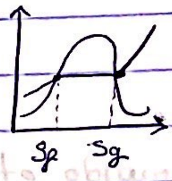
Chapter 6 : Entropy → 2nd law for a c.m System

Entropy chang in Reversible process:-

In sat region:

$s = s_f + s_{fg}\,x$



1- Isothermal heat addition at T_H

$$s_2 - s_1 = \frac{q_{12}}{T_H} = \frac{q_H}{T_H}$$

2- Adiabatic & Reversible expansion (Isentropic)
constant entropy

$$s_2 = s_3$$

3- Isothermal heat rejection at T_L

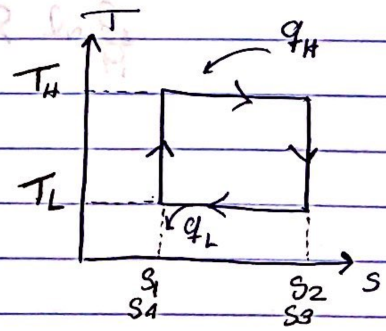
$$S_4 - S_3 = \frac{Q_{34}}{T_L}$$

$$s_4 - s_3 = \frac{q_{34}}{T_L}$$

where Q & q is negative

4- Adiabatic and Reversible compression at T_L

$s_1 - s_4 = 0 \rightarrow s_1 = s_4$



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2^{nd} law for a control mass system :-

always > 0

$$m(S_2 - S_1) = \underbrace{\frac{Q}{T}}_{\substack{T_{sourse} \qquad T_{ambient}}} + {}_1S_2 \text{ generated}$$

$m(S_2 - S_1)$ → from Tables

T_{sourse}: اذا ال Source is Syst

$T_{ambient}$: اذا من sys لبرا تكون T هي تاعة ال surround

You will need to use first law to obtain Q.

$${}_1Q_2 = m(u_2 - u_1) + W_{12}$$

- Violates or doesn't violate 2^{nd} law ?

irreversable: → $S_g > 0$, reversible: $S_g = 0$ — Does not

→ $S < 0$ — Does

- **Ideal Gas :-**

$$S_2 - S_1 = C_{v0} \ln \frac{T_2}{T_1} + R \ln \frac{v_2}{v_1}$$

$$S_2 - S_1 = C_{p0} \ln \frac{T_2}{T_1} - R \ln \frac{P_2}{P_1}$$

$$= S_2^\circ - S_1^\circ$$

from

For a rev adiabatic and Ideal Gas:-

$$K = \frac{C_{p_0}}{C_{v_0}}$$

$$C_{p_0} = \frac{KR}{K-1} \qquad C_{v_0} = \frac{R}{K-1}$$

$$Pv^K = \text{Constant}$$

isothermal $n=1$ polytropic $n=n$ Isentropic $K=n$

$$P_1V_1^K = P_2V_2^K$$

$$W_{12} = \frac{P_2V_2 - P_1V_1}{1-K}$$

Ideal Gas & not Isothermal:

$$W_{12} = \frac{m R(T_2 - T_1)}{1-K} \qquad K \neq 1$$

Ideal Gas & Isothermal $K=1$

$$W_{12} = P_2V_2 \ln \frac{v_2}{v_1}$$

Chapter 7: 2nd law of thermodynamics for C.V system.

Cases:-

1- SSSF

$$\sum \dot m (s_e - s_i) = \sum \frac{\dot Q_{c.v}}{T} + \dot S_{c.v\,gen}$$

and you will need first law:-

$$\sum \dot m (h_e - h_i) + \dot W_{c.v} = \dot Q_{c.v}$$

ال Turbine، ال condensor، ..... كلها بتجي

($\dot W_T = \dot m_{st} (h_1 - h_2)$)

2- Transient

$$\cancel{Q_{c.v} + m_e h_e - m_i h_i = m_2 u_2 - m_1 u_1 + W_{c.v}}$$

$$m_2 s_2 - m_1 s_1 + m_e s_e - m_i s_i = \frac{Q_{c.v}}{T} + S_{c.v\,gen}$$

and you will need first law:-

$$Q_{c.v} + m_e h_e - m_i h_i = m_2 u_2 - m_1 u_1 + W_{c.v}$$

Addi. Note :-

$$W = \underbrace{\frac{V_1^2}{2} - \frac{V_2^2}{2} + g(z_1 - z_2)}_{\text{usually zero}} - \int_1^2 v\, dP$$

Ideal Gas

$$\left.\begin{aligned} T_e &= T_i \left(\frac{P_e}{P_i}\right)^{\frac{k-1}{k}} \\ S_{T_2}^{\circ} &= S_{T_1}^{\circ} + R \ln\left(\frac{P_2}{P_1}\right) \end{aligned}\right\} \text{Both can be used}$$

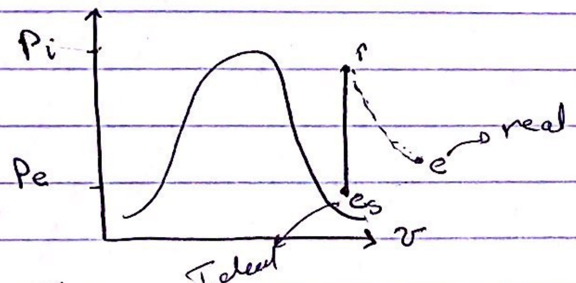
could be used in → Transient and SSSF (when process is isentropic) efficiency :-

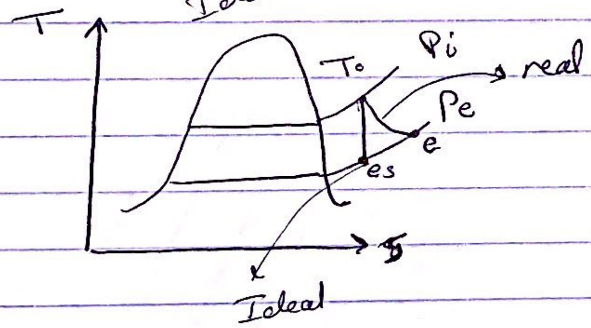
$$\eta = \frac{W_{net}}{Q_{H}}$$

Turbine efficiency

$$\eta_T = \frac{W}{W_s} = \frac{h_i - h_e}{h_i - h_{es}}$$

h_{es} obtained from $s_i = s_e$ new





Bernoulis equation :-

Single steady flow, No work, Adiabatic
Incompressible and reversible

$$\left(vP + \frac{1}{2}V^2 + gz\right)_1 = \left(vP + \frac{V^2}{2} + gz\right)_2$$