The Shirpur Education Society's

R. C. Patel College of Engineering and Polytechnic, Shirpur

QUESTION BANK

Chapter 2. Ideal gases and steam fundamentals

Program Name: Mechanical Engineering
Name of Subject & Code : Thermal Engineering (313310)
Date & Time Slot: 27/05/2026 ;

Program Code: ME3k
Semester : Third

Q. NO.	QUESTION	DETAIL	MAPPING
1	List any two assumptions for ideal gas.	W25 Q1B 2M	CO 2.1 R
2	Define :– i) Dry saturated steam ii) Wet steam.	W25 Q1C 2M	
3	Define the term Universal Gas Constant. State its unit.	W24 Q1B 2M S25 Q1B 2M	
4	Define Dryness fraction of steam	W24 Q1C 2M	
5	Derive characteristics gas equation using Boyle's law and Charle's law.	W24 Q5B 6M	CO 2.1 U
6	Represent following gas processes on P-V and T-S diagrams :– i) Isochoric process ii) Isobaric process.	W25 Q3B 4M	CO 2.2 U
7	Represent Isobaric process and Isochoric process on P-V and T-S diagram.	W24 Q2C 4M	
8	Represent the isothermal process on P-V and T-S chart. State the relation to calculate the work done during isothermal process	S25 Q2C 4M	
9	The initial volume of 0.17 kg of a certain gas was 0.14 m^3 at a temperature of 15°C and a pressure of 1 bar. After adiabatic compression to 0.057m^3, the pressure was found to be 4 bar. Find - i) Gas constant ii) If ratio of specific heat is 1.407, find the value of C_P and C_V. iii) Change in internal energy.	W25 Q4E 4M	CO 2.2 A
10	2 kg of gas at 50°C is heated at constant volume until the pressure is doubled. Determine the final temperature and change in internal energy. (Assume C_v = 0.718 kJ/kgK)	W25 Q2B 4M	
11	A volume of 0.5 m^3 of gas at a pressure of 10 bar and 200°C is expanded in a cylinder to 1.2 m^3 at a constant pressure. Calculate the amount of work done by the gas and the increase in internal energy. Assume (C_p = 1.005 kJ/kg K and C_v = 0.712 kJ/kg K).	W24 Q2D 4M	
12	A vessel of 0.03 m^3 capacity contains gas at 350 kN/m^2. pressure and 35°C temperature. Determine the mass of the gas in the vessel. If the pressure of this gas is increased to 1.05 × 106 N/m2 while the volume remains constant, what will be the temperature of the gas? Take R = 290 J/kg K for the gas	W24 Q3A 4M	
13	A gas has a volume of 0.14 m^3 , pressure 1.6 bar and temperature 110°C. If gas is compressed at constant pressure until its volume becomes 0.112 m^3. Determine :– i) Work done in compression of gas. ii) Heat given out by gas.	W25 Q4A 4M	
14	Define the terms: i) Sensible Heat ii) Latent Heat	S25 Q1C 2M W25 Q4B 4M	CO 2.3 R
15	Explain the process of steam generation with the help of T-H chart.	S25 Q2D 4M W25 Q6A 6M	CO 2.3 U
16	Represent the Rankine cycle on the P-V and T-S chart. Name the various processes involved in it.	W25 Q3A 4M	CO 2.3 U

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UNIT-02

Ideal Gases & steam fundamentals

Total Hrs = 12
Total Marks = 16

Question pattern. Q1B, Q1C Q2C Q2B Q3A
2M 2M 4M 4M 4M

2.1 characteristics Gas Constant & universal gas Constant. Derivation of characteristics gas eqn [4M]

Ideal gas:-

The gas which follows gas law ie. $Pv = RT$ equation for all ranges of pressure & temperature such as gases are known as ideal gases or perfect gases.

Assumptions:-

a) No intermolecular force of attraction between the molecules.

b) large Number of molecules in finite volume

c) molecular collision within molecules or on the walls of container is perfectly elastic.

d) molecules are seperated by large distance compare to their own dimensions.

charles law:-

At constant pressure, volume of ideal gas is directly proportional to the absolute temperature.

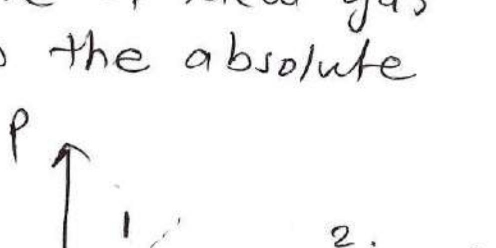
ie. at $P = \text{Const.}[C]$

$$V \propto T$$

$$\therefore V = CT$$

$$\therefore \boxed{\frac{V}{T} = C}$$

or $\frac{V_1}{T_1} = \frac{V_2}{T_2} = \text{const}$



Boyle's law:-

At constant temperature,
Pressure of ideal gas is
~~directly~~ proportional to the
Inversely
volume of gas.

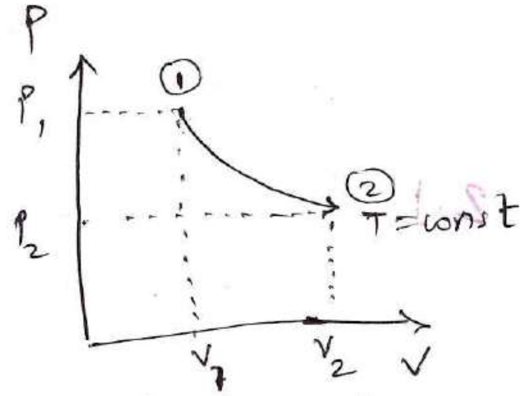


fig. P-V-diag

i.e. if, Temperature [T] = Const. [c]

then, $\underset{(P)}{\text{pressure}} \propto \dfrac{1}{\text{Volume}[V]}$

$$\therefore \quad P \propto \frac{1}{V}$$

$$\therefore \quad P = \frac{\text{constant}}{\text{volume}}$$

$$\therefore \quad \boxed{PV = \text{Constant}}$$

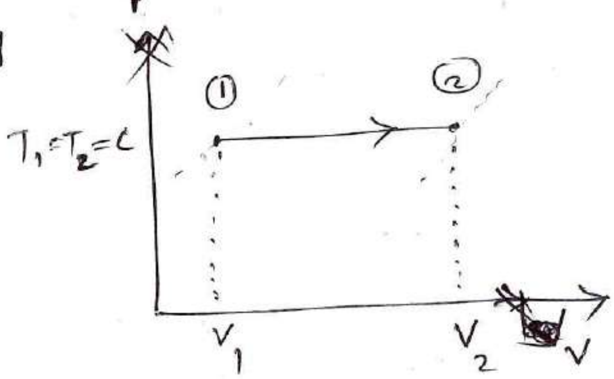


fig. T - V diagram

or $\boxed{P_1V_1 = P_2V_2 = \text{Constant [c]}}$

Gay-Lussac's law:-

Pressure of given mass of gas is directly proportional to its absolute temperature, at constant volume

i.e. Pressure [P] ∝ Temp [T]

$$\therefore \quad P = \text{Constant} \times T$$

$$\therefore \quad \boxed{\frac{P}{T} = \text{Constant}} \text{ at } \underline{V = \text{const}}$$

