fluid prop → pressure, temp, density ~~etc~~, velocity, discharge

- Newton's Law of viscosity = $\tau \propto \frac{du}{dy}$, $\tau = \mu \frac{du}{dy}$ → {measure of viscosity}

Imp {Exam+viva}

Q) Bernoulli Equation {Assumptions + Derivation}

- Ideal fluid: It is should/capable to flow continuously means ~~the~~ fluid has no resistance or viscosity is zero
- Fluid is steady: {steady fluid} means properties of fluids with respect to time does not change is ~~steady fluid~~ is called steady flow
- Unsteady flow: change in temp with respect to time
- Flow is incompressible: no variation in fluid density (ρ) → $\frac{m}{V}$ → mass/volume
- Flow is one directional {means fluid flow in one dimension eg X-axis}
- Flow is continuous, velocity is uniform

Imp Laminar and Turbulent flow

Laminar: ~~St~~ When a fluid particle follow well define path

Turbulent flow: fluid particles follow zig-zag Path

- In aeroplane there is laminar flow is tried to applied

{RE} Raynold number: Ratio of inertia forces to the viscous flow ($F = ma$)

Viscous force: $F = \frac{ma}{\tau \times A}$, ~~$\sigma$~~ $= \frac{F}{A}$

P.E = mgh

$KE = \frac{1}{2}mv^2$

non uniform cross section area

convergent tube = and decrease 1 → 2

→ discharge

$\uparrow Q = \uparrow A \cdot V$ — $\uparrow V \propto \frac{1}{A \downarrow}$ → velocity, → Area

My @anubhav

Raynolds number ≤ 2000 is laminar

Raynolds number ≥ 2000, is turbulent

- Bernoulli Theorem Derivation V.V. Imp {Q) Derive bernoulli theorem for incompressible fluid}

i) using Mass Conservation: {$M_1 = M_2$}

$\rho = \frac{M}{V}$ mass con

At section 1,

$\rho_1 = \frac{M_1}{V_1} = \frac{M_1}{A_1 \times ds_1}$ → displacement at section 1

$\boxed{V = A_1 \times ds_1}$ — ①

$\boxed{M_1 = \rho_1 . A_1 . ds_1}$ → $A_1 ds_1 = \frac{M_1}{\rho_1}$

At Section 2,

$\boxed{M_2 = \rho_2 . A_2 . ds_2}$ → $A_2 ds_2 = \frac{M_2}{\rho_2}$ — ②

ii) Net flow Work

earlier $W = F \times$ displace

now, work done =

$W = P \times dv$

$W = P.V$ → volume not pressure

$W = P \times V$

$W_1 = P_1 \times A_1 ds_1$

$\boxed{W_1 = P_1 \times \frac{M_1}{\rho_1}}$

$\boxed{W_2 = P_2 \times \frac{M_2}{\rho_2}}$ — ③

① Mass conservation : $m_1 = m_2 = m$
② fluid is incompressible so $\rho_1 = \rho_2 = \rho$

put in ③

∘ Net work, (iii)

$$W_{net} = W_1 - W_2$$

$$\Rightarrow \rho_1\left(\frac{m_1}{\rho_1}\right) - \rho_2\left(\frac{m_2}{\rho_2}\right)$$

$\Rightarrow m_1 = m_2 = m$
$\Rightarrow \rho_1 = \rho_2 = \rho$

iv) Net potential Energy

$$(P.E)_{net} = mgh_1 - mgh_2$$

$$\boxed{(P.E)_{net} = mg(h_1 - h_2)}$$

v) Net kinetic Energy

$(K.E)_{net} =$

→ more K.E at section 2 ~~hence~~ higher - lower

$$\boxed{(K.E)_{net} = \frac{1}{m} \quad \frac{1}{2} m (V_2^2 - V_1^2)}$$

In this all we need to increase K.E

T.E = kinetic + P.E + pressure energy

Application of fluids :-

1) Pump
2) Compressure
3) Turbine

∘ ~~Tur~~ If a machine receives energy from flowing water, then it is called turbine

∘ If a machine gives energy to the (flowing) water, then it is pump.
∘ pump and turbine are hydrolic machines ☆☆

hydrolic machine converts hydrolic energy to mechanical energy.

