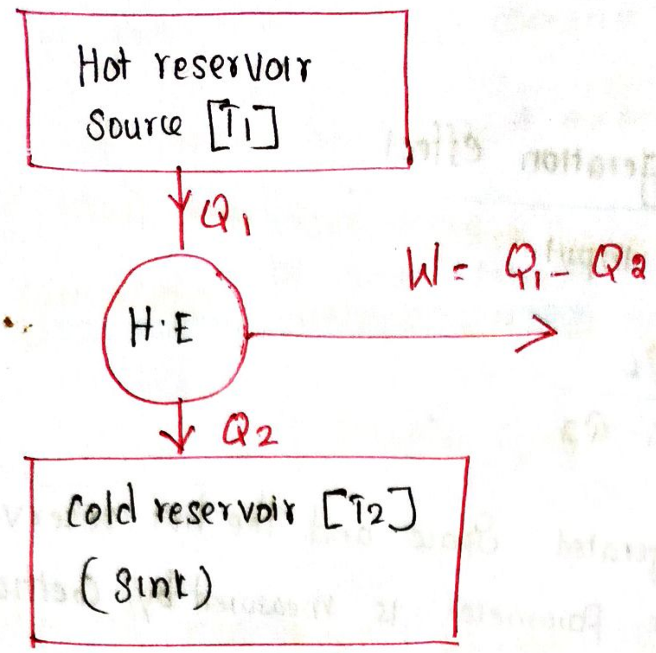


T_1 = Temp of hot reservoir [source]

T_2 = Temp of Cold " " [sink]

Q_1 = Heat Supplied to engine

Q_2 : Heat rejected to engine

W : Workdone by the heat engine $[Q_1 - Q_2]$

$$\eta_{\text{heat engine}} = \frac{\text{Workdone}}{\text{Heat Supplied}}$$

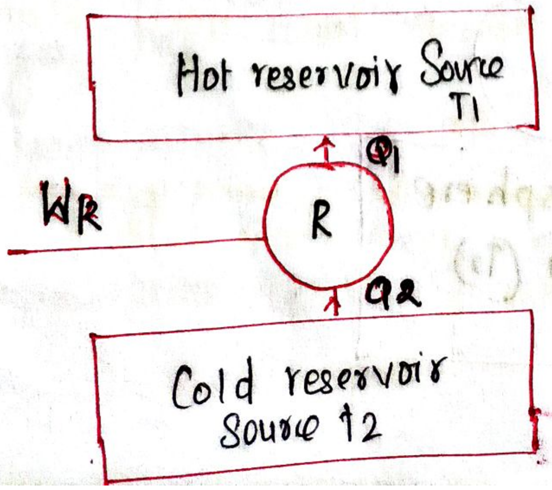
$$= \frac{Q_1 - Q_2}{Q_1} = 1 - \frac{Q_2}{Q_1}$$

(or)

$$\frac{T_1 - T_2}{T_1} = 1 - \frac{T_2}{T_1}$$

Refrigerator and heat Pump:

Refrigerator is a device Which operates in a cycle maintaining the temp lower that of its Surrounding.



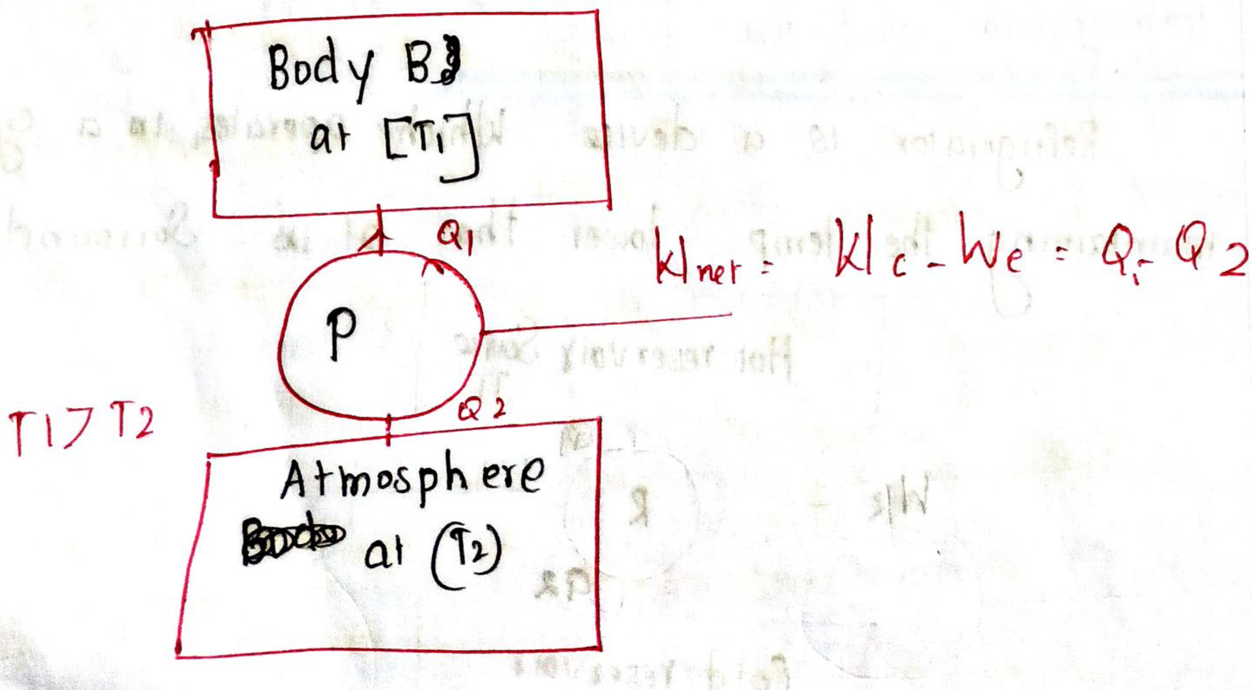
$$C.O.P = \frac{\text{Net Refrigeration effect}}{\text{Work input}}$$

$$[COP]_{refr} = \frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_2}$$

The cold reservoir is refrigerated Space and the hot reservoir is atmosphere. The Performance Parameter is measured by Coefficient of Performance [C.O.P]

