept loose over the same.

Welding Neck- The welding neck flanges are attached by butt welding to the pipe. These are used mainly for critical services where the weld joint need radiographic inspection.

Blind - The Blind flanges are used to close the ends which need to be reopened.

Reducing - The reducing flanges are used to connect between larger and smaller sizes without using a reducer. In case of reducing flanges, the thickness of flange should be that of the higher diameter.

Integral - Integral flanges are those, which are cast along with the piping component or equipment.

2. How can flanges be classified based on Pressure – Temperature ratings ?

Answer :

Flanges are classified based on Pressure Temperature ratings as:

A. 150 #
B. 300 #
C. 400 #
D. 600 #
E. 900 #
F. 1500 #
G. 2500 #

Pressure temperature rating carts in the standards ASME 16.5 Specify the non – stock working gauge pressure to which the flanges can be subjected to at a particular temperature .

3. How can flanges be classified based on facing ?

Answer :-

Flanges are classified based on facing as :

A. Flat face (FF)
B. Raised face (R/F)
C. Tongue and groove (T/G)
D. Male and female (M/F)
E. Ring type joint (RTJ)

4. How can flanges be classified based on face finish?

Answer :-

Flanges are classified based on face finish as :-

A. Smooth Finish
B. Serrated finish

5. Where the smooth finish flange & serrated finish flange finds its use?

Answer :-

The smooth finish flange is provided when metallic gasket is provided and serrated finish flange is provided when non- metallic gasket is provided.

6. What are the types of serrated finish provided on flange face?

Answer :-

A. Concentric or
B. Spiral (Phonographic)

7. How the serration on flanges is specified ?

Answer :

The serration on flanges is specified by the number, which is the **Arithmetic Average Rough Height (AARH)**

8. Where the concentric Serration is insisted for face finish?

Answer :

Concentric serration are insisted for face finish where the fluid being carried has very low density and can find leakage path through cavity.

9. How the Gaskets are classified based on the type of construction ?

Answer :-

Based on the type of construction, gasket are classified as :-

A. Full face
B. Spiral wound metallic
C. Ring type
D. Metal jacketed
E. Inside bolt circle.

10. What is the most commonly used material for Gasket?

Answer :-

Compressed Asbestos Fibre.

11. Which type of gasket is recommended for high temperature & high – pressure application?

Answer:-

Spiral Wound Metallic Gasket.

11. What are the criteria for selection of MOC of Spiral Wound metallic Gasket winding material ?

Answer :-

The selection of material of construction of Gasket winding depends upon:-

A. The corrosive nature and concentration of fluid being carried
B. The operating temperature of the fluid.
C. The relative cost of alternate winding material.

12. What are the most common materials used for spiral wound metallic gasket winding ?

Answer :-

The most commonly used material for spiral wound metallic gasket winging is:-

A. Austenitic stainless steel 304 with asbestos filler.
B. Austenitic stainless steel 316 with asbestos filler.
C. Austenitic stainless steel 321 with asbestos filler.

13. Which material is used as filler material for spiral wound gasket is case of high temperature services ?

Answer : -

For very high temperature services, graphite filler is used.

14. What is centering ring in connection to spiral wound gasket?

Answer :-

Spiral wound gaskets are provided with carbon steel external ring called centering ring.

15. What will be the AARH Finish on flange face for using spiral wound gasket?

Answer :-

125- 250 AARH finish.

16. On which type of flanges the use of spiral wound gasket are restricted?

Answer :-

ASME B 16.5 does not recommend the use of 150# rating spiral wound gasket on flanges other than welding neck an lapped joint type.

17. Up to what temperature limits the low strength carbon steel bolts should not be used for flanged joints?

Answer :-

Flanged joints using low strength carbon steel shall not used above 200^0C or below – 28^0C

17. How the pipe fittings are classified based on end connections ?

Answer :-

Pipe fittings are classified based on end connection as :-

A. Socket weld fittings.
B. Screwed end fittings.
C. Beveled end or Butt weld fittings.
D. Spigot socket fittings.
E. Buttress end fittings.

18. Up to what temperature the carbon steel materials shall be used?

Answer :-

Carbon steel materials shall be used for temperature up to 425^0C.

19. Which material is used for temperature above 426^0C?

Answer :-

Alloy steel materials shall be used for temperature above 426^0C?

20. Which type of material is used for corrosive fluid?

Answer :-

Stainless steel materials shall be used for corrosive fluid.

21. Which type of piping materials are used for drinking water, instrument air etc?

Answer :-

Galvanized steel materials shall be used for drinking water, instrument air and NI lines (LP)

22. What is the different between pipe and Tube?

Answer :-

Pipe is identified by NB and thickness is defined by Schedule whereas Tube is identified by OD & its thickness as BWG (Birmingham wire gauge 1/100 inch)

23. From which size onwards NB of pipe equal to OB of pipe?

Answer :-

From the size 14" and onwards NB = OD of pipe.

24. What should be the radius of long radius elbow?

Answer :-

1.5D (Where "D" is the diameter of the pipe.)

25. What should be the radius of short radius elbow?

Answer :-

1D(Where "D" is the diameter of the pipe)

26. What is the basics of using of short radius & long radius elbow?

Answer :-

Long radius elbow are used for small pressure drop whereas short radius elbow are used for high pressure drops. For catalyst flows very long radius elbows are used.

27. Normally where to we use the following?

A. Eccentric reducers.

B. Concentric reducers.

Answer :

A. Eccentric reduces = Pump suction to avoid Cavitation, To maintain elevation (BOP) in rack.

B. Concentric reducers = Pump discharge, vertical pipeline etc.

28. Concentric reducer is used in pump suction (Yes / No) Explain.

Answer :

No. Air pockets may form if concentric reducer is used at pump suction, which results in cavitation and cause damage to pump. To avoid this problem, Eccentric Reducer with flat side up (FSU) is used in Pump Suction.

29. Where the ERW spiral & longitudinal pipes are used?

Answer :-

Use depends upon the availability of pipes. Nothing functional difference.

30. Where the ERW & Seamless pipes are used?

Answer :-

Above 18" ERW pipes are used. Below 18" seamless pipes are used. Seamless pipes can sustain higher temperature & Pressure.

31. What is the main use of ASTM A53 & A106 Gr. B Pipes?

Answer :-

ASTM A53 Pipes are mainly used for utility services whereas A106 Gr.B pipes are used for high pressure & high temperature services.

32. From which side of pipe will you take a branch connection?

Answer :-

When fluid is Gas, Air or Steam and Cryogenic Service – Topside.

When Fluid is Liquid – Bottom Side.

33. Why don't we take a branch for Cryogenic Service from bottom side though the fluid is in liquid state?

Answer :-

There is the chance of ice formation during normal operation and since ice flous from the bottom of the pipe it will block the branch pipe connection.

33. Why do we provide High Point Vent (HPV) and Low Point Drain (LPD) in Piping?

Answer :-

HPV - For removing Air during Hydro – test.

LPD - For draining water after conducting Hydro – test.

34. What do you mean by Jacketed Piping?

Answer :-

Piping which is recognized as providing the most uniform application of heat to the process, as well as maintaining the most uniform processing temperatures where steam tracing is not capable of maintaining the temperature of fluid constant. Usually used for molten sulphur, Polymers service.

35. What is the minimum distance to be maintained between two welds in a pipe?

Answer :-

The thumb rule is that the minimum distance between adjacent butt welds is 1D. If not, it is never closer than 1-1/2". This is supposedly to prevent the overlap of HAZs. Minimum spacing of circumferential welds between centerlines shall not be less than 4 times the pipe wall thickness or 25 mm whichever is greater.

36. What do you mean by IBR and which lines comes under IBR Purview?

Answer :-

IBR : Indian Boiler Regulation Act.

Steam lines with conditions listed bellow comers under IBR purview:-

- Lines for which design pressure is 3.5 kg/ sq. cm and above.
- Line size above 10" having design pressure 1.0 kg/sq. cm and above.
- Boiler feed water lines to steam generator, condensate lines to steam generator and flash drum.

37. What are Weldlet and Sockolet ? And where they are used?

Answer :-

Weldolet and Sockolet are basically self – reinforced fittings.

Weldolet is used for Butt weld branch connection where should tee is not available due to size restrictions and the piping is of critical/ high- pressure service. Sockolet is used for socket welding branch connection, which require reinforcing pad.

38. What is the MOC for Superheated high pressure Steam Lines?

Answer :-

A 335 Gr. P1/P11, Composition: Cr – ½ Mo (P1) / 1 ¼ Cr. – ½ Mo (P11)

39. What is the normal upstream and downstream straight length of orifice flow meter?

Answer :-

Upstream – 15D Downstream – 5D

Questions related to valves:-

1. What is the function of valves?

Answer :-

A. Isolation
B. Regulation
C. Non- Return
D. Special purpose.

2. How the valves are classified based on their function?

Answer :-

A. Isolation

1. Gate valve
2. Ball valve
3. Plug valve
4. Piston valve
5. Diaphragm valve
6. Butterfly valve
7. Pinch valve

B. Regulation

1. Globe valve
2. Needle valve
3. Butterfly valve
4. Diaphragm valve.
5. Piston valve
6. Pinch Valve

C. Non – Return

1. Check – valve

D. Special Purpose

1. Multi- Port valve
2. Flush Bottom valve
3. Float valve
4. Foot valve
5. Line blind valve
6. Knife Gate valve

3. How the valves are classified based on its method of operation?

Answer :-

Valves are classified based on its method of operation as :

A. Self – operated valves.
B. Operated valves.

4. Name the self – operated & operated valves?

Answer :-

Mainly the check valves are self – operated and all other valve types comes under operated valves.

5. How the valves are classified based on end connection?

Answer :-

Valves are classified based on end connection as :

A. Screwed ends.
B. Socket ends.
C. Flanged ends.
D. Butt weld ends.
E. Water type ends.
F. Bultrees ends.

End connection means arrangement of attachment of the valve with the equipment or the piping

6. What are the types of check valves?

Answer :-

Check valves are divided into two based on check mechanism as:-

A. Lift check valve.
B. Swing check valve.

7. What do you mean by special purpose valves?

Answer :-

Valves that perform duties other than the two- way isolation, control and check are called special purpose valves.

8. What are Glandless options valves? Where these are used?

Answer :-

Glandless piston valves are regulating valves used in steam services.

Questions related to welding/ Weld defects / Post heating / Post weld heat treatment / Electrode / Filler wire.

1. What do you mean by following type of welding?
A. SMAW B. TIG

Answer :-

A. SMAW: Shielded Metal Arc Welding.
B. TIG : Tungsten Inert Gas Welding.

2. Mention the contents of TIG welding set?

Answer :-

A. Torch : Consist of hose for argon gas / welding lead / ceramic nozzle / collet tungsten rod as cathode to create arc.

B. Regulator with Pressure Gauge (HP & LP) & flow meter.

C. Argon Cylinder – Gr. 2/ Gr.1 depending upon requirements of the job.

D. Transformer / Rectifier.

E. Filler wire.

3. While welding of Pipe trunion to pipe/ reinforcement pad you have to put a hole or leave some portion of welding why?

Answer :-

For venting of hot gas which may get generated due to welding.

4. What is the thumb to calculate Current required for Welding?

Answer :-

Current (Amp) = [Diameter of Electrode (mm) x 40 $\pm$] 20

5. What is the minimum thickness of cs pipe that requires stress reliving to be done as per B 31.3?

Answer :-

19.05 mm thk.

