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ETD-II

Model Short Answer Questions And Answers

VAPOUR POWER CYCLES

1. What are the methods to increase thermal efficiency of Rankine cycle
a) by regenerative feed heating
b) by reheating of steam
c) By using binary vapour cycles
d) By water extraction

2. What are the advantages and disadvantages of regenerative cycles over simple Rankine cycle
advantages
a) thermal efficiency is improved
b) heating process in boiler will become reversible
c) small size condenser can be used
disadvantages
a) steam power plant becomes more complicated
b) greater maintenance is required
c) heaters are costly and gain in thermal efficiency is not much in comparison with heavier cost.

3. What are the advantages and disadvantages of reheat cycle over simple Rankine cycle?
advantages
1). Dryness fraction of exhaust steam is improved
2). There is an increased output of turbine
3). Erosion and corrosion problems can be eliminated
4). Increase in nozzle blade efficiencies
5). Thermal efficiency of the turbine will be improved
disadvantages
1) reheating requires more maintenance
2) the increase in thermal efficiency is not appreciable in comparison to the expenditure increased in reheating.

4. What are the required properties of an ideal binary fluid?
a) It should have high critical temperature at reasonable low pressure
b) High heat of vaporization
c) Available in large quantities at reasonable cost
d) Non corrosion and non toxic
e) Freezing point temperature should below Room temperature
f) It must have ability to wet the metal surfaces.

5. What is bleeding in steam power plants
Ans: Bleeding is the process of draining steam from the turbine at certain points during the expansion and using this steam for heating the feed water supplied to the boiler.

6. What is reheat factor?
It is defined as the ratio of cumulative heat drop to the isentropic heat drop

7. Define Rankin efficiency, efficiency ratio, specific steam consumption?
Rankine efficiency: It is the ratio of isentropic enthalpy drop to heat supplied
Efficiency ratio: It is also known as relative efficiency and is defined as ratio of thermal efficiency to Rankin efficiency

Specific steam consumption: It is defined as the mass of steam that must be supplied to a steam engine or turbine in order to develop a unit amount of work or power output.

1. Explain
    a. Pure substance
    b. Critical point
    c. Tripple Point
    d. Sublimation

Pure substance

A pure substance is a system which is 1) homogeneous in composition 2) homogeneous in chemical aggregation, and 3) invariable in chemical aggregation.

Critical point

Critical point is a point at which liquid and vapour phases merge . At critical point latent heat of vapourisation becomes zero.

Tripple point

Tripple point is merely the point of intersection of sublimation and vapourisation curves.on p-T diagram the triple point is a point,on p-Vdiagram it is a line and on a U-V diagram it is a triangle.

Sublimation

Direct conversion of solid phase to vapour phase is called sublimation process

2.Explain Gibbs-Dalton Law and Amagat's-Leduc's law or law of partial volumes?

Gibbs-Dalton Law

The pressure of a gaseous mixture is the sum of the pressures which each component would exert, if it alone occupied the volume of the mixture at the temperature of the mixture.

The internal energy, enthalpy and entropy of a gaseous mixture are respectively equal to the sums of the internal energies, the enthalpies and the entropies which each component would have, if it alone occupied the volume of the mixture at the temperature of the mixture.

Amagat's-Leduc's law or law of partial volumes

The volume of a gaseous mixture is equal to the sum of the volumes of individual constituents when each exists alone at the pressure and temperature of the mixture.

STEAM NOZZLES

1. Define steam nozzle and what are the different types of nozzles?

Ans. A steam nozzle may be defined as a passage of varying cross section through which heat energy of steam is converted to kinetic energy. Its major function is to produce steam jet with high velocity to drive steam turbines.

Types of nozzles.

1. Convergent nozzle
2. Divergent nozzle
3. Convergent – divergent nozzle

2. What is back pressure in steam nozzles?

Ans. The pressure at which the steam leaves the nozzle is known as back pressure.

