Thermodynamics

Basic Concepts of thermodynamics

Thermodynamics system (variable or co-ordinate) :

In thermodynamics, the state of a system at any instant is represented by it's condition at that instant, the condition being completely specified by a set of adequate and minimum number of measurable quantities. Called thermodynamic variables. such as temperature, pressure, volume, electric field, surface area etc.

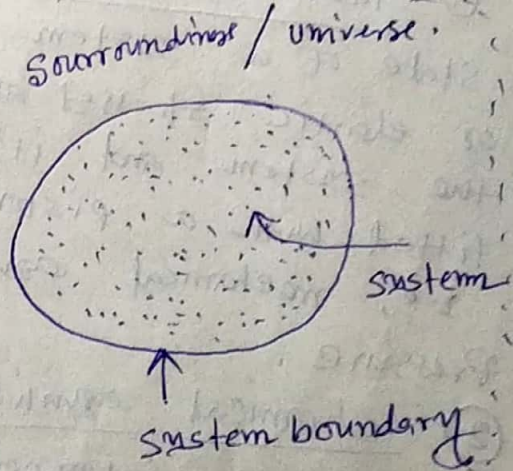
Thermodynamics system

A thermodynamics system is any part whatsoever of the universe selected for the purpose of investigation. This means that a thermodynamic system is essentially macroscopic.

The system may be a gas such as air, a vapour such as steam, a vapour in contact with it's liquid such as liquid ammonia and ammonia vapour. A system may be simple or complex. It may also be homogeneous or heterogeneous where each component can exist in different phases. A gas enclosed in a cylinder fitted with a frictionless gas-tight piston is a simple homogeneous system, but a phenol-water mixture is an example of a complex heterogeneous system.

Surroundings and Boundary :

Everything outside the system that can it's behaviour constitutes the surroundings and the envelope which encloses a system and separates it from it's surroundings is called the boundary of the system.



The boundary that does not allow any exchange of matter and energy between the system and it's surroundings is called an isolating boundary.

A system with a boundary that permits exchange of matter and energy between the system and the surrounding is called an open system.

State of a system and thermodynamic variables

The thermodynamic variables may be divided into two categories: intensive and extensive variables.

Intensive variables of a system in a given state are those which are independent of the system - size and cannot be scaled out at all.

Example: Pressure, temperature, magnetic field, density etc.

Extensive variables, however, are proportional to the system - size and can be scaled by a factor.

Example: volume, mass, length, area, energy.

Thermodynamic equilibrium

Thermodynamic equilibrium may have three types thus are,

1. Mechanical equilibrium
2. chemical "
3. Thermal "

① Mechanical equilibrium: Mechanical equilibrium is that state of a system in which it experience no pressure or elastic stresses and there is no unbalanced force between the system and it's surroundings. A gas in a cylinder fitted with a piston is said to be in mechanical equilibrium. i.e, mechanical equilibrium refers to uniformity of pressure.

② chemical equilibrium: The absence of any spontaneous change of internal structure (by way of diffusion or chemical reaction or by both) is implies chemical equilibrium. In chemical equilibrium to uniformity of

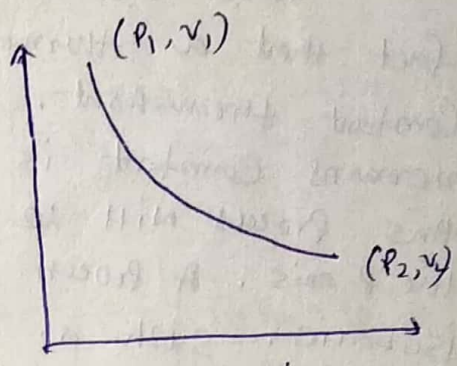
(3) Thermal equilibrium

All parts of the system are in same temperature with surroundings.

i.e, In thermal equilibrium to constancy of temp^r

● Thermodynamic Processes (If thermodynamic variables or co-ordinates change from one equilibrium state to another)

When the value of thermodynamic variables associated with a system change from one equilibrium state to another, the system is said to undergo a thermodynamic process.



To analyse a thermodynamic process, the variation one thermodynamic variable is plotted with respect to another and the plot is known as an indicator diagram. And a process means a line connecting a series of such points. In the adjacent diagram, the initial state of the system is represented by the point (P, V_1), the system undergoes an expansion, and the final state of the system is defind by the point (P_2, V_2).

A thermodynamics process can be made to retrace it's original path to reach back the initial state. If retracing is possible, the process is said to be reversible; if not, it is said to be irreversible.

● quasistatic process :-

A process is called quasistatic if all the parameters of the system $(P, V, T$ etc.$)$ vary physically indefinitely slowly so that the system is found all the time in an equilibrium state.

physically, an indefinitely slow or quasistatic variation of any parameter A with time t is such that the rate of change dA/dt is considerably smaller than its mean rate of variation in relaxation. If the relaxation time is τ and the corresponding variation of the parameter is ΔA, then for a quasistatic process to occur,

$$\frac{dA}{dt} \ll \frac{\Delta A}{\Delta \tau}$$