MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC - 27001 - 2005 Certified)
SUMMER – 16 EXAMINATION

Subject Code : **17410** **Model Answer**

Important Instructions to examiners:

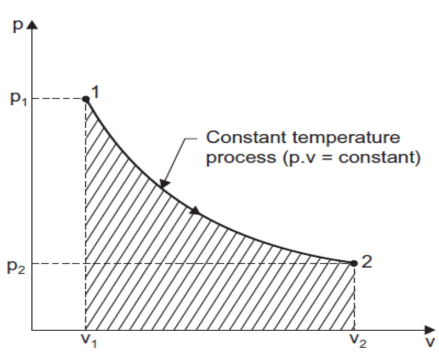
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

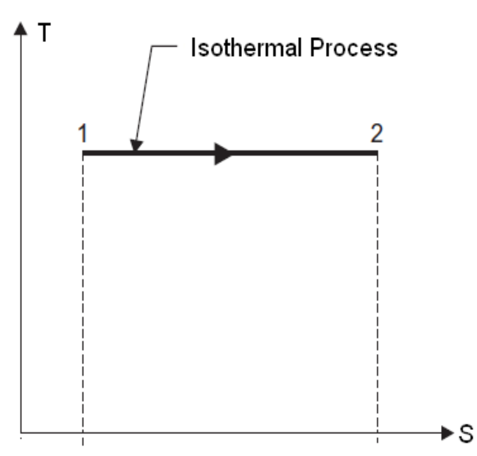
Q.1 (a) Attempt any six each 2 mark

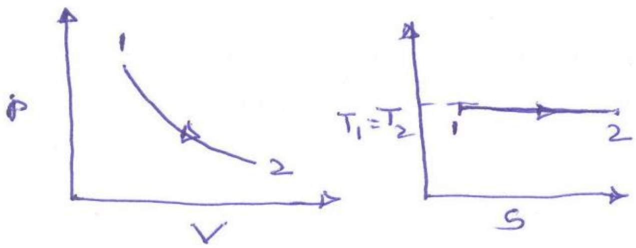
(i) Avogadro's Law : It state that Equal volume of all gases at same temperature and pressure contain equal number of molecules.

(ii) Isothermal Process

(Pl change if possible)







(iii) 1) The quality of steam is designated by the term 'dryness fraction of steam" which is defined as the ratio of the mass of dry vapor to the total mass of the mixture (vapor & liquid) and is designated by "x".

The value of dryness fraction for saturated liquid is zero.

Dryness fraction of steam- It is defined as a fraction of steam that in the vapour form in liquid vapour mixture is called as a dryness fraction of steam .

2) Degree of super heat- it si the difference between the temperature of sup superheated vapour and the saturation temperature corresponding to given pressure is said to be degree of superheat.

(iv) Vacuum efficiency- It is ratio of vacuum actually present at steam inlet to condenser to maximum vacuum which could be produced in a perfect condensing plant.

$$\text{Vaccum efficiency} = \frac{\text{Actual vaccum}}{\text{Ideal Vaccum}}$$

(v) List of losses in steam turbine (any two)

1. Residual velocity loss- at blade exit
2. Loss due to friction – nozzle turbnine blade & between steam & rotating
3. Leakage loss
4. Loss due to mechanical friction- between shaft & bearing
5. Radiation Loss
6. Loss due to moisture.

(vi) Define

1. Mach number is defined as square root of the ratio of the inertia force of fluid to elastic force.

$$Mach\ number = \sqrt{\frac{inertia\ force}{elastic\ force}}$$

Mach number is also defined as velocity at point in a fluid to velocity of sound at that point at a given instant of time.

2. Critical pressure – the pressure at throat in nozzle is known as critical pressure.

(vii) Fourier's Law of heat transfer

The Law state that for homogeneous material the rate of heat transfer in any direction is linearly proportional to temperature gradient in that direction.

(viii)

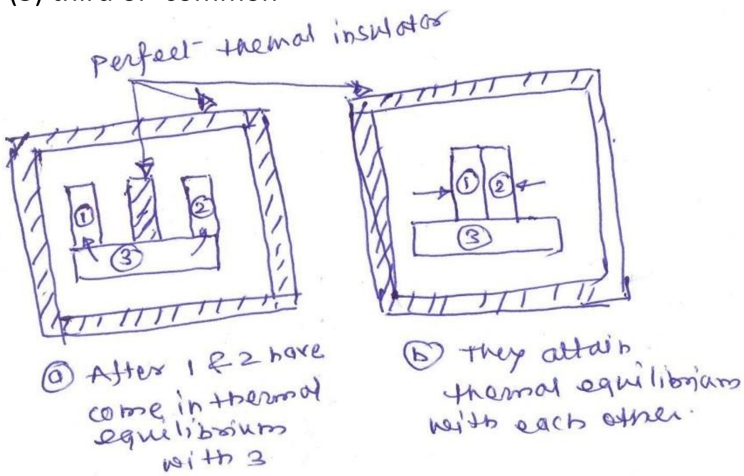
1. Transmissivity : It is the ratio of transmitted energy to the incident energy .it is denoted by τ

2. Emissivity is defined as the total emissive power to the total emissive power of black surface, at the same temperature.

Q.1 (b) i) Attempt any two each x4 (8)

(1) Zeroth Law of thermodynamics – It state that 'Two systems in thermal equilibrium with a third, are in equilibrium with each other.