3. What is the effect of friction in nozzle?

Ans. Effect of friction in nozzle is

1. Loss in heat drop. i.e. actual heat drop is less than isentropic heat drop.

2. Raise in entropy, dryness fraction of steam.
3. Loss of kinetic energy.

4. What is nozzle efficiency?
Ans. Nozzle efficiency or coefficient of nozzle is defined as the ratio of actual heat drop to the isentropic heat drop. It is denoted by K

$$K = \frac{\text{Actual heat drop}}{\text{Isentropic heat drop}}$$

5. What is the significance of critical pressure ratio?
Ans. At critical pressure ratio the discharge through the nozzle is maximum.
The ratio of exit pressure to the inlet pressure for maximum discharge is called as critical pressure ratio.

6. What is meant by super saturated or metastable expansion of steam in a nozzle?
Ans. The converging part of the nozzle is so short and the steam velocity so high that the molecules of steam have insufficient time to collect and form droplets so that normal condensation does not take place. Such rapid expansion is said to be metastable and produces a super saturated state. In this state of super saturation the steam is under cooled to a temperature less than that corresponding to its pressure.

7. What are the effects of super saturation?
1. There is increase in the entropy and specific volume of steam.
2. Heat drop is reduced and exit velocity of steam is reduced.
3. Dryness fraction is improved.
4. The temperature at which the super saturation occurs will be less than the saturation temperature corresponding to the pressure. Therefore, the density of super saturated steam will be more than for the equilibrium conditions, which gives the increase in the mass of steam discharged.

8. What is dryness fraction or quality of wet steam?
Ans. Dryness fraction is the ratio of mass the actual dry steam to the mass of same quantity of wet steam. It is denoted by x.

$$x = \frac{m_g}{m_g + m_f} = \frac{m_g}{m}$$

m_g = Mass of actual dry steam
m_f = Mass of water in suspension
m = Mass of wet steam = $m_g + m_f$

9. What is meant by wet steam, dry saturated steam, super heated steam?
Wet steam: When the steam contains moisture or particles of water in suspension, it is said to be wet steam.

Dry steam: When the wet steam is further heated and it does not contain any suspended particles of water, it is known as dry saturated steam.

Super heated steam: When the dry steam is further heated at constant pressure, thus raising its temperature, it is said to be super heated steam.

10. What are the properties of steam?
Ans. Enthalpy, Entropy, Specific volume, Internal energy, Saturation Temperature, Pressure, etc. are the properties of steam.

11. What are different steam calorimeters to determine the dryness fractions of wet steam?
a) barrel calorimeter b)separating calorimeter c)throttling calorimeter d)combined separating and throttling calorimeters
12. What is degree of under cooling, degree of super saturation in steam nozzles

Ans The difference of super saturated temperature and saturation temperature at that pressure is **degree of under cooling**

The **degree of super saturation** is defined as ratio of saturation pressure corresponding to saturation pressure and saturation pressure corresponding to super saturation temperature.

13. What is Wilson line?

Wilson line is line drawn on T-s and h-s diagram to show a limit to which the supersaturated flow is possible

14. What is function of steam injector?

The function of injector of steam injector is forcing the feed water into boiler under pressure it utilizes kinetic energy of steam jet for increasing pressure of velocity of feed water

STEAM TURBINES

1. Classification of steam turbines?

1. According to the mode of steam action
   a. Impulse turbine b. Reaction turbine
2. According to the direction of steam flow
   a. Axial flow turbine b. Radial flow turbine
3. According to the exhaust condition of steam
   a. Condensing turbine b. Non-condensing turbine
4. According to the pressure of steam

a. High pressure turbine b. Medium pressure turbine c. Low-pressure turbine

5. According to the number of stages
   a. Single stage turbine b. multistage turbine.

2. Differentiate between impulse steam turbine and reaction stream turbine.

Impulse steam turbine	Reaction steam turbine
1. Steam flows through the nozzles and impinges on the moving blades. Eg. D-level impulse turbine	1. Steam flows first through guide mechanism and then through the moving blades Eg. Parson's reaction turbine
2. Steam impinges on the buckets with kinetic energy.	2. Steam glides over the moving vanes with pressure and kinetic energy.
3. Steam pressure remains constant during its flow through the moving blades	3. Steam pressure is reduced during its flow through the moving blades
4. Relative velocity of steam while gliding over the blades remains constant (assuming no friction)	4. Relative velocity of steam while gliding over the blades increases (assuming no friction)
5. Less no. of stages required for developing same power	6. More no. of stages required for developing same power