Now, $\boxed{\dfrac{P_1}{T_1} = \dfrac{P_2}{T_2} = \text{Const [c]}}$

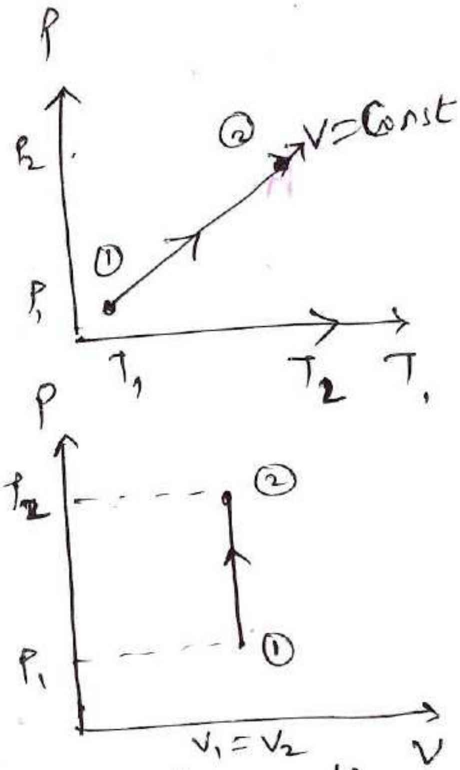
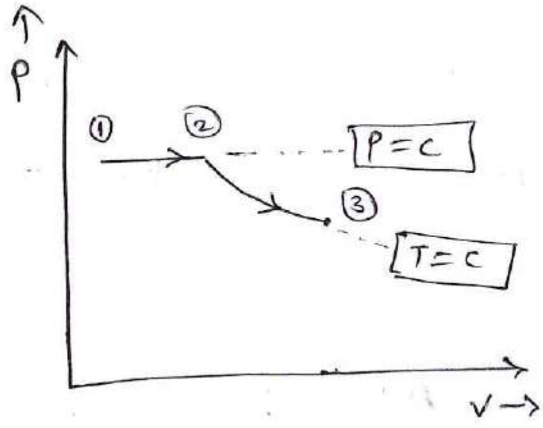


fig. P-V & T-V diag.

Derivation of characteristics gas equation:-[4M]



consider 1kg of gas at state ① & goes to the ~~chang~~ state ③ through state ②.

let $P_1 V_1 T_1$, $P_2 V_2 T_2$ & $P_3 V_3 T_3$ properties corresponding to state ①, ② & ③ resp.

process ① → ② = constant pressure process.

$$\therefore \frac{V_1}{T_1} = \frac{V_2}{T_2} = \text{Constant} \quad - (I)$$

Process ② → ③ = Constant volume process

$$\therefore P_2 V_2 = P_3 V_3 = C \quad — (II)$$

$$\therefore V_2 = \frac{P_3 V_3}{P_2} \quad — (III)$$

~~[illegible]~~ from eqⁿ (I)

$$\therefore V_2 = \frac{V_1}{T_1} \times T_2 \quad - (IV)$$

∴ from eqⁿ (III) & (IV)

$$\frac{P_3 V_3}{P_2} = \frac{V_1}{T_1} \times T_2$$

since, $P_2 = P_1 = P$ & $T_2 = T_3$

$$\therefore \frac{P_3 V_3}{P_1} = \frac{V_1}{T_1} \times T_3$$

$$\therefore \frac{P_3 V_3}{T_3} = \frac{P_1 V_1}{T_1}$$

ie. $\boxed{\frac{P_3 V_3}{T_3} = \frac{P_1 V_1}{T_1} = \text{constant}}$

characteristics gas constant [R] :-

$\therefore$ $\boxed{\frac{PV}{T} = \text{Constant}[R]}$ — Known as characteristics gas equation.

where, R = characteristics gas ~~equation~~ Constant
= unit ⇒ $J/kg.K$. or KJ/kgK
= $287\ J/kgK$ for air. = $0.287\ KJ/kgK$

For mass m kg.

$$PV = mRT \quad — \text{Ⓐ}$$
$$Pv = RT \quad — \text{Ⓑ}$$
} ideal gas equation

where, p = Pressure in N/m^2, T = temp in °K
v = volume in m^3, R = char. gas constant [J/KgK]

Universal gas Constant [Ru]

It is a product of molecular weight of gas [M] & characteristics gas constant (R)

$\therefore$ $\boxed{R_u = R \times M}$

where, R_u = universal gas constant [J/kmol K]
R = characteristics gas constant [J/kgK]
M = molecular weight (kg/kmol)

for all gases, Ru is same.

$$R_u = 8.314\ J/mol.K$$
$$\boxed{R_u = 8.314\ KJ/Kmol.K}$$

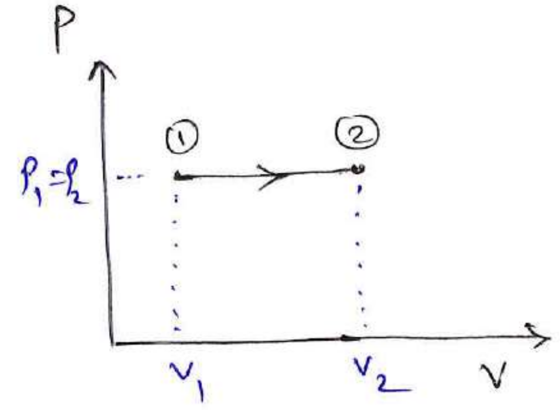
$\therefore$ $\boxed{R_u = R_1 \times M_1 = R_2 \times M_2 = R_3 \times M_3}$

for n-moles, eqn Ⓐ will be

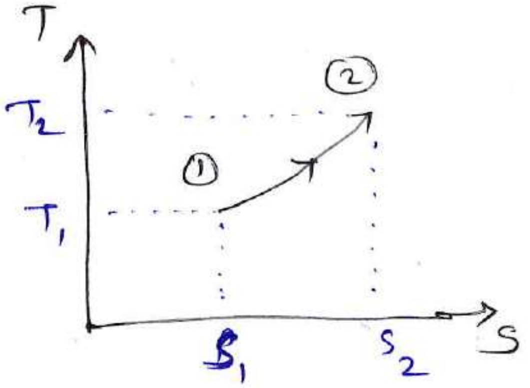
$$\boxed{PV = nR_uT}$$

2.2 Ideal gas processes :→ 4M - Pv & T-s diagram

A] Isobaric process :- During a process, Pressure is remains constant.