6. Which is the Electrode & filler wire used for welding of following materials ?

A. Alloy Steel

I. ASTM A335P1

II. ASTM A335P2

III. ASTM A335P11

IV. ASTM A335P5

V. ASTM A335P9

B. Stainless Steel

I. ASTM A312TP304

II. ASTM A312TP304L

III. ASTM A312TP304H

IV. ASTM A312TP308

V. ASTM A312TP310

VI. ASTM A312TP316

VII. ASTM A312TP316L

VIII. ASTM A312TP316H

IX. ASTM A312TP321

X. ASTM A312TP321H

Answer :

		Covered Electrode	Bare electrode
Alloy Steel			
I.	ASTM A335P1	E7018	E70 S- 1B
II.	ASTM A335P2	E80 18 – B1	--
III.	ASTM A335P11	E8018-B2	ER515
IV.	ASTM A335P5	E502	ER502
V.	ASTM A335P9	E505	ER505
Stainless Steel			
I.	ASTM A312TP304	E308	ER308
II.	ASTM A312TP304L	E308L	ER308L
III.	ASTM A312TP304H	E 16-6-2	ER16-8-2
IV.	ASTM A312TP308	E309	ER309
V.	ASTM A312TP310	E310	ER310
VI.	ASTM A312TP316	E316	ER316
VII.	ASTM A312TP316L	E316L	ER316L
VIII.	ASTM A312TP316H	E16-8-2	ER-16-18-2
IX.	ASTM A312TP321	E347	ER347
X.	ASTM A312TP321H	E16-6-2	ER16-8-2

7. What are the common welding defects?

Answer :-

A. Lack of penetration.
B. Lack of fusion.
C. Undercut.
D. Slag inclusion.
E. Porosity.
F. Crack
G. Faulty weld size & profile.
H. Distortion.

A. <u>Lack of penetration.</u>

This defect occurs at the root of the joint when the weld metal fails to reach it or weld metal fails to fuse completely the root faces of the joint. As a result, a void remains at the root zone, which may contain slag inclusions.

Cause :-

A. Use of incorrect size of electrode in relation to the form of joint.
B. Low welding current.
C. Faulty fit- up and inaccurate joint preparation.

B. <u>Lack of Fusion.</u>

Lack of fusion is defined as a condition where boundaries of unfused metal exist between the weld metal & base metal or between the adjacent layers of weld metals.

Cause :-

A. Presence of scale, dirt, oxide, slag and other non- metallic substance which prevents the weld metal to reach melting temperature.
B. Improper deslagging between the weld pass.

Precaution :
A. Keep the weld joint free from scale, dirt, oxide, slag and other non- metallic substance.
B. Use adequate welding current.
C. Deslag each weld pass thoroughly.
D. Place weld passes correctly next to each other.

C. Undercut
The defect appears as a continuous or discontinuous groove at the toes of a weld pass and is located on the base metal or in the fusion face of a multipass weld. It occurs prominently on the edge of a fillet weld deposited in the horizontal position.

Cause :-
A. Excessive welding current.
B. Too high speed of arc travel.
C. Wrong electrode angle.

Rectification :
The defect is rectified by filling the undercut groove with a weld pass. If undercut is deep & contains slag, it should be chipped away before rewelding.

D. Slag inclusion
Non – metallic particles of comparatively large size entrapped in the weld metal are termed as slag inclusion.
Cause :-
A. Improper cleaning of slag between the deposition of successive passes.
B. Presence of heavy mill scale, loose rust, dirt, grit & other substance present on the surface of base metal.

Precaution :-
A. Clean the slag thoroughly between the weld pass.
B. Keep the joint surface (especially gas cut surface) and bare filler wire perfectly clean
C. Avoid undercut & gaps between weld pass.
D. Use proper welding consumables.

E. Porosity

The presence of gas pores in a weld caused by entrapment of gas during solidification is termed as porosity. The pores are in the form of small spherical cavities either clustered locally or scattered throughout the weld deposit. Sometimes entrapped gas give rise to a single large cavity called Blowholes .

Cause :

A. Chemically imperfect welding consumables, for example, deficient in deoxidiser.
B. Faulty composition of base material or electrode, for example, high sulphur content.
C. Presence of Oil, grease, moisture and mill scale on the weld surface.
D. Excessive moisture in the electrode coating or submerged- arc flux.
E. Inadequate gas shielding or impure gas in gas – shielded process.
F. Low welding current or too long an arc.
G. Quick – freezing of weld deposit.

F. Crack

Fracture of the metal is called crack. Two types of cracks :- Cold crack & Hot crack. Cold crack usually occur in HAZ of the base metal when this zone becomes hard and brittle due to repaid cooling the weld metal has been deposited & sufficient hydrogen has been absorbed by the weld metal from the arc atmosphere.

Precaution :-

A. Use of low carbon equivalent materials.
B. Higher heat input during welding.
C. Preheating
D. Use of low hydrogen electrode.

G. Faculty weld size and profile

A weld is considered faulty if it has lack of reinforcement, excessive reinforcement or irregular profile.

H. Distortion

Because a weldment is locally heated (by most welding processes), the temperature distribution in the weldment is not uniform and changes take place as welding processes. Typically. The weld metal and the base metal heat – affected zone immediately adjacent to it are at a temperature substantially above that of the unaffected base metal. As the molten pool solidifies and shrinks, it begins to exert shrinkage stresses on the surrounding weld metal and heat-affected zone area. When it first solidifies, this weld metal is hot, relatively weak, and can exert little stress. As it cools to ambient temperature, however, the shrinkage of the weld metal exerts increasing stress on the weld area and eventually reaches the yield point of the base metal and the heat- affected zone. Residual stresses in weldments have two major effects. First, they produce distortion, and second, they may be the cause of premature failure in weldments. Distortion is caused when the heated weld region contracts nonuniformly, causing shrinkage in one part of the weld to exert eccentric forces on the weld cross section. The distortion may appear in butt joints as both longitudinal and transverse shrinkage or contraction, and as angular change (rotation) when the face of the weld shrinks more than the root.

Distortion in fillet welds is similar to that in butt welds : transverse and longitudinal shrinkage as well as angular distortion results from the unbalanced nature of the stresses in these welds.

5. What is the depth of penetration in steel by cobalt – 60, cesium – 138, Iridium – 192 & Thulium – 170.

Answer :-

Penetration in steel by :-

A.	Cobalt -	160	:	9 inch
B.	Cesium -	137	:	3 ½ inch
C.	Iridium -	192	:	3 inch
D.	Thulium -	170	:	½ inch

6. What do you mean by photographic Density ?

Answer :-

It is the quantitative measurement of film blackness. It is expressed as:-

$D = \text{Log} / I_n / I_t$ ……. Where, D is density

I_0 - Light intensity incident on the film.

I_t – Light intensity transmitted through the film.

7. Name the instrument used for measuring density of photographic or radiographic film ?

Answer :-

Densitometre is an instrument for measuring the density of photographic and radiographic film.

8. What are the factors on which the density of radiographic film depends?

Answer:-

The density of radiographic films depends upon the following :-

A. Total amount of radiation emitted by X – ray or gamma ray.
B. Amount of radiation reaching the specimen.
C. The amount of radiation passing through the specimen.
D. Intensifying action of the screen if used.

9. How the intensity of source is related with film distance.

Answer :-

Intensity of X – ray or gamma ray varies inversely with the square of the distance from focal spot or source of light. This relation is known as the inverse square law.
mathematically, it is expressed as :

$$\frac{I_1}{I_2} = \frac{D_2^2}{D_1^2}$$

… Where I_1 and I_2 are intensities at the distance D_1 and D_2 respectively.

10. What are the governing factors for exposure from particular radioisotopes?

Answer :-

There are three factors for governing the exposure with a given kilovoltage for X- ray or with the gamma ray from particular radioisotopes.

A. Milliamperage (X – ray) or source strength (for Gamma ray)
B. Focal spot to film distance or source to film distance.
C. Time of exposure

11. What is the relation between Milliamperage (source strength) and film distance?

Answer :-

The Milliamperage (M) is directly proportional to the square of the focus to film distance (D). The equation is expressed as :-

$$\frac{M_1}{M_2} = \frac{D_1^2}{D_2^2}$$

..... Where M_1 and M_2 are the Milliamperage.

D_1 and D_2 are the distance from focus to film.

12. What is the relation between exposure time & film distance?

Answer :-

The exposure time (T) is directly proportional to the square of the focus to film distances (D).

The equation is expressed as:

$$\frac{T_1}{T_2} = \frac{D_1^2}{D_2^2}$$

13. What is the relation between source strength & exposure time?

Answer :-

The Milliamperage (M) is inversely proportional to the time of exposure (T). The equation is expressed as :-

$$\frac{M_1}{M_2} = \frac{T_2}{T_1} \quad \text{or} \quad M_1 T_1 = M_2 T_2$$

…… Where , M_1 and M_2 are the Milliamperage.

T_1 and T_2 are the time of exposure.

Note : The above relation is also called Reciprocity law and is true for direct X –ray or gamma ray with lead screen exposure. The above relation is not quit accurate for exposure to light.

14. How the source strength of radiographic isotopes expressed?

Answer:-

The source strength of radiographic isotopes expressed in terms of Curie.

15. What do you mean by exposure?]

Answer :-

It is defined as the quantity of X or gamma radiation that produces in air, ions carrying 1 coulomb (C) of charge (of either sign) per Kg of air. The unit of exposure is C /Kg.

16. What do you mean by Roentgen?

Answer :-

Roentgen is the old unit for exposure. It is defined as the amount of X or gamma radiation which liberates 1e s u of change of either sign in 1 C. C. of air at S T P.

1R = 1 e s u / C C of air at STP.

= 2.58×10^{4} C / Kg air.

17. What is Does equipment ?

Answer :-

Dose Equivalent = Quality factor X absorbed dose.

Quality factor generally considered as:

A. 1 for X, γ or β.
B. 3 for Thermal neutrons.
C. 20 for α – particles.

The unit of dose equivalent is Sievert (SV)

Formerly, the unit of dose equivalent was 1 rem.

1 Sievert = 100rem (Roentgen)

18. What is the function of radiographic screens ?

Answer :-

It intensifies the radiographic images on the film.

19. What are the types of radiographic screens generally used?

Answer :-

Types of radiographic screens generally used are:-

A. Lead Screen.
B. Fluorescent screen or salt screens.

20. What are the types of Lead Screens?

Answer :-

Types of lead screen are:-

A. Lead foil screen.
B. Lead oxide screen.

21. What do you mean by intensification factor (IF)?

Answer :-

$$\text{Intensification factor} = \frac{\text{Exposure time required to produce required film density without screen.}}{\text{Exposure time for same density using screen.}}$$

In the above definition it is assumed that same film and radiation source used for the both the exposure.

22. What are the factors upon which the intensification factor depends?

Answer :-

Intensification factor due to metallic screens depends on the following :-

A. Metal of foil.
B. Thickness of foil.
C. Energy of radiation.
D. Specimen thickness.

23. How the intensification factor depends on metal of foil?

Answer :-

For a given radiation source, the number of electrons produced depends on the nature of the metal foil. Intensification factor increases with atomic number of the metal. For gamma ray radiography generally Lead screen are used.

24. How the intensification factor depends on thickness of foil?

Answer :

The intensification factor increases with the increase in the thickness of the foil. Intensification increase maximum corresponding to the range of photoelectron in that metal. After further increase it remains practically constant. If the thickness further increased, greater number of gamma photons will be attenuated and this will reduce the produce of photoelectrons.

25. How the intensification factor depends on energy of radiation?

Answer:

More is the energy of radiation, more is the intensifying action.