3. What is meant by degree of reaction?

Ans. The ratio of the enthalpy or heat drop in the moving blades to the total enthalpy or heat drop in the stage is known as degree of reaction

$$\text{Degree of reaction} = \frac{\text{Enthalpy or heat drop in the moving blades}}{\text{Total enthalpy or heat drop in the stage}} = \frac{h_2 - h_3}{h_1 - h_3}$$

4. What is meant by compounding of turbines (Methods to reduce rotor speed)?

Ans. It is the method of reducing rotor speed to lower value by utilizing a multiple system of a rotors in series, keyed on a common shaft and the steam pressure or jet velocity is absorbed in stages as the steam flows over the blades.

Different types of compounding

1. Velocity compounding
2. Pressure compounding
3. Pressure velocity compounding

5. What is the effect of friction in steam turbines?

Ans: Friction in steam turbines causes reduction of relative velocity, blade (diagram) efficiency and stage efficiency.

6. What is governing and what are different methods?
Ans: Governing is a mechanism, which keeps the turbine speed constant irrespective of load variations

Methods of governing

a) throttle governing
b) nozzle governing
c) by pass governing

7. What are the losses in steam turbines?
Ans: Nozzle losses, blade losses, wheel friction losses, mechanical losses, residual losses, moisture losses, radiation losses, governing losses

8. What are diagram or blade efficiency, nozzle efficiency and gross or stage efficiency
Ans: Blade efficiency: it is the ratio of work done on the blades to energy supplied to the blades

$$\eta_b = 2(V_w+V_{w1})V_b/V^2$$

Nozzle efficiency it is defined as the ration of energy supplied to the blades per kg of steam to the total energy supplied per kg of steam.

$$\eta_n = V^2/2000h_d$$

Stage efficiency : it is the ratio of the work done on the blades per kg of steam to the total energy supplied per stage per kg of steam

$$\eta_s = (V_w+V_{w1})V_b/2000h_d$$

$$\eta_s = \eta_b \text{ X } \eta_n$$

STEAM CONDENSERS

1. What is a steam condenser ? what are advantages of a condenser?
Ans Steam condenser is a closed vessel in which exhaust steam of steam turbine or steam engine gets condensed and heat released by the steam is absorbed by cooling water.

Advantages:

1.Condenser will maintain low pressure and allow low back pressure and higher expansion ratio in steam turbines or steam engines and more work with high efficiency.

2. It will supply pure feed water to the boiler via hot well.

2 What is the difference between jet condenser and surface condenser?
Ans

Jet Condenser	Surface Condenser
1. Cooling water and steam mixed up	Cooling water and steam are not mixed up.
2. Low manufacturing cost	High manufacturing cost
3. Lower up keep	Higher up keep
4. Requires small floor space	Requires large floor space
5. The condensate cannot be used as feed water in the boilers unless the cooling water is free from impurities.	Condensate can be reused as feed water as it does not mix with the cooling water.

6. More power is required for air pump	Less power is needed for air pump
7. It requires less quantity of cooling water	It requires large quantity of cooling water
8. The condensing plant is simple	The condensing plant is complicated
9. Less suitable for high capacity plants due to low vacuum efficiency	More suitable for high capacity plants as vacuum efficiency is high
10. Less power is required for water pumping	More power is required for water pumping

3. Define vaccum, corrected vacuum, vacuum efficiency and condenser efficiency?

Ans Vacuum is Sub-atmospheric and measured as difference between atmospheric pressure and the absolute pressure. It is measured by vacuum gauge.

The vacuum corrected corresponding to standard atmospheric pressure, which is taken as 760 mm of Hg is called corrected vacuum.

Corrected vacuum= 760-(Barometer reading –vacuum gauge reading)

Vacuum efficiency is defined as ratio of actual vacuum to the ideal vacuum (Maximum obtainable vacuum)

$$\eta_v = \frac{\text{Actual Vacuum}}{\text{Ideal vacuum}}$$

Condenser efficiency is defined as ratio of temperature rise of cooling water to the vacuum temperature minus inlet cooling water temperature.

$$\eta_c = \frac{\text{Temperatur e rise of cooling water}}{\text{Vacuum temperatu re - inlet cooling water tem perature}}$$

$$= \frac{t_0 - t_i}{t_v - t_i}$$

4. Classify steam condensers?

Ans. Steam condensers are two types.