~~C.O.P of refrigeration = Net refrigeration effect / Work Input~~

Heat Pump is a device which operating in a cycle maintains a body at a temperature higher than that of it Surrounding



The network is difference b/w Compressor work and expansion device work

C.O.P of heat pump = Heat supplied / Net work

$$C.O.P_{H.P} = \frac{Q_1}{W_1} = \frac{Q_1}{Q_1 - Q_2}$$

$$[C.O.P]_{HP} = \frac{Q_1 - Q_2 + Q_2}{Q_1 - Q_2}$$

$$= \frac{Q_1 - Q_2}{Q_1 - Q_2} + \frac{Q_2}{Q_1 - Q_2} = 1 + \frac{Q_2}{Q_1 - Q_2}$$

$$[COP]_{HP} = 1 + [COP]_{ref}$$

Second law of Thermodynamics

(i) Kelvin - plank Statement

It is impossible to Construct a heat engine to produce net work in a Complete cycle If it exchanges heat from a single reservior at single fixed temperature.

(or)

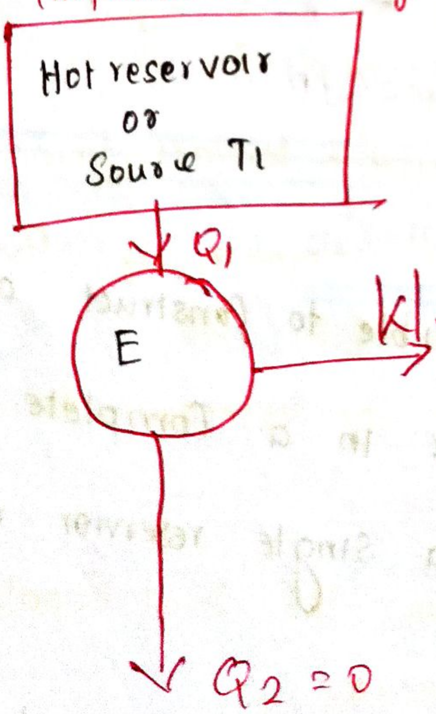
It is impossible to Construct a heat engine which will Convert all heat energy into equal amount of work in a cyclic process.

- All heat Cannt be Converted into Work.
- Some heat will be rejected to the Surrounding

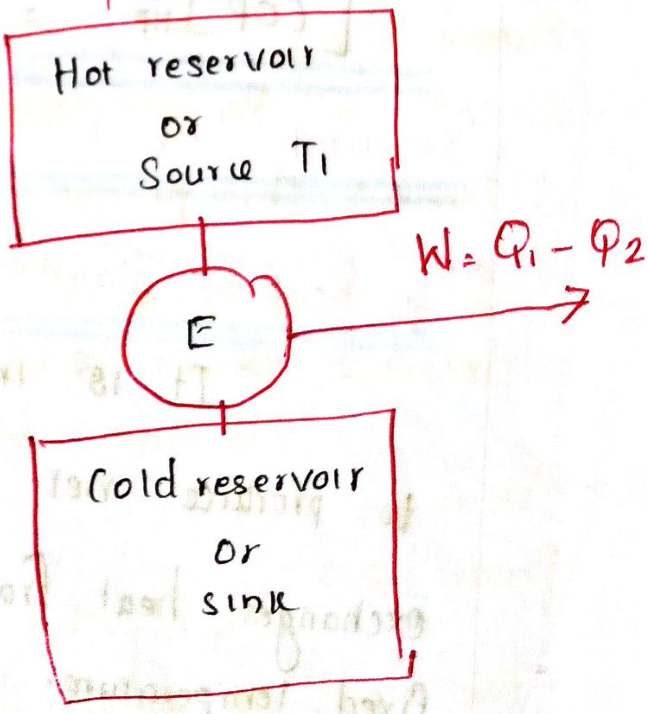
The heat engine must exchange heat with low temp sink as well as high temp Soure to keep Operating. The Kelvin - planck Statement Can also be expressed as no heat engine Can have thermal efficiency of 100, or as for a Power Plant to Operate the working fluid must exchange heat with the environment as well as the furnace.

