APPLICATION SFEE

PIAT

Function : It is a device for producing work output from a flow of fluid (steam or gas) which is expanding from high pressure to low pressure. The work output from the turbine may be used to run a generator and produce electric power as shown in Fig.

Water with high P.E ⟶ Mechanical Energy

We know that SFEE

$$m\left(h_1 + \frac{C_1^2}{2} + z_1 g\right) + Q = m\left(h_2 + \frac{C_2^2}{2} + z_2 g\right) + W$$

For turbine,

(1) $z_1 \cong z_2$, $\Delta PE = 0$

(2) $C_1 \cong C_2$, $\Delta KE = 0$

(3) $Q = 0$ (Heat transfer is negligible, since the turbine is thermally insulated)

(4) $W \neq 0$ (shaft work done by the system, so W is positive)

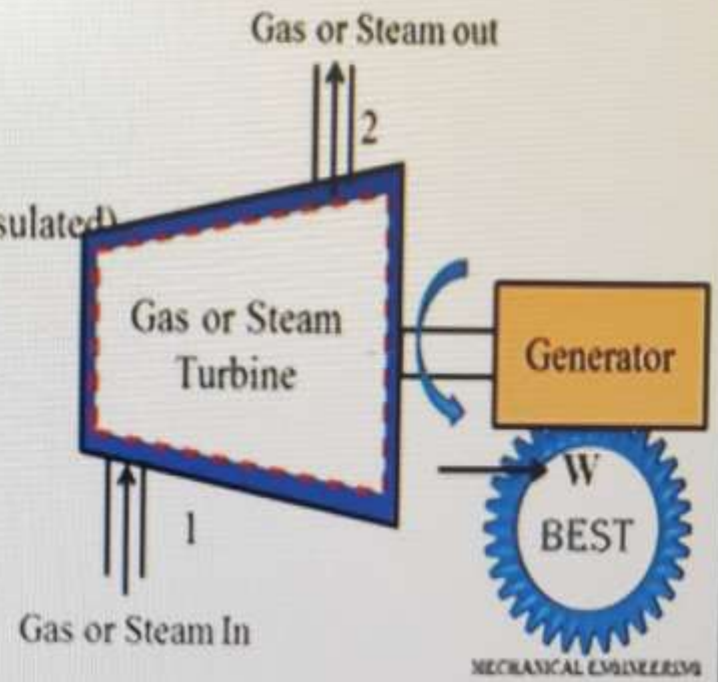
Hence

$mh_1 = mh_2 + W$

$W = m(h_1 - h_2)$

Where $h_1 > h_2$

So W Positive



Steady Flow Energy Equation For Compressor

Function : It is a device used to increases the pressure of a Air or Gas.

(A) Rotary Compressor:

We know that SFEE

$$m\left(h_1 + \frac{C_1^2}{2} + z_1 g\right) + Q = m\left(h_2 + \frac{C_2^2}{2} + z_2 g\right) + W$$

For rotary compressor,

(1) $z_1 - z_2 = 0$ (generally taken)

(2) $C_1 \cong C_2$ (change in velocity is negligible, change of kinetic energy is = 0)

(3) $Q \cong 0$ (Heat transfer is negligible, since the compressor is thermally insulated)

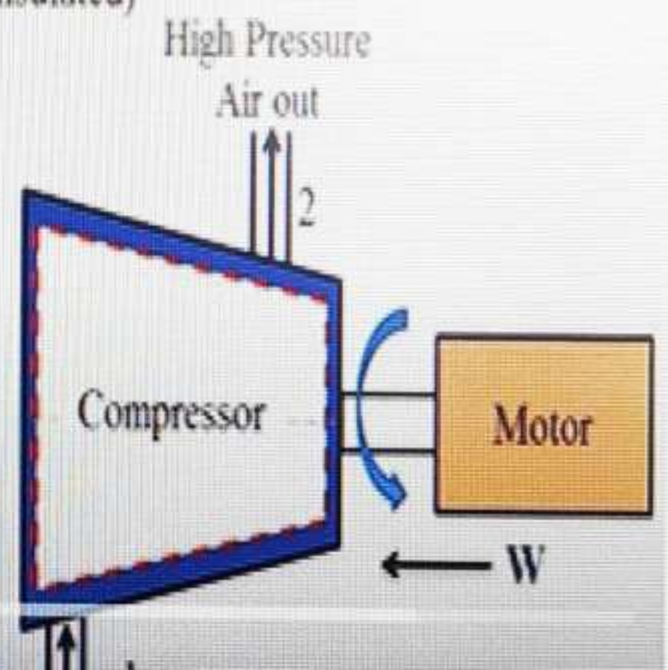
(4) $W \neq 0$ (shaft work done by the system, so W is negative)