Pv - diagram



Ts - diagram.

Consider a Constant pressure heating process of 1 kg of gas in closed container.

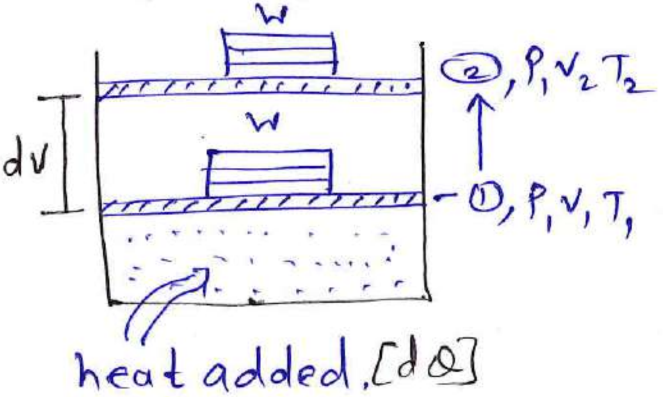


fig. Constant pressure heating.

During this process gas expanded from state ① to state ② with pressure as constant [$P_1 = P_2$] & volume increases from V_1 to V_2

let dQ = amount of heat added to system.

Now,

$$dw = \text{work done by system} = P.dv = P[V_2 - V_1]$$

According to I^{st} law of Thermodynamics,

$$dQ = dU + dW = dU + Pdv$$

$$dQ = d[U + dv]$$

$$\boxed{dQ = dH}$$

heat supplied is utilised to increase the enthalpy.

characteristics equation :-

a] for isobaric process $P = C$.

$$\therefore \left[\frac{V_1}{T_1} = \frac{V_2}{T_2} = \text{constant}\right]$$

b] heat supplied to system.

$$dQ = dH = m\,C_p[T_2 - T_1]$$

c] work output.

$$dW = P.dV = P[V_2 - V_1]$$

d] change in Enthalpy, $dH = dQ = m\,C_p[T_2 - T_1]$

e] change in entropy $[dS] = m\,C_p \ln\left(\frac{T_2}{T_1}\right)$

2]

2] Isochoric process [$V=C$] :- During this process, volume remains constant.

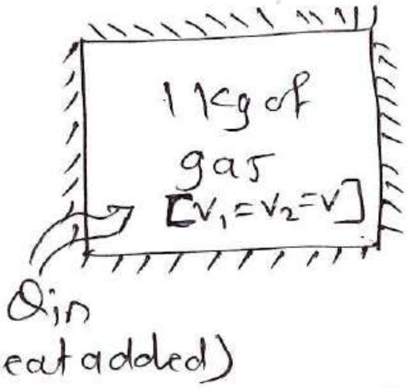


fig. constant vol^m heating process.

consider 1 kg of gas contained in fixed container.

1] work done $[dW] = P.dV$

$$= P[V_2 - V_1]$$
$$= P[0]$$
$$= 0$$

2] by I^{st} law of Thermodynamic

$$dQ = du + dW$$
$$dQ = du \Rightarrow m\,C_v\,dT$$
$$\therefore dQ = m\,C_v[T_2 - T_1]$$

heat added at constant volume is utilized to increase the internal energy of system.

3] For isochoric process, $\boxed{\frac{P_1}{T_1} = \frac{P_2}{T_2} = \text{constant}}$

⑥ 4] $dS = m\,C_v \ln[T_2/T_1]$.

3] Isothermal process [T=C] :-

- It is a process [Expansion or Compression] during which temperature of system is remains constant
- It is very very slow process.

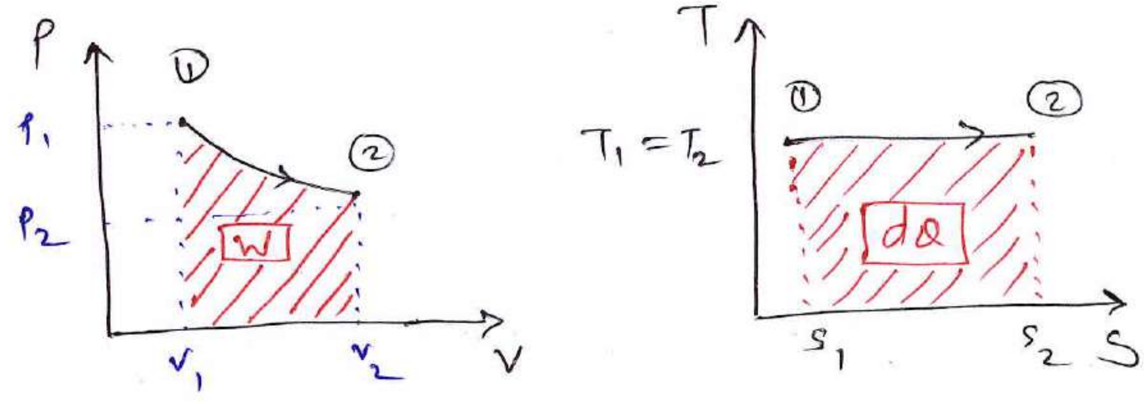


fig. P-V & T-S diagram.