When two bodies , one hotter than other are brought into contact, after some time, both will be equally not, when this state is attained it is said that bodies are ion thermal equilibrium they have some properly in common and it is temperature we consider system (1) & (2) insulated from each other but in good thermal conduct with (3) third or common



System. As indicated in figure (a) system(1) & system(2) will come to thermal equilibrium with system (3). If the insulator is removed and system(1) & system (2) are brought into contact as shown in figure (d) we find that there is no future change. This means that the combined system has come to thermal equilibrium

(2) Differentiate

Heat Work

1.	Heat is the form of energy that transferred across a boundary by virtue of temperature difference	1.	Work is said to be done by a system if a sole effect on things external to the system can be reduced to the raising of weight.
2.	Heat is a low grade energy	2.	Work is a high grade energy.
3.	SI unit is Joule	3.	SI unit is N-m or Joule
4.	Heat flow into a system is taken to be positive.	4.	Work is done by a system on surroundings is taken to be positive.

(ii) Steady flow energy equation

For unit mass of flow

$q + h_1 + gZ_1 + {}^1/_2C^2 = W + h_2 + gZ_2 + {}^1/_2C^2$

Where

q = Heat supplied in kj or j

$h_1 = \mu_1 + pv_1$

h_2= Enthalpy of substance leaving form system.

$PE_1 = mgZ_1$ potential energy entering into system.

$PE_2 = mgZ_2$ potential leaving the system.

$KE_1 = {}^1/_2mC_1^2$ Where C_1 = velocity of substance entering m/s.

$KE_2 = {}^1/_2mC_2^2$ Where C_2 = velocity of substance leaving m/s.

W= work perform in kj or J

iii) Classified the steam boiler on basis of

1) Content in the tube

a) Fire tube boiler- Cornish boiler, lancashier boiler

b) Water tube boiler – Babcock & Wilcox

2. Circulation of water & steam

a) Natural circulation- Babcock & Wilcox, Lancashier

b) Forced circulation – Lamount boiler, Velox boiler

3) According to boiler use

a) Stationary – (Industrial & Power generation)

b) Mobile – (Marine and Locomotive)

4) According to Axis of shell.

a) Vertical shell boiler.

b) Horizontal shell boiler.

Q.2 Attempt any four

a) Differentiate

(Any four one mark each)

	Heat Engine		Heat pump
1.	Heat engine is device in which heat energy is converted into work.	1.	Heat pump is a device in which to maintain the temperature of system above the atmospheric temperature (surrounding)

2.	It is measured in term of efficiency	2.	It is measured in term of co-efficient of performance (cop)
3.	$\text{efficienty} \; = \dfrac{workdone}{heat\ supplied}$	3.	$\text{cop} = \dfrac{Desired\ heating\ effect}{work\ supplied}$
4.	Efficiency of heat engine is always less than one	4.	Cop of heat pump is always greater than one.
5	HTR ⇩QH H ⇨work done=(QH –QC) ⇩QH LTR $\mu = \dfrac{\mathrm{QH - QL}}{\mathrm{QH}}$	5	HTR ⇩QH H ⇦w ⇩ QL LTR $cop = \dfrac{\mathrm{QH}}{\mathrm{QH - QL}}$

Q.2 (b)

Pl check extra matter and allocate marking scheme

P_1= 7 bar, T_1 = 400 ^{0}k V_1= 0.2 m^3 , P_2 = 1.5bar, n= 1.5

$P_1V_1^n = P_2V_2^n$

$$174.72\,x_1 = -71.42\,x_1 + 28.22$$

$$174.72\,x_1 + 71.42\,x_1 = 28.224$$

$$246.14\,x_1 = 28.224$$

$$\boxed{x_1 = 0.1146\,m}$$

$$\therefore \quad x_2 = 0.32 - 0.1146$$

$$\boxed{x_2 = 0.2054\,m}$$

(II) Heat loss per unit area

$$Q = \frac{t_1 - t_2}{0.1146/0.84} = \frac{1325 - 1200}{0.1146/0.84}$$

$$Q = \frac{125}{0.1364} = 916.42\ W/m^2$$

$$\boxed{Q = 916.42\ W/m^2}$$

2 (b)

$P_1 = 7$ bar, $T_1 = 400^{\circ}K$ $V_1 = 0.2\ m^3$

$P_2 = 1.5$ bar $n = 1.5$

$P_1 V_1^n = P_2 V_2^n$

$\left(\frac{P_2}{P_1}\right) = \left(\frac{V_1}{V_2}\right)^n$

$\left(\frac{1.5}{7}\right) = \left(\frac{V_1}{V_2}\right)^{1.5}$

$(0.214) = \left(\frac{0.2}{V_2}\right)^{1.5}$

$(0.214)^{1/1.5}$

$(0.214)^{0.666} = \frac{0.2}{V_2}$

$0.358 = \frac{0.2}{V_2}$

$V_2 = \frac{0.2}{0.358} = 0.558\ m^3$ — (2)

$W = \frac{P_1 V_1 - P_2 V_2}{n-1} = \frac{7 \times 10^5 \times 0.2 - (1.5 \times 10^5 \times 0.558)}{1.5 - 1}$

$= \frac{56300}{0.5} = 112600$ Joule

Work transfer $= 112.6$ KJ — (2)

Q.2 (C) Classify the steam turbine

1. According to the action fo steam over the moving blade
   - (a) Impluse turbine
   - (b) Reaction turbine
   - (c) Combination of impulse and reaction turbines.
2. According to expansion of stages of steam.
   - (a) single stage
   - (b) multistage
3. According to expansion of steam entering turbine
   - (a) High pressure
   - (b) Medium pressure.
   - (c) Low pressure.
4. According to steam exhaust pressure.
   - (a) Condensing type