Hence $mh_1 = mh_2 + W$

$W = m(h_1 - h_2)$

where $h_2 > h_1$

∴ W is negative



Steady Flow Energy Equation For Compressor

(B) Reciprocating Compressor:

We know that SFEE

$$m\left(h_1 + \frac{C_1^2}{2} + z_1 g\right) + Q = m\left(h_2 + \frac{C_2^2}{2} + z_2 g\right) + W$$

For reciprocating compressor,

(1) $z_1 \cong z_2$, $\Delta PE = 0$ (generally taken)

(2) $C_1 \cong C_2$, $\Delta KE = 0$ (change in velocity is negligible, change of kinetic energy is = 0)

(3) $Q \neq 0$ (appreciable heat transfer is involved, heat is rejected from system, Q is negative)

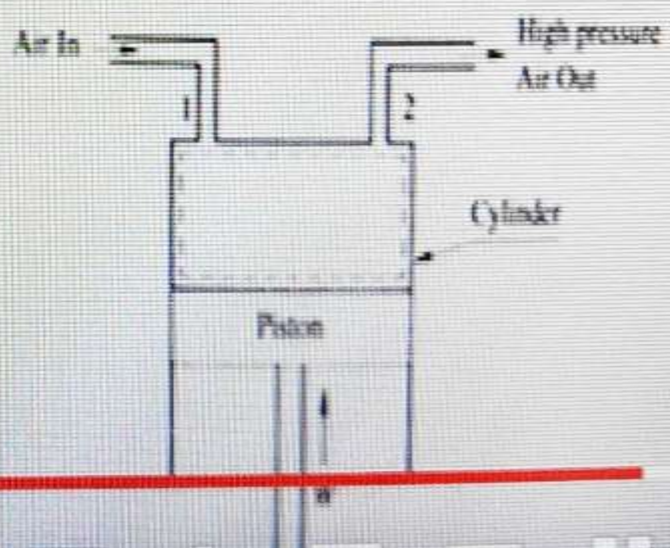
(4) $W \neq 0$ (shaft work is done on the system and fluid is compressed, so W is negative)

Hence

$$mh_1 - Q = mh_2 + W$$

$$W = m(h_1 - h_2) - Q$$

where $h_2 > h_1$



Steady Flow Energy Equation For Nozzle

Function : It is a device that increases the velocity (kinetic energy) of a fluid at the expense of its pressure drop (pressure energy).

Pressure energy (pressure) $\xrightarrow{\text{conversion}}$ Kinetic energy (velocity)

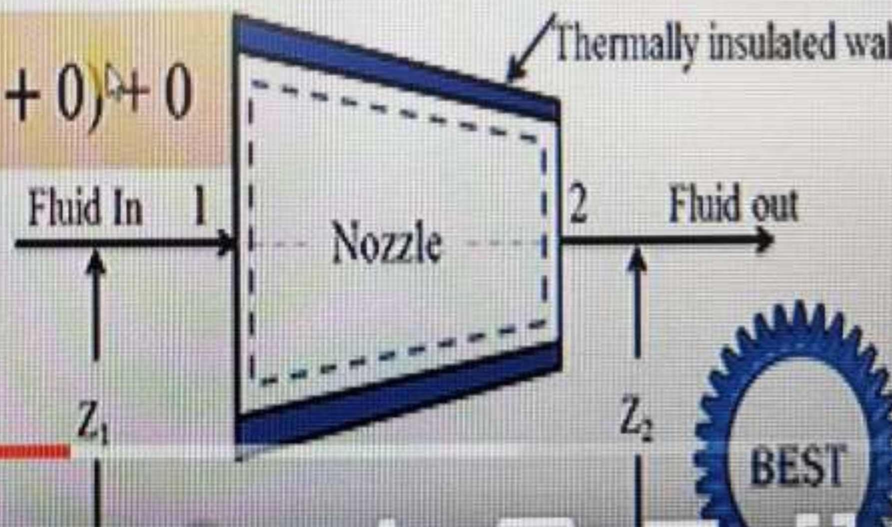
Nozzle is a passage of varying cross section by means of which pressure energy of flowing fluid is converted into kinetic energy.

