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Thermodynamics

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Unit 1: Fundamental Concepts

Lecture 1: Thermodynamics Terminology

Unit 1: Fundamental Concepts

- ❑ Scope of Thermodynamics
- ❑ Thermodynamics Terminology
 - ❑ System
 - ❑ Process
 - ❑ Thermal Contact
 - ❑ Thermal Equilibrium
- ❑ The Zeroth Law of Thermodynamics
- ❑ Temperature and Temperature scale
- ❑ The Ideal Gas





Scope of Thermodynamics

- The study of thermodynamics is an experimental science concern with the concept of **heat** and **temperature** at a **macroscopic scale**.



The principle of thermodynamics are used by engineers in the design of internal combustion engines, conventional and nuclear power stations, refrigeration and air-conditioning system and also rockets, missiles, aircraft, ships, submarine, and vehicles.



Macroscopic and Microscopic Approaches?

Behavior of matter can be studied by these two approaches.

Macroscopic Approaches **الطرق الجاهرية**

In **macroscopic approach**, certain quantity of matter is considered, **without a concern** on the events occurring at the molecular level. These effects can be perceived by human senses or measured by instruments.

Microscopic Approaches **الطرق الجوهريّة او الميكروسكوبية**

In **microscopic approach**, the effect of molecular motion is considered. Most microscopic properties cannot be measured with common instruments nor can be perceived by human senses.

Macroscopic Properties

pressure, volume, temperature, *Entropy; Enthalpy; Internal energy*, composition, density, viscosity, surface tension, refractive index, colour etc.

Thermodynamics Terminology



The important parts of the study of thermodynamics are a few **terms and definitions**, which must be understood clearly, and these are as follows:

(1) System **النظام**

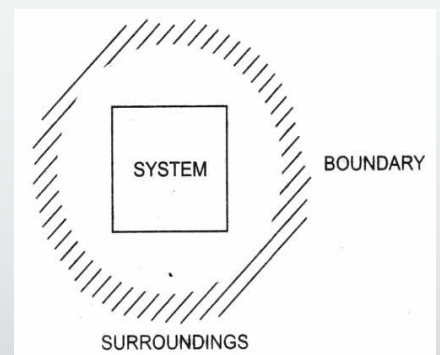
A thermodynamic system may be defined as any **specified portion of matter in the universe which is under study**. A system may consist of one or more substances.

(2) Surrounding **المحيط**

The rest of the universe which **exchange energy and matter with the system** is called the surroundings. Thus, the system is separated from the surroundings by a **boundary** which may be real or imaginary.

(3) Universe **الكون**

System + Surrounding



Thermodynamics Terminology

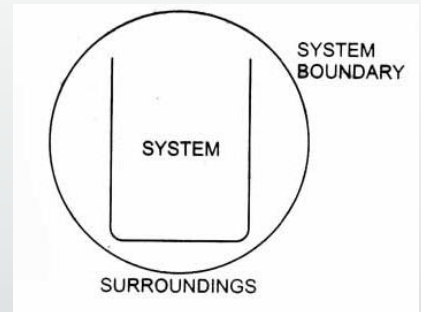


(4) Homogeneous and Heterogeneous system النظام المتجانس والغير متجانس

A system is said to be **homogeneous** when it is completely **uniform**, for example, a pure solid or liquid or a solution or a mixture of gases. In other words, a homogeneous system consists of **only one phase**.

A system is said to be **heterogeneous** when it is **not uniform**. In other words, a heterogeneous system is one which consists of **two or more phases**.

Thus a system consisting of two or more immiscible liquids or a solid in contact with a liquid in which it does not dissolve, is a **heterogeneous system**. A liquid in contact with its vapor is also a **heterogeneous system** because it consists of two phases.



Thermodynamics Terminology



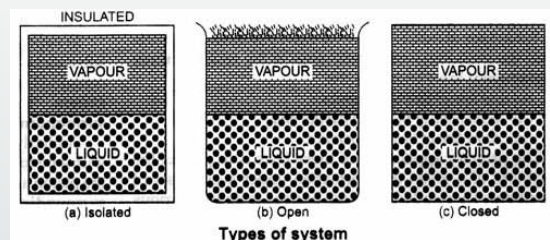
(5) Types of Thermodynamic Systems انواع انظمة الديناميكا الحرارية

There are three types of thermodynamic systems, depending on the nature of the boundary which are as follows:

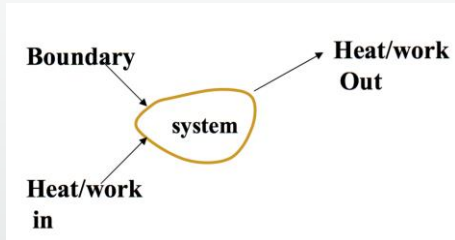
(i) **Isolated system:** When the boundary is both **sealed and insulated**, *no interaction is possible with the surroundings*.