(b) Noncondending type

5. According to the direction of steam flow

(a) Axial flow

(b) Tangential flow

(c) Radial flow

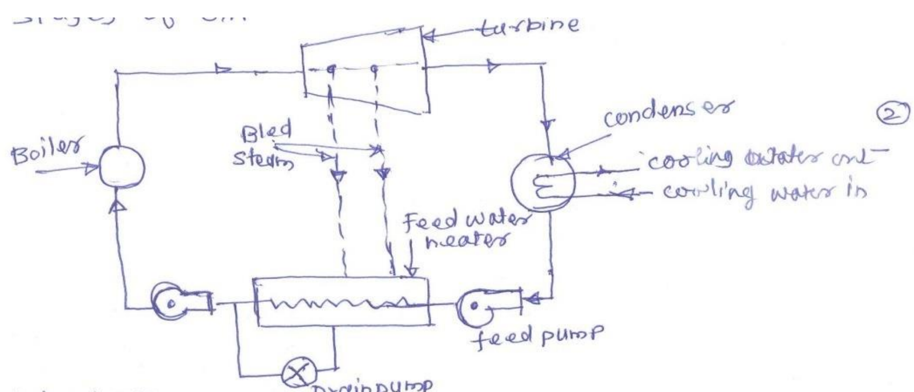
(d) mixed flow

Q.2 (d)

(d) Differentiate

Impulse turbine		Reaction turbine	
1.	Steam completely expand in nozzle & pressure remain constant during flow through the blade passage	1.	Steam expand partially in nozzle and further expansion take in rotor blade passage.
2.	Relative velocity of steam passing over blades of impulse turbine is constant.	2.	Relative velocity increases as steam passing over the blade expands.
3.	Blade is symmetrical profile	3.	Blade is aerofoil section.
4.	Pressure is same at inlet and outlet	4.	Pressure is different at inlet and outlet.
5.	Steam velocity is very high	5.	Steam velocity is not very high
6.	Lesser no of stages require	6.	More no. of stages requires
7.	Occupies less space per unit power	7.	Occupies more space per unit power
8.	Suitable for small power.	8.	Suitable & higher power.
9.	At low load the efficiency is low	9.	At low load, the efficiency is high

(e) Regeneration feed heating: Heating of feed water of boiler by bleeding steam during expansion in turbine at certain (1) stages of expansion is known as Regeneration feed heating



Advantages

1) It increases the thermal effiency of the plant (1)

2) The temperature stresses in boiler are reduced due to decreased range of working temperature.

Advantages

1. It increases the thermal affiance of the plant
2. the temperature stresses in boiler are reduced due to decreases range of working temperature.

Q-3 Attempt ant <u>FOUR</u> [16]

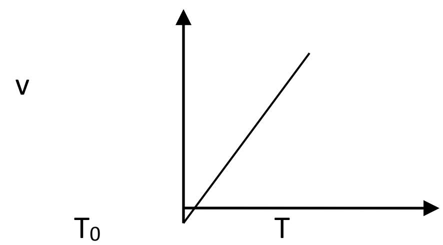
(a) State-

(i) Charle 's law-Charles discovered this law in 1787 A.D. This law states that the volume of given mass of perfect gas varies directly with the absolute temperature if the pressure is kept constant.

Let V= Volume of gas in m^3

T=Absolute temperature in K

P= pressure



Then, V ∝ T (If P= Constant)

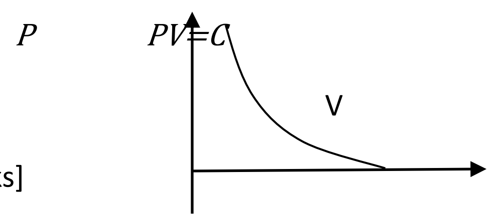
∴ V / T =Constant

$\frac{V1}{T1} = \frac{V2}{T2}$ [2 Marks]

(ii) Boyle's law –Robert Boyle discovered this law in 1662 A.D. This law states that the volume of given mass of perfect gas varies inversely with absolute pressure when temperature remains constant.

V ∝ $1/P$ *(If Temperature is kept Constant)*

$V = C/P$; $PV = C$; $P_1V_1 = P_2V_2$

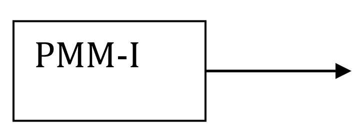


....................[2 Marks]

(b) First law of Thermodynamics – According to this law, when a closed system undergoes a thermodynamic cycle, the net heat transfer is equal to net work transfer. In other words, heat and work are mutually convertible and they should be expressed in same units. Cyclic integral of heat transfer is equal to cyclic integral of work transfer.

$\oint dQ = \oint dW$ It is law of conservation of energy. [2 M]

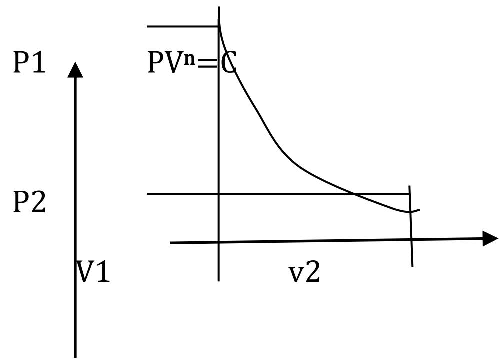
PMM-I :- Perpetual motion machine of first kind



WORK

A machine which violates First law of thermodynamics (i.e. Energy can neither be created nor destroyed, but can be transformed from one form to another) is known as Perpetual motion machine of first kind. It is defined as a machine which produces 'work energy 'without consuming an equivalent of energy from any other source. It is impossible to construct such machine because no machine can produce energy of its own without any input. . [2 M]

(c) For a polytropic process



(i) Change in internal energy

$dU = U2 - U1$

$= mCv(T2-T1)$ [2 Marks]