The cross sectional area of nozzle decrease in the flow direction for subsonic flows as shown in Fig. and increases for supersonic flows.

We know that SFEE

m (h_1 +

$$m\left(h_1 + \frac{C_1^2}{2} + 0\right) + 0 = m\left(h_2 + \frac{C_2^2}{2} + 0\right) + 0$$



For nozzle,

(1) No work input/output, W = 0

(2) No heat interaction between Nozzle and surroundings, Q = 0 (Thermally insulated wall)

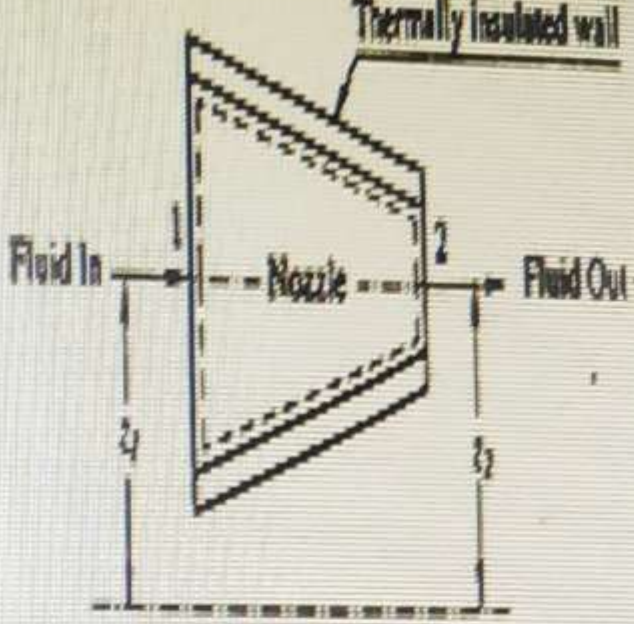
(3) $z_1 - z_2 = 0$ (change of potential energy = 0)

Steady Flow Energy Equation For Nozzle

Hence, SFEE

$$m\left(h_1 + \frac{C_1^2}{2} + 0\right) + 0 = m\left(h_2 + \frac{C_2^2}{2} + 0\right) + 0$$