∘ If mechanical energy is converts into hydrolic energy then it is pump

∘ PUMP :- { reciprocating : cylinder + piston reciprocating
Value : suction A discharge { centrifugal pump
Single : only one discharge, forward
double : 2 discharge on both 180 and 360° or in both forward ad inward

∘ Euler = newton second law

∘ S = direction
∘ ds = height of cylinder
∘ weight acting downward $dW = mg$
we know $\rho = \frac{m}{V}$
$m = \rho V$
So, $W = \rho V g$
$= \rho g \, \underbrace{dA}_{\text{area very small}} \, ds \rightarrow V$
ds → length of cylindrical element in s-direction

∘ Volume ← $V = A \times L$
$P = \frac{F}{A}$ or PdA
So $F = PA$ but partial differential (∂) shows very very small / slow change

$\left(P + \frac{\partial P}{\partial s} ds\right) dA$ → exit → Pressure force
→ extr pressure difference from environment

$\cos = \frac{B}{H}$

dz = height of cylinder

o Turbine {Hydrolic energy → Mechanical Energy}

1) Impulse Turbine or Pelton wheel turbine / velocity turbine / Tangential force turbine
2) Reaction Turbine

penstock → carry water from resevoir to Turbine
blade shape → hemisphere shape
imphaler → circular disk consists of rotating blades.

o Impulse turbine {water K.E converted into pressure energy / Force}
means impulse of jet
o Drawback → need water reservoir at high head, means need $PE = mgh$ which is then converted in K.E then pressure energy
high head about 100m

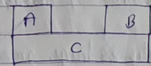
o nozzel use: It is a wheel control used for control the flow of water, guide water to imphaler, converts water to high velocity jet.

o Reaction ~~Energy~~:- Turbine :- {uses K.E + Pressure energy}
o Guide vanes or fixed blade increases the K.E
same work as nozzel
Q) Classification of reaction turbine
Ans → francis, kaplan and their uses
fixed blades are fix in casing
moving blade fix in shaft

Heat given to system → +
Heat taken from system → −

EQUILIBRIUM:-

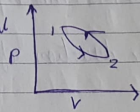
o Zeroth laws:-
o 1 step → Take three bodies



$T_A = T_C$, $T_B = T_C$, then $T_A = T_B$
it concepts of temprature management. gives

o I^{st} Law of Thermodynamics:- ☆

1) For a cycle:- Initial and final states are same, valid only for a cylic, not process



Cyclic → $\boxed{J(\Sigma Q) = \Sigma W}$ → work
Energy (heat)
Joul equivalent
All the heat is equal to work done transfer

o In process there is change in state / properties

process → $\boxed{Q = \Delta U + W}$

$\boxed{\partial Q = dU + \partial W}$ → first law of thermodynamics
change in heat → change in work done
U → internal energy
dU → change in internal energy
total energy → $\underbrace{P.E + K.E}_{\text{very small hence neglected}} + U$

P V
T ρ
V
in these we d not ∂
and we ∂ in Q and W
heat

- II^{nd} law of thermodynamics :- / Directional law → MCQ

Source : Supply large amount of heat (Q_s), without change in temp

Sink : It is a heat reservoir, it can absorbe large amount witout change in temp

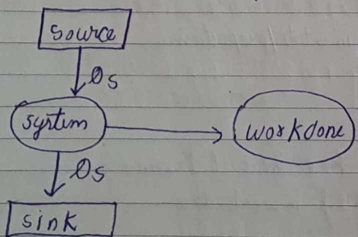
An engine / thermodynamic machine needs both Source and sink.