~~P M M~~ Kind II

Impossible to heat engine

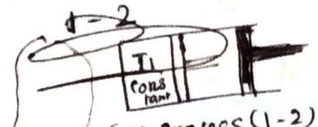


Possible to heat engine



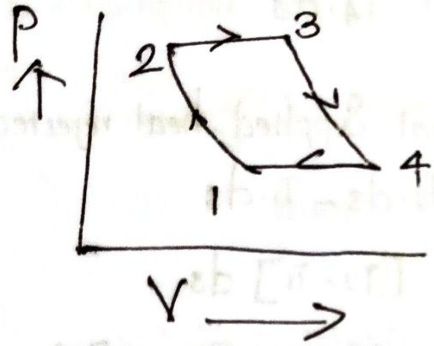
Carnot Cycle and its Performance :

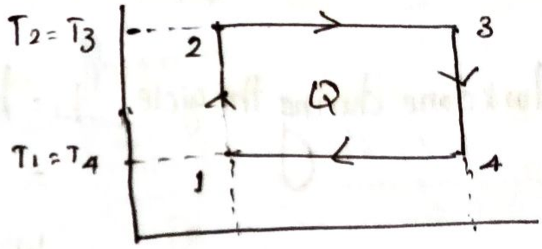
- It is also called as Constant temperature Cycle.
- It is introduced by sadi carnot



(a) process (1-2)

- It Consists of 4 Process
  - (i) Two Isentropic or reversible adiabatic
  - (2) Two Iso thermal Probss.





Process 1-2 :

- Air Compressed Isentropically from state (1) to (2)
- During this process Pressure & temperature increase from P_1 to P_2 and T_1 to T_2 respectively. But Volume decrease from V_1 to V_2.
- No heat addtion or rejection during this Process.

Process 2-3 :

- During this Process, the heat Supplied to the fluid at Constant temperature.
- There is no change in temperature $T_3 = T_2$
- Both Volume and entropy increse from V_2 to V_3 and S_2 to S_3 respectively,

Heat Supplied $Q_{s_{2-3}} = T_2 \cdot ds = T_3 \cdot ds$

$ds = \frac{dQ}{T}$ and $T_2 = T_3$

$ds = T \cdot ds$

Process 3-4:

Air is Isentropically Expanded from State 3 to 4

Both Pressure and temperature decrese from P_3 to P_4 and T_3 to T_4. But entropy remain Constan $[S_3 = S_4]$

Process 4-1:

During this Process, the heat is Isothermally rejected from the fluid and it attain its Initial Position.

Heat rejected $Q_{4-1} = T_1 \cdot ds = T_4 \cdot ds$

Workdone during the cycle W = heat Supplied - heat rejected

$$= T_2 \cdot ds - T_1 \cdot ds$$

$$W = [T_2 - T_1] ds$$

Efficiency of Carnot engine $\eta = \frac{W}{Q_s} = \frac{[T_2 - T_1] ds}{T_2 \cdot ds}$

$$\eta_{carnot} = \frac{T_2 - T_1}{T_2} = \frac{T_H - T_L}{T_H}$$

T_1 and T_2 are minimum and maximum temperature

T_L and T_H are Lower and Higer temp

Heat reservoir:

- Ideal body having large thermal capacity, With either continiously supplies or absorbs the infinite amount of heat without charging its temperature is called thermal energy reservoir.
- If the reservoir continiously supplies heat energy to system. It is called Source.
- If reservoir continiously absorbs heat energy from the system It is called sink

2.16 An Inventor claim to have developed an efficient heat engine which would have a heat soure at 1000°C and reject heat to sink at 50°C and give an efficiency 90%. Justify whether his claim is possible or not

G.D :

$T_H = 1000°C = 1273\ K$

$T_L = 50°C = 323\ K$

$\eta = 90\%$

To find :

whether Inventor claim is correct or not

Sol :

According to Carnot theoram,

$$\text{max } \eta = \frac{T_H - T_L}{T_H} = \frac{1273 - 323}{1273} = 0.76$$

$$= 74.6\%$$

max η [74.6] is less than ~~Produced~~ Proposed engine

A Carnot engine working b/w 400°C and 40°C Produce 130 KJ of work Calculate (i) Cycle efficiency (ii) heat added (iii) entropy changes during heat rejection Process

Source Temp $(T_1 = T_2)$ $= T_1 = 400 + 273$ $673K = T_2$

Sink Temperature $= T_3 = T_4 = 40 + 273 = 313K$

Work Produced $W_{net} = 130\,KJ$

$$\eta_{carnot} = \frac{T_1 - T_2}{T_2}$$

$$= \frac{673 - 313}{673} = 53.5\%.$$

$$\boxed{\eta_{car} = 0.535}$$

To find heat added:

