Chapter 2.3: Steam System

Part–I: Objective type Questions and Answers

1.	For industrial process heating, the best quality of steam is: a) dry saturated steam b) superheated steam c) wet steam d) high pressure steam
2.	What type of steam is generally used for power generation/application. a) high pressure steam with super heat b) dry saturated low pressure steam c) dry saturated steam with high pressure d) wet steam with very high pressure
3.	In indirect steam heating, ...heat is utilised for heating application. a) Sensible b) Latent c) Specific heat d) none of the above
4.	The normal velocities encountered in pipes for superheated steam is a) 50-70 m/sec b) 30-40 m/sec c) 20-25 m/sec d) 15-20 m/sec
5.	The normal velocities encountered in pipes for saturated steam is a) 60 to 80 m/sec b) 10-30 m/sec c) 5 to 10 m/sec d) 30 to 40 m/sec
6.	Which among the following steam traps has the principle of operation "Difference in temperature between steam and condensate" a) thermodynamic trap b) thermostatic trap c) orifice type trap d) float trap
7.	In industrial applications the type of trap used for main steam lines are a) thermodynamic b) thermostatic c) bimetallic d) float
8.	Velocity of steam in steam pipe is directly proportional to a) number of bends in pipe b) specific volume of steam c) length of pipe d) none of the above
9.	Steam is not desirable among the choice given below from process heating application point of view for drying application will be less if we heat with a) saturated steam b) dry steam c) superheated steam d) high pressure steam
10.	Which type of insulation is more economic or energy efficient for steam pipelines carrying saturated steam? a) glass wool b) ceramic fibre c) calcium silicate d) fibre bricks
11.	For flash steam calculation, flash steam quantity available depends upon ___ a) condensate pressure and flash steam pressure b) pressure of steam generated in boiler c) Steam enthalpy at atmospheric pressure d) Total heat of flash steam
12.	Superheat is the addition of heat to dry saturated steam without increase in pressure. State True or False

	False.
13.	Enthalpy of evaporation is also known as latent heat. True/false
14.	Match the steam traps to the application listed below: **Application** — **Suitable traps** 1. steam mains — a. Mechanical, bucket, float 2. Equipments – re-boiler, heater dryer, heat exchanger etc. — b. Bi-metallic 3. Tracer lines, instrumentation — c. Thermodynamics Ans. 1-c; 2-a; 3-b
15.	The equipment used to remove dirt from steam lines before steam trap is a) Vent b) Drain c) Strainer d) By pass line
16.	As a thumb of rule, in case of efficiency issues for boiler, for every 6 °C rise in feed water temperature, there will be approximately 1% saving of fuel. True/False
17.	Water hammer is common in a) water pipes b) condensate pipes c) steam pipes with steam and condensate d) main steam lines with good traps
18.	Mechanical steam traps works on the principle of a) Difference in density between steam and condensate b) Difference in thermodynamic properties between steam and condensate c) Difference in temperature between steam and condensate d) None of the above
19.	Proper sizing of steam pipeline helps in minimising a) steam requirement b) temperature drop c) Boiler efficiency d) pressure drop
20.	The problem of water hammer can be eliminated by positioning the pipes so that there is a continuous slope in the direction of flow. State True or False.

Part- II: Short type questions and answers

1.	Why dry saturated steam is preferred for heating applications? Dry steam does not contain moisture. The presence of moisture reduces the total heat in the steam. Hence dry saturated steam is preferred for process.
2.	Name the characteristics of steam which makes it most popular and useful to industries? The following characteristics of steam make it so popular and useful to the industry: • Highest specific heat and latent heat • Highest heat transfer coefficient • Easy to control and distribute

	• Cheap and inert
3.	State the principle of thermodynamic steam trap? Thermodynamic or disk traps are designed with a flat disk which moves between a cap and seat. On start-up, condensate flow raises the disk and opens the discharge port. When steam or very hot condensate arrives, it closes the disk, which stays closed as long as pressure is maintained above the disk. Heat radiates out through the cap, which diminishes the pressure over the disk, opening the trap to discharge condensate.
4.	Why drain points are required in a steam system? The drain points help in removing water in pipes due to condensation of steam. Drains should be so arranged that the condensate can easily flow into the trap.
5.	Explain why low pressure steam is more efficient? The low pressure steam has more latent heat compared with the high pressure steam. Indirect heating efficiency will be more for low pressure steam.
6.	What is water hammer in a steam system? A water hammer in a steam system is caused by condensate collection in the plant or pipe work picked up by the fast moving steam and carried along with it.
7.	Why steam condensate recovery is important? The condensate is very valuable not only because of its heat content but also because of its purity. It is already treated and any quantity of condensate recovered will also mean saving of treatment chemicals corresponding to that much of condensate.
8.	What are the parameters to be considered while sizing a flash vessel in a flash steam recovery system from steam condensate? a) Pressure of condensate b) Pressure to be maintained in the flash vessel c) Quantity of condensate per hour entering the flash tank
9.	Give any three functions of steam trap? a) To discharge condensate as soon as it is formed b) Not to allow steam to escape c) To be capable of discharging air and other incondensable gases
10.	What is the principle of working of Float type steam trap? Difference in density between steam and condensate
11.	What function a thermo compressor dust in a steam system? Thermo compressor is a device used to recover flash from the process and generate low pressure steam with the help of medium pressure steam.
12.	What is flash steam? Flash steam is produced when condensate at a high pressure is released to a lower pressure.
13.	What is sensible heat of a substance? The heat required to change the temperature of a substance is called its sensible heat.