1] For isothermal process T = Const.

$$\therefore \boxed{P_1 V_1 = P_2 V_2}$$

2] change in internal energy (du) $= mC[T_2 - T_1]$

$$= 0 \quad [\because T_1 = T_2]$$

3] ~~By~~ work done $[dW] = P_1 V_1 \ln\left[\frac{P_1}{P_2}\right]$ OR

$$[dW] = P_1 V_1 \ln\left(\frac{V_2}{V_1}\right)$$

4] heat supplied $[dQ] = du + dw$

$$\therefore \quad dQ = dw = P_1 V_1 \ln\left(\frac{V_2}{V_1}\right)$$

5] change in entropy

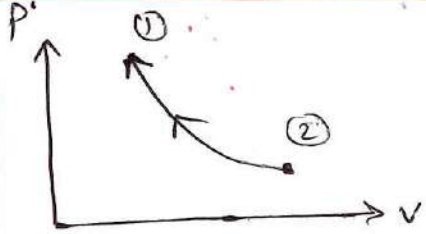
$$\Delta s = mR \ln\left(\frac{V_2}{V_1}\right)$$ OR

$$\Delta s = mR \ln\left(\frac{P_1}{P_2}\right)$$

4] Isentropic process/Reversible adiabatic process :-

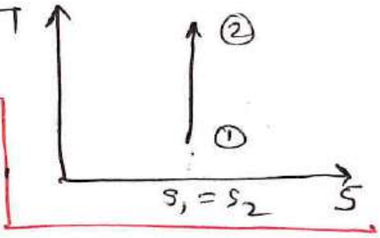
It is a process during which entropy of system Remains constant. [No transfer of heat].
ie. change in entropy [ds] = 0.

a] The process is represented by $PV^{\gamma} = \text{constant}$
where, $\gamma = \frac{C_P}{C_V}$ = sp. gas constant
for, air, $\gamma = 1.4$



b] $$\frac{T_2}{T_1} = \left[\frac{P_2}{T_1}\right]^{\frac{\gamma-1}{\gamma}} = \left[\frac{V_1}{V_2}\right]^{\gamma-1}$$

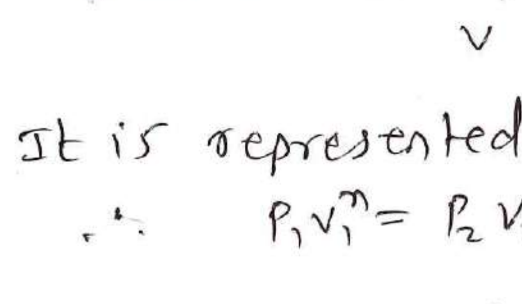
c] heat supplied [dQ] = 0

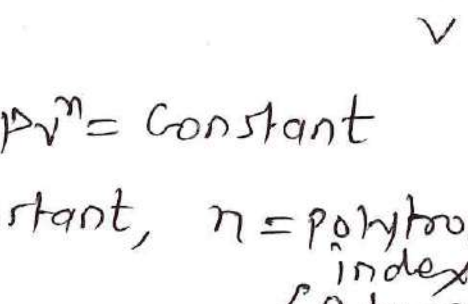


d] work done [dw] = $\frac{P_1V_1 - P_2V_2}{\gamma - 1}$

e] system is insulated from surrounding.

5] Polytropic process :- [PV^n = constant]





1] It is represented by PV^n = Constant
∴ $P_1V_1^n = P_2V_2^n$ = constant, n = polytropic index [0 to ∞]

2] $$\frac{T_2}{T_1} = \left[\frac{P_2}{T_1}\right]^{\frac{n-1}{n}} = \left(\frac{V_1}{V_2}\right)^{n-1}.$$

3] work done [dw] = $\frac{P_1V_1 - P_2V_2}{n-1}$

4] change in internal energy
$du = m c_v [T_2 - T_1]$

5] Heat supplied [dQ] = du + dw.

Other Formulae:-

1] $PV = mRT$
$Pv = RT$
$PV = nR_uT$
} ideal gas equation

2] change in enthalpy [dh] = mc_pdT.

3] change in internal Energy [du] = mc_vdT

4] $\gamma = \frac{c_p}{c_v}$ ⇒ sp. heat ratio

5] $c_p - c_v = R$

for air, $c_p = 1.005$ KJ/kgK,
$c_v = 0.718$ KJ/kgK
$R = 0.287$ KJ/KgK.

sp. heat at constant pressure = c_p.
sp. heat at constant volume = c_v.

Problems on ideal gas processes.

A] Constant volume process problem-

Q. 2 Kg of gas at 50°C is heated at constant volume until the pressure is doubled. determine the final temperature & change in internal energy [Assume $C_v = 0.718$ KJ/kgK]. [W-25, Q2B, 4M]

→ $m = 2\,kg$, $T_1 = 50^\circ C = 50 + 273 = 323^\circ K$

$\boxed{V_2 = V_1 = V = const}$, $P_2 = 2P_1$

$T_2 = ?$ $\Delta U = ?$

i] we know, for constant volume process,

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\therefore \frac{\cancel{P_1}}{323} = \frac{2\cancel{P_1}}{T_2}$$

$$\therefore \boxed{T_2 = 323 \times 2 = 646^\circ K}$$

$$= [646 - 273]^\circ C$$

$$\boxed{T_2 = 373^\circ C}$$

ii] we know, change in int. Energy,

$$\Delta U = m C_v [T_2 - T_1]$$

$$= 2 \times 0.718 [646 - 323]$$

$$= 2 \times 0.718 \times 323$$

$$\boxed{\Delta U = 464\,kJ.}$$

H.W

Q. Air with initial volume $8\,m^3$, pressure 3.9 bar, & temperature 10°C is filled into fixed (closed) container. It is heated to 75°C at constant volume.

Find the internal Energy change & heat supplied.

⑩ take, R = 287 KJ/KgK, $C_v = 0.1695$ KJ/KgK.

Problem on Constant pressure process:-

Q:

A volume of $0.5 m^3$ of gas at a pressure of 10 bar & 200°C is expanded in cylinder to $1.2 m^3$ at a Constant pressure. Calculate the amount of work done by the gas & the increase in internal energy. [W-24, Q2B, 4M]

Assume [$C_p = 1.005$ kJ/kgK, & $C_v = 0.712$ kJ/kgK]

Ans:- $V_1 = 0.5 m^3$, $P_1 = 10 bar = 10 \times 10^5 N/m^2$ & $T_1 = 200°C$

$V_2 = 1.2 m^3$, $\boxed{P_1 = P_2 = P = const}$

$= (200+273)°K$

$= 473°K$

i] for constant pressure process:-

$$\text{Work done} = P[V_2 - V_1] \Rightarrow 10 \times 10^5 [1.2 - 0.5]$$

$$= 7 \times 10^5 J \Rightarrow 700 \times 10^3 J \Rightarrow 700 kJ$$

$$\therefore \boxed{\text{Work done} = 700 kJ}$$

ii] for constant pressure process:-

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \Rightarrow T_2 = T_1 \left[\frac{V_2}{V_1}\right]$$

$$T_2 = 473 \left[\frac{1.2}{0.5}\right]$$

Now,

$$\boxed{T_2 = 1135°K,}$$

Now, $R = C_p - C_v \Rightarrow 1.005 - 0.712 \Rightarrow 0.293$ kJ/kgK

also, $PV = mRT \Rightarrow m = \frac{PV}{RT} \Rightarrow \frac{100000 \times 0.5}{293 \times 473.} \approx 3.6 kg$