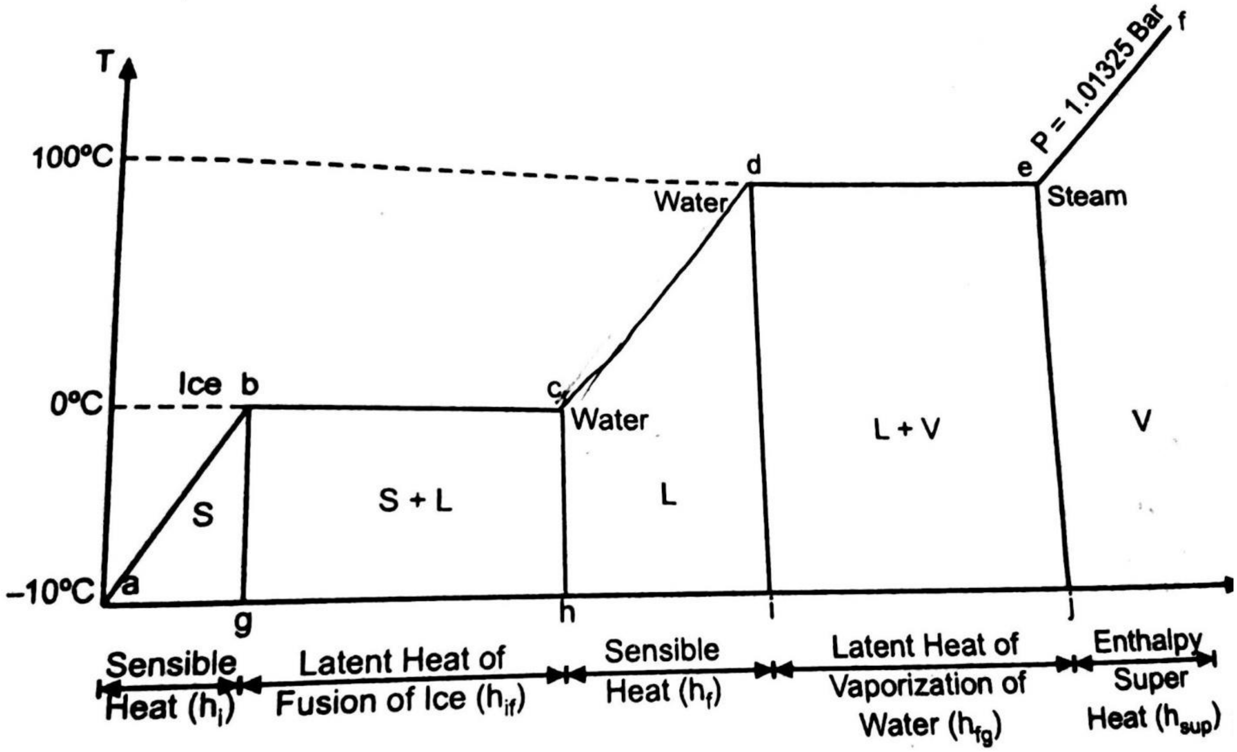
(ii) Work done , $W = (P1V1 - P2V2)/n-1$ ……. For expansion

$= mR(T1-T2)/ n-1$

$W = (P2V2-P1V1)/n-1$ …….For compression

$= mR(T2-T1)/ n-1$ [2 Marks]

(d) Formation of steam at constant pressure



Consider formation of steam from ice at -10^{o} C at atmospheric pressure of 1.01325 bar. This is explained from stage a to stage f as shown in fig.

a-b (Heating of ice from -10^{o}C to melting point of ice) :-

In this heating, temp of ice will increase , which can be sensed by thermometer . Therefore it is called as 'sensible heat'. During this heat addition, solid phase exists. This sensible heat is denoted as 'h_i '

b-c (Latent heat of fusion of ice):-

Point b is saturation state of ice. Further addition of heat will not increase the temp of ice but ice will start converting into water. Thus b-c is transformation phase. In this region, solid as well as liquid phase exists and heat supplied is called as 'Latent heat' as it is not sensed by thermometer. It is denoted by 'h_{if} '

c-d (Sensible heating of water from 0^{o}C to saturation temp) :-

In this region water at 0^{o}C is heated to 100^{o}C (Boiling point of water at 1.01325 bar.) This change in temp is sensed by thermometer. So it is known as ' sensible heat' of water. It is denoted by h_f . Here only liquid phase exist.

Heat supplied = h_f = mCp (Td -Tc) = 1 X 4.18 (100-0) =4.18 KJ/ Kg

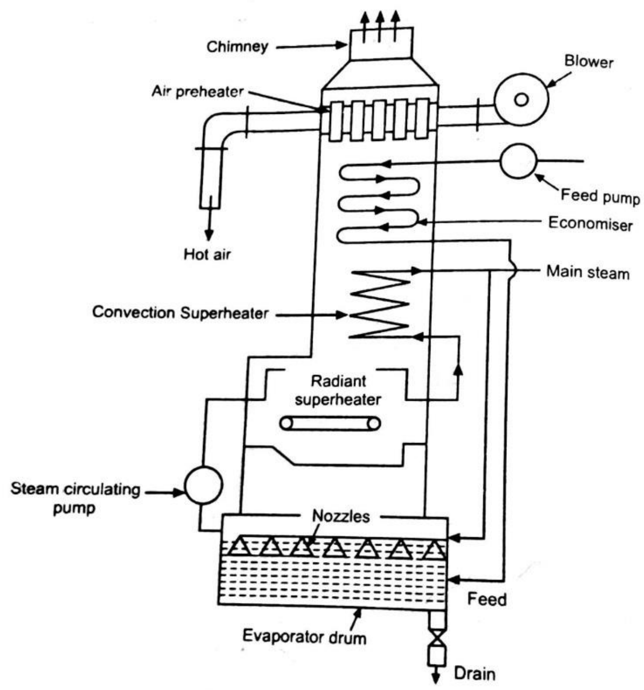
d-e (Latent heat of vaporization of water) :-

At point 'd' water is at saturation state. Further addition of heat will not increase the temp but heat is transferred at constant temp to change the phase from liquid to vapour (steam). This is known as ' Latent Heat of vaporization of water'. It is denoted by' h_{fg} ' .From steam tables, at 1.01325 bar, h_{fg} = 2256.9 KJ/Kg . In this region, both liquid and vapour phase exist.

e-f (Superheating of steam):-

At point ‘e’, steam is present in dry saturated state. It does not contain any moisture, as all liquid is converted into steam. Further heating of steam will increase the temp of steam, which is known as superheating. Thus, superheating is defined as heating of steam above saturation temperature.

