Thermodynamics

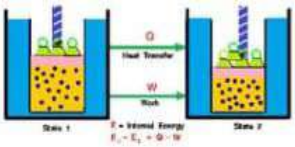
Zeroth-Law of Thermodynamics: If two systems A&B are in thermal equilibrium with a third system C, then A&B are in thermal equilibrium with each other.

Thermodynamics state variable:

i) Extensive – indicate the size of the system. e.g. U, volume, total mass.

(ii) Intensive – do not indicate size of the system. e.g. , pressure & temperature

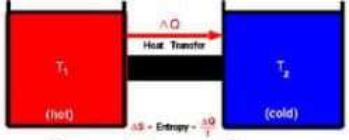
Thermel Equilibrium: Two systems are in thermal equilibrium with each other if they have the same temperature.



First-Law of Thermodynamics: It is the statement of law of conservation of Energy;

$\Delta Q = \Delta U + \Delta W.$

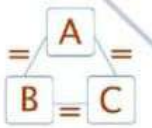
$= \Delta U + P\Delta U$ (Here, $\Delta U = P\Delta U$)



Second-Law of Thermodynamics: It is impossible for an engine working between a cyclic process to extract heat from a reservoir and convert completely into work.

Entropy (S): Measure of molecular disorder of a system.

Change in Entropy $\delta S = \frac{\delta Q}{T}$



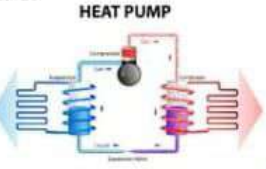
Laws

Specific heat capacity relation

$\frac{C_p}{C_v} = \gamma$

Mayer's Equation

$C_p - C_v = R$



Refrigerator and Heat Pump

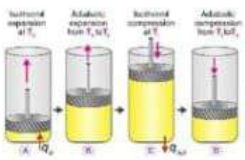
Refrigerator is a heat engine working in the reverse direction.

Coefficient of performance

$\beta = \frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_1} = \frac{T_2}{T_1 - T_2}$

Reversible & Irreversible Process

- Any process made to proceed in the reverse direction by changing its conditions is called **Reversible Process.**
- Any process which cannot be retraced in the reverse direction exactly is called **Irreversible Process**



Carnot's Engine

An Ideal engine works on a reversible cycle of four operations in succession.

(i) isothermal expansion ,

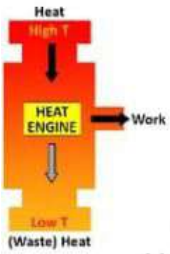
(ii) adiabatic expansion,

(iii) isothermal compression,

(iv)adiabatic compression.

Efficiency of Carnot's Engine

$\eta = 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_2}{T_1}$



Heat Engine

Converts continuously heat into mechanical energy in cyclic process

Efficiency

$\eta = \frac{W}{Q} \quad 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_2}{T_1}$

Quasi-static Process: Infinity slow process such that systems remain in thermal & mechanical equilibrium with the surroundings throughout.

Properties: The pressure (P) & temperature (T) of the environment can differ from those of the system only infinitesimally.

Cyclic Process: In this process, system returns to initial state for a cyclic process

$\Delta U = 0$ (zero)

Thermodynamics

Branch of Science which deals with concepts of heat & temperature and their interconversion by thermodynamic process

Isobaric Process: Pressure = constant

$\frac{V}{T} = \text{constant};$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Isochoric Process: Volume = constant

$\frac{P}{T} = \text{constant};$

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Adiabatic Process: A thermally insulated system neither gains nor loses heat

$PV^{\gamma} = \text{constant}$

$TV^{\gamma-1} = \text{constant}$

$\frac{P^{n-\gamma}}{T^{\gamma}} = \text{constant}; \quad \frac{C_p}{C_v} = \gamma$

Isothermel Process: Temperature = Constant

$PV = \text{Constant} = nRT$

$W = \frac{nRT}{V} dV$