$$\eta_{carnot} = \frac{W_{net}}{Q_1} = \frac{\cancel{130}}{}$$

$$Q_1 = \frac{W_{net}}{\eta_{carnot}} = \frac{130}{0.535}$$

$$\boxed{Q_1 = 243\,K}$$

Entropy Change during Heat Rejection process

$$Q = Ts$$

Heat rejected $Q_2 = T_3 [S_3 - S_4]$

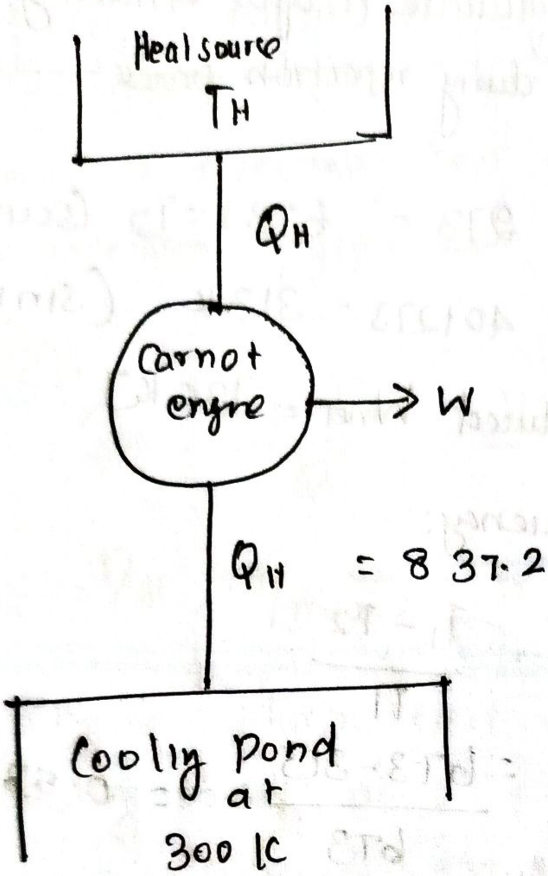
$$S_3 - S_4 = \frac{Q_2}{T_3}$$

$$W_{net} = Q_1 - Q_2$$

$$Q_2 = Q_1 - W_{net} = 243 - 130 = 113\,KJ$$

$$\text{Now } (S_3 - S_4) = \frac{Q_2}{T_3} = \frac{113}{313}$$ $\underline{0.361\,KJ/K}$

$T_H = 428.5\ K$



$$\frac{Q_L}{Q_H} = \frac{T_L}{T_H}$$

$$Q_H = \frac{Q_L}{T_L} \cdot T_H$$

$$= \frac{837.2 \times 428.5}{300} = 1196\ kJ/min$$

Power developed $W = Q_H - Q_L$

$= 1196 - 837.2$

$= 358.6\ kJ/min$

5 (b) ~~Micrometer~~

2.24 Sem 1

A carnot engine working b/w 400°C and 40°C produce 130 KJ of work. Calculate (i) cycle efficiency (ii) heat added (iii) entropy changes during rejection process

G.D: $T_1 = 400 + 273 = 673\,K = T_2$ (source)

$T_3 = T_4 = 40 + 273 = 313\,K$ (sink)

Work produced $W_{net} = 130\,KJ$

To find Carnot efficiency:-

$$\eta_{carnot} = \frac{T_1 - T_2}{T_1}$$

$$= \frac{673 - 313}{673} = 0.535 = 53.5\%$$

To find head added :-

$$\eta_{carnot} = \frac{W_{net}}{Q_1} =$$

$$Q_1 = \frac{W}{\eta_{carnot}} = \frac{130}{0.535} \quad \boxed{Q_1 = 243\,KJ}$$

To find entropy change during heat rejection process

$$Q = Tds$$

Heat rejected $Q_2 = T_3 [S_3 - S_4)$

~~But $W_{net} = Q_1 - Q_2$~~

$S_3 - S_4 = \frac{Q_2}{T_3}$

$W = Q_1 - Q_2$

$Q_2 = Q_1 - W$

$= 243 - 130$

$= 113\,KJ$

Now $(S_3 - S_4) = \frac{Q_2}{T_3} = \frac{113}{313}$ 0.361 KJ/K

Case(ii)

$$\eta_{(ii)} = \frac{Q_S - Q_R}{Q_S} = \frac{1120-560}{1120} = \cancel{0.196}\ 0.50 = \cancel{19.6\%}\ 50\%$$

$(\eta_{II} = \eta_{max})$ equal so reversible

There fore, It is reversible heat engine because by II law all the reversible engines have same efficieny

Case(iii):

$$\eta_{(iii)} = \frac{Q_S - Q_R}{Q_S} = \frac{1120-108}{1120} = 0.90 = 90\%$$

$\eta_{III} > \eta_{max}$ ∴ It is impossible

A Carnot engine which reject heat to a Cooling to a cooling pond at 27°C has an efficieny of 30%. If Cooling bond receives 837.2 KJ/min, what is the Power developed by the Cycle? Find the temp of Soure.

doubt 50 m

G.D :-

$T_L = 27° + 273 = 300\,K$

$\eta_{th} = 30\%$

$Q_L = 873.2\,KJ/min$ $= \frac{873.2\,KJ/min}{60}$

139.5 KW

$$\eta_{carnot} = \frac{T_H - T_L}{T_H}$$

$$0.3 = \frac{T_H - [300]}{T_H}$$

$T_H =$

Determine whether the following cases represent the reversible irreversible or impossible heat engine

(i) 900 kW of heat rejected

(ii) 560 kW " "

(iii) 108 kW of heat rejected

In each case the engine is supplied with 1120 kJ/s of heat. Source and sink temperature are maintained at 560 K & 280 K.

G.D:

$T_1 = 560\ K$

$T_2 = 280$

$Q = 1120\ kJ/s$

(i) $Q_R = 900\ kJ/s$

(ii) $Q_R = 560\ kW$

(iii) $Q_R = 108\ kW$

To find:

Concluded above cases are reversible, irreversible and impossible heat engines.

Solution:

From Carnot theorem

max efficiency $\eta_{max} = \dfrac{T_H - T_L}{T_H} = \dfrac{560 - 280}{560} = 0.5 = 50\%$

(maximum efficiency is 50%. value [illegible] engine possible practical run [illegible])

Case (i)

$$\eta_i = \frac{Q_S - Q_R}{Q_S} = \frac{1120 - 900}{1120} = 0.196 = 19.6\%$$

$\eta_{(i)} < \eta_{max}$ ∴ The engine is possible heat engine.

