Exergy

The control mass system

Exergy transfered by heat

$$W_{rev} = T_0(S_2 - S_1) - (U_2 - U_1) + {}_1Q_2\left(1 - \frac{T_0}{T_H}\right)$$

- produced from c.m when changing from $1 \to 2$ in which ${}_1Q_2$ is transformed from T_H to environment T_0

$$I = ({}_1W_2)_{rev} - {}_1W_2 = T_0\, {}_1S_{2\,gen_{act}}$$

Steady state steady flow process (SSSF)

$$\dot{W}_{rev} = \dot{m}T_0(s_e - s_i) - \dot{m}(h_e - h_i) + \dot{q}_i\left(1 - \frac{T_0}{T_i}\right)$$

exergy transfered by flow

$$\dot{I} = \dot{W}_{rev} - W$$

Uniform state Uniform flow process : (Transient)

$$W_{rev} = m_i(h_i - T_0 s_i) - m_e(h_e - T_0 s_e) + m_1(u_1 - T_0 s_1) - m_2(u_2 - T_0 s_2) + Q_{c.v}\left(1 - \frac{T_0}{T_J}\right)$$

$$I = W_{rev} - W$$

flow of exergy

Exergy: $\Psi = (h - T_0 s) - (h_0 - T_0 s_0)$
$= (h - h_0) - T_0 (s - s_0)$

$$\Phi = \Psi_i - \Psi_e = (h_i - h_e) - T_0 (s_i - s_e)$$

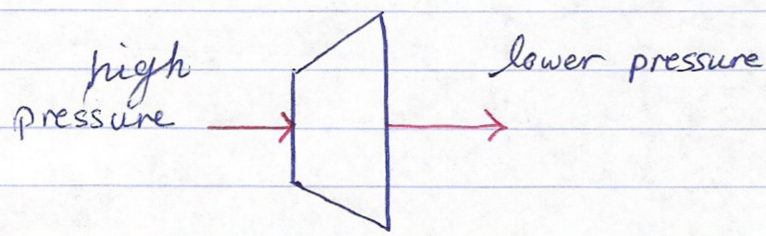
Second law efficiency:

$$\eta_{2nd\ law} = \frac{\Phi \text{ wanted}}{\Phi \text{ source}}$$

Devices included and Notes about it

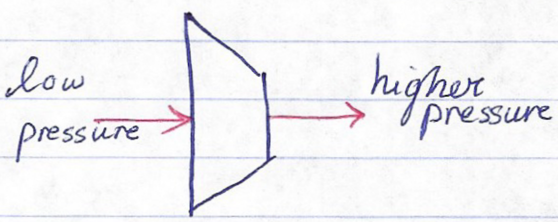
- Turbine :-

W_T = positive
$\dot{Q} = 0$ (unless given)



$$\eta_{2nd} = \frac{W_a}{W_{rev}} = \frac{W_a}{\Psi_i - \Psi_e}$$

- Compressor :- = (Pump)

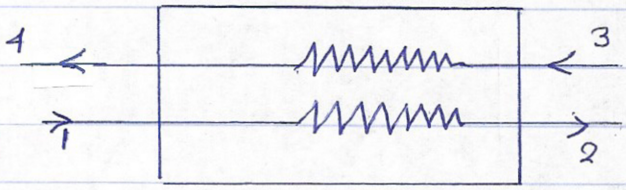


W_C = negative
$\dot{Q} = 0$ (unless given)

$$\eta_{2nd} = \frac{W_{rev}}{W_{act}} = \frac{\Psi_i - \Psi_e}{W_{act}}$$

heat exchanger

In heat exchangers
Work is zero
so to find
$\eta_{2nd\,law}$:-

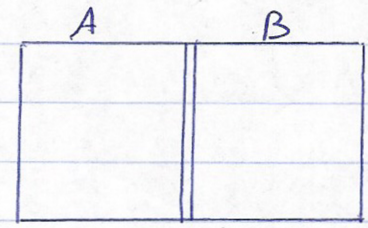


$$\eta_{2nd\,law} = \frac{\dot{m}_1 (\psi_2 - \psi_1)}{\dot{m}_3 (\psi_3 - \psi_4)} = \frac{\Phi_{wanted}}{\Phi_{source}}$$

$$\dot{I}_{c.v} = \Phi_{source} - T\dot{S}_{gen\,c.v} = \Phi_{source} - \Phi_{wanted}$$

In flash evaporator : $W = 0$, $Q = 0$

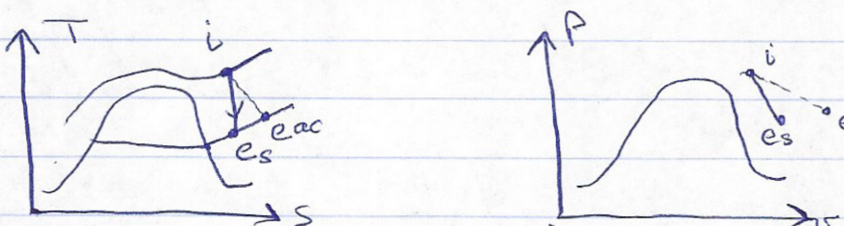
Mixing Process



Work = 0 since V = C
$m_2 = m_A + m_B$

when you are taking propecties :-
State 1 :- Take u_1, s_1 for A and B separatly
State 2: Take u_2, s_2 That is common multiplied by $(m_A + m_B)$

Extra Notes :-
for isentropic processes:- (Turbine)



for a compressor its is in the opposite direction