26. How the intensification factor depends on thickness of the specimen?

Answer:

A Specimen placed in between the source and film performs following two functions:

A. It filters the primary radiation.
B. Gives low energy scattered radiation.

The radiographic screen can have different sensitivities for primary radiation and the radiation given by the above two effects. Hence the change in intensification factor with object thickness is expected. The intensification of low energy scattered radiation is more than the intensification of high energy filtered radiation.

27. Where the fluorescent screen finds its use?

Answer :

The fluorescent screen are widely used for medical purpose to reduce the exposure time.

28. What are the main constituents of a radiographic film?

Answer:

The radiographic films consist of the following:

A. Base material
B. Subbing layer
C. Emulsion and
D. Protective layer / super coat.

29. What is the different base material tried so far for radiographic film?

Answer:

The materials so far tried for base is:

A. Glass.
B. Cellulose Nitrate.
C. Cellulose Acetate.
D. Cellulose Triacetate.
E. Polyester (Most suitable material to be used as base material)

30. What is the function of subbing material, Emulsion & protective layer in radiographic film?

Answer :

Subbing material	:	It provide the sticky action to the emulsion, as the emulsion does not adhere directly on the base material.
Emulsion	:	It contains silver bromide gelatin (Generally animal bone marrow)
Protective Layer	:	It is coated on emulsion in order the same from physical damage, abrasion and stress mark.

31. How the Radiographic films are classified?

Answer :

The Radiographic films are classified as:-

A.	Class	-	I	:	Highest contrast, Lowest speed.
B.	Class	-	II	:	High contrast, Low Speed.
C.	Class	-	III	:	Medium contrast, Medium Speed.
D.	Class	-	IV	:	Low contrast, High Speed.

32. What is the basis of classification of classification of radiographic film?

Answer:-

Classification of Radiographic film is done on the basis of grain size of Silver Bromide (Silver Bromide Crystals), Finer the grain size of Silver Bromide in emulsion, slower will be the speed. Generally used crystal size is 0.22, 0.52, 0.68, 0.80 and 1 micron.

33. What is speed with reference to Radiography film?

Answer:

It can be defined as the density records on the film resulting from a given exposure. It is inverse of exposure required to produce on radiograph of particular density under the specified conditions. A film requires less exposure to achieve particular density is called fast film and more exposure to achieve particular density is called fast film and more exposure called slow film.

34. What type of film is generally used for Radiography?

Answer :

Class – III type (D5, D7 – Agfa make) film is generally used for radiography.

35. What type of film is not used for industrial purpose (Used for Medical Purpose)?

Answer :

Class – IV type (D10 --- Agfa make) film is not used for industrial purpose.

36. What do you mean by film processing?

Answer :-

When the film exposed to the radiation, creates latent image or invisible image by converting the silver bromide present in the emulsion into metallic silver. The exposed film when processed converts latent image into visible image.

37. What are the main steps in film processing?

Answer :-

Main steps in film processing are:-

a. Developing
b. Stop bath.
c. Fixture
d. Washing
e. Drying

38. What are the ingredients of developer?

Answer:

A.	Developing Agent	:	Metol, Hydroquinone and Pencilone.
B.	Accelerator	:	Sodium Carbonate.

C. Restrainer : Potassium Bromate
D. Preservative : Sodium Sulphate.

39. What is the function of Accelerator present in Developer?

Answer:
In encourages the developer to supply more electrons.

40. What is the function of Restrainer present in Developer?

Answer:
It opposes to reduce the unexposed silver bromide. It acts as antifogging agent.

41. What is the function of Preservative present in Developer?

Answer:
It prevents oxidation.

42. What is the affect of temperature on Developer?

Answer:
The Developer supplies more electrons at high temperature and reduces the developing time. Opposite is the case when the temperature is lower.

43. What is the ideal developing temperature?

Answer :-
Below 18^0C and above 24^0C, developing is not recommended.

44. What is the developing time generally recommended?

Answer:
5 to 8 minutes. Lager developing time increases the fog density. The developing time below 3 minutes is not recommended as the required density shall not be achieved and may miss minor discontinuities.

45. What is the ingredient of Stop Bath?

Answer:
2% Acitic Acid.

46. What is the function of stop Bath?

Answer:
Stops the Developing action by neutralizing the alkaline developer.

47. What are the Ingredients of Fixer?

Answer:
Fixing Agent A. Sodium thiosulphate commonly known as Hypo.

Commonly used fixing agent.

B. Ammonium thiosulphate. Used as rapid fixing agent.

48. What is the function of Fixer?

Answer:

It removes all unexposed silver grains and clouded film starts to become clear.

49. What is the recommended time for Fixer?

Answer:

General recommendation is 5 to 15 minutes

50. What is Radiographic sensitivity?

Answer:-

It is the combination of Radiographic contrast and Radiographic definition. The Radiographic sensitivity is judged by image quality indicator (IQI), also known as pentameter. judging, the qualitative & quantitative quality of radiograph, a penetrametre is required. The image of IQI on the radiograph is the evidence that the radiographic inspection was conducted under proper condition and achieved the required sensitivity.

$$\% \text{ Sensitivity} = \frac{\text{Minimum visible wire diameter}}{\text{Thickness of the job}} \times 100$$

51. What is the general requirement of Radiographic Sensitivity?

Answer:

General requirement of Radiographic sensitivity are:-

> 2% (Less than two percent) - God

< 2% (More ten two percent) – Not acceptable.

52. What are the commonly used IQI?

Answer:-

A. Wire type penetrametre.
B. Plate type penetrametre.
C. Step type penetrametre.
D. Step – Hole type penetrametre.

53. What are the criteria for selection of IQI or Penetrametre?

Answer:

Penetrametre should be made of same material as that of the specimen.

The selection of IQI should be made as:

A. For carbon Steel & Low Alloy Steel : Carbon Steel IQI.
B. For high Alloy Steel & Stainless Steel: Stainless Steel IQI

C. For Aluminium & Aluminium Alloy : Aluminium IQI.
D. Copper & Copper Alloy : Copper IQI.

54. Name some IQI?

Answer:

Wire types IQI :- 1 – ISO – 7, 6 – ISO – 12, 10- ISO- 16.

55. What do you mean by Radiographic constrast?

Answer:-

Density difference between the two adjacent areas of the radiograph is known as contrast.

Radiographic contrast is the combined effect of the following.

A. Subject contrast.
B. Film contrast.

56. What is subject contrast?

Answer:

The factor of the specimen, which affects the contrast, is known as subject contrast.

57. What is film contrast?

Answer :

The factor of the film, which affects the contrast, is known as film contrast.

58. What are the factors, which affects subject contrast?

Answer :-

Subject contrast affected by:

A. Thickness difference in the specimen.
Uniform thickness of the specimen shows no contrast but thickness difference in the specimen sows good contrast.
B. Radiation Quality.
Best contrast is achieved by ray of suitable low kilovoltage (Soft Radiation). By increasing, the kilovoltage (Harder Radiation) penetration will increase but decrease the subject contrast.
C. Scattered Radiation.
By reducing the Scattered radiation (internal, side and back scatters) using diaphragm, masks, filters, and lead screens increase the subject contrast.

59. What are the factors, which affects the film contrast?

Answer :-

Film contrast affected by:

A. Type of film:
Grain size of the film controls the film contrast. Finer the grains (lower speed) of the film higher the film contrast.

B. Film Processing.
Increasing the developing time increase the density as well as fog density and decreases the film contrast. Processing of film in fresh developer gives higher contrast then the exhausted developer.

D. Film Density:
At higher film density, the film contrasts is more and at low density the film contrast is less.

60. Where the IQI (Penetrametre) is placed?

Answer:

The IQI or penetrametre should be placed as possible on the source slide of the radiation. When it is not possible as in case of double wall single image radiography, it can be placed on the film side with a lead letter 'F' near the IQI. The IQI should be placed in most unfavorable location with respect to the radiation beam.

61. What are the different types of Radiography or Exposure technique?

Answer :-

Different types of Radiography techniques are :-

A. Single wall single image (Panoramic Exposure)
B. Double wall single image.
C. Double wall double image.

Question related to Equipment and Piping Layout:-

1. What are the steps involve in plant design ?

Answer :-

The mechanical design and development of the plant has three major steps as :-

A. Conceptual layout design.
B. Equipment layout design.
C. Piping layout design.

2. What is conceptual layout design?

Answer :-

It is the part of basic engineering package. It consists of following information :-

A. Essential process design requirement such as horizontal & vertical relationship of equipment.
B. Space allocation for basic plant requirement (space required for laboratories, office, storage etc.)
C. Planning for control room, motor control centre room etc.

3. What is Equipment layout design?

Answer :-

It is the detailing of conceptual layout. It is the basic document of mechanical engineering design or in other words this document is the basis for development of construction drawing by all disciplines. It is sometimes also referred as plot plan for large outdoor plant.

It consists of following information:-

A. Floor space needed for the equipment and other facilities are shown.
B. Access, removal space, cleaning area, storage space and handling facilities are outlined.

4. What are the essential data / documents required for preparation of equipment layout ?

Answer :-

The essential data or documents required for preparation of equipment layout is as:-

A. Process flow diagrams (PFD) and piping & instrument Diagrams (P& ID)
PFD / P & ID indicates the interconnectivity of each equipment, information regarding solid handling, gravity feed, line slopes, loop sizes, venting requirement, special piping materials etc. which in turns governs the equipment location to a great extent.

B. Project design data.
This consists of following information as :-

- Geographic location, proximity to roads and railway, topography and local codes and regulations. Weather conditions such as rainfall records, seasonal temperature differences, wind direction, outlet points for drains etc.
- The above information such as wind direction influences the location of cooling towers, furnaces, stack etc. similarly, the information regarding outlet drain points affects the design of storm water drains and requirements of enclosures.

C. Equipment sizes and Building.
This includes fabricated equipment such as vessels, Heat Exchangers, Reactors, Tanks and proprietary equipment like pumps, Compressors, Furnaces etc. For locating the above, the equipment is grouped to have optimum location for minimum pipe run as well as follow the process flow sequence.

5. What are the two basic configurations for the equipment layout (unit plot plan)?

Answer :-

The equipment layout can basically be divided into two configurations :-

A. The Grade Mounted Horizontal arrangement as seen in the refineries and petrochemical plants.
B. The vertical Arrangement as seen in many chemical process industries.

6. What is Grade mounted Horizontal Arrangement of equipment layout?

Answer :-

In the grade mounted Horizontal Arrangement , the equipment is placed on the either side of the central pipe rack with auxiliary roads. Advantage of this arrangement is that the equipment is located at grade level, which makes it easier to construct, operate and maintain. Disadvantage is that it takes lot of ground area.

7. What is vertical arrangement of equipment layout?

Answer:-

The structure mounted vertical arrangement has equipment located at multilevel in steel or concrete structure. This could be indoor or outdoor. Advantage is of small coverage area and ability to house the facility to suit process requirement or climate conditions.

8. What are the basic principles of locating the Equipment irrespect of the type of arrangement?

Answer :-

The certain basis principles to be followed while locating the equipment is as :-

A. Economics piping:

In order to minimize the cost of piping, the equipment should be located in process sequence and close enough to suit safety needs, access requirements and flexibility. The equipments are identified which forms the subsystem within the unit. The component within the subsystem to be arranged to have most economical piping and the whole subsystem to be arranged within the unit to have most economic interconnection.

B. Process Requirement :

The equipment layout should support requirement like minimum pressure drop, gravity feed and loop.