2.8

A heat engine of 30% efficiency drive a heat pump of COP = 5. The heat is transferred both from engine and heat pump to the circulating water for heating the building in winter. Find the ratio of heat transfer to circulating water from the heat pump to the heat transfer to the circulating water from the heat engine

G. D :

$\eta_{H.E} = 30\%$

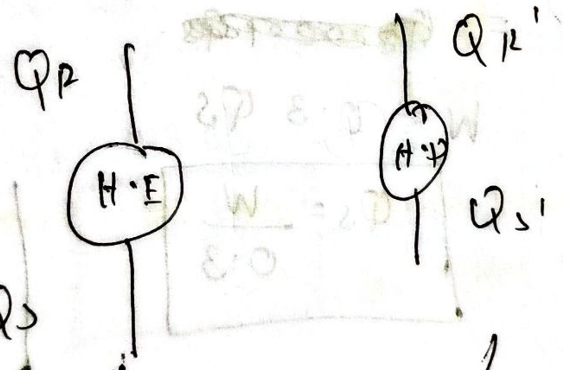
COP of H.P = 5

To find

$\frac{Q_S}{Q_S'} =$

$Q_S =$

Solution :



For heat engine

$$\eta_{H.E} = \frac{Q_S - Q_R}{Q_S} = 0.3$$

Consider assume $Q_S = 1$

$$~~Q_S - Q_R = 0.3 Q_S~~$$

$$~~= Q_S - 0.3 Q_S~~$$

$$~~= 1 - 0.3~~$$

$\cancel{Q_S} \rightarrow \cancel{0.3 Q_S} = Q_R$

For heat engine:

$$\eta_{H.E} = \frac{Q_S - Q_R}{Q_S} = 0.3 \Rightarrow$$

$$Q_S - Q_R = 0.3 Q_S$$

$$Q_R = Q_S -$$

$$\cancel{\quad} \rightarrow Q_R$$

Qs [illegible]

We considering Qs = 1

$$(1) Q_S - 0.3 Q_S = Q_R$$

$$\left(\frac{1 - 0.3}{0.7}\right) \rightarrow 0.7 Q_S = Q_R$$

$$= \frac{Q_R}{Q_S} = 0.7 \Rightarrow Q_R = 0.7 Q_S$$

$$\boxed{Q_R = 0.7 Q_S}$$

$$W = Q_S - Q_R = Q_S - 0.7 Q_S$$

$$= \cancel{\quad}$$

$$W = 0.3 Q_S$$

$$\boxed{Q_S = \frac{W}{0.3}}$$

For heat Pump:-

$$C.O.P = \frac{Q_S'}{Q_S' - Q_R'} = 5$$

$$Q_S' - Q_R' = \frac{Q_S'}{5}$$

$$Q_S' - \frac{Q_S'}{5} = Q_R'$$

$$Q_S' \left[1 - \frac{1}{5}\right] = Q_R'$$

$$\frac{Q_R'}{Q_S'} = 0.8$$

$$W = Q_R' - Q_S' = Q_S' - 0.8 Q_S'$$

$$W = 0.2 Q_S'$$

$$Q_S' = \frac{W}{0.2}$$

$$\therefore \frac{Q_S'}{Q_S} = \frac{\frac{W}{0.2}}{\frac{W}{0.3}} = \frac{0.3}{0.2} = 1.5$$

0.3//.

2-9

$$\eta_{H\cdot E} = \frac{Q_s - Q_R}{Q_s} = 0.3$$

$$Q_s - Q_R = 0.3 \times Q_s$$

$$Q_s - 0.3\,Q_s = Q_R$$

$$(1 - 0.3)\,Q_s = Q_R$$

$$0.7\,Q_s = Q_R \quad (1)$$

$$\boxed{\frac{Q_R}{Q_s} = 0.7} \quad (2)$$

$$W = Q_s - Q_R \quad (3)$$

Sub (1) in (3)

$$W = Q_s - 0.7\,Q_s$$

$$W = 0.3\,Q_s$$

$$\boxed{Q_s = \frac{W}{0.3}} \quad (4)$$

Heat Pump :

$$Cop = \frac{Q_s'}{Q_s' - Q_R'} = 5$$

Bracket
Of
Division
Multiplication
Addition
Subtraction

BODMAS - rule

$$\cancel{\frac{Q_s'}{5} = Q_R' - Q_s'}$$

$$\frac{Q_s'}{5} = Q_s' - Q_R'$$

$$Q_R' = Q_s' - \frac{Q_s'}{5}$$

$$Q_s' - \frac{Q_s'}{5} = Q_R'$$

$$Q_s'\left(1 - \frac{1}{5}\right) = Q_R'$$

$$Q_R' = Q_s'(1 - 0.2)$$

$$\boxed{Q_R' = Q_s'(0.8)} \text{ — } ⑤$$

$$\boxed{\frac{Q_R'}{Q_s'} = 0.8} \text{ — } ⑥$$

$$W = Q_S' - Q_R' \text{ — } ⑦$$

sub 5 in 7

$$\cancel{W = Q_s'(0.8) - Q_s'}$$

$$W = Q_s' - 0.8\,Q_s'$$

$$W = 0.2\,Q_s'$$

$$Q_s' = \frac{W}{0.2}$$

$$\boxed{\frac{Q_s'}{Q_s} = \frac{(W/0.2)}{(W/0.3)} = \frac{\cancel{W}}{0.2} \times \frac{0.3}{\cancel{W}} = \frac{0.3}{0.2} = 1.5}$$

$$\frac{Q_s'}{Q_s} = \frac{\frac{W}{0.2}}{\frac{W}{0.3}} = \frac{W \times 0.3}{0.2 \times W} = 1.5$$