(ii) **Open system:** In such system the boundary is **open and un-insulated** therefore, *An open system is one which can transfer both energy and matter to and from its surroundings*.

(iii) **Closed system:** Here the boundary is **sealed but not insulated**. Therefore, *A closed system is one which cannot transfer matter but can transfer energy in the form of heat, work and radiation to and from its surroundings*

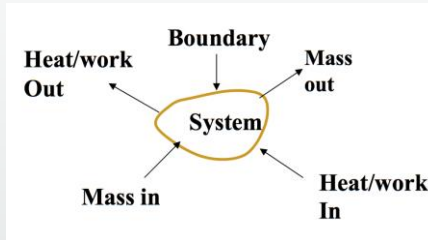


Closed system



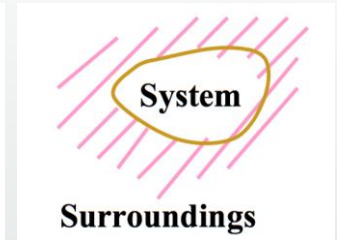
cannot transfer matter but can transfer energy

Open system



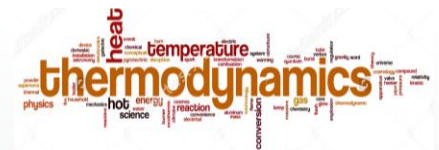
can transfer both energy and matter to and from its surroundings

Isolated System



no interaction is possible with the surroundings

Thermodynamics Terminology



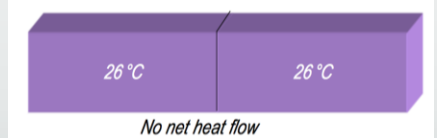
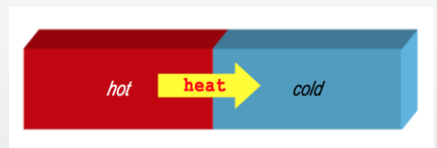
(8) Thermal contact الاتصال الحراري

Two object are in thermal contact with each other if the energy exchange can occur between them in the absence of work done by one in the other

(9) Thermal Equilibrium الاتزان الحراري

A system in which the macroscopic properties do not undergo any change with time is said to be in thermodynamic equilibrium.

A system is said to be in **thermal equilibrium**. if there is no flow of heat from one position of the system to another. This is possible if the temperature remains the same throughout in all parts of the system.



Thermodynamics Terminology

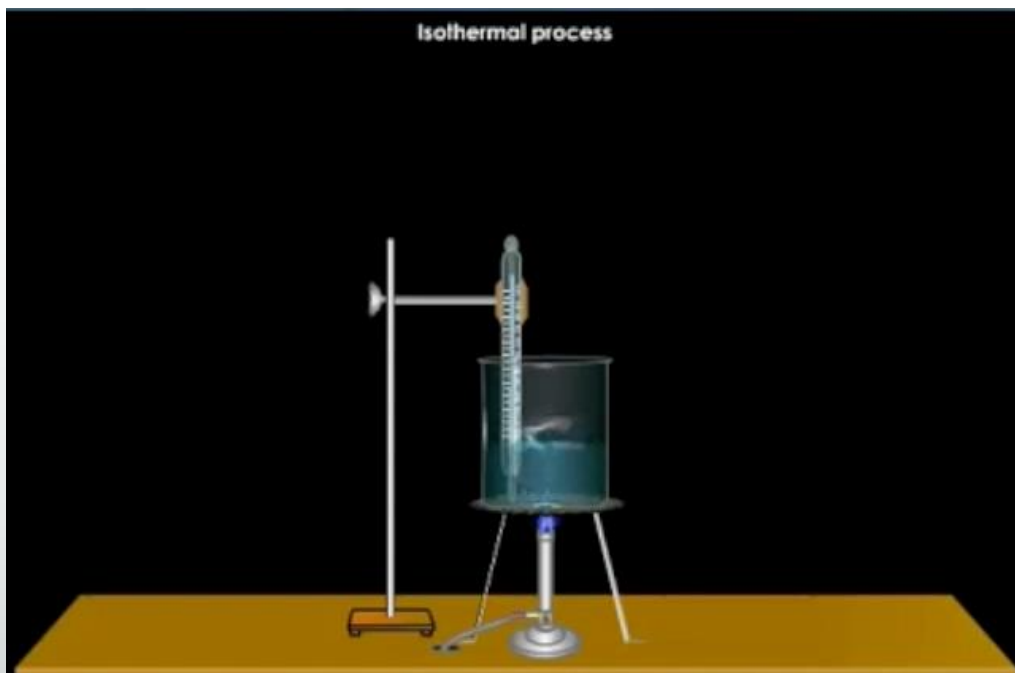
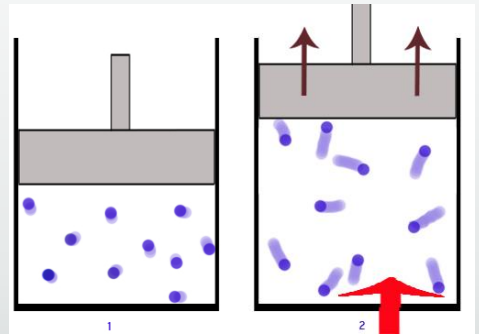