(1) Jet condensers

(2) Surface condensers

Jet condensers are further classified as

1. Parallel flow condensers
2. Counter flow low level condenser
3. Counter flow high level condenser
4. Ejector type

Surface condensers are classified as

1. Down flow type surface condensers
2. Central flow type surface condensers
3. Inverted flow type surface condensers
4. Regenerative type surface condensers
5. Evaporative type surface condensers

5. What are the factors contribute loss of efficiency in a surface condenser?

Ans.

1. Pressure drop occurs; as the steam flows over the tubes results to increase the volume of the steam tends to decrease the vacuum results in less amount of work done by unit mass of steam.
2. Steam entering the condenser with high resistance.
3. Heat conduction through the brass tube walls. This conduction of heat is not perfect and results in less efficiency.
4. Under cooling of condensate
5. Circulating water passing through the condenser with high friction and a velocity not consistent with high efficiency.

6. What are the sources of air in condensers?

Ans.

1. The dissolved air in the feed water enters in to the boiler, which in turn enters in to the condenser with exhaust steam.
2. Air leaks in to the condenser through various joints, due to the high vacuum pressure in the condenser.
3. In case of jet condenser, dissolved air with the injection water into condenser.

7. What are the effects of air leakage in steam condenser?

Ans.

1. Reduce the vacuum pressure in the condenser
2. It reduces the rate of heat transmission, as air is poor heat conduction
3 Require large air pump and more power is required to drive air pump.

8. What are the methods used to obtain maximum vacuum in steam condensers?

1) Using air pumps to remove air and other non-condensable gases and condensate.
2) Using de-aerated feed water in boiler.
3) By providing airtight joints with sensible packing and time-to-time inspection.

9. What is function of air pump?

Ans.

1. To maintain vacuum in the condenser as nearly as possible corresponding to exhaust steam temperature by removing incondensable air from the condenser.
2. It may also remove condensate together with air from condenser.

Air pump which extracts the both condensate and air is called a wet air pump
Air pump, which extracts only moist air, is known as dry air pump.
Air pump may also classified as

1. Reciprocating piston or Bucket pump
2. Rotary pump
3. Steam jet air pump
4. Wet jet pump

10. State Dalton's law of partial pressures applied to mixture of air and steam in condensers?

Ans. The pressure of the mixture of air and steam is called to the sum of pressures/which each constituent would exert if it occupied the same space by itself

$P_c=P_a+P_s$
P_a= Partial pressure of air
P_s= Partial pressure of steam
P_c=Mixture pressure or condenser pressure

PSYCHROMETRY &AIR CONDITIONING

1.Define **psychrometry and psychrometrics?**

The art of measuring the moisture content of air is termed **"psychrometry".**

The science which investigates the thermal properties of moist air, considers the measurement and control of the moisture content of air and studies the effect of atmospheric moisture on material and human comfort may probably be termed "**psychrometrics"**

2.Define various **psychrometric terms?**

1.Dry air.

The term 'Dry air' is used to indicate water free contents of air having any degree of moisture.

2. Moist air.

It is a mixture of dry air and water vapour.

3. Saturated air.

. Moist air is said to be saturated when its condition is such that it can co-exist in natural equilibrium with an associated condensed moisture phase presenting a flat surface to it.

4. Dry-bulb temperature

Dry-bulb temperature (DBT). It is the temperature of air as registered by an ordinary thermometer (t_{db}).

4. Wet-bulb temperature (WBT).

It is the temperature registered by a thermometer when the bulb is covered by a wetted wick and is exposed to a current of rapidly moving air (t_{wb}).

5. Adiabatic saturation temperature.

It is the temperature at which the water or ice can saturate air by evaporating adiabatically into it. (t_{Wb}).

6. Wet bulb depression;

It is the difference between dry-bulb and wet bulb teimperature (t_{db} — t_{Wb}).