0.3 → Denominator Bun Bum vayo so

Concept of entropy:

2.80

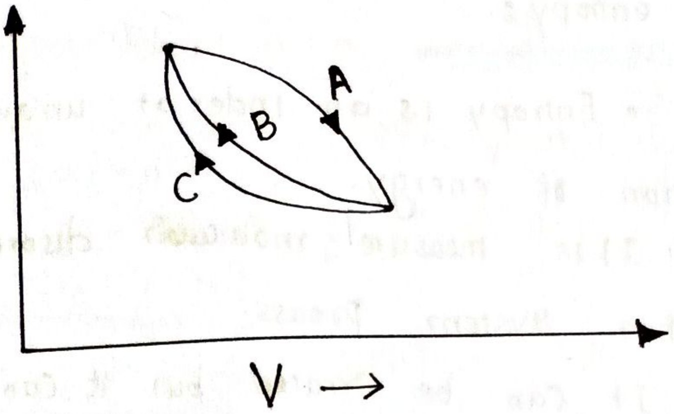
- Entropy is an index of unavailability or degradation of energy.
- It is measure molecular disorder or random function of a system process.
- It can be created but it cannot be destroyed.
- Heat always flow from hot body to cold body and thus become lesser value available. This unavailability of energy is measured by entropy.
- It is an important thermodyanamics property of the working substance.

$$\text{Change in entropy } ds = \frac{\text{change of Heat transfer } (dQ)}{\text{Absolute temperature } (T)}$$

Unit is kJ/K or J/K

$$\text{Change in entropy } \Delta s = S_1 - S_2 = \int_1^2 \left[\frac{dQ}{T}\right]$$

Entropy : A property of the system



The thermodynamic system undergo change of state from 1 to 2 by reversible process 1 – A – 2 and returns to its original state 1 by another reversible process 2 - B - 1 and completing cycle 1 - 2 - 1

For cyclic reversible process the entropy equation is

$$\oint_{rev} \frac{dQ}{T} = 0 = \int_{1A}^{2A} \frac{dQ}{T} + \int_{2B}^{1B} \frac{dQ}{T} \quad \text{—— (1)}$$

Now let us consider the cycle 1-2-1 completed another reversible proble 2 - C - 1

$$\text{Then } \oint_{rev} \frac{dQ}{T} = 0 \int_{1A}^{2A} \frac{dQ}{T} + \int_{2C}^{1C} \frac{dQ}{T} \quad \text{—— (2)}$$

Subtracting equation (2) from (1)

$$\int_{2B}^{1B} \frac{dQ}{T} = \int_{2C}^{1C} \frac{dQ}{T}$$

Availability:

- The maximum portion of energy which Could be Converterted into useful Work. and Which reduces the system to a dead state.

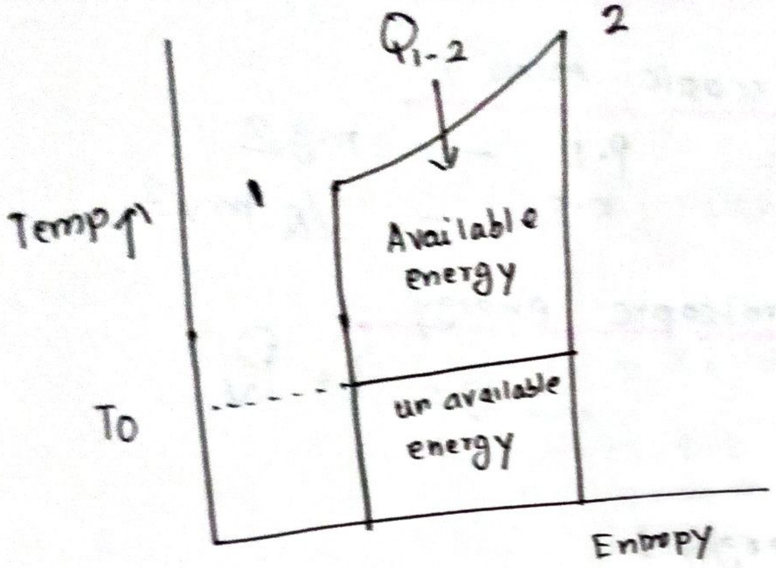
Ψ

- The portion of the available energy which is not Converted to usefull Work is known as unavailable energy.

Availabilitye energy Referred A Cycle:

The maximum out put obtainable from a Certaen heat input in a Cylic heat engine [reversible engine] is Called the available energy (AE).

The minimum energy has that has to be rejected to the sink as per the second law is called unavailable energy or unavailable Part of Supplied energy.



Available and unavailable energy

Classification of energy :-

Energy is defined as Capacity to do Work.

