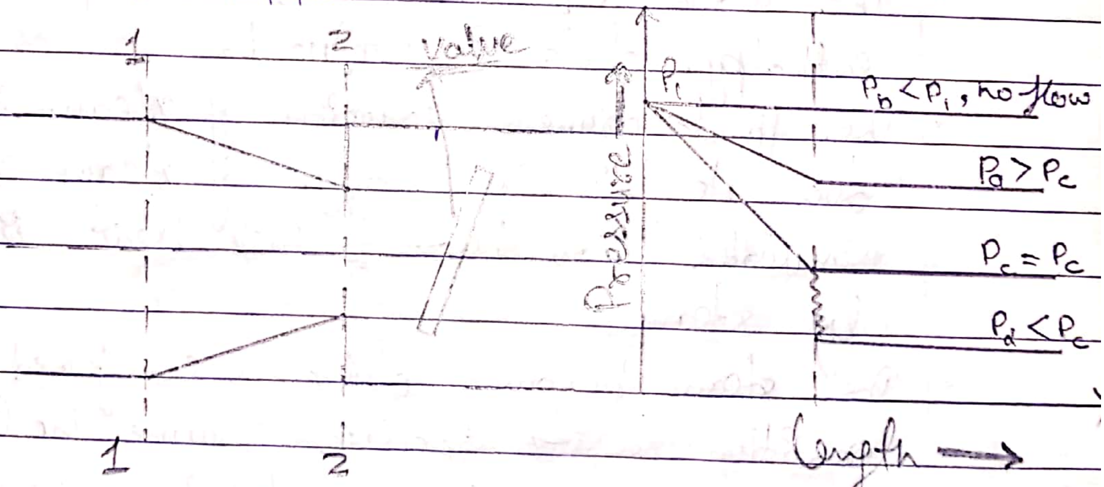
Section-5

Q1 Ans :-

⇒ **Choked Flow :-** The flow condition in which a nozzle operating with max. mass flow rate is known as Choked flow.

- Choking of a fluid in nozzle is the condition of reduction in fluid pressure.
- A valve is provided at exit of nozzle for regulating the back pressure at section 2-2.
- Let the back pressure is P_b & P_1 is the pressure at the inlet.



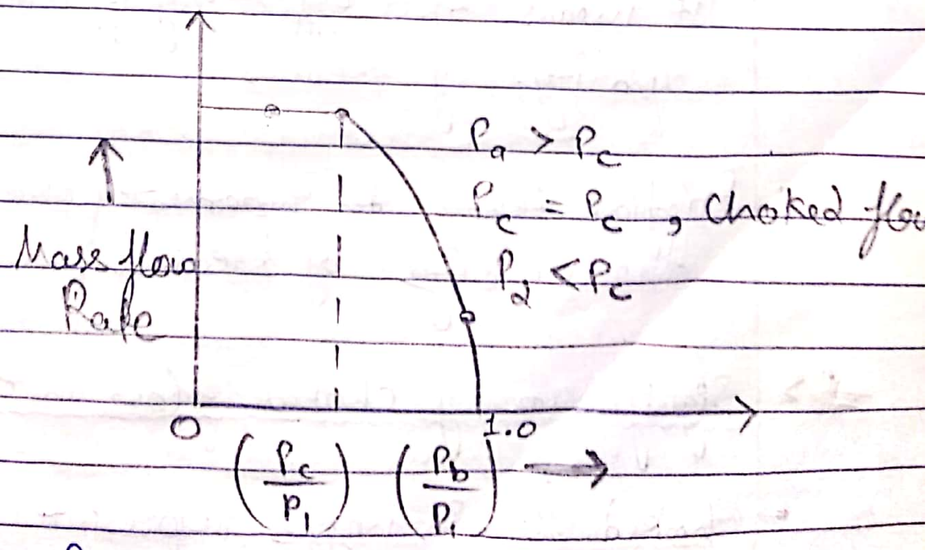


Fig :- Flow through a convergent nozzle.

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(i) When $p_b = p_1$, (No flow through the nozzle).

(ii) When $p_b < p_1$, (Mass flow rate starts increasing)

(iii) When $\frac{p_b}{p_1}$ = Critical pressure Ratio, $p_c = \left(\frac{2}{n+1}\right)^{\left(\frac{n}{n-1}\right)}$

(Mass flow through nozzle is max. & the this flow is known as choked flow or critical flow).

Effect of Friction on Nozzle :-

- The actual expansion is not isentropic hence enthalpy drop is reduced.
- The final dryness fraction of steam is inc.(res) due to kinetic energy of steam gets converted into heat & this heat is absorbed by steam.
- The steam becomes drier as compared to ideal condition so its specific volume inc.(res). It means the effect of friction improves the quality of steam.
- Friction tends to superheat the steam & dec.(res) the velocity of steam.

Significance of choked flow in a nozzle :-

→ Choked flow in nozzle represent nozzle operating with max. flow. Mass flow does not inc.(res) or dec.(res) beyond choked flow.

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→ If the nozzle does not operate with pressure ratio equal to critical press. ratio then it is called "off Design operation of nozzle."

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Off Design Operation of Nozzle :-

Design operation of nozzle refers to the nozzle operating with pressure ratio equal to critical press. ratio & max. discharge rate per unit area then nozzle is said to be operating under design conditions.

If the nozzle does not operate under design conditions then it is called,
"off design operation of nozzle."

Nozzle efficiency :-

- It is defined as the ratio of actual enthalpy drop to the isentropic enthalpy drop b/w the same pressure.

$$\eta_{nozzle} = \frac{h_1 - h_{2'}}{h_1 - h_2}$$

- If the actual velocity at exit from the nozzle is $C_{2'}$ and the velocity at exit when the flow is isentropic is C_2 then,

$$\eta_{nozzle} = \frac{C_{2'}^2 - C_1^2}{C_2^2 - C_1^2}$$

- As the inlet velocity C_1 is negligible then,

$$\eta_{nozzle} = \frac{C_{2'}^2}{C_2^2}$$

hes)