C. Common operation :-

The equipment that requires common maintenance facilities, common utility and continuous operator attention shall be located the same area.

E. Underground Facilities :

Before deciding the equipment location, the facilities such as storm water drain, effluent drain, fire water, cooling water to be placed underground.

9. What is Line Routing Diagram?

Answer :-

A line routing diagram is a schematic representation of all process and utility – piping system drawn on a copy of plot plan. This diagram does not show the exact locations, elevations or interference but it locates the most congested area.

10. How do you calculate the width of pipe rack?

Answer :-

W = (f x n x s) + A + B

…… Where f : Safety Factor

= 1.5 if pipes are counted from PFD.

= 1.2 if pipes are counted from P & ID.

n : number of lines in the densest area up to size 450NB

= 300 MM (Estimated average spacing)

= 225 mm (if lines are smaller than 250 NB)

A = Additional Width for :-

: Lines larger than 450 NB.

: For instrument cable tray / duct.

: for Electrical cable tray.

s : 300 mm (estimated average spacing)

: 225 mm (if lines are smaller than 250 NB)

B : future provision

= 20% of (f x n x s) +A

11. Up to what the width of pipe Rack is restricted ? What type of arrangement shall be done if the width of rack calculated is more then the restricted limited?

Answer :-

Normally pipe Rack width is limited to 6.00 Mtrs. If the width of rack calculated is more then the arrangement shall be done in multiple layers. The arrangements adopted are :-

A. Single column Rack 'T' type.
B. Double column Rack with a single tier.
C. Double column Rack with a double tier.

12. How much space is kept in between column of pipe rack?

Answer :-

Normally, 5 to 6 Mtrs. Spacing is kept in between the column of pipe rack.

13. At which location the wide spacing (spacing more than the normal) in between the column is necessary?

Answer :-

Wide spacing is necessary at road crossing or where loading or access space is needed.

14. How much Headroom clearance is required under the following type of crossing?

A. Structures / pipe lines inside operating area.
B. From top of the Rail.
C. Above crest of road for crane movement.
D. Above crest of road for Truck movement.
E. Above crest of road between process units.

Answer:-

The Headroom normally provided is as :-

A.	Structures / pipe lines inside operating area	:	2200
B.	From top of the Rail	:	7000
C.	Above crest of road for crane movement	:	7000
D.	Above crest of road for Truck movement	:	6000
E.	above crest of road between process units	:	4500

15. What sort of drawing / layout is required for piping layout?

Answer :-

The following Drawing / Layout are required for piping layout.

A. Piping & instrumentation Diagram (P & ID).
B. Equipment layout.
C. Piping Specification
D. Equipment Drawing.
E. Vendor Requirement for proprietary equipment.

16. What care shall be taken while routing piping for instruments ?

Answer :-

Following points shall be taken care of while routing piping for instruments.

A. Flow measuring instrument needs certain straight length on upstream & downstream of the instruments. Normally, 15D on the upstream and 5D on the downstream is kept.

B. The pipe line in which flow meters such as magnetic flow meters, vortex meters, turbinemeters etc are located shall be routed in such a way that the line must be filled with liquid all the time. The pipe line shall be supported with robust support on both side of the meter.

C. Control valves are located at grade e. g. at about 500mm height from finished ground to provide convenient access for operation and maintenance. Block and bypass valve shall be located to have easy operation /access from the grade. Locating control valve on the vertical line shall be avoided.

D. Isolation valves for level gauges and pressure gauges shall be made accessible. All primary and secondary indicators of pressure, temperature, flow, level, petitioners etc shall be visible from the operating area.

E. Rotameter shall be placed on vertical line and the inlet shall be from the bottom of the instrument.

Question related to Mechanical Design Fundamentals :-

1. What are the Failures with reference to the structural design ?

Answer:

Failure of a structural part can occur by :-

A. Excessive elastic deformation.

B. Excessive non – elastic deformation.

C. Fracture.

Any design has to guard against these perceived failures.

2. What are the factors upon which the mechanical properties of mechanical are dependent?

Answer:-

Mechanical properties of any material of construction are dependent on :-

A. Chemical composition of the material.

B. Method by which the material is manufactured.

3. What is stress ?

Answer:-

It is defined as the applied load per unit cross – section of the specimen. The common unit are psi (pound per square inch), kpa , Mpa, kg / $cm^{2.}$

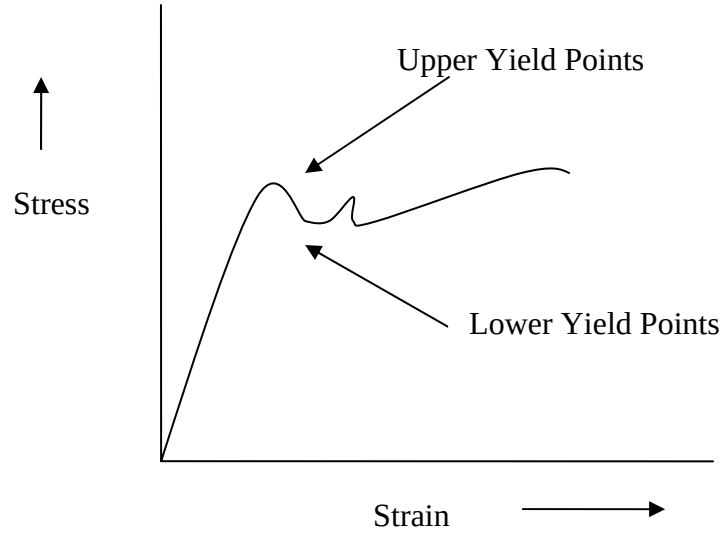
3. what is strain ?

Answer :-

For tensile load, it is the ratio of increase in length of the specimen under constant sustained load to the original of the specimen the load is applied. For compressive load, it the radio of decrease in length to the original length under sustained load. Strain is thus an

observable and measurable quantity as the extension or compression of the specimen can be directly measured. It is a dimensionless quality.

4. Draw the Stress –Strain curve showing the behavior of the specimen under stress ?
Answer :-



When there is no load, there are no stresses and no strain. When a small tensile load is applied, the strain can be measured and stress derived. If the load is removed, the specimen returns to its original shape. That is there is no residual or permanent strain in the specimen. This situation continues up to a certain level of stress. A stress strain curve in this region is a straight line i. e stress is proportional to strain. This region of curve is called the elastic region, as the MOC;s behavior is elastic like a rubber.

As the tensile load during the test is increased further, a situation arises when the specimen does not return to the original dimension even when the load is withdrawn. This is also the level or stress level at which the stress strain curve begins to deviate from the elastic straight – line behavior as shown in the graph. Thus, the metal / specimen are undergoing plastic deformation in addition to elastic deformation. When the load is withdrawn, the elastic deformation is recovered but the plastic deformation stays.

5. What is upper yield point with reference is above stress – strain Graph (Ultimate Tensile Strength)?
Answer :-

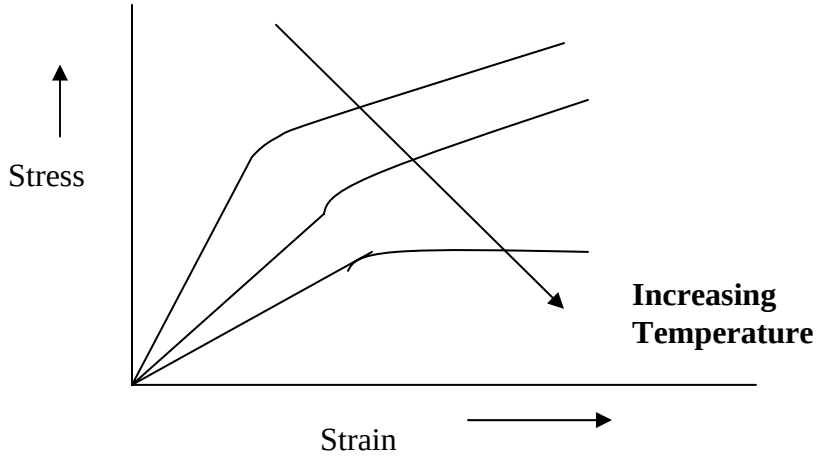
The highest stress that the metal can withstand under sustained load without continuing to elongate under same load to called the upper yield point.

6. What is lower yield point with reference to above stress- strain Graph?
Answer :-

7. What is the effect on the specimen when subjected to a sustained load with higher temperature ?
Answer :-

As the temperature of the test increases, specimen of the same material would elongate more for the same load as compared to specimen tested at lower temperature. It means that the material becomes softer as it is subjected to higher and higher temperatures.

Stress – strain curves are different for different materials and at different temperatures for the same materials.



Stress – Strain curves at different Temperatures

8. What is Allowable Stress ?

Answer :-

It is defined as ultimate tensile strength divided by factor of safety. The safety factor is obviously greater than 1. Design which ensure that the stress value anywhere in the structure is less than his allowable stress are considered safe as they do not allow the structure element to come anywhere close to the point where plastic instability leading to disruption or disintegration of element would set in.

9. What is the value of allowable stress if yield stress or 0.2% proof stress value is available at design temperature ?

Answer :-

If the yield stress or 0.2% proof stress value is available at design temperature, the same shall be divided by a safety factor of 1.5 to get allowable stress.

10. What is the value of allowable stress if the yield stress is not available at design temperature but is available at room temperature?

Answer :-

If the yield stress in not available at design temperature but is available at room temperature, the same shall be divided by safety factor of 3.0 to get allowable stress.

11. What is the value of allowable stress if the stress value for rupture due to static fatigue or creep failure is available at design temperature ?

Answer :-

If the stress value for rupture due to static fatigue or creep failure is available at design temperature, the same shall be divided by safety factor or 1.5 to get allowable stress.

12.. How much design temperature shall be considered for the structural parts which are heated by steam, thermic fluid etc ?

Answer :-

Design temperature shall be the highest expected temperature of the heating media or highest expected body part temperature plus 10^0C. Here 10^0C is the safety margin .

13. What shall be the safety margin (temperature related) considered for fired vessel parts which are shielded (by Refractory) and the parts which are unshielded?

Answer :-

Safety margin for shielded parts	:	20^0C
Safety margin for unshielded parts	:	50^0C

Note : The above safety margins are just guidelines. What should be the safety margin would depends upon the severity of operation

14. Define Proof Stress ?

Answer :-

It is also called 0.2% proof stress. It is stress for 0.2% strain. In simpler terms, It is the stress value for strain value of 0.002 on the stress strain curve.

15. How the proof stress in a material is altered (increased marginally) ?

Answer:-

Consider a stress strain curve as shown above. Let a fresh specimen be subjected to gradually increasing tensile loads. A 0.2% proof stress can be marked on the curve as the stress value corresponding to point C on the curve. Let the curve. Let the load be increased beyond this point up to point D on the curve. The specimen has surely passed the ealastic range and crossed over to plastic deformation. On withdrawal of the load, the specimen would return back to point E with a residual permanent strain as shown above. Tensile load test can now be conducted on this specimen which has seen plastic deformation or cold work previously. The specimen would now follow a stress- strain curve with strain zero at point E. Along this stress strain curve (EGF),0.2% proof stress corresponds to point G which is higher than the proof stress for the fresh specimen.

The material in the above case seems to have hardened with its experience of stress earlier. Most material shows this marginal increase in their proof stress due to cold work.

16. What are the types of failures encountered in piping?

Answer :-

1. Catastrophic Failure. 2. Fatigue Failure.

17. Define catastrophic failure?

Answer :-
The failures which occurs suddenly as soon as the load crosses the threshold (Ultimate tensile strength). These failures take place on the first occurrence of the loads in excess of yield stress.