Energy has many form

(1) Mechanical
(2) Chemical
(3) electrical
(4) Thermal
(5) Nuclear
(6) electromagnetic
(7) Wind etc

Thermodyanamic energy Classified into two type

(i) Stored energy

(ii) Transit energy

Store energy has two type

(i) Macroscopic energy

$P.E - mgz$

$K.E - \frac{1}{2} mv^2$

(ii) Microscopic energy

$U = h + P_v$

Transit energy :-

The energy possed by the system which is capable of crossing the boundaries

FORMULA'S

Availability at Initial ψ_1

$mcp[T_1 - T_0][C_p \ In [T_1/T_0] - R \ in [\frac{P_1}{P_0}]$

Availability at Final ψ_2

$mcp(T_2 - T_0)(C_p \ In (T_2/T_0) - R \ In [P_2/P_0]$

Maximum work :

$W = \psi_1 \ \psi_2$

Formulas :

For any Process

change in entropy $\Delta s = S_2 - S_1 = m\left[c_p \ln\left[T_2/T_1\right] - R \ln\left[P_2/P_1\right]\right]$

Decrese availability $= \psi_1 - \psi_2$ (Avai)

$\psi_1 - \psi_2 = m\left[h_1 - h_2\right] - T_0\left[S_1 - S_2\right]$

$= m\,c_p\left[T_1 - T_2\right] - T_0\left[S_1 - S_2\right]$

Irreversibility $I = T_0\left(\Delta S_{system} + \Delta S_{surrounding}\right)$

ψ_1 Availability of hot fluid

$\psi = m_1\left[c_p\left[T_1 - T_2\right) - T_0\left(S_1 - S_2\right)\right]$

$\therefore S_1 - S_2 = c_p \ln \frac{T_1}{T_2}$

· Availability of cold fluid

$\psi_2 = m_2\left[\left(h_4 - h_3\right] - T_0\left(S_4 - S_3\right)\right]$

IInd law of Efficiency η_{II} $= \dfrac{\text{Availability of cold fluid}}{\text{Availability of Hot fluid}}$

Availability at Inlet $\psi_1 = h_1 - T_0 S_1$

Availability at outlet ψ_2 $= h_2 - T_0 S_1$

The available energy $= m C_p \int_{T_0}^{T} \left[1 - \frac{T_0}{T}\right] dT$

Irreversibility

$$(\Delta s)_{system} = m C_v \times In \left[\frac{T_2}{T_1}\right] + mR * \ln\left[\frac{V_2}{V_1}\right]$$

Irreversibility =

$$I = T_0 \left(\Delta s_{system} + \Delta s_{souroundiy}\right)$$

TB:

$$= T_0 \left[(S_2 - S_1) + Q_0/T_0\right]$$

Whore

ψ_1 - Availability energy for Initial

ψ_2 ... " final

h_1 - enthalpy

h_g - enthalpy

S_1 - entropy

S_2 - entropy

T_0 = Souroundiny or atmospheric temp

P_0 = " " Pressure.

To Find Entropy:

Change in Entropy $ds = mR\ln\left[\frac{V_2}{V_1}\right] + mc_v\ln\left[\frac{T_2}{T_1}\right]$
(In terms of Volu & temp)

Change in entropy $ds = mR\ln\left[\frac{P_1}{P_2}\right] + mC_p\ln\left[\frac{T_2}{T_1}\right]$
(In terms of Press & temp)

Change in entropy $ds = mR\ln\left[\frac{V_2}{V_1}\right] + mC_v\ln\left[\frac{P_2}{P_1}\right]$

Expression for the energy of an open system in terms of Availability and secound law efficiency

Steady flow energy equation for any kind of open system follows the energy balence concept

$$m\left[h_1 + \frac{C_1^2}{2} + Z_1 g\right] + Q = m\left[h_2 + \frac{C_2^2}{2} + Z_2 g\right] + W$$

Case (a) Turbine:-

The following assumptions are made

(i) potential energy are negligible

(ii) Inlet Velocity of the turbine is negligible when compared to exit Velocity The S.F.E.E reduce

The actual Work output $W_{act} = m(h_1 - h_2) + Q$

[∴ For air $(h_1 - h_2) = C_p[T_1 - T_2]$ $Q = -ve$ when heat is transferred to the Surrounding]

Reversible Work (or) Maximum Work or availability change

$$W_{max} = [h_1 - h_2] - T_0(S_1 - S_2]$$

Irreversibility $I = T_0 \Delta s$ $[\Delta s = S_1 - S_2]$

Case b: Compressor / Pump:

The following assumption are made such as change in P.E & K.E are negligible Therefore SFEE reduces to

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

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

Actual Work input $W_{act} = m(h_2 - h_1) = Q$

[∴ Compr/pump are work absorbing devices]

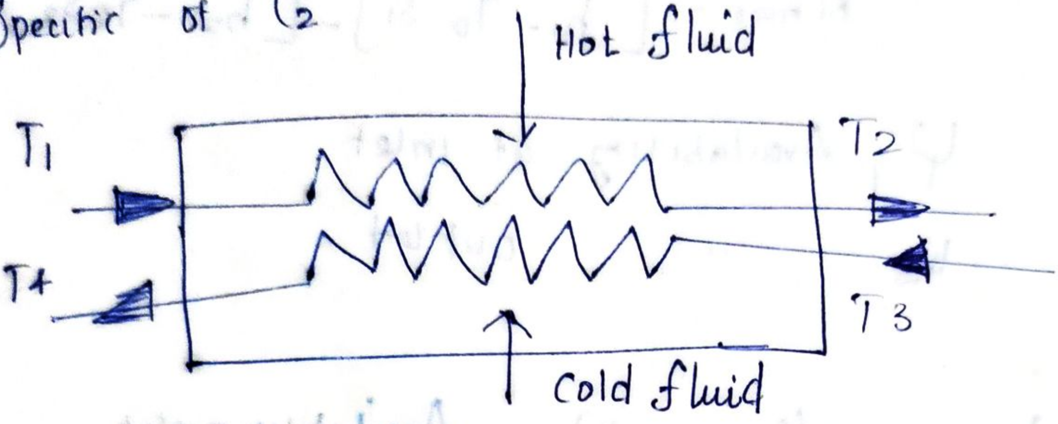
Max work input $W_{max} = m[h_2 - h_1] - T_0(s_2 - s_1)$