(e) Loeffler Boiler marking



Loeffler Boiler is a forced circulation, indirect heating type boiler. In this boiler, water is heated by means of superheated steam. Steam acts as heat carrying and absorbing medium. Thus, boiler uses circulation of steam instead of water to eliminate the difficulty of deposition of salt and sediment in boiler tubes.

It consists of evaporator drum, which may be placed at convenient location outside furnace. The feed pump feeds water to economizer, which is placed in the path of flue gases. Thus water is heated near to saturation temp and comes into evaporator drum. From superheater , big portion (About ¾) is trapped off for external use and remainder portion (About ¼) is passed to evaporator drum. The evaporator drum is provided with set of nozzles through steam enters in evaporator drum. The steam from evaporator drum is passed to superheter by circulating pump.

Loeffler Boiler has steam generating capacity of 100 tons/hr at 140 bar.

(f) State function of [1 Mark each]

(i) Superheater :- The function of superheater is to increase the temp of steam above its saturation temp, without increasing its pressure. This is achieved by passing the steam through a small set of tubes and hot flue gases over a tube. Superheater increases overall efficiency of plant and it reduces specific steam consumption of engine/turbine.

(ii) Economiser :-An economizer is a device used to heat feed water by utilizing the heat in the exhaust flue gases before leaving through the chimney. As the name indicates, it improves the economy of the steam boiler. It increases thermal efficiency , steam rising capacity and life of boiler.

(iii) Air pre heater :-Air pre heater is used to heat the air entering in the combustion chamber by recovering heat from flue gases when it comes out from economizer. It is installed between economizer and chimney. The air is passed through the tubes of heater internally while hot flue gases passed over outside the tubes. This gives better combustion and less soot, smoke ,ash and increase in boiler efficiency.

(iv) Feed pump used in steam boilers :-To deliver the feed water in boiler against the boiler pressure, feed pump is required. It continuously feeds the water equal to evaporative capacity of boiler and maintains the water level almost constant. Generally, pressure of feed water is 20% more than that in boiler.

Q-4 Attempt ant FOUR [16]

(a) Temp at condenser entry = 35^oC

From steam tables, saturation pressure corresponding to 35^oC is 0 .0562 bar ….[1M]

Barometric pressure h_b= 760 mm of Hg = 1.01325 bar

Vacuum = h_v= 690 mm of Hg

Absolute pressure in condenser = h_b- h_v = 760-690 =70 mm of Hg

$$=\frac{70}{760} \times 1.01325 = 0.0933 \text{ bar} \quad \text{...[1 M]}$$

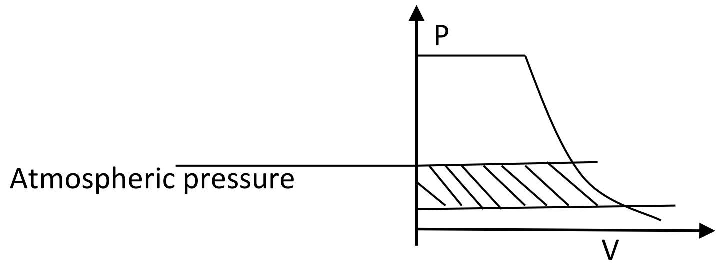
$$\text{Vacuum efficiency of condenser} = \frac{Barometric\ pressure - Condenser\ pressure}{Barometric\ pressure - Pressure\ corresponding\ to\ 35^0\text{C}}$$

$$= \frac{1.01325-0.0933}{1.01325-0.0562} = 0.9612= 96.12\% \quad \text{………..[2M]}$$

(b) Intensive property :-The properties of system , which are independent of the mass of the system are known as intensive properties. Examples are- pressure, temperature, density, specific volume [2 Marks]

Extensive property :-The properties of system , which are dependent on the mass of the system are known as extensive properties. Examples are- Enthalpy, entropy, energy, volume [2 Marks]

(c) Function of condenser-The primary function of condenser is to maintain a very low back pressure on exhaust side of steam engine or turbine. Due to this, steam is expanded to a greater extent, which results in increase in available energy for converting into mechanical work.



The secondary function of condenser is to supply pure and hot feed water to boiler. The condensed steam(condensate) is discharged from condenser and collected in hot well, can be used again as feed water to boiler. …….[2M]

Condensers are classified as – A] Jet condensers (Mixing type)

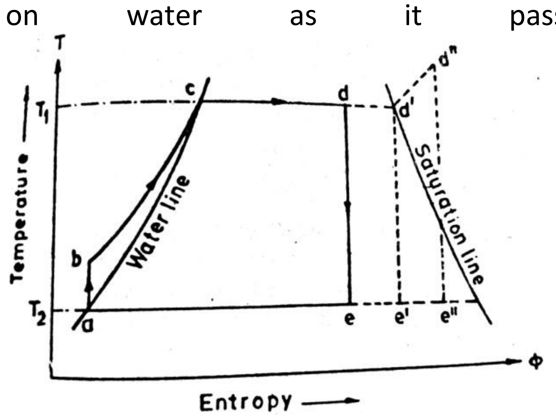
(i) Parallel flow jet condenser
(ii) Counterflow or low level Jet condenser
(iii) Barometric or high level Jet condensers
(iv) Ejector condensers

B] Surface condensers (Non mixing type)

(i) Down flow Surface condensers
(ii) Central flow Surface condensers
(iii) Regenerative Surface condensers
(iv) Evaporative condensers ………..[2 M]

(d) Draw T-S diagram for Rankine cycle (considering steam at inlet of turbine as superheated)

During the operation of Rankine cycle, heat is added in the boiler, the work is performed in the prime mover (steam engine) , heat is rejected in the condenser, and the work is done on water as it passes through a feed pump.