18. What is fatigue failure?

Answer :
The failure which occurs due to damaging of the grain structure of the specimen subjected to prolonged application of sustained load and or tensile- compressive load cycle.

18. What are the type of fatigue failure?

Answer :-
Type of fatigue failure are :-

A. Static Fatigue.
B. Cyclic Fatigue.

19. What is Static Fatigue ?

Answer :-
The specimen which fails under sustained load subjected to considerable length of time. The total time for which the load was applied id important. Whether it is applied continuously or in installments is not important.

20. What is cyclic fatigue ?

Answer :-
The specimen which fails under a load cycle subjected to considerable number of times. The total numbers of cycles for which the load was applied is important. Whether the cycle was frequent or infrequent is not important.

21. Explain the failure of the specimen subjected to cycle load ?

Answer :-
Consider a specimen subjected to a tensile load increasing from zero to X and then this load is gradually withdrawn till it a is zero . Now compressive load applied gradually till it is X and then it is drawn till the load zero. This comprises a cycle and is repeated again and again. With each cycle, the grain in the material get displaced relative to each other and get more and more interlocked. With each cycle, the material loses its ductility in small increments. A time comes when the grain are so badly interlocked that they cannot allow deformation to withstand load and small crack develops. The crack grows with further cycle and failure occurs.

22. What is creep failure?

Answer:-
Occurrence of static fatigue failure when the material is under prolonged sustained load coupled with high temperature is called creep failure.

23. Write the sequence of stress values at failure for solid rod, sphere and cylinders?

Answer:-

A typical sequence of stress values at failure for solid rods and two most important shapes in process industry namely, sphere and cylinder is Rod > Sphere > Cylinder.

Questions Related to Pipe under stress:-

1. What are Primary toads? Mention some of Primary Loads?

Answer:-

These are typically steady or sustained types of loads. These loads have their origin in some force acting on the pipe causing tension, compression, torsion etc leading to normal and shear stress. Primary loads are not self liming. Some of the primary loads are as:-

A. Internal fluid pressure
B. External Pressure.
C. Gravitational forces acting on the pipe such as weight of the pipe& fluid.
D. Forces due to relief or blow down.
E. Pressure waves generated due to water hammer effects.

2. What do you mean by self limiting?

Answer:-

In means that the stresses continue to exist as long the load persists and deformation does not stop because the system has deformed info a no – stress condition but because strain hardening has come into the play.

3. What are secondary loads? Mention some of the secondary loads?

Answer:

Secondary loads are caused by displacement of some kind. Some of the secondary loads are as:-

A. Force on piping due to tank settlement.
B. Vessel nozzle moving up due to expansion of vessel.
C. Pipe expansion or contraction.
D. Vibration due to rotational equipment.

4. What is the most used choice of co – ordinate system for defining the stress?

Answer :

In a pipe subjected to internal pressure or any other land, the most used choice of co-ordinate system is as:

A. Axial or Longitudinal direction.
B. Circumferential or Hoope's direction.
C. Radial direction.

The stresses in the pipe wall are expressed as axial (S_l), Hoope's (S_H) and (S_R). These stresses which stretch or compress a grain/ crystal are called normal stress because they are normal to the surface of the crystal.

5. What do you mean by Hoop Stresses and how do you calculate it?

Answer:-

Stresses which are generated circumferentially due to the action of internal pressure of pipe are called Hoop Stress. It is calculated by:-

Hoop Stress (S_h)	=	Pd_o / 2t
Where P	=	Force Acting from inside.
d_o	=	OD of Pipe.
t	=	Pipe Thickness

6. How does Hoop Stress affect the system?

Answer:

As per membrane theory for pressure design of cylinders., as long as hoop stress is less tan vield stress of Moc, the design is safe. Hoop stress induced by thermal pressure is twice the axial stress (SL). This is widely used for pressure thickness calculation for pressure vessel.

PIPING DESIGN QUESTIONAIRE

Simple

1. What is the ASME code followed for design of piping systems in Process pipings (Refineries & Chemical Industries)?

(i) B31.1
(ii) B31.3
(iii) B31.5
(iv) B31.9

Answer (III)

2. What do you mean by following items?

i) ISLB-400 ii) ISMB-600 iii) ISHB-350 iv) ISMC-300 v) ISJB-150 vi) ISLB-200 vii) ISMB-450 viii) ISWB-400 ix) ISJC-200 x) ISLC-350 xii) ISMC-250

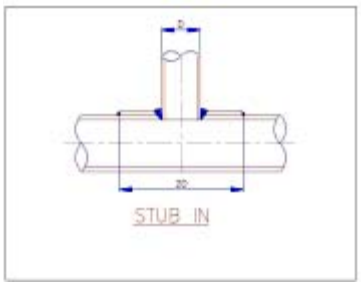
Answer:

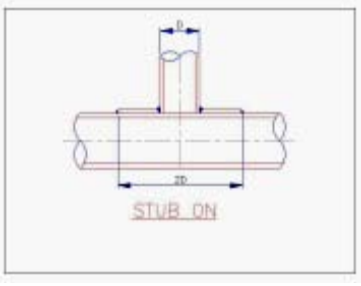
i. Indian STD light weight beam, Web size – 400
ii. Indian STD medium weight beam, Web size – 600
iii. Indian STD 'H' beam, Web size – 350
iv. Indian STD medium weight channel, Web size –300
v. Indian STD junior beam, Web size – 150
vi. Indian STD light weight beam, Web size – 200
vii. Indian STD medium weight beam, Web size – 450

viii. Indian STD wide flange beam, Web size – 400
ix. Indian STD junior channel, Web size – 200
x. Indian STD light weight channel, Web size – 350
xi. Indian STD medium weight channel, Web size – 250

3. What is this item?
i) ISA-100X100X12 ii) ISA-80X50X10 iii) ISLT-100X100
Answer:
i. Equal angle size 100x12 THK
ii. Unequal angle size 80x50x10 THK
iii. Indian STD light weight tee bar size 100x100

4. What is the difference between stub in and stub on branches? Describe with sketch. Which one is preferred?





For branching of one size lesser of run pipe, Stub On is preferred. For other branching less than one size of run pipe stub in is preferred. The Design is based on ANSI B 31.3

5. What is the difference between Pipe and Tube?
Ans: Pipe is identified by NB and thickness is defined by Schedule whereas Tube is identified by OD.

6. From which size onwards NB of pipe is equal to OD of Pipe?
Ans: From the size 14" and onwards NB = OD of pipe.

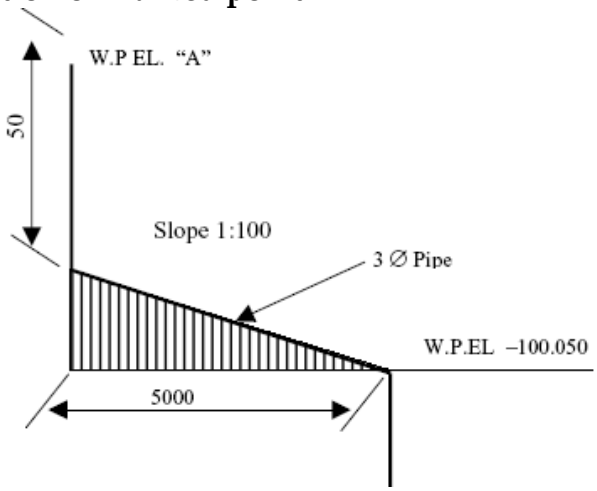
7. Write down the outside diameter of following pipe?
i) 3 inch ii) 6 inch iii) 10 inch iv) 14 inch
Answer:
i. 3 inch = 88.9mm ii) 6 inch = 168.28mm
iii) 10 inch = 273.06mm iv) 14 inch = 355 mm(OD= Size X 25.4)

8. What is the difference between machine bolt and stud bolt?
Answer:
Machine bolt has a head on one side and nut on other side but stud bolt have nuts on both sides.

9. What is soluble dam?
Answer:
Soluble dam is a water-soluble material used for restricting the purging gas within the pipe.
10. While welding of pipe trunion to pipe/reinforcement pad you have to put a hole or leave some portion of welding why?
Answer:
For venting of hot gas which may get generated due to welding

11. What do you mean by following type of welding
i. SMAW ii)TIG
Answer:
ii. SMAW = SHIELDED METAL ARC WELDING
iii. TIG = TUNGSTEN INTER GAS WELDING

12. Find out the elevation of marked point 'A'



Answer:
Elevation of marked point 'A' is 100.050

13. What should be the radius of long radius elbow?
Answer:
1.5D (Where "D" is the diameter of the pipe)

14. Normally where do we use the following?
i. Eccentric reducers ii)Concentric reducers
Answer:
i. Eccentric reducers = Pump suction to avoid Cavitation, To maintain elevation (BOP) in rack.
ii. Concentric reducers = Pump discharge, vertical pipeline etc.

15.Concentric reducer is used in pump suction. (Yes / No). Explain.

Answer:
No. Air pockets may form if concentric reducer is used at pump suction, which results in Cavitation, and cause damage to Pump. To avoid this problem, Eccentric Reducer with Flat Side Up (FSU)is used in Pump Suction.

16. What do you mean by Cavitation in Pump?
A pump is designed to handle liquid, not vapour. Vapour forms if the pressure in the pump falls below the liquid's vapour pressure . The vapour pressure occurs right at the impeller inlet where a sharp pressure drop occurs. The impeller rapidly builds up the pressure which collapses vapour bubbles causing cavitation and damage . This is avoided by maintaining sufficient NPSH.

(Cavitation implies cavities or holes in the fluid we are pumping. These holes can also be described as bubbles, so cavitation is really about the formation of bubbles and their collapse. Bubbles form when ever liquid boils. It can be avoided by providing sufficient NPSH.)

17. What do you mean by NPSH? How do you calculate it?
NPSH: Net Positive Suction Head. NPSH is the pressure available at the pump suction after vapour pressure is substarcted.
It is calculated as : Static head + surface pressure head - the vapor pressure of your product - the friction losses in the piping, valves and fittings.
It thus reflects the amount of head loss that the pump can sustain internally before vapour pressure is reached.

18. What is the ASTM code for the following?
i) CS pipe ii) CS fittings iii) CS flanges iv) AS pipe P5/P11 v) Cast CS Valves
Answer:
i. CS pipe = A106 Gr.B
ii. CS fittings = A234 Gr.WPB/WPBW
iii. CS flanges = A105
iv. AS pipe = A335 Gr P1/P11
v. Cast CS Valves = A216 Gr.WCB

19. What is the thumb rule to calculate spanner size for given bolt?
Answer:
1.5 x diameter of Bolt

20. What is the thumb rule to calculate Current required for Welding?
Answer:
Current (Amp) = [Diameter of Electrode (mm) X 40] + 20

21. What is steam tracing? How do we decide the location of SSM & CRM.
Answer:
Steam Tracing is a process which is used to prevent the fluid passing through a process line from freezing by keeping the temperature high enough for free flow of fluid and thus maintaining pumpability.

SSM and CRM are generally located 38M max for open system and 24 M max for closed system when we use LP Steam up to 3.5 kg/sq cm. as a heating media.

22. Which piping items will you drop down before conducting Flushing and Hydrotest?
Ans: Items like Control Valve, Orifice plates, Rotameters, safety valves , Thermowells are dropped or replaced with temporary spools before hydro test.

23. ***Why do we provide a Dampner in the Piping of Reciprocating Pump?***
Ans: To take care of Pulsation.

24.Why do we provide Full Bore Valve in connecting pipeline of Launcher /Receiver?
Ans: For Pigging.

