Steam Nozzles

The steam nozzle is a passage of varying cross section by means of which the thermal energy of steam is converted into kinetic energy. The shape of the nozzle is designed such that it will perform this conversion of energy with minimum losses continuity equation is used for designing produce a jet of steam of high velocity for the purpose of driving steam turbine. When steam f lows through a nozzles expansion process take place. As the steam expand there is drop in pressure and enthalpy of steam and consequently its velocity and specific volume both increases .The smalls section of the nozzle is known as throat.

Types of nozzles:

There are two types:

1-Convergent nozzle. (fig.(1))

2-Convergent-Divergent nozzle.(fig.(2))

fig.(1)

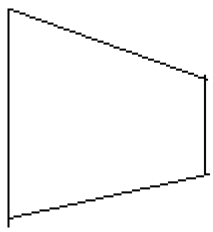
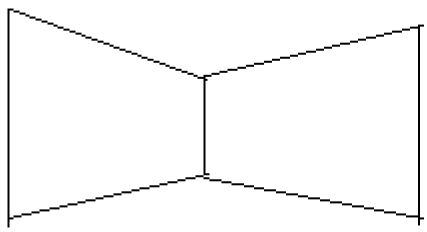


fig.(2)



throat

Variation of specific volume, area and velocity:

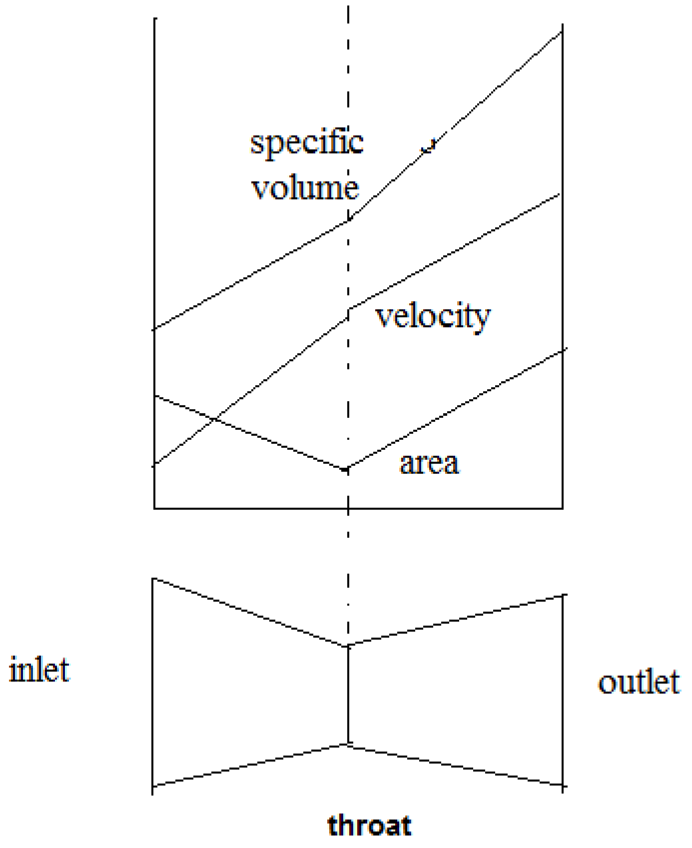
1-Velocity:except for the first part of the nozzle, the velocity increases at almost constant rate.

2-specific volume :for a considerable part of expansion ,the specific volume increases gradually. However during the latter part of the expansion. The specific volume increases very rapidly.

3-Area:

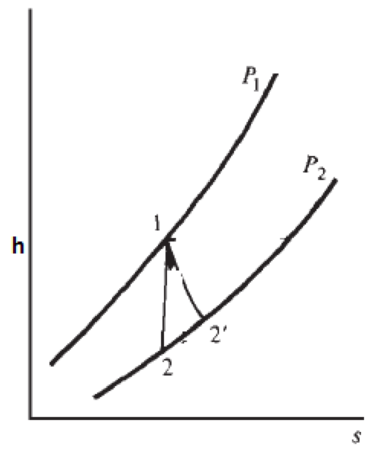
a) when a specific volume increases less rapidly(low rate) than the velocity the area increases

b) when a specific volume increases more rapidly than the velocity the area increases



Nozzle efficiency:

$$\eta_{nozzle}=\frac{actual\ heat\ drop}{isentropic\ heat\ drop}$$



$$\eta_n=\frac{H_1-H_2^{'}}{H_1-H_2}$$

Velocity cofficient:

$$C_v = \frac{Actual\ velocity}{Isentropic\ velocity}$$

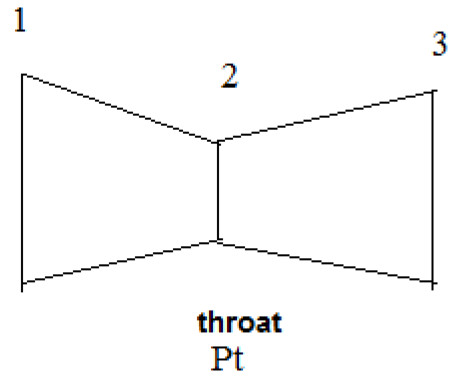
$$= \sqrt{Nozzle\ efficiency}$$

$$H_1 - H_2 = \frac{V_2^2 - V_1^2}{2}$$

$$V_1^2 = 0.0$$

$$V_2^2 = 2(H_1 - H_2)$$

$$V_v = \frac{\dot{V_2}}{V_2} = \sqrt{\frac{2(H_1 - \dot{H_2})}{2(H_1 - H_2)}} = \sqrt{\eta n}$$



THE REHEAT FACTOR:

Consider a multi-stage turbine as shown by the Mollier diagram, Figure

The reheat factor is defined by:

Example (1): Dry saturated steam at 2 MPa enters a steam nozzle and leaves at 0.2 MPa. Find the exit velocity of the steam and dryness fraction. Assume isentropic expansion and neglect inlet velocity.