Thermodynamics and Heat

Lecture One

Second stage

Introduction

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INTRODUCTION AND BASIC CONCEPTS IN THERMODYDNAMICS

Thermodynamics appeared in the late eighteenth century, and is one of the branches of statistical mechanics. Thermodynamics is an experimental science concerned with studying everything related to temperature and thermal energy and its transformation into different types of energy such as mechanical energy, to benefit from it in the operation of engines. It is concerned with all phenomena that appear or are related to this energy, such as the processes of heat transfer from one body to another, or how this energy is stored and generated.

The Thermodynamics is based on four major laws, which are the zeroth law)or the fourth law (,the first law, the second law and the third law. This science studies the transformation of thermal energy into mechanical work. Based on this, it laid the theoretical foundations for the operation of thermal machines, and this helped in the invention of the steam engine and the gasoline engine and ways to increase their efficiency. Science also studies the relationship between heat and chemical reactions and their applications. Finally, it studies the relationship between heat and electricity, as it helps us generate electrical energy from several means, such as coal-fired, hydroelectric, or nuclear power plants. All these technologies depend on the development of the science of thermodynamics. Its efficiency is often increased. Several scientists have contributed to the development of this science, most notably Rudolf Clausius, William Thomson, Hermann von Helmholtz, Josie Kipps, Sandy Carnot, William Rankine, and others.

- Thermodynamics can be defined as the since of energy.
- The word thermodynamics stems from the Greek words therm (heat) and dynamics (force).

This science is divided into two studies :

1 – Macroscopic View Point

It includes the study and transformation of system properties such as pressure (P), volume (V) and temperature (T), which are properties that can be measured, to give a visual description that can be seen with the naked eye.

2-Microscopic View Point

It is the point of view of the statistical description that deals with molecules. If we imagine a system consisting of N molecules, and each molecule is formed in

several energy states, **E1, E2, E3**, then the basic issue is to find the number of molecules in each energy state when reaching the state of equilibrium.

Basic concepts in thermodynamics

1-System: is part of the universe in which a chemical or physical change occurs, or is the specific part of the material to which the study is directed. The system may be real or ideal.

A real system is a system that is used in an experiment or for any practical purpose. It could be a solid, liquid, or gaseous substance, such as a liquid in a thermometer or a gas in a cylinder, the Earth, and its atmosphere. In short, any substance in the universe is a real system. One of the specifications of this system is that it is thermally balanced.

An ideal system is a system that does not exist, i.e. it is a theoretical system that we imagine for the purpose of facilitating the solution of thermodynamic problems, such as an ideal gas.

2-Surrounding : is the part that surrounds the system and follows the energy in The shape of heat or work can be real or imaginary.

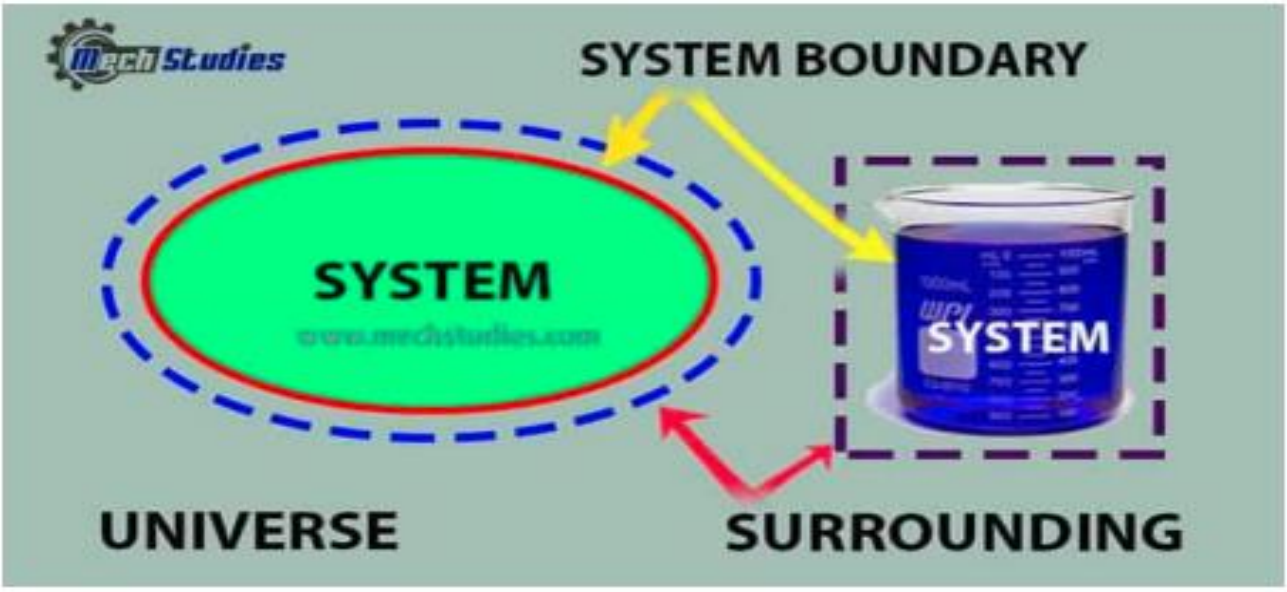
3-System boundaries: is the envelope that surrounds the system and separates it from the surrounding medium and represents the container walls of the system.

4-The universe is about the system based on the way the system shares energy and matter with the ocean.

5- Adiabatic Wall: It is the wall that allows heat to pass through it.

6- Diathermal Wall: It is the wall that dose not allows heat to pass through it.

7- Thermal Contact: It is a connection between two bodies if it is possible for them to exchange thermal energy between them without doing any work.