25. Which parameters will u check during checking Piping Isometrics?
Ans: Bill of Material, Pipe Routing wrt GAD, Supporting arrangement , details of insulation, hydrotest pressure, painting specs and provision of Vent and Drains at appropriate locations.

26. What is the ANSI/ASME dimensional standard for steel flanges & fittings?
(i) B16.3
(ii) B16.5
(iii) B16.9
(iv) B16.10
Answer : (II)

27. How can flanges be classified based on facing?
a. Flat Face b. Raised Face c. Tongue and groove d. Ring type joint

28. What do you mean by AARH (Flange Finish)?
Ans: Arithmetic Average Roughness Height.

29. Which are the different types of Gaskets?
Ans: Full Face, Spiral Wound, Octagonal Ring Type, Metal Jacketed and Inside Bolt Circle.

30. What should be the relative hardness between the RTJ gasket and flange groove
Ans: For a RTJ flange , the joint ring should have a 30-40 Vickers hardness less than that of the mating face of flange.(Brinnel hardness for RTJ groove shall be 20-50 BHN more than the corresponding gasket hardness)

31. From which side of pipe will you take a branch connection?
Ans: When Fluid is Gas, Air or Steam and Cryogenic Service – Topside.

When Fluid is Liquid – Bottom Side.

32. Why don't we take a branch for Cryogenic Service from bottom side though the fluid is in liquid state?
Ans: There is the chance of Ice formation during normal operation and since ice flows from the bottom of the pipe it will block the branch pipe connection.

33. Why do we provide Drip Leg in Steam Line?
Ans: To remove Condensate when there is a rise in the pipe along the flow direction. If we do not provide the drip leg in steam line, the condensate which forms inside the pipe will result in Water Hammer effect causing damage to piping system.

34. How do you support any small size HDPE/PVC (Plastic) pipe?
Ans: It should be supported continuously by using channel or Angle so that line should not Sag or fall from the sleeper/rack due to uneven expansion because of Hot Temp.
35. Why do we provide High Point Vent (HPV) and Low Point Drain (LPD) in piping?
Ans: HPV – for removing Air during Hydro-test.
LPD – for draining water after conducting Hydro-test.

36. Which standard and codes will you refer while designing the piping?
Ans: Following are the codes and standards –

- ASME SEC I : Rules for construction of Power Boilers.
- ASME SEC VIII : Rules for construction of Pressure Vessels.
- ASME B 31.1 : Power Piping
- ASME B 31.3 : Process Piping
- ASME B 31.4 : Pipeline Transportation system for liquid hydrocarbon and other liquids.
- API RP 520 : Sizing selection and installation of Pressure Relieving Devices in refineries
- API Std 610 : Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Services.
- ANSI/NEMA SM 23 : Steam Turbines for Mechanical Drive Services.
- API Std 617 : Centrifugal Compressor for Petroleum, Chemical and Gas Industry Service.
- EJMA : Expansion Joints Manufacturer's Association.
- OISD – 118 : Layout for Oil and Gas Installations.
- IBR : Indian Boiler Regulations.
- NACE MR–0175 : Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment.
- NACE MR – 0284 : Evaluation of Pipeline and Pressure Vessel Steel for Resistance to Hydrogen Induced Cracking.
- NACE TM – 0177 : Laboratory Testing of Metals for Resistance to Sulfide Stress

Cracking in H2S Environment.

37. What do you mean by IBR and Which lines comes under IBR purview?
Ans: IBR: Indian Boiler Regulation Act.
Steam lines with conditions listed bellow comes under IBR purview –
• Lines for which design pressure is 3.5 kg/sq cm and above.
• Line size above 10" having design pressure 1.0 kg/sq cm and above.
• Boiler feed water lines to steam generator, condensate lines to steam generator and flash drum.

38. What are Weldolet and Sockolet? And where they are used?
Ans: Weldolet and Sockolet are basically self reinforced fittings.
Weldolet is used for Butt weld branch connection where standard tee is not available due to size restrictions and the piping is of critical / high pressure service. Sockolet is used for socket welding branch connection, which require reinforcing pad.

39. What is the MOC for Superheated high pressure Steam Lines?
Ans: A 335 Gr P I / P II
Composition : 0.5 Mo(P1) /1.25 % Cr-.5 Mo(P11)

40. What is the normal upstream and downstream straight length of orifice flow meter?
Answer : Upstream - 15D Downstream - 5D

41. What are the essential data required for the preparation of equipment layout?
Ans : 1)PFD and P&ID 2. Project Design data 3. Equipment Sizes & Buildings

42. What are the various statutory requirements to be considered during layout?
State Industrial Development Corporation (SIDC)
Central / State Enviromental Pollution Control Boards (PCBS)
Factory Inspectorate
State Electricity Boards
Chief Controller of Explosives (CCOE)
Static & Pressure Vessel Rules (SMPV)
Tariff Advisory Committee
Aviation Laws
Chief Inspector of Boilers (CIB)
Oil Industry Directorate (OISD)
Food and Drug Administartion (FDA)
Ministry of Environment and Forest (MoEF)

43. What do you mean by Composite Flange?
The flange that is made up of more than one MOC is called a Composite flange.

a. Lap Joint Flanges
Insert Flanges are a specialty in the arena of pipe size flanges and consist of two parts - the insert and the flange ring. The flange ring is the outer part of the insert flange assembly, containing the bolt holes.

The two piece construction of the insert flange also offers the economy of matching the insert material to the process pipe (usually some corrosion resistant alloy) while the outer flange ring may be manufactured from steel. When the environment requires the flange ring to be made of some alloy the rotating feature is still maintained.

b. RF flanges with Raised of one MOC and rest of the flange with different MOC

c. RF blind flange with an overlay of 90/10 Cuni for Sea water service.

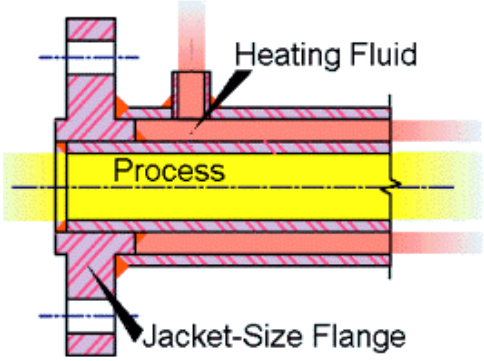
44. What do you mean by Insulated Joint?

Ans: Insulating Joints are a prefabricated, non separable union used to isolate specific sections of Pipelines to prevent corrosion caused by stray electrical currents or interference from other pipelines and power transmission cables.

45. What are Insulating Gasket Kits?
Ans: Insulation gasket kits are designed to combat the effects of corrosion often found in flanged pipe systems. Galvanic corrosion between dissimilar metal flanges (flow of currents) , flange insulation associated with cathodic protection of underground piping are also the places where Insulating gasket kits are used. It consists of

Gasket	Neoprene faced Phenolic /Glass Reinforced Epoxy (G10)
Insulation sleeve	Reinforced Phenolic/Nylon/Polyethylene/(G10)
Insulation washer	Reinforced Phenolic/Nylon/Polyethylene/(G10)
Plated Washer	Electro plated steel washer

46. What do you mean by Jacketed Piping?
Ans:



Piping which is recognized as providing the most uniform application of heat to the process, as well as maintaining the most uniform processing temperatures where steam tracing is not capable of maintaining the temperature of fluid constant. Usually used for

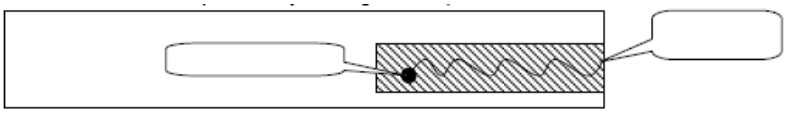
molten sulphur, Polymers service.

47. What is the min. distance to be maintained between two welds in a pipe
The rule of thumb is that the minimum distance between adjacent butt welds is 1D. If not, it is never closer than 1-1/2". This is supposedly to prevent the overlap of HAZ s. Minimum spacing of circumferential welds between centrelines shall not be less than 4 times the pipe wall thickness or 25 mm whichever is greater.

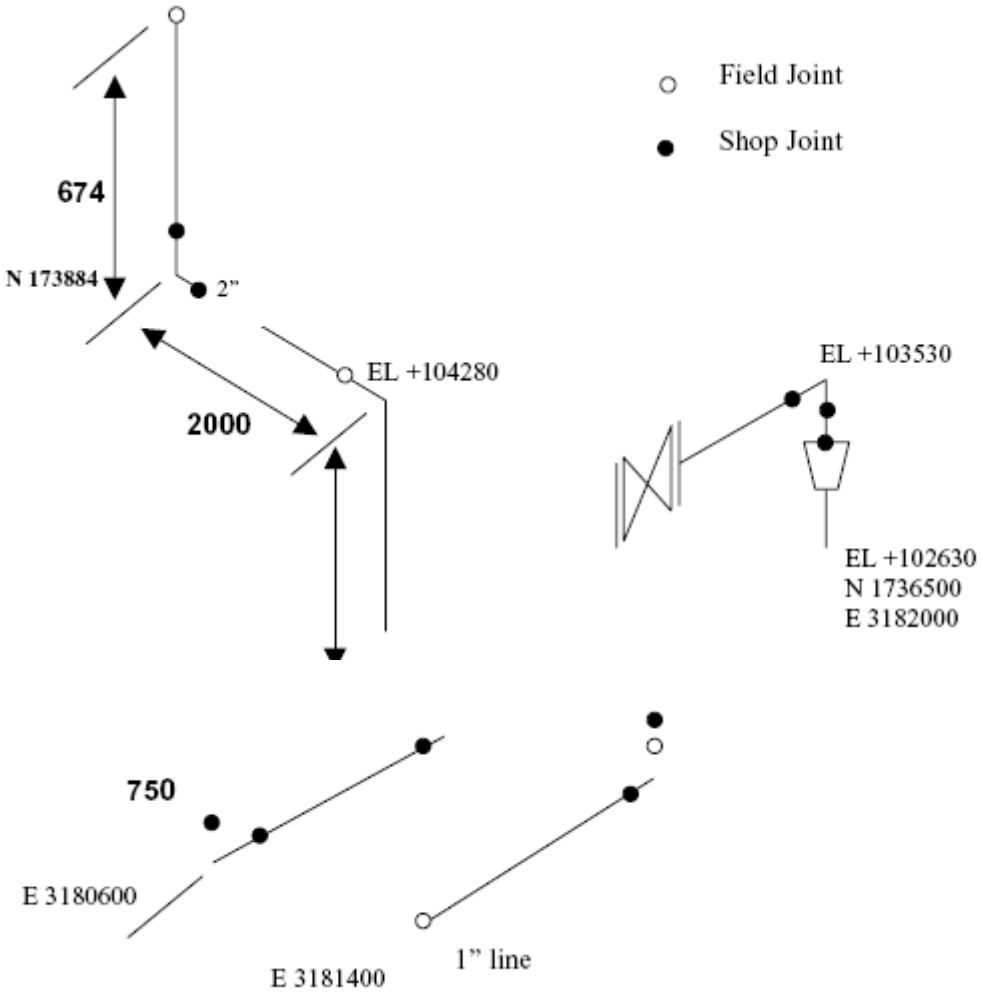
48. What are the different hardness tests carried out?
Ans:
Brinell Hardness Test
Rockwell Hardness test
Vicker Hardness Test

49. What is the relation between Brinell Hardness No and Rockwell Hardness No?
Ans:
22 HRC (Rockwell Hardness) = 238 BHN (Brinell Hardness No)
Harder

1.During fabrication you observed that one small crack has appeared on a fresh plate, what type of measure you will take to obtain desired quality with minimum wastage?
Answer:
First identify the exact length of crack by DP test. Drill on the end point to resist further crack. Remove the crack portion by cutting the strip.



