THERMODYNAMIC PROCESS
&
CYCLE

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Thermodynamic System

- It is defined as a quantity of matter or a region in space upon which attention is concentrated in the analysis of a problem

- Everything external to the system is surroundings or the environment

- The real or imaginary surface that separates the system from its surroundings is called the Boundary
  - Boundary can be fixed or movable
  - Boundary is Shared by both the system & surroundings
  - Boundary has zero thickness
  - It can neither contain any mass nor occupy any volume in space

EQUILIBRIUM STATES

- Equilibrium implies a state of balance

- There are no unbalanced potentials within the system

- A system is not in thermodynamic equilibrium unless the conditions of all the relevant types of equilibrium are satisfied

- Thermal Equilibrium. A system is in thermal equilibrium if the temp is same throughout the system

- Mechanical Equilibrium. A system is in mechanical equilibrium if there is no change in pressure at any point of the system with time

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EQUILIBRIUM STATES

- **Chemical Equilibrium. A system is in chemical equilibrium if its chemical composition does not change with time, that is, no chemical reactions occur**

- **If a system involves two phases, it is in phase equilibrium when the mass of each phase reaches an equilibrium level and stays there**

- **A system will not be in equilibrium unless all the relevant equilibrium criteria are satisfied**

THERMODYNAMIC STATE

- **State**

- Thermodynamic state is the condition of the system as characterized by certain thermodynamic properties like pressure, temperature, specific volume

- If system not undergoing any change, properties can be measured, state can be described and properties of the system has same value throughout the system

- Thus when all the properties of a system have definite values, the system is said to exist at a definite state

THERMODYNAMIC PATH

- **Path**

  - Succession of states passed through between initial and final states is called a path

  - System may reach from one state to another by a number of paths depending on the type of expansion

THERMODYNAMIC PROCESS

- **Process**

  - Any Change that a system undergoes from one equilibrium state to another is called a process

  - The transformation of a thermodynamic system from one thermodynamic state to another is called process

  - A serious of states through which a system passes during a process is called the path of the process

CLASSIFICATION PROCESS

- Flow Process
- Non-Flow Process
- Quasi-Static Process
- Reversible Process
- Irreversible Process
- Adiabatic Process

CLASSIFICATION PROCESS

- **Flow Process. It is one in which fluid enters the system and leaves it after work interaction, which means that such processes occur in the systems having open boundary permitting mass interaction across the system boundary.**

- **Non flow process: It is the one in which there is no mass interaction across the system boundaries during the occurrence of process. Different type of non-flow process of perfect gas are given:**

  - **(a) constant volume process (Isochoric process)**
  - **(b) constant pressure process (Isobaric Process)**
  - **(c) Isothermal process**
  - **(d) adiabatic process**
  - **(e) polytropic process (a polytropic process is a reversible process involving a gas or vapor in a closed or open system involving both heat and work transfer such that a combination of properties are maintained constant. It follows the equation PV^n= C where P is pressure, V is Volume and n the polytropic index and C is a constant)**

CLASSIFICATION PROCESS

- (c) Isothermal process
  - (i) Temperature Remains Constant
  - (ii) Changes Take place at slow rate
  - (iii) Specific Heat of the gas is infinite
- (d) Adiabatic process
  - (i) No Transfer of Heat energy
  - (ii) Changes must take place at fast rate
  - (iii) Specific Heat of the gas is Zero
- (e) Polytropic process (a Polytropic process is a reversible process involving a gas or vapor in a closed or open system involving both heat and work transfer such that a combination of properties are maintained constant. It follows the equation PV^n= C where P is pressure, V is Volume and n the polytropic index and C is a constant)

CLASSIFICATION PROCESS

- **Quasi-Static Process.** When a process proceeds in such a manner that the system remains infinitesimally close to an equilibrium state at all times, it is called a 'Quasi-static or – Quasi Equilibrium' process

  - **(a) A sufficiently slow process**
  - **(b) Properties change is steady in all parts**
  - **(c) It is an idealized process**
  - **(d) Easy to analyze**
  - **(e) Max output at Quasi static process**

CLASSIFICATION PROCESS

- **Steady - Flow Process.** Defined as a process during which a fluid flows through a control volume steadily
  - **(a) Fluid properties can change from point to point within the control volume, but at any fixed point they remain the same during the entire process**
  - **(b) During a steady – flow process, fluid properties within the control volume may change with position but not with time**
  - **(b) The Volume V , the mass m, and the total energy content E of the control volume remain constant during a steady flow process**

TYPE OF PROCESS

- **Prefix *iso-* is often used to designate a type of process for which a particular property remains constant**

  - An Isothermal Process. Temperature remains constant during the process

  - An Isobaric Prpcess. Pressure remains constant during the process

  - An Isochoric (Isometric) Process. Volume remains constant during the process

  - An Isentropic Process. Entropy remains constant during the process

  - An Isenthalpic Process. Enthalpy remains constant during the process

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