Operation a-b

Point a indicates condition of feed water in the condenser. Pressure of this water is raised to boiler pressure by adiabatic compression in the feed pump. Due to this compression, temp of feed water is raised and this is represented by a-b in T-S diagram.

Operation b-c

Feed water is supplied with heat to raise the temp to saturation temp corresponding to boiler pressure. . The operation b-c takes place in either in economizer or in a special feed heater.

Operation c-d"

During this process evaporation takes place at constant pressure and further it is superheated upto point d'' .

Operation d''-e''

The steam enters the turbine or engine where it expands adiabatically.

Operation e''-a

At point e'' , the exhaust steam enters the condenser by circulating water and condensation takes place . Thus the cycle is completed.

(e) Important provisions made on IBR

Since boilers (vessel exceeding 22.75 liters capacity come under IBR) are high pressure vessels, they are required to be operated within safe pressure limits with regular upkeep and maintenance. Boiler explosion may cause extensive damage. To ensure safety, some standard rules and regulations are enforced through legislation in the form of Boiler act 1923.The main provisions under this are-

1. A boiler cannot be put to use unless it has been registered with the Chief Inspector of Boilers.
2. The maximum working pressure of the boiler has to be determined by Boiler Inspector who will issue certificate for this. Owner cannot exceed this pressure limit in any case.
3. In case of accident, it should be reported by owner within 24 hours with full details.
4. The rules, regulations and bye-laws governing the upkeep and maintenance of boilers, procedure of registration, inspection and certification of maximum pressure, safety conditions etc. are subject to a revision by a Central Board under control of Govt. of India.
5. The boiler house plan, chimney design (Max height 30.48 m from floor) should be approved by boiler inspector.
6. Owner should apply for registration in prescribed format, inspector should fix date of inspection within 30 days, conduct inspection/examination of boiler, Issue the certificate of registration not exceeding 12 months period.
7. Following inspections are carried out by Boiler Inspector at various stages/ levels /need**->**Inspection for registration, Hydraulic test, steam test, annual inspection, Inspection under steam, Internal inspection, Accident inspection, Casual inspection
8. Violation of law is liable to prosecution and punishment with fine.

(f) Initial condition of steam :- p1=30 bar , t1= 400 ^oC (Point A)

Final condition of steam :- p2 =0.05 bar (Isentropic expansion) (Point B)

Using Mollier chart,

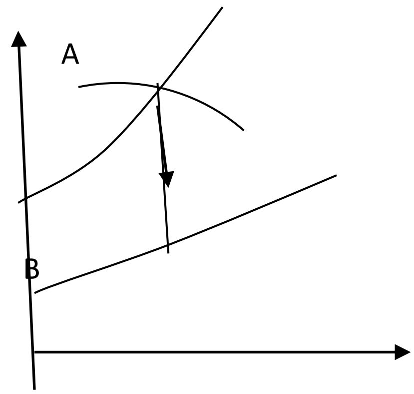
hA =3230 KJ/KG

hB= 2110 KJ/KG

Enthalpy drop = hA - hB= 1120 KJ/KG [2 M]

Final condition of steam

From Mollier chart, dryness fraction at B is 0.815 [1M]



Sketch of h – Ø chart [1M]

Q. 5 a) i) Kelvin-Plank Statement:- It states that, "it is impossible to construct a heat engine, which while operating in cyclic process, will produce no effect other than transfer of heat from a single thermal reservoir and performance an equivalent amount of work.

(02 Marks)

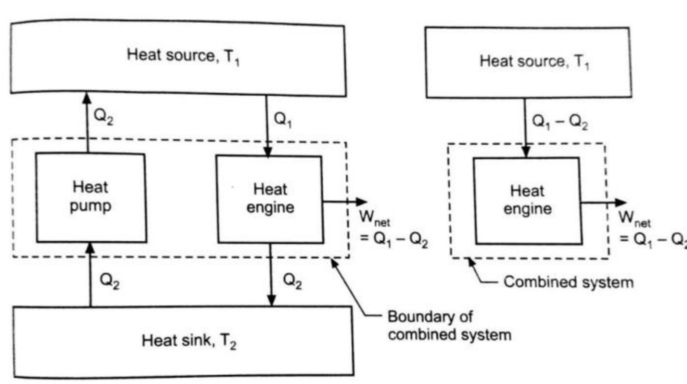
ii) Clausius statement: It state that " it is impossible to construct a heat pump , which while operating in a cyclic process, which will produce no effect other than transfer of heat from lower temperature reservoir to higher temperature reservoir

(02 Marks)

i) Equivalence of two statements

Violation of Kelvin plank statement resulting into violation of clausius statement.