14. Define latent Latent heat of **vaporisation of** fluid?

This quantity of heat required to change a fluid from the liquid to the gaseous state is called latent heat.

15. Name the three types of classifications of steam traps and also give their principle of operation?

The steam traps are classified as follows:

Group	Principle	Sub-group
Mechanical trap	Difference in density between steam and condensate.	Bucket type a) Open bucket b) Inverted bucket, with lever, without lever c) Float type d) Float with lever e) Free float
Thermodynamic trap	Difference in thermodynamic properties between steam and condensate	a) Disc type b) Orifice type
Thermostatic trap	Difference in temperature between steam and condensate	a) Bimetallic type b) Metal expansion type.

16. What are the two common causes of wet steam formation in a steam generation and distribution network?

The two most common causes of wet steam formation are:

- Generation of steam in a boiler without a super heater
- Effectiveness of lagging of steam distribution pipelines

The wetness in steam is removed by providing steam separators and steam trap at suitable locations.

17. What are the advantages of direct injection of steam for heating of liquid?

- The equipment required is relatively simple, cheap and easy to maintain
- No condensate recovery system is necessary
- The heating is quick, and the sensible heat in the steam is also used up along with the latent heat, making the system thermally efficient

18. What are the important precautions to be addressed while designing a flash vessel for flash steam recovery system?

- The diameter of the vessel should be such that a considerable drop in velocity allows the condensate to fall to the bottom of the vessel from where it is drained out by the steam trap
- Flash steam itself rises to leave the vessel at the top
- The height of the vessel should be sufficient enough to avoid water being carried over in the flash steam

19. What are the ways of reduction of steam usage?

- Reduction in operating hours
- Reduction in steam quantity required per hour
- Use of more efficient technology
- Minimizing wastage

20. Name the 4 most commonly used insulation material for steam pipes.

	• Cork • Glass wool • Rock wool • Asbestos

Part – III: Long type questions and answers

1.	Write in detail about "flash steam recovery" from steam condensate. Flash steam is produced when steam condensate at a high pressure is released to a lower pressure and can be used for low pressure heating. The higher the steam pressure and lower the flash steam pressure the greater the quantity of flash steam that can be generated. In many cases, flash steam from high pressure equipments is made use of directly on the low pressure equipments to reduce use of steam through pressure reducing valves. The flash steam quantity can be calculated by the following formula with the help of a steam table: Flash steam available % = $\frac{S_1 - S_2}{L_2}$ Where: S_1 is the sensible heat of higher pressure condensate. S_2 is the sensible heat of the steam at lower pressure (at which it has been flashed). L_2 is the latent heat of flash steam (at lower pressure). Flash steam can be used on low pressure applications like direct injection and can replace an equal quantity of live steam that would be otherwise required. The demand for flash steam should exceed its supply, so that there is no build up of pressure in the flash vessel and the consequent loss of steam through the safety valve. Generally, the simplest method of using flash steam is to flash from a machine/equipment at a higher pressure to a machine/equipment at a lower pressure, thereby augmenting steam supply to the low pressure equipment. In general, a flash system should run at the lowest possible pressure so that the maximum amount of flash is available and the backpressure on the high pressure systems is kept as low as possible. Flash steam from the condensate can be separated in equipment called the 'flash vessel'. The diameter of the vessel is such that a considerable drop in velocity allows the condensate to fall to the bottom of the vessel from where it is drained out by a steam trap preferably a float trap. Flash steam itself rises to leave the vessel at the top. The height of the vessel should be sufficient enough to avoid water being carried over in the flash steam.
2.	Enumerate on the methods of testing steam traps? There are two proven methods of testing of steam traps: - Sound method and Temperature method. **Sound Method** Mechanisms within steam traps and the flow of steam and condensate through steam traps generate sonic (audible to the human ear) and supersonic sounds. Proper listening equipment, coupled with the knowledge of normal and abnormal sounds, can yield reliable assessments of steam trap working condition. Listening devices range from a screwdriver or simple mechanic's stethoscope that allow listening to sonic sounds. **Temperature Method** Saturated steam and condensate exist at the same temperature. So it's not possible to distinguish between the two based on temperature. Still, temperature measurement provides important information for evaluation purposes. A cold trap (i.e., one that is significantly cooler than the expected saturated steam temperature)