2. ISOMETRIC :-
i. What are the fittings required for fabrication of the isometric.
ii. Find out the length of pipe required.
iii. Do joint numbering and show the following things in the isometric.
a) Shop joint
b) Field joint
c) Spool no



Answer:

- 2 INCH ELBOW – 4NOS
- 2 INCH WNRF FLANGE – 2NOS
- 2 INCH GATE VALVE – 1NO
- 2 x 1 INCH CONC. REDUCER – 1NO
- 1 INCH ELBOW 90 DEG – 1 NO
- 2 INCH PIPE - 4.210 MTRS
- 1 INCH PIPE – 1.424 MTRS

3. Describe different types of destructive and non-destructive tests?
Answer:
DESTRUCTIVE TEST: Bend test, Tensile test, Impact test, and Hardness test.
NON-DESTRUCTIVE TEST: DPT, MPT, Radiography and ultrasonic test

4. What is mean by 'PWHT'? Why it is required?
Answer:
"POST WELD HEAT TREATMENT" This is done to remove residual stress left in the joint which may cause brittle fracture.

5. What is the minimum thickness of pipe that requires stress relieving to be done as per B31.3?
Ans: 19 mm thk.

6. What is the difference between Thermostatic and Thermodynamic Steam Trap?
Ans: Thermostatic Trap is actuated by Temp differential and is economic at steam pressure less than 6 PSI. It is operated by the movement of liquid filled bellows or by bimetal element which may get damaged by Water Hammer.
Thermodynamic traps are most suited to applications where the pressure downstream of trap is always less than about ½ the upstream pressure. These are suitable for pressure higher than 8 PSI. Water hammer doesn't affect it.

7. What is the Code for Sour Service?
Ans: Code for Sour Service is NACE (NACE MR – 0175)
NACE: National Association of Corrosion Engineers.

8. How much should be the pressure for Hydro-Test?
Ans: Hydrotest pressure should be calculated as follow excecpt as provided against point no-4.
1. 1.5 Times of Design Pressure.
E 3180600
E 3181400
1" line
2. For a design temperature above the test temperature, minimum test pressure can be calculated as:
Pt = (1.5 X P X St) / S

Where:-

Pt: Minimum Test Pressure.
P : Internal design pressure.
St: Allowable stress at test temperature.
S : Allowable stress as design temperature.
(see SE in table A-1 or S in table B-1/2/3).

3. If a test pressure as per above would produce a stress in excess of the yield strength at test temp. the test pressure may be reduced to maximum pressure that will not exceed the yield strength at test temp.
4. If the test pressure of piping exceeds the vessel pressure and it is not considered practicable to isolate piping from vessel, the piping and vessel may be tested together at test pressure of the vessel when approved by owner and provided the test pressure for vessel is not less than 115% of piping design pressure adjusted for temperature as per point no 2.

9. How do you calculate the pipe spacing?
Ans: Pipe Spacing (mm) = (Do + Dt) / 2 + 25mm + Thickness of Insulation (mm).

Where: D0 : OD of Small size Pipe (mm).
Dt : OD of Flange of Large size Pipe (mm).

10. How do you calculate the width of Pipe rack?
Ans: W = (f X n X s) + A + B.
Where: s=
f : Safety Factor
= 1.5 if pipes are counted from PFD.
= 1.2 if pipes are counted from P&Id.
n : number of lines in the densest area up to size 450 NB
= 300 mm (estimated average spacing)
= 225 mm (if lines are smaller than 250 NB)
A : Additional Width for –
Lines larger than 450 NB.
For instrument cable tray / duct.
For Electrical cable tray.
s : 300 mm (estimated average spacing)
: 225 mm (if lines are smaller than 250 NB)
B : future provision
= 20% of (f X n X s) + A

11. Which fluid is used in Heat Exchanger in shell side and tube side?
Ans: Generally corrosive fluid is used from the tube side (as tube can be easily replaced) and cleaner fluid is used from shell side. Sometimes Hot fluid is also used from the shell side.

12. What is Reynold's number and what is the value of Reynold's number upto which the flow is laminar?
Ans: It's a dimensionless number to classify the nature of flow.
Re= ™vd/™
Where: Re : Raynold's no.
□□□ss Density of fluid.
d : diameter of Pipe.
V : average velocity of fluid.
□□Viscocity of fluid.

Flow is laminar upto Re=2100

13. What are Glandless Piston Valves. Where these are used?
Ans: Glandless piston valves are maintenance free valves used in the steam service.

14. How do you carry out Estimation?
Ans:
1. Input from Bid:-
- & Id, Line list, Temperature, Pressure.
- Overall Plant Layout and Piping corridor plan.
- cope of work and the Specifications for the Job.
- Specifications for materials like PMS and VMS.

2. Value Addition:-
- Items like Valves, Flanges, Speciality items, Reducers can be estimated from P & Id.
- Length of Pipes, Elbows, Width of Pipe Rack can be estimated by referring P& Id and Overall Plot Plan.
- No of Tires (on rack) can be estimated by referring the spacing required for pipes and also the space available.
- MTO for Steam Traps, Valves (for Vent and drain) can be calculated by using Thumb Rules.

3. Loads:-
- Hydro Test Loads: Can be estimated by assuming all the Pipes (on a grid) empty except some bigger size lines filled with Water.
- Actual Operating Loads: Gas lines to be considered as empty and rest of the lines to be considered as filled with the Fluid (which they are suppose to carry in operating condition).

The loads which ever is higher from above two cases should be referred for structural loading.

Stress

1. What is the objective of stress analysis?
Answer :
1. To ensure that the stresses in piping components in the system are within allowable limits
2. To solve dynamic problems developed due to mechanical vibration, fluid hammer, pulsation, relief valves, etc
3. To solve problems associated due to higher or lower operating temperature such as a) Displacement stress range b) Nozzle loading on connected equipments c) Pipe displacements d) Loads & moments on supporting structure.

2. What are the steps involved in stress analysis (or any stress package carries out)?
Answer :
1. Identify the potential loads that the piping system would encounter during the life of the plant
2. Relate each of these loads to the stresses and strains developed

3. Get the cumulative effect of the potential loads in the system
4. Decide the allowable limits the system can withstand without failure as per code
5. After the system is designed to ensure that the stresses are within safe limits

3. What are the different types of stresses that may get generated within pipe during normal operation?
Ans: Axial Stresses (Tensile / Compressive), Shear Stresses, Radial Stresses, Hoopes Stresses.
4. How are the loads classified in stress analysis package?
Ans : a. Sustained Loads 2. Occasional Loads 3. Displacement Loads (Self limiting stresses due to thermal effects)
What are the Inputs for stress analysis of a piping system
i) Pipe Size ii) Fluid Temperature iii) Pipe Material
iv) Design pressure v) Insulation Thickness
vi) Specific gravity vii) Friction coeff. viii) Model

5. What are the sources of sustained loads generated in piping system?
Ans :- a. Pressure b. Dead weight of Pipe and attachments
Sustained load is calculated as
Weight of Pipe with Fluid + Pressure load + Load due to springs

W+P1

6. How do you calculate the operating load?

W+P1+T1

T1 – Load due to thermal expansion

7. Give some Examples for occasional Loads.
Wind, wave & earthquake

8. Mention some of Primary Loads (Have their origin in force)
Dead Weight, Pressure, forces due to relief or blowdown, force due to water hammer Effects

9. Mention some of secondary Loads (Have origin in displacement)
Force on piping due to tank settlement
Vessel nozzle moving up due to expansion of vessel
Pipe expansion or contraction
Vibration due to rotational equipments

10. What is the failure theory subscribed under ASME B31.3?
(i) Maximum principal stress theory (Rankines Theory)
(ii) Maximum Shear Theory
(iii) Tresca Thory
Answer : (I)

11. What are the types of failures encountered in Piping?
Answer : 1. Catastrophic Failure 2. Fatigue Failure

12. Select the failure stress range for fatigue failure due to thermal expansion as per B31.3
(i) (1.6Sc+1.6Sh)f
(ii) 0.78 Sh
(iii) (1.25 Sc+0.25Sh)f
(iv) Sc+Sh

Answer : (III)
Sc and Sh –Basic Allowable material stress in cold & hot condtions respectively.
f ---- is the stress range reduction factor(1 for 7000 cycles

13. What is desired life cycle for Piping in operation?
Ans: Desired life cycle for Piping in operation is 20 Years (7000 Cycles).
The normal no. of cycles for which the displacement or thermal stresses are designed is
7000 cycles

14. How do you calculate the stress developed due to thermal expansion?
Stress developed = E x e/L
E – Young's Modulus
e- Increase in length due to thermal expansion
L – Original Length of the pipe

15. How do you calculate the thermal expansion in a pipe?
e= O x L x Rise in Temperature
O – Co.efficeint of expansion
L- Length of pipe

16. What do you mean by Stress Intensity Factor (SIF)? Give some examples.
Stress Intensity Factor (SIF) is the ratio of maximum stress intensity to normal stress. It is used as safe factor to account for the effect of localised stress on piping under respective loading. In piping it is applied to welds, fittings, branch connections etc where stress concentration and possible fatigue failure may occur.
Eg: SIF for Reducer and Weldneck Flange : 1.0

SIF for socket weld flange : 1.3

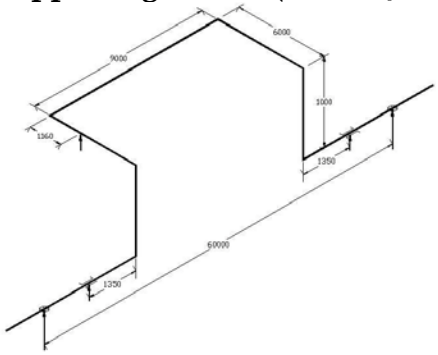
17. Which is the Criteria for Pipe Supporting?
Ans: Following are the points which should be taken into account for proper supporting
–
- Load of bare pipe + fluid + insulation (if any).
- Load of bare pipe + waterfill.
- Load of valves and online equipment and instrument.
- Thermal loads during operation.
- Steam out condition, if applicable.
- Wind loads for piping at higher elevation, if required.
- Forced vibration due to pulsating flow.

Bare pipe with size above 12″ shall be supported with Pad or Shoe

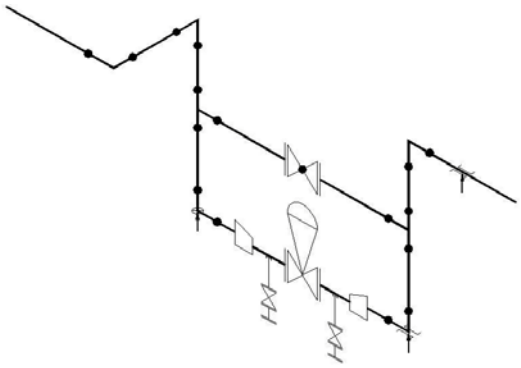
18. What is the basic span of supports for 2″/6″/10″/24″ pipe.
Answer:
Basic Span is 5.5m / 9m / 11.5m / 15m respectively.

19. How do we decide the anchor / cross guide and guide for offsite rack piping
Answer:
Anchor is provided to restrict all the axial and rotational movements of Pipe, whereas Cross Guide is provided to restrict displacements of Pipe along with the axis perpendicular to it's centreline and Guide is provided to restrict the longitudinal movements of pipes along with it's axis.