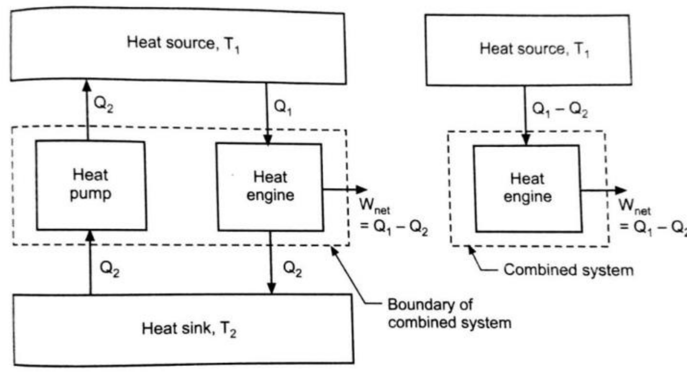
(02 Marks)



Consider the heat pump which violates the kelvin plank statement by absorbing heat Q_1 from single reservoir and producing equal amount of work $W = Q_1$. The work delivered by this heat engine is used to drive the heat pump which takes the heatQ_2 from low temperature reservoir and delivers Q_1+Q_2 amount of heat to high temperature reservoir by consuming the work $W = Q_1$ as shown in figure

ii) **Violation of clausius statement resulting into violation of Kelvin plank statement.**

Consider heat pump which violets the Clausius statement by transferring Q_2 amount of heat from low temperature to high temperature body without consumption of work. Let us assume the heat engine working between the same thermal reservoirs which absorbs Q_1 amount of heat (which is greater than Q_2) and delivers work $W = Q_1 – Q_2$ and rejects the Q_2 amount of heat to low temperature reservoir as shown fig.



b) Various modes of Heat Transfer with example

(02marks each)

i) **Conduction –** It is transmission of heat energy between two bodies or two parts of same body through molecules which are more or less stationery **e.g. (heating or solid)**

ii) **Convection –** It is process of heat transfer from higher temperature to lower temperature due to movement of matter or fluid molecules (density differences) is called convention **e.g. heating of water**.

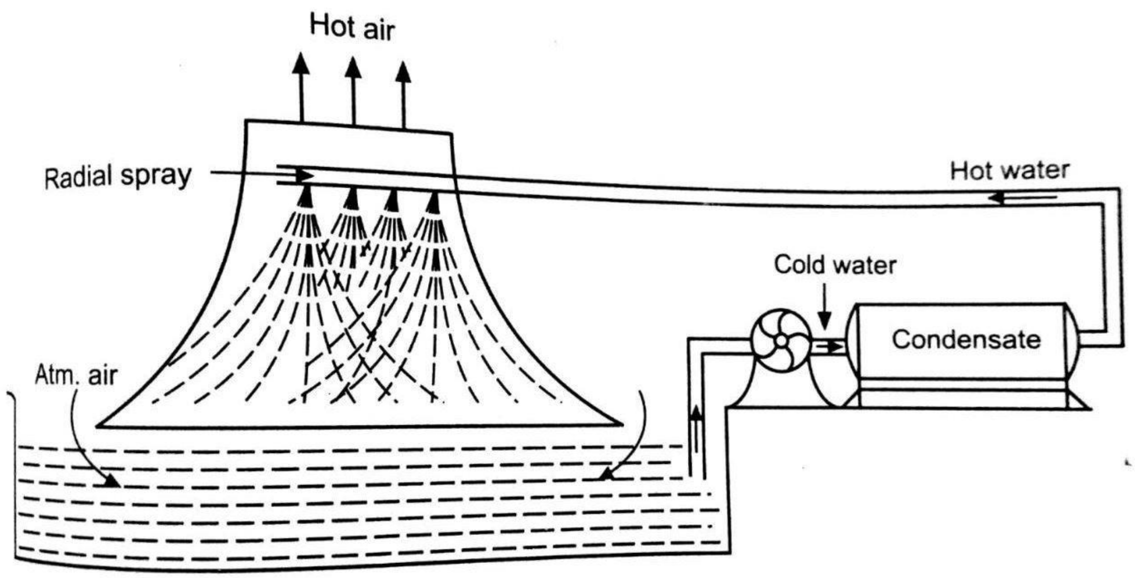
iii) **Radiation –** It is process of heat transfer between two bodies without any carrying medium through different kind of **electro-magnetic wave**.

Applications of Heat Exchanger for thermal systems (any four 02mark)

i) Condenser coil in refrigerator
ii) Evaporator of Domestic Refrigerator
iii) Condenser used in cooling tower
iv) Domestic boiler
v) Solar water heater

c) Natural draft cooling tower: (Figure 04 marks , explanation 04 marks)

- In natural draught cooling tower, the circulation of air is produced by the pressure difference of air inside the tower and outside atmospheric air
- Hot cooling water falls down in a form of sprays and atmospheric air enters from bottom of the tower
- The falling water gives up its heat to the rising column of air and temperature of circulating water reduces



Q. 6 **a) Classification of heat exchangers: (Any 4 from the following) (04Marks)**

1. Classification according to construction:

- Tubular heat exchangers.
- Plate heat exchangers.
- Extended surface heat exchangers.
- Regenerative heat exchangers.

2. Classification according to transfer process:

- Indirect contact heat exchangers.
- Direct contact heat exchangers.

3. Classification according to flow arrangement:

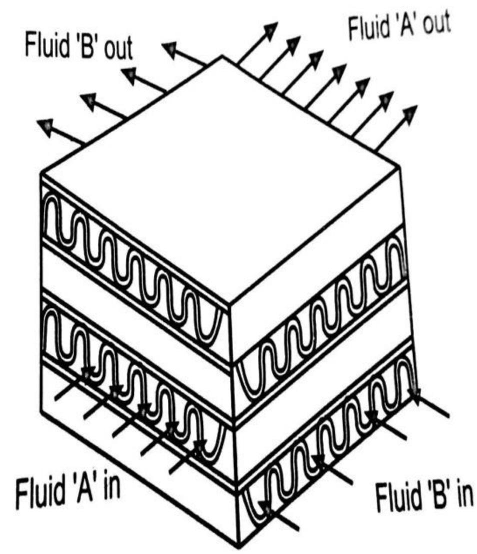
- Parallel flow exchangers.
- Counter flow heat exchangers.