Now, $\Delta U = mC_v [T_2 - T_1] = 3.6 \times 0.712 \times 10^3 \times [1135 - 473]$

$= 1700 kJ$

Practice problem on constant volume & constant pressure process:

Q.1] A vessel of $0.03\,m^3$ capacity contains gas at 350 KN/m² pressure & 35°C temperature. determine the mass of gas in the vessel. if the pressure of gas increased to $1.05\times10^6\,N/m^2$, while the volume remains constant, ~~while the~~ what will be the temperature of gas? Take $R = 290\,J/kg\,K$. [W-24] 4M

Q.2] A gas has a volume of $0.14\,m^3$, pressure 1.6 bar & temperature 110°C. if gas is compressed at constant pressure until its volume becomes $0.112\,m^3$. determine i] work done in compression ii] heat given out by gas. [W-25].

Problem on adiabatic process:-

The Initial volume of 0.17 kg of a certain gas was $0.14\,m^3$ at a temperature of 15°C & a pressure of 1 bar. after adiabatic compression to $0.057\,m^3$, the pressure was found to be 4 bar. find. i] Gas constant ii] Cp & Cv if $\gamma = 1.407$ iii] ΔU.

→ $P_1 = 1\,bar = 1\times10^5\,N/m^2$, $V_1 = 0.14\,m^3$, $m = 0.17\,kg$,
$T_1 = 15°C = 15 + 273.15 = 288.15°K$

Now, we know, $P_1V_1 = mRT_1 \Rightarrow R = \frac{P_1V_1}{mT_1}$,

$$\therefore R = \frac{10^5 \times 0.14}{0.17 \times 288.15} \Rightarrow \underline{\underline{285.8\,J/kg\,K}}$$

Now, we know, $C_p - C_v = R$; $\gamma = \frac{C_p}{C_v}$.

2.3 steam fundamentals:-

steam:- gaseous Phase of water.

A] Application of steam:-

a) Industrial process heating.

b) power generation. through steam turbines.

c) sterilization to destroy deep seated weeds & pests.

d) To drive massive turbine-driven compressors.

B] Generation of steam at Constant pressure with representation on T-H chart:- [4M-IMP]

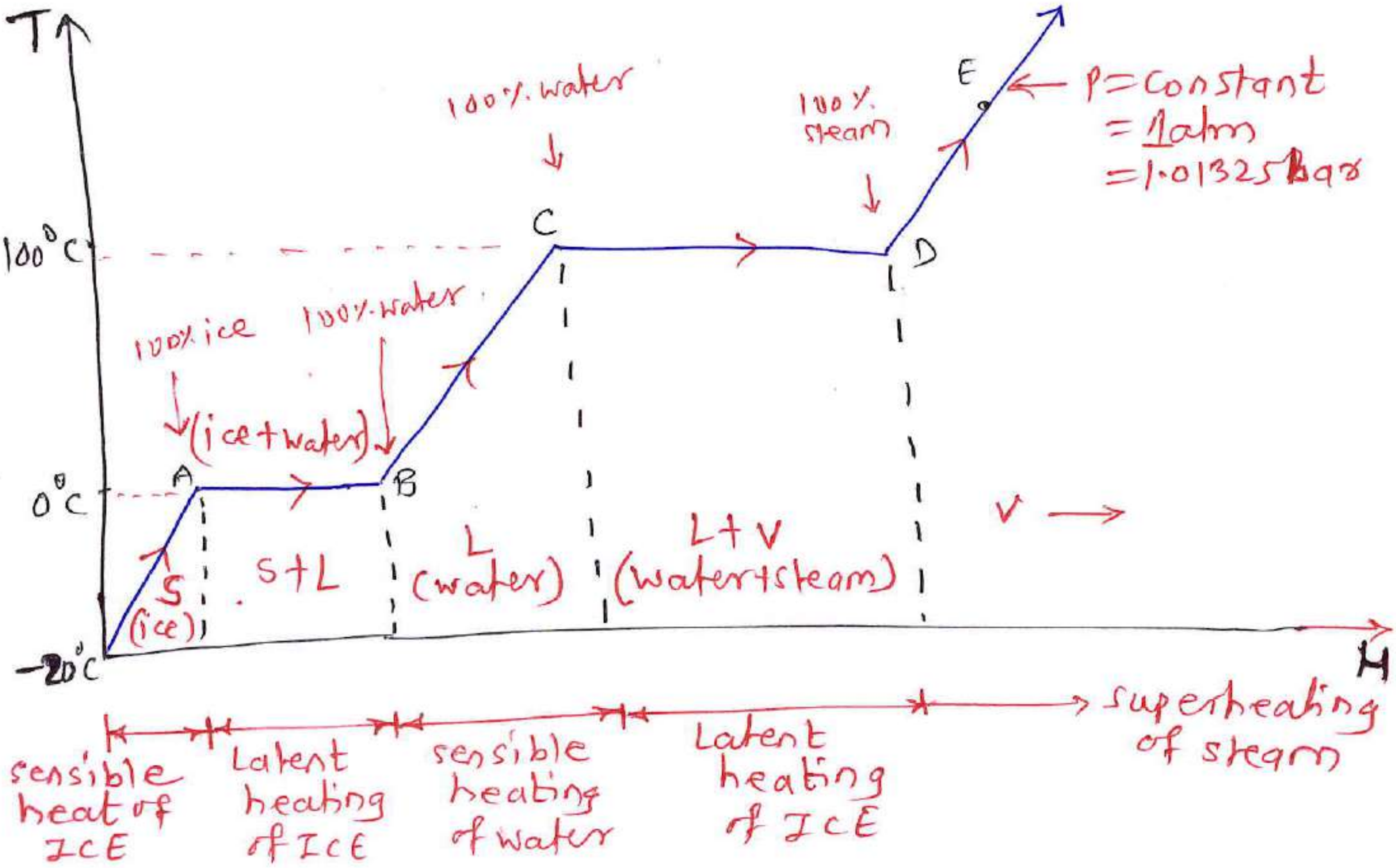


fig. Temperature [T] - Enthalpy [H] chart of formation of steam at constant pressure

- Consider a ice at -20°c, is heated & converted into steam at constant pressure [P = 1atm].