	indicates that the trap is flooded with condensate, assuming the trap is in service. On the other hand, the temperature downstream of the trap will be nearly constant if significant steam is getting past the trap. At the low-end, spitting on the trap and watching the sizzle provides a general indication of temperature. Alternatively, a glove-covered hand can provide a similar level of accuracy. Finally, non-contact (i.e., infrared) temperature measuring devices provide the precision of thermometers and thermocouples without requiring physical contact. Non-contact temperature measurement makes it easier to evaluate traps that are relatively difficult or dangerous to access closely.
3.	"Steam should always be utilised at the lowest possible pressure" – What are the important aspects to be considered before fixing up the steam pressure for a particular application? A study of the steam tables would indicate that the latent heat in steam reduces as the steam pressure increases. It is only the latent heat of steam, which takes part in the heating process when applied to an indirect heating system. Thus, it is important that its value be kept as high as possible. This can only be achieved if we go in for lower steam pressures. As a guide, the steam should always be generated and distributed at the highest possible pressure, but utilized at as low a pressure as possible since it then has higher latent heat. However, it may also be seen from the steam tables that the lower the steam pressure, the lower will be its temperature. Since temperature is the driving force for the transfer of heat at lower steam pressures, the rate of heat transfer will be slower and the processing time greater. In equipment where fixed losses are high (e.g. big drying cylinders), there may even be an increase in steam consumption at lower pressures due to increased processing time. There is, however, several equipment in certain industries, where one can profitably go in for lower pressures and realize economy in steam consumption without materially affecting production time. Therefore, there is a limit to the reduction of steam pressure. Depending on the equipment design, the lowest possible steam pressure with which the equipment can work should be selected without sacrificing either on production time or on steam consumption.
4.	Write short notes on: (a) Thermodynamic steam traps (b) Thermostatic steam traps. a) Thermodynamic steam traps: Thermodynamic or disk traps are designed with a flat disk which moves between a cap and seat. On start-up, condensate flow raises the disk and opens the discharge port. When steam or very hot condensate arrives, it closes the disk, which stays closed as long as pressure is maintained above the disk. Heat radiates out through the cap, which diminishes the pressure over the disk, opening the trap to discharge condensate. Wear and dirt can be a problem with a disk trap because of the large, flat seating surfaces involved. If pressure is not maintained above the disk, the trap cycles frequently, wastes steam, and fails prematurely. Thermodynamic steam traps are relatively small and compact for the amount of condensate they are capable of discharging. Their advantage is that one unit can handle a wide range of pressures. The primary disadvantage is difficulty in discharging air and other non-condensable gases. b) Thermostatic traps: Thermal-element thermostatic traps are temperature actuated. On startup the thermal element is in a contracted position with the valve wide-open, purging condensate, air, and other noncondensable gases. As the system warms up, heat generates pressure in the thermal element, causing it to expand and throttle the flow of hot condensate through the discharge valve. When steam follows the hot condensate into the trap, the thermal element fully expands, closing the trap. If condensate enters the trap during system operation, it cools the element, contracting it off the seat, and quickly discharging condensate. Thermostatic traps are small, lightweight, and compact. One trap operates over extremely broad pressure and capacity ranges. Thermal elements can be selected to operate within a range of steam temperatures. In steam tracing applications it may be desirable to actually back up hot condensate in

	the lines to extract its thermal value.
5.	What are the important guidelines for proper drainage and layout of steam lines? Guide for proper drainage and layout of steam lines: • The steam mains should be run with a falling slope of not less that 125 mm for every 30 metres length in the direction of the steam flow. • Drain points should be provided at intervals of 30-45 metres along the main. • Drain points should also be provided at low points in the mains and where the steam main rises. Ideal locations are the bottom of expansion joints and before reduction and stop valves. • Drain points in the main lines should be through an equal tee connection only. • It is preferable to choose open bucket or TD traps on account of their resilience. • The branch lines from the mains should always be connected at the top. Otherwise, the branch line itself will act as a drain for the condensate. • Insecure supports as well as an alteration in level can lead to formation of water pockets in steam, leading to wet steam delivery. Providing proper vertical and support hangers helps overcome such eventualities. • Expansion loops are required to accommodate the expansion of steam lines while starting from cold. • To ensure dry steam in the process equipment and in branch lines, steam separators can be installed as required.