20. Define a typical 6D loop supporting details (Anchor/Guide)



21. Provision of anchor / cross guide for control valve.



22. What are the things to be taken care of while doing pump piping?
Answer:
Pipe strain may distort equipment alignment, so welding should be done in such a way that the tension in the equipment flange is minimised

23. What is the Steam out condition?
Ans: Hydrocarbon lines are usually subjected to Steam Out condition and designed and anlysed at low pressure steam design temperature (should be minimum 180 degree C) or design temp. whichever is more . Lines having negative design temp. is analysed for both conditions seperately.

24. Where do you provide Anchor and Slotted Support of Heat Exchanger?
Ans: Anchor support of Heat exchanger is provided on the side from which Tube Bundle will be pulled out for the purpose of Maintenance work also it is based on the growth of the connecting piping as exchanger should grow with the piping.

25. What do you mean by Hoop Stresses and how do you calculate it?
Ans: Stresses which are generated circumferancially due to the action of Internal pressure of pipe are called as Hoop Stress. It is calculated by
Hoop Stress (Sh) = Pdo / 4t

Where P = Force Acting from Inside.
Do = OD of Pipe.
t= Pipe Thickness.

26. How does Hoop Stress affect the system?
Ans: As per membrane theory for pressure design of cylinder, as long as hoop stress is less than yield stress of Moc, the design is safe. Hoop stress induced by thermal pressure is twice the axial stress (SL). This is widely used for pressure thickness calculation for pressure vessel.

27. What is the design standard followed for the calculation of allowable forces / Moments in nozzles of centrifugal compressor & Steam turbines nozzle?
For strain sensitive equipment piping to be routed and supported to limit nozzle loadings and moments in equipment within allowable limits furnished by respective vendors or in absence of vendor data API 560/610/615/621/661 & NEMA SM23. NEMA – SM 23 (Referred by API 617) is used for compressor & steam turbine nozzle.

28. What is the mill tolerence to be considered for the thickness of pipe during stress analysis as per ASME B31?
(i) 1%
(ii) 2.5%
(iii) 7.5%
(iv) 12.5%
Answer : iv

29. What is the purpose of providing Graphite Pads in supports below shoes?
Answer : To reduce the friction factor. The co-efficient of friction for Graphite Pads is 0.1

30. How is piping to Tank inlet nozzle is supported and why?
Ans: Piping to Tank Nozzle is supported with Spring type support (first support from Nozzle) in order to make the Nozzle safe from the loads which occurs due to the displacement of pipe (thermal expansion of pipe / tank material, tank settlement etc).

31. What are the two types of flexible spring hangers?
1. Constant Spring and 2. Variable Spring

32. What is the difference between Variable Spring Hanger and Constant Spring Hanger?
Ans: Variables use coiled springs to support a load and allow movement. The resistance of the coil to a load changes during compression, which is why these devices are called "variables". Constant Spring Hanger provides constant support force for pipes and equipment subjected to vertical movement due to thermal expansion at locations where maintaining a constant stress is critical. This constant resistance is achieved by having two moment arms pivoted about a common point. The load is suspended from one of these arms, and a spring is attached to the other. With an appropriate choice of moment arms and spring properties, a resisting force can be provided that is nearly independent of position.

Constant support hangers are principally used to support pipes and equipment subjected to vertical movement due to thermal expansion at locations where transfer of stress to other supports or equipment can be critical. The maximum recommended variation according to MSS standard from the operating load is 25% for variable spring

hangers. If the variation exceeds 25%, a constant support hanger should be used. The constant resistance to a load is achieved by combining a spring coil with a cam which rotates about a main pivot point. The cam is designed such that the distances from the main pivot changes to compensate for the variable resistance during compression of the coil. The MSS standard provides for a tolerance of 6% in the constant load through the travel range. Constant support hangers are designed per MSS, ANSI, and ASME standards. The sizing of constants primarily depends on the total travel and load.

33. How much should be the difference between the load which will be taken by Variable Spring Hanger during Cold and Hot condition of Pipe?
Ans: It should be Maximum 25% of Load for which Spring is designed.

34. Differentiate between static load and dynamic load.
Ans: A piping system may respond far differently to a dynamic load than it would to a static
load of the same magnitude. Static loads are those which are applied slowly enough that the system has time to react and internally distribute the loads, thus remaining in equilibrium. In equilibrium, all forces and moments are resolved (i.e., the sum of the forces and moments are zero), and the pipe does not move.
With a dynamic load—a load which changes quickly with time—the piping system may not have time to internally distribute the loads, so forces and moments are not always resolved—resulting in unbalanced loads, and therefore pipe movement. Since the sum of forces and moments are not necessarily equal to zero, the internally induced loads can be different—either higher or lower—than the applied loads.

35. Give different types of dynamic loads with example
Ans:
1. Random – Wind, Earthquake
2. Harmonic – Equipment Vibration, Pulsation, Acoustic Vibration
Impulse – Fluid Hammer, relief valve opening, slug flow
76. What is Dynamic Analysis and why it is used?
Ans: Dynamic analysis is performed for all two phase lines in order to ensure that the line supported is safe from vibrations loads which may occur during normal operation as well as in start up or any upset condition.(Diesel mixed with hydrogen in DHDT process)

36. What is WRC 107 / WRC 297?
Ans: Localised stresses at Nozzle to Shell is calculated by WRC 107 / 297 and these computed stress values shall be limited in accordance with ASME Sec VIII for Pressure Vessels.

37. How to get the Foundation Loads?
Ans: Foundation Loads for pipe rack should include the loads of Pipes, Cable Trays

and Instrumentation duct at that location and also the design load for future tier shall be full load of the most heavily loaded tier in addition to all other ind/seismic/fraction and piping thermal loads for future pipes.

Load of pipes filled with water(Largest of 1st case – During hydrotesting dead Weight (wt/m X piperack spacing) of pipes + 2 –3 maximum size pipes filled with water
2nd case – Actual commissioned condition except the gas lines) + Proportionate wt of extra space required by client (normal 30%) + Load of 1 heavily loaded tier + Electrical cables + Instrument duct + Guide load for 50% of lines

Guide Load = 0.3X(Dead wt of pipes at including water)
The maximum induced thermal loads on the Anchor at the battery limit shall be limited to
F in kg <= 150 X NB of pipe in inches (It should be <2 tonnes)
M in Kgm <=75 X NB of pipe in inches.

Horizontal Load = 0.3 X (Dead wt of pipes including water)
This load is used for designing of foundation bolts.

Foundation loads for any vessel having agitator mounted on top should contain weight of tank at operating or design condition (whichever is more) plus 20% of it for dynamic loading.

38. What is the maximum expansion absorbed in loops in normal design?
Ans:10 Inches

39. What is the limiting factor in deciding the length of the spool in Jacketed piping?
Ans: Force exerted by dissimilar expansion of inner pipe = Force exerted by dissimilar expansion of jacket pipe
The stress developed due to this should be within limits as per ANSI B31.3
(Also fabrication constraints)

40. What is the factor to be checked concerning the expansion of header attached to air cooler piping?
Ans: Vendor drawing to be checked to see how much movement is permitted to compensate line expansion. To accommodate the diff. Expansion between inlet and outlet (The inlet temperature >The outlet temperature) offset can be built in to outlet piping to compensate for diff.expansion.
Since the tubes are of floating design the nozzle flange is of 150# and loads transferred are to be kept minimum.
Since the tubes are of floating design, the nozzle flange is 150#. Load of the nozzle to be kept minimum.

41. What is the maximum no. of cell nozzles connected to a single header of air cooler piping header in normal practice?
Ans: Six nos.

42. What is fluid hammer and how it is generated?
Ans: When the flow of fluid through a system is suddenly halted at one point, through valve closure or a pump trip, the fluid in the remainder of the system cannot be stopped instantaneously as well. As fluid continues to flow into the area of stoppage (upstream of the valve or pump), the fluid compresses, causing a high pressure situation at that point. Likewise, on the other side of the restriction, the fluid moves away from the stoppage point, creating a low pressure (vacuum) situation at that location. Fluid at the next elbow or closure along the pipeline is still at the original operating pressure, resulting in an unbalanced pressure force acting on the valve seat or the elbow.

The fluid continues to flow, compressing (or decompressing) fluid further away from the point of flow stoppage, thus causing the leading edge of the pressure pulse to move through the line. As the pulse moves past the first elbow, the pressure is now equalized at each end of the pipe run, leading to a balanced (i.e., zero) pressure load on the first pipe leg. However the unbalanced pressure, by passing the elbow, has now shifted to the second leg. The unbalanced pressure load will continue to rise and fall in sequential legs as the pressure pulse travels back to the source (or forward to the sink). The ramp up time of the profile roughly coincides with the elapsed time from full flow to low flow, such as the closing time of the valve or trip time of the pump. Since the leading edge of the pressure pulse is not expected to change as the pulse travels through the system, the ramp down time is the same. The duration of the load from initiation through the beginning of the down ramp is equal to the time required for the pressure pulse to travel the length of the pipe leg.

43. What is the purpose of expansion bellows?
Ans: Expansion bellows are used absorb axial compression or extension, lateral shear or angular torsion developed in the pipes (specially near nozzles)

44. You have to connect a 20" pipe to a manhole of existing tank , how will you go about in carrying out the suitability of the manhole flange.

45. What should be the material of shoes for supporting AS pipes & why?
Ans: If CS shoes are used Pad in contact with the pipe to be of Alloy steel to avoid dissimilar welding at pipe. To avoid alloy steel welding and dissimilar welding fabricated clamps either of CS or SS can be used.

46. What is the allowable stress range for CS pipes.
Ans: 2070 kg/cm2
47. What are sway braces?

Ans: Sway Braces are essentially a double-acting spring, housed in a canister. Unlike variable effort supports, Sway Braces are not intended to carry the weight of pipework; their purpose is to limit undesirable movement. Sway Braces act like a rigid strut until a small preload is reached, whereafter the restraining force increases in proportion to the applied deflection. *Fig. 1*
Undesirable movement can occur due to many phenomena, such as wind loading, sympathetic vibration, rapid valve closure, relief valves opening, two phase flow or earthquake. It may be necessary to limit this type of deflection to prevent the generation of unacceptable stresses and equipment loadings.
The Sway Brace is a cost-effective means of limiting pipework deflection. It should be noted however that it does provide some resistance to the thermal movement of the pipework and care should be taken when specifying to ensure that this is acceptable.
Installation of Sway Braces will have the effect of raising the fundamental frequency of vibration of a pipework system; this is likely to reduce undesirable deflections. Sway Braces are often used to solve unforeseen problems of resonant vibration. For situations where the resistance to thermal movement provided by Sway Braces is unacceptable, you are referred to Pipe Supports Limited's range of hydraulic snubbers and dampers.

48. Give a typical stress report including input and output and what is interpreted form the output.

49. For offshore structures what analysis is performed by Caesar.

50. In an offsite pipe rack change in direction during analysis it is found two adjacent pipes are having unequal expansion with the inner pipe having 50 cm thermal expansion. What can be done to eliminate collision during hot condition.
Ans: Use Cold Pull technique. Calculate the thermal expansion of the inside pipe, cut an equal length form the elbow joint and then reweld with a shorter length to take care of expansion in hot condition.

51. What are the Insulation material used for piping systems.
Ans:
1. Fibrous – Rock & Glass Wool
2. Rigid - Calcium silicate, Polyisocyanurate, cellular Glass