$\because \quad C_p = \gamma C_v$

$\therefore \quad R = \gamma C_v - C_v \Rightarrow C_v[\gamma - 1]$

$$C_v = \frac{R}{\gamma - 1} \Rightarrow \frac{285.8}{1.407 - 1} \Rightarrow 0.702 \text{ kJ/kgK}.$$

Now, $C_p = 1.407 \times 0.702$

$= 0.988 \text{ kJ/kgK}$

iii) final temp:-

$$P_2 V_2 = mRT_2$$

$$\therefore \quad T_2 = \frac{P_2 V_2}{mR} = \frac{4 \times 10^5 \times 0.057}{0.17 \times 285.8}$$

$$= 469.27 \text{ K}$$

iv) change in Internal Energy [ΔU]:-

$$\Delta U = mc_p[T_2 - T_1]$$

$$= 0.17 \times 0.7022 \times [469.27 - 288.15]$$

$$\boxed{\Delta U = 21.62 \text{ kJ}}$$

A] Process [-20°c to 0°c] :- sensible heating of ice.
Temperature of ice increases from -20°c to 0°c.

B] Process [0°c] :- Latent heating of ice at constant
[A-B] temperature 0°C.
ice starts converting into water, & completed at point B.

C] Process [B-C] :- Sensible heating of water.
Temperature of water increases from 0°c to 100°c, steam between point B & C, is wet steam.

D] Process [C-D] :- Latent heating of water at 100°c.
Water starts Converting into steam & completed at point D. steam found at point D is dry saturated steam.

E] Process after point D :- sensible heating of steam.
- The Temperature of steam increases further, & goes on increasing with heating.
- This heating process is known as superheating of steam.
- steam found at point E is superheated steam

Sensible heat :- It is a amount of heat added to ~~matter or~~ water during a temperature raise from 0°c to 100°c.
It is calculated as follow.

$$\text{sensible heat} = m \times cp [T_2 - T_1]$$

m = mass of water in kg, cp = sp. heat of water [4.18 kJ/kg]

$T_2 = 100^\circ C$, $T_1 = 0^\circ C$, let $m = 1 kg$

$\therefore$ sensible heat $= 1 \times 4.18 \times [100 - 0]$

$= 418 \text{ KJ}$.

Note:- No phase change during a process.

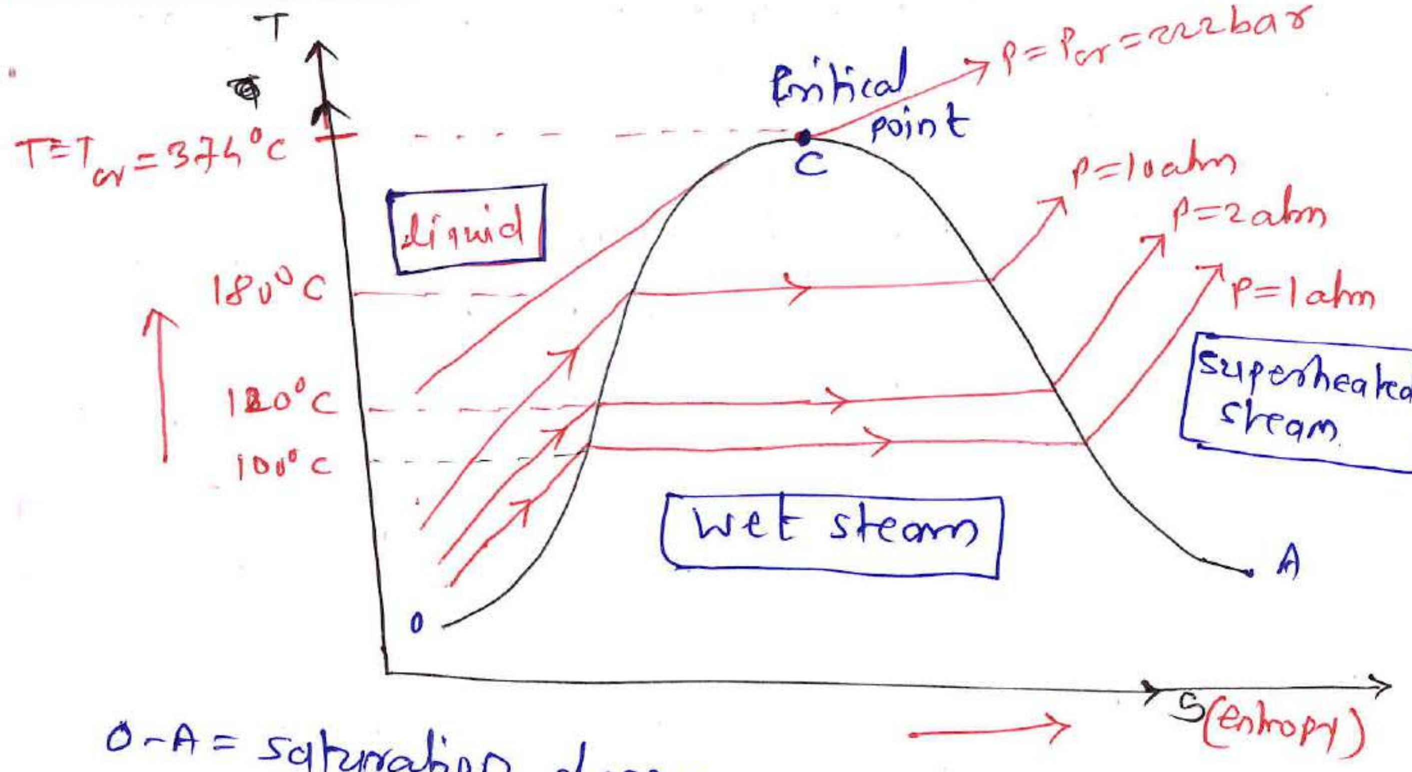
Latent heat:-

It is a amount of heat added to water during heating of water at constant temperature. [say 100°c at 1 atm].

During this heating water starts converting into steam, temperature of water remains constant.

It is a hidden heat or heat of vaporization of water.