(10) Process عملية

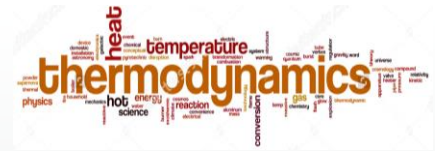
Whenever the state of a **system changes**, it is said to have undergone a process. *Thus a process may be defined as the operation by which a system changes from one state to another.*

In a process at least one of the properties of the system changes.

A change in state of the system is always accompanied by a change in energy. Therefore, a process may also be defined as *a path of change of a system from one equilibrium state to another which is usually accompanied by a change in energy or mass.*



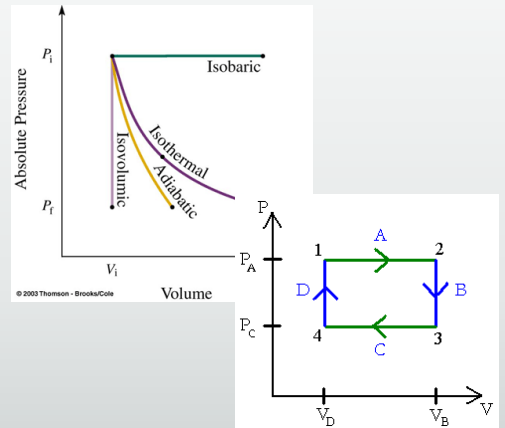
Thermodynamics Terminology



Types of Processes

Different types of processes connecting an initial state, in which, one of the properties to remain a constant during a process.

- i. **Isothermal process** (T remains constant)
- ii. **Isobaric process** (P remains constant)
- iii. **Isochoric process** (V remains constant)
- iv. **Adiabatic process** (Thermally insulated from the surroundings).
- v. **Cyclic process** (The process which brings back a system to its original state after a series of changes).
- vi. **Quasi-Static Process** The deviation from thermodynamic equilibrium is infinitesimal.



Thermodynamics Terminology



(1.1) Reversible and Irreversible Processes

Reversible process: A process that can be reversed without leaving any trace on the surroundings.

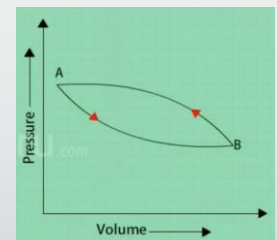
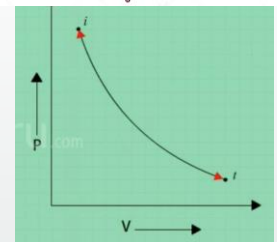
A thermodynamic reversible process is one that takes place **infinitesimally slowly** and its direction at any point can be reversed by an infinitesimally change in the state of the system.

Irreversible process: A process that is not reversible.

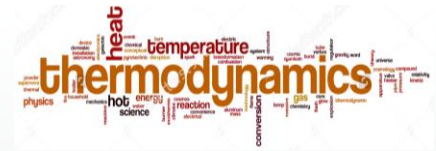
All the processes occurring in nature are irreversible.

Why are we interested in reversible processes?

(a) They are easy to analyze and (b) they serve as idealized models to which the actual processes can be compared.



Thermodynamics Terminology



System

- Homogeneous
- Heterogeneous

System

- Isolated system
- Closed system
- Open system

Surrounding

Universe

Process

- Isothermal process
- Isobaric process
- Isochoric process
- Adiabatic process
- Cyclic process
- Quasi-Static Process

Process

- Reversible process
- Irreversible process

Thermal contact

Thermal Equilibrium

إلى اللقاء مع المحاضرة (٢)

Definition of Temperature & Zeroth Law of Thermodynamics