- Cross flow heat exchangers.

4. Classification according to pass arrangement:

- Single pass arrangement.
- Multi-pass arrangement.

Construction and working of Plate type heat exchanger. (02 marks diagram, 02 marks working)

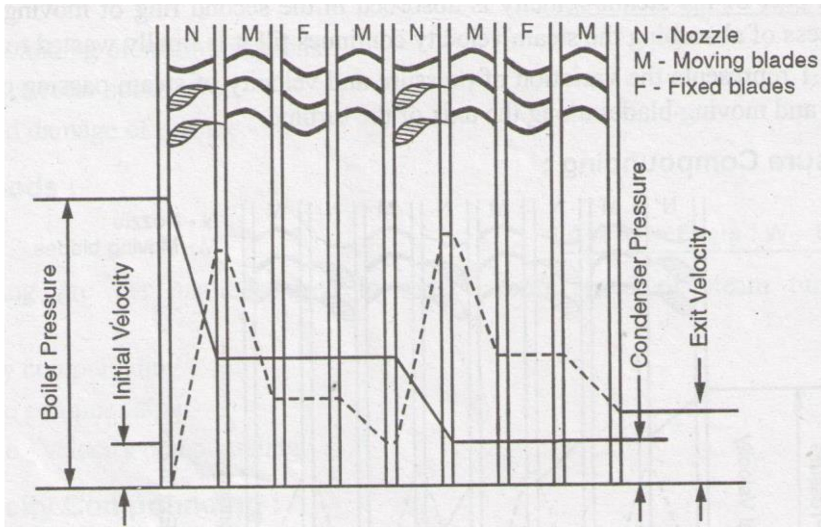


It consist of a series of closely spaced parallel plates with fins held in between. The plates separate the two fluids which flow through passages alternately formed between the plates. It also has fins attached over primary heat transfer surface so as to increase heat transfer area. This improves the effectiveness of heat exchanger. Fins from the individual flow passeges for single fluid. A typical cross flow, both fluids unmixed arranged is shown below, in which heat is transferred between fluid “A” and fluid “B”.

The counter flow or parallel flow arrangement can also be possible. The fins may be plain fin (Sraight or corrugated) or interrupted and are attached to plate by brazing or soldering. They are more suitable for gas to gas application. Plate fin type heat exchanger is as shown in figure

b) Compounding of steam turbine:- (Diagram 04 marks for meaning, 02 for explanation and 02 for sketch Marks)

High pressure and high temperature steam is used in the industries for various reasons. If the total pressure drop is occurring at one stage, velocity of steam entering into the turbine will be very high, because of which rotor run with very high speed. To reduce rotor speed of a turbine various methods are used called as compounding



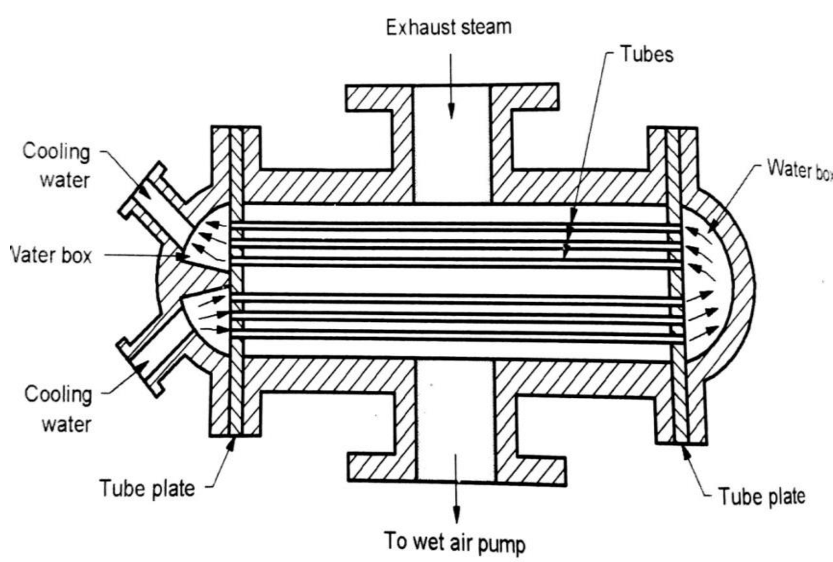
Pressure and velocity compounding of an impulse turbine

Figure shows Variation of pressure and velocity of steam in impulse turbine. The total pressure drop of steam is divided into stages and velocity of steam obtained due to expansion in each stage s also compounded.

The arrangement to reduce pressure from boiler pressure to condenser pressure by use of multiple system of rotors in series, keyed to common shaft or by increasing number of stages and the steam pressure or steam velocity is absorbed in stages as it flows over moving blades. This is known as compounding.

c) Construction and working of two tube pass surface condenser (Diagram-04 Marks, Explanation 04 Marks)

- A surface condenser shown in fig. consist of a cast iron shell, cylinder in shape and closed at each end to form a water box. A tube plate located between each cover head and the shell.
- A number of water tubes are fixed to the plates. The exhaust steam from



the engine steam or turbine enters at the top of the condenser and is condensed by transferring the heat due to conduction and convection by coming in contact with the cold surface of the tubes through which cooling water is circulated.

- The cooling water enters at one end of the tubes situated in the lower half of the condenser and after flowing to the other end returns in the opposite direction through the tubes situated in the upper half of the condenser. The air, condensate and un-condensable gasses are removed from bottom of the condenser.
- This condenser requires two pumps. One is to remove condenser and air from bottom and second pump is to force the cooling water through the tubes to the circulating of heat through the tubes to the circulating water increases with the increase of number of flow, but the power required to circulate the water is increased