Irreversibility $I = T_0 \Delta s$

Second law of efficiency $\eta_{II} = \frac{W_{max}}{W_{act}}$

heat exchanger

Consider m_1 hot fluid with Specific heat of C_1 exchanging heat with Cold fluid of m_2 Kg w/m Specific of C_2



Heat exchanger

By heat balence

∴ heat gained by cold fluid = heat given out by hot fluid

$$m_2 C_2 [T_4 - T_3] = m_1 C_1 (T_1 - T_2)$$

Availability of cold flud $B_c = m_2 C_2 [T_4 - T_3] - T_0 [S_4 - S_3]$

" hot " $B_h = m_1 C_1 [T_1 - T_2] - T_0 [S_1 - S_2]$

2nd law of efficuency $\eta_{II} = \dfrac{\text{Availability of cold fluid}}{\text{Availability of hot fluid.}}$

Throttling Process

Enthalpy before throotling = Enthalpy after throttling

$$h_1 = h_2$$

Throttling Process both work output and heat transfer are zero

Max work $W_{max} = h_1 - h_2 - T_0 [s_1 - s_2]$

$W_{max} = [h_1 - T_0 s_1] - [h_2 - T_0 s_2] = \psi_1 - \psi_2$

ψ_1 Availability at inlet

$\psi_2 =$ " outlet

2nd law of efficiency $\eta_{II} = \frac{\text{Availability outlet}}{\text{Availability inlet}} = \frac{\psi_2}{\psi_1}$

Sentil

At the inlet of the Nozzle, the enthalpy & Velocity of fluid are 3000 kJ/kg and 50 m/s respectively. There is negligible heat loss from the Nozzle. At the out let of the Nozzle enthalpy is 2450 kJ/kg. If the Nozzle is horizontal find the Velocity of fluid at exit

Sol:

G.D:

$h_1 = 3000$ kJ/kg

$C_1 = 50$ m/s

$Q = 0;$ ~~$z_1 = z_2$~~

(height above datum line) $Z_1 = Z_2$ (So $z_1 = z_2$)

To find

Velocity of fluid exit $[C_2]$

$$h_1 + \frac{C_1^2}{2} + z_1 g + Q = h_2 + \frac{C_2^2}{2} z_2 g + W$$

$\because z_1 = z_2$

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

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

$$C_2 = \sqrt{2 \times (3000 - 2450) + 50^2}$$

$$\boxed{C_2 = 1050 \text{ m/s}}$$

[$\because \times 10^3$ for make h in J/kg.

kJ/k

p ln

$\frac{P_2}{P_0}$

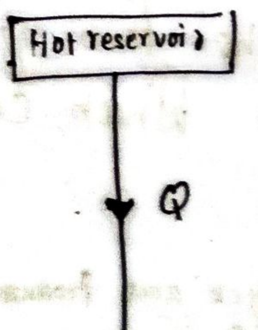
Introduction To The secound Law of Thermodynamics

- A process must satisfy the 1st Law ~~of Thermodynamics~~ to occur
- However satisfying 1st law alone doesnot ensure that the Process klill actually take place.
- According to 1st law of thermodynamics all form of energ are equivalent.
- One form of energy Can be Converted into other form and any Process is possible as long as it doesnit Create energy or destroy energy.

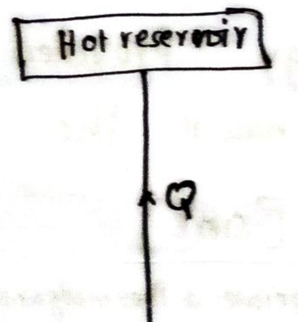
But actual practice, all form of energy can't be changed into work. Hence there are certain process which are not possible to occur even though these process donot violate first law of thermodynamics.

~~Classt~~ Clausis Statement :-

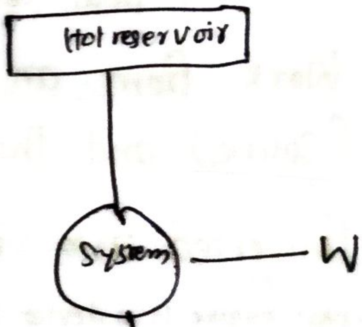
- heat Cannt flow from Cold reservoir to hot reservoir With out any External device.
- But heat Can flow from hot reservoir to cold reservoir without any External aid.



possible



Impossible



possible system.

Heat reservoir :-

Source :

It is the thermal energy reservoir from which the heat Q_1 is transferred to the system operating in the heat engine Cycle is Called Source.

Sink :

It is Thermal energy reservoir to which the heat Q_2 is rejected from the system during a cycle is Called sink.

(or)

A reservoir that Supplies energy in the form of heat is Called a Source, and one that absorbs energy in the form of heat is called a sink. Thermal energy reservoir are often referred to as heat reservoirs sine they supply or obsorb energy in the form of heat.

Heat engine :-

Heat engine is used produce the maximum Work from an energy Provided in the form of heat (Soure) and that exhausts the heat Which cannt be Converted into Work [sink]

p.no 2.1

- Heat engine is a device which operate a thermodyanamic cycle and Produce work by Supplying heat from hot reservoir. Ex I.C Engine, Boiler etc...
- Performance measured by Efficiency