T- s- diagram :-



O-A = saturation dome

O-C = saturated liquid line, water is dry sat. liquid

C = critical point, $T = T_{cr} = 374^\circ C$ & $P = P_{cr} = 222 bar$

C-A = saturated vapour line.
steam is dry saturated steam/vapour.

Types of steam:- [4M-IMP]

a] Dry saturated steam:-

"steam containing no water droplet in it."

The temperature of steam is saturation temperature of water

i.e. $T_{(steam)} = T_{(sat\ @\ given\ pressure)}$

b] wet steam:-

"steam containing water particles in suspended form".

c] superheated steam:-

"The steam at a temperature greater than saturation temperature of water at given pressure."

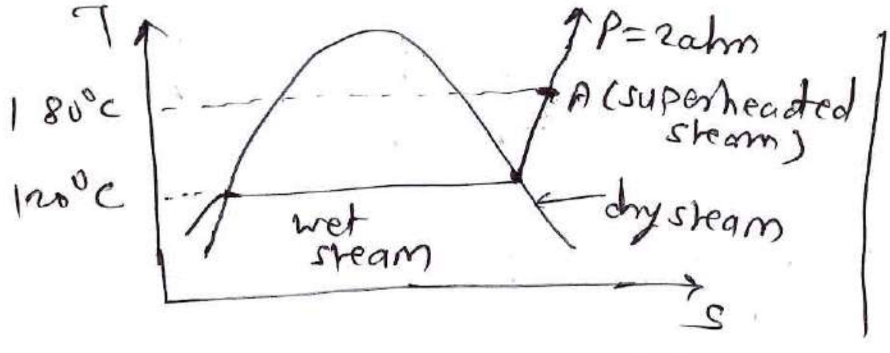
$T_{steam} > T_{sat.\ @\ given\ pressure}$

d] Degree of superheat:-

"The difference between temperature of superheated steam & the saturation temp. corresponding to given pressure.

degree of superheat = $T_{sup} - T_{sat\ @\ given\ pressure}$

eg.



degree of superheat

$= 180^{\circ} - 120^{\circ}$

$= 60^{\circ}C$

e] Dryness fraction of steam:-

- It is also known as quality of steam.
- It is a ratio of mass of dry steam to the mass of wet steam:-
- denoted by 'x'.

$$\therefore \text{dryness fraction } [x] = \frac{\text{mass of dry steam}}{\text{mass of wet steam}}$$

$$= \frac{m_g}{m_w + m_g}$$

- It's value lies betn 0 to 1, for wet steam.
  0 for liquid. & 1 for dry steam

f]:- Total heat or Enthalpy of steam:- [H or h]

The total heat contain of steam above water at 0°C is known as Enthalpy of steam.

Enthalpy of wet steam, $\boxed{h = h_f + x h_{fg}}$ ---- in [kJ/kg]

h_f = enthalpy of fluid/liquid, in kJ/kg

x = dryness fraction

$h_{fg} = (h_g - h_f)$, latent heat of vapourization

h_g = enthalpy of dry steam in [kJ/kg].

Enthalpy of dry steam $(x = 1)$ $\quad h = h_f + 1 \times [h_f - h_g]$

$$\boxed{h = h_g}$$

Enthalpy of superheated steam $[h_{sup}]$ $= h_g + C_p [T_{sup} - T_{sat}]$

Specific volume:-

It is a volume of steam per kg mass of steam.

unit = m³/kg

a) for wet steam

$$\boxed{v_{\text{wet steam}} = v_f + x v_{fg}}$$

v_f = sp. vol^m of fluid/liquid. in m³/kg

$v_{fg} = (v_g - v_f)$,

b) for dry saturated steam, $\boxed{v = v_g}$

c) for superheated steam, $\boxed{v_{sup} = \frac{T_{sup}}{T_{sat}} \times v_g}$.

Entropy:-

a) for wet steam $(S)_{\substack{\text{wet}\\\text{steam}}} = S_g + x S_{fg}$

b) for dry saturated steam $[S] = S_g$

c) for superheated steam $[S] = S_g + C_p \ln\left[\frac{T_{sup}}{T_{sat}}\right]$

USE of steam table:-

Q.1] determine dryness fraction of steam if 0.8 kg of water is suspended in 35 kg of dry steam.

→ $m_w = 0.8$ kg, $m_g = 35$ kg, $x = ?$

Now, $x = \frac{m_g}{m_w + m_g} \Rightarrow \frac{35}{35 + 0.8} \Rightarrow 0.977$

$$\boxed{x \approx 0.98}$$

[illegible]

Q. Find the Enthalpy of steam if $T_{sat} = 90°C$, entropy of steam is 7.276 KJ/KgK. Assume sp. heat at constant pressure of superheated steam as 2.1 KJ/KgK.

→ $T_{sat} = 90°$; entropy of steam $[S] = 7.276$ KJ/KgK

$(C_p)_{sup} = 2.1$ KJ/KgK

$h = ?$

Soln. → from steam table, at $T_{sat} = 90°C$, $P_{sat} = 0.701$ bar

$(S_g)_{at\ 90°C} = 7.480$, $h_f = 376.9$ KJ/Kg

$h_{fg} = 2283.2$ KJ/Kg

Now, $(S_g)_{at\ 90°C} > [S]_{steam}$

So, steam is wet steam.

