Steady flow Energy Equation. [SFEE].

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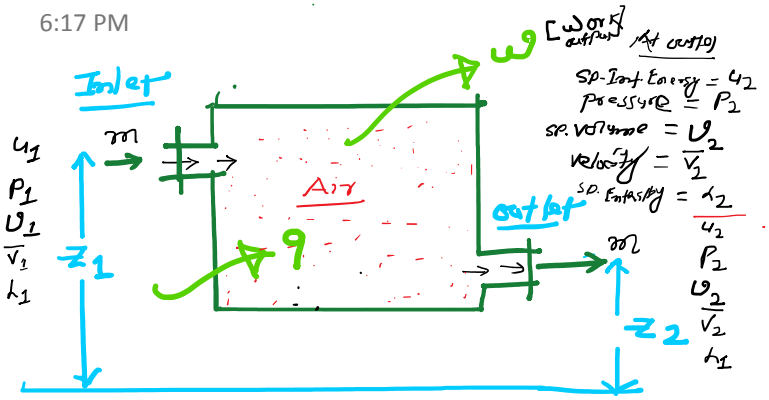
At inlet
Sp. Int. Energy = u_1
Pressure = P_1
sp. volume = v_1
Velocity of air = $\bar{v}_1$
Sp. enthalpy = h_1
mass of air = m
mass flow rate of air = $\dot{m}$
Heat supplied = q



This equation is applied for open system. Since both energy and mass interaction are taken place.

Total Energy at inlet = Total energy at outlet.

Case-I [when units are in KJ] :→

$$U_1 + P_1V_1 + \frac{1}{2}m\bar{v}_1^2 + mgz_1 + Q = U_2 + P_2V_2 + \frac{1}{2}m\bar{v}_2^2 + mgz_2 + W$$

Since $H = U + PV$

$$\Rightarrow H_1 + \frac{1}{2}m\bar{v}_1^2 + mgz_1 + Q = H_2 + \frac{1}{2}m\bar{v}_2^2 + mgz_2 + W \quad (A)$$

The above equation is applicable only when units are in KJ

Case-II [when units are in KJ/Kg] →

If the above equation is devided by mass m then the unit will be converted into KJ/Kg.
so devide the above equation by m. we get

$$h_1 + \frac{1}{2}\bar{v}_1^2 + gz_1 + q = h_2 + \frac{1}{2}\bar{v}_2^2 + gz_2 + w \quad (B)$$

Note: → The unit of all terms are in $\frac{KJ}{Kg}$

Case-III [when units are in KW] :→

If equation (B) is multiplied by mass flow rate of air then the units will be converted into KW.

For example $\dot{m} \times h = \frac{Kg}{sec} \times \frac{KJ}{Kg} = KW$

∴ Multiply the equation (B) by mass flow rate. we get

$$\dot{m}\left[h_1 + \frac{1}{2}\bar{v}_1^2 + gz_1\right] + \dot{m}q = \dot{m}\left[h_2 + \frac{1}{2}\bar{v}_2^2 + gz_2\right] + \dot{m}w$$

$$\Rightarrow \dot{m}\left[h_1 + \frac{1}{2}\bar{v}_1^2 + gz_1\right] + \dot{Q} = \dot{m}\left[h_2 + \frac{1}{2}\bar{v}_2^2 + gz_2\right] + \dot{W}$$

$$\therefore \dot{m}\left[h_1 + \frac{1}{2}\bar{v}_1^2 + gz_1\right] + \dot{Q} = \dot{m}\left[h_2 + \frac{1}{2}\bar{v}_2^2 + gz_2\right] + \dot{W} \quad \text{(c)}$$

So, OVERALL :→

#) Case-I :→ when units are in KJ :→

$$H_1 + \frac{1}{2}m\bar{v}_1^2 + mgz_1 + Q = H_2 + \frac{1}{2}m\bar{v}_2^2 + mgz_2 + W$$

Case-II :→ when units are in $\frac{KJ}{Kg}$:→

$$h_1 + \frac{1}{2}\bar{v}_1^2 + gz_1 + q = h_2 + \frac{1}{2}\bar{v}_2^2 + gz_2 + w$$

Case-III :→ when units are in KW :→

$$\dot{m}\left[h_1 + \frac{1}{2}\bar{v}_1^2 + gz_1\right] + \dot{Q} = \dot{m}\left[h_2 + \frac{1}{2}\bar{v}_2^2 + gz_2\right] + \dot{W}$$