- Directional laws → It state direction of process

$\boxed{\begin{matrix} H \to L \\ L \to H \end{matrix}}$

☆☆

1) Kelvin Planks Statement : It is imposible construct such a device which can produce work by exchanging heat from single reservoir.



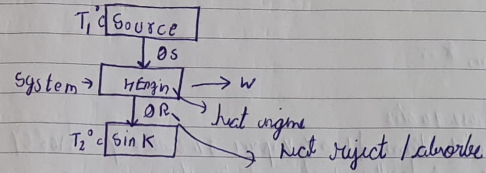
$\boxed{Q_s = W}$

if any one source and sink is then it is imposible to construct

eg → all engine

MCQ [H–L we get work done ↓ { natural }
if L–H we get change in direction of work done ↑

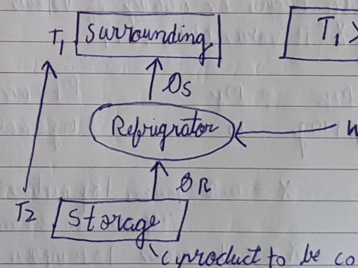
- Engine/Heat Engine : It is a device which convert part of heat into work done and remaining in atmosphere



$\eta_{eff} = \frac{O/P}{I/P} = \frac{W}{Q_s} \to Q_s - Q_R$

☆☆

2) Clausius Statement :- It is imposible to construct such a device which can transfer heat from lower temp to higher temp without any external help / work done



$\boxed{T_1 > T_2}$

eg : ~~refrg~~ refrigrator

* Steam is vapour of water, pure substance → same chemical composition

○ BOILER: Are devices which produce steam at very high pressure and very high temperature

○ Types of Steam * –

1) Wet steam → moisture + water
2) Dry steam → / saturated steam {100% vapour 0% water} {100°C}
3) ~~Dry~~ super heated steam : further heating of dry steam

○ Saturation of water temp → 0°C and 100°C ↗ this steam is called dry steam

○ Dryness Fraction * : amount of vapour present in mixture of water and vapour
→ It is also known as quality of vapour
→ denoted by X {it varies b/w 0 to 1}

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

m_f → mass of water
m_g → mass of vapour

○ numerical can also come

X = 0.8 mean 1kg mixture 80% is vapour to 20 water
X = 0.9 mean 90% vapour to 20 water
X = 0 mean 0% vapour 100 water
X = 1 mean 100 vapour 0% water

○ Two types of heat used for vapour making :-

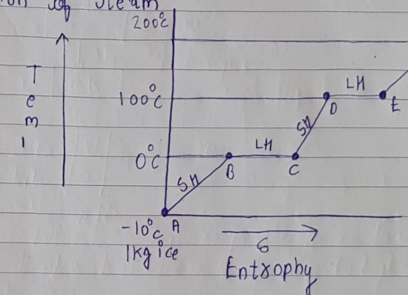
* ○ Sensible heat (SH) : heat sensed by thermometer, or any instrument + no phase change and only temp change (ΔT)

types of system
intensive
extensive → depends on mass

f = fluid

* ○ Latent heat (LH) : cannot be measured or sensed by anything, only phase change no temp change, eg: 0 and 100° constant temp
↓
or hidden heat

○ Formation of Steam



○ Enthalpy: (H) – It is an amount of heat required to convert 1kg of ice at 0° to required quality of steam.

$$\boxed{H = SH + LH + \theta_{sup}}$$

{Enthalpy equal to sum of all heat

For MCQ –

$H = U + PV$ → means enthalpy
↓
internal energy

S_f – Entrophy of water

Enthalpy for :-

$H_{dry} = h_f + h_{fg} = h_g$
$H_{wet} = h_f + X h_{fg}$ → dryness fraction
$H_{sup} = h_f + h_{fg} + C_p (\Delta T)$ {where $\Delta T = T_{sup} - T$
$= h_g + C_p (\Delta T)$ ⇒ simply → $H_g + \theta_{sup}$