So, for wet steam, $h = h_f + x h_{fg}$

here, x is Calculated by,

$$S = S_f + x S_{fg}$$

from steam table @ $T_{sat} = 90°C$

$S_f = 1.193$ KJ/KgK

$S_{fg} = 6.287$ KJ/KgK

$\therefore$ $7.276 = 1.193 + x \times 6.287$

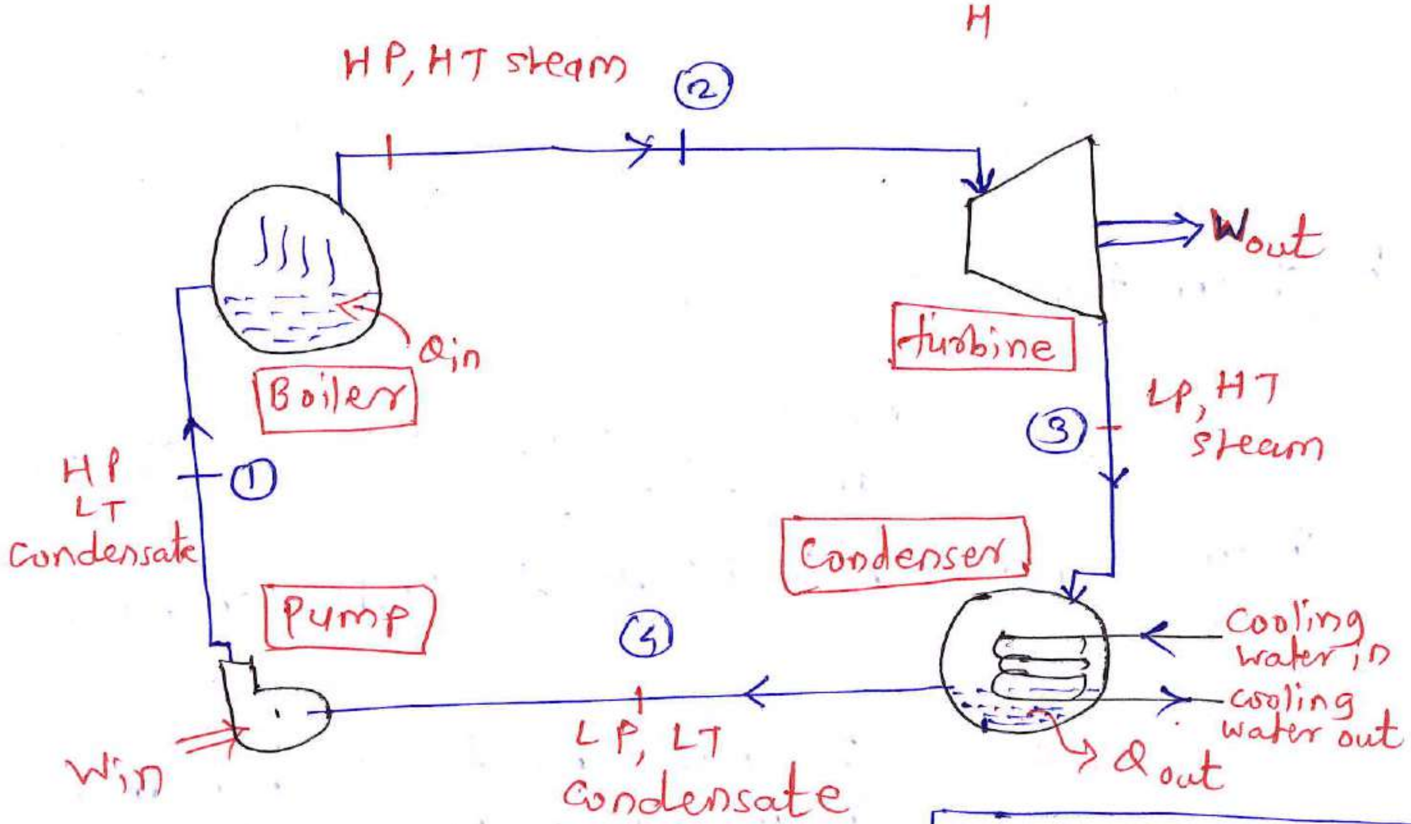
$\therefore$ $\boxed{x = 0.96}$

$\therefore$ $h = h_f + x h_{fg}$

$= 376.9 + 0.96 \times 2283.2$

$\boxed{h = 2.56 \times 10^3 \text{ KJ/Kg}}$

Rankine cycle & its Representation on P-v & T-s diagram



HP = high pressure
HT = high Temp.
LP = low pressure
LT = low temp.

fig. Rankine cycle.

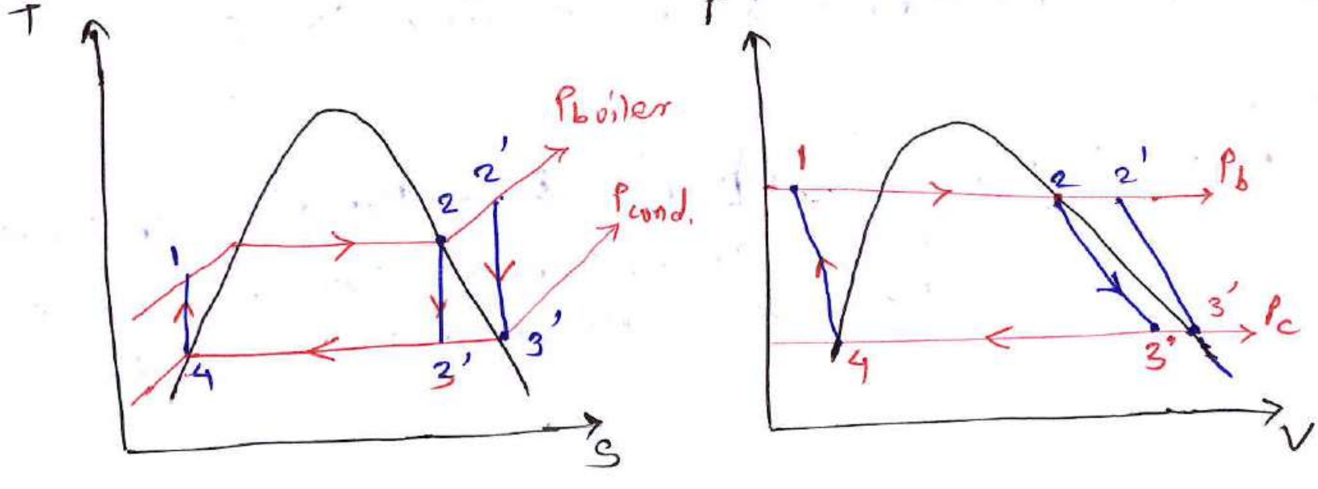


fig. P-v & T-s diagram of Rankine cycle.

Rankine cycle consists of 4 components.

a] Boiler :- constant pressure heat addition along a process [1-2] [isobaric process]

HP & LT water is heated at constant pressure by burning of fossil fuels & converted into HP, HT steam.

~~[illegible] cycle [illegible] representation on [illegible]~~

The steam coming from boiler it may be ~~dry~~
a) dry saturated steam OR b) superheated. steam

b] **steam turbine**:- Isentropic Expansion of steam from boiler pressure to condenser pressure along a process [2-3] OR [2'-3'].

steam expands from HP, HT to LP, HT. steam.

c] **steam Condenser**:- Isobaric heat rejection from steam along process [3-4] OR [3'-4].

- steam from turbine after doing work is condensed into condenser at constant pressure by circulating over cooling coils.

d] **Feed pump**:- Isentropic ~~[illegible]~~ pumping of condensate from condenser pressure to boiler pressure along a process [4-1]