7. Dew point temperature (DPT).

It is the temperature to which air must be cooled at constant pressure in order to cause condensation of any of its water vapour. It is equal to steam table saturation temperature corresponding to the actual partial pressure of water vapour in the air (t_{dp}).

8. Dew point depression.

It is the difference between the dry bulb and dew point temperatures (t_{db} — t_{dp}).

9. Humidity (Specific humidity or Humidity ratio).

It is the ratio of the mass of water vapour per unit mass of the air in the mixture of vapour and air, it is generally expressed as grams of water per kg of dry air.

10. Relative humidity (RH)

It is the ratio of the partial pressure of water vapour in the mixture to the saturated partial pressure at the dry bulb temperature, expressed as percentage.

11. Sensible heat.

It is the heat that changes the temperature of a substance when added to or abstracted from it.

12. Latent heat.

It is the heat that does not affect the temperature but changes the state of substance when added to or abstracted from it.

13. Enthalpy.

It is the combination energy which represents the sum of internal and flow energy in a steady flow process. It is determined from an arbitrary datum point for the air mixture and is expressed as kJ per kg of dry air (h).

Note. When air is saturated DBT, WBT, DPT are equal.

. **PSYCHROMETERS**

A psychrometer is a device which is used for measuring dry bulb and wet bulb temperatures simultaneously.

The psychrometers may be classified as follows

1. Laboratory psychrometer
2. Sling psychrorneter
3. Aspirating psychrometer
4. Continuous recording psychrometer

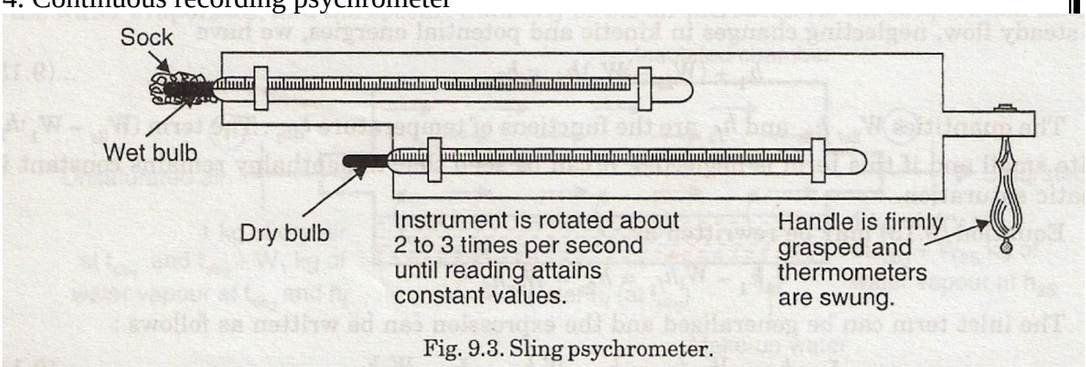

Fig. 9.3. Sling psychrometer.

PSYCHROMETRIC PROCESSES

The processes affecting the psychrometric properties of air are called psychrometric processes.

1. Mixing of air streams
2. Sensible heating

3. Sensible cooling
4. Cooling and dehumidification
5. Cooling and humidification
6. Heating and dehumidification
7. Heating and humidification.

AIR CONDITIONING is the simultaneous control of temperature,humidity,motion and purity of the Atmosphere in confined space.

Fans
Filters
Refrigerating plant
Means for warming
Means for humidification; and or dehumidification.
Control system
Classification ofAir conditioning systems
According to purpose
1.Comfort Air conditioning system
2. Industrial Air conditioning system
According to season of year
1.Winter Air conditioning system
2. Summer Air conditioning system
3. Year-round Air conditioning system
According to the arrangement of equipment
1.Unitary Air conditioning system
2. Central Air conditioning system

Advantages of central system:

1. Low investment cost as compared to total cost of separate unit.

2. Space occupied is unimportant as compared to a room unit conditioner which must be placed in the room.
3. Better accessibility for maintenance.
4. The running cost is less per unit of refrigeration.
5. Noise and vibration troubles are less to the people in air-conditioned places as the air-conditioning plant is far away from the air-conditioned places.
6. The exhaust air can be returned and partly reused with obvious saving in heating and refrigeration.