$$h_1 + \frac{C_1^2}{2} = h_2 + \frac{C_2^2}{2}$$



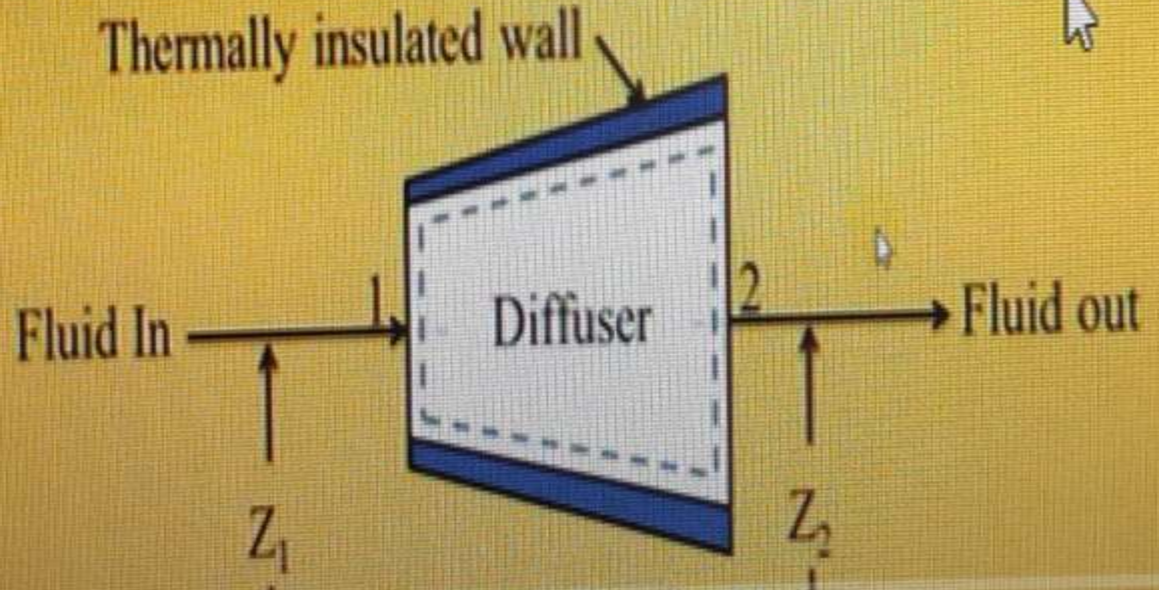
$$h_1 - h_2 = \frac{C_2^2 - C_1^2}{2}$$

$$C_2 = \sqrt{2(h_1 - h_2) + C_1^2}$$

When inlet velocity C_1 is small compared to the exit velocity C_2, $\therefore C_1 = 0$

$$C_2 = \sqrt{2(h_1 - h_2)}$$

Steady Flow Energy Equation For Diffuser



Steady Flow Energy Equation For Diffuser

Hence, SFEE

$$m\left(h_1 + \frac{C_1^2}{2} + 0\right) + 0 = m\left(h_2 + \frac{C_2^2}{2} + 0\right) + 0$$

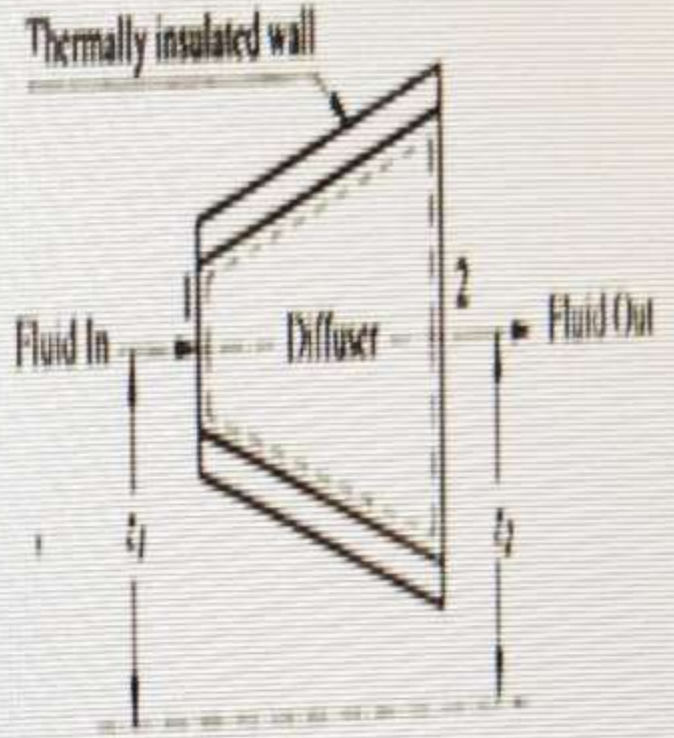
$$h_1 + \frac{C_1^2}{2} = h_2 + \frac{C_2^2}{2}$$

$$h_2 - h_1 = \frac{C_1^2 - C_2^2}{2}$$

$$C_1 = \sqrt{2(h_2 - h_1) + C_2^2}$$

In case of diffuser C_2 (velocity of outlet) $< C_1$ ($C_2 = 0$)

$$C_1 = \sqrt{2(h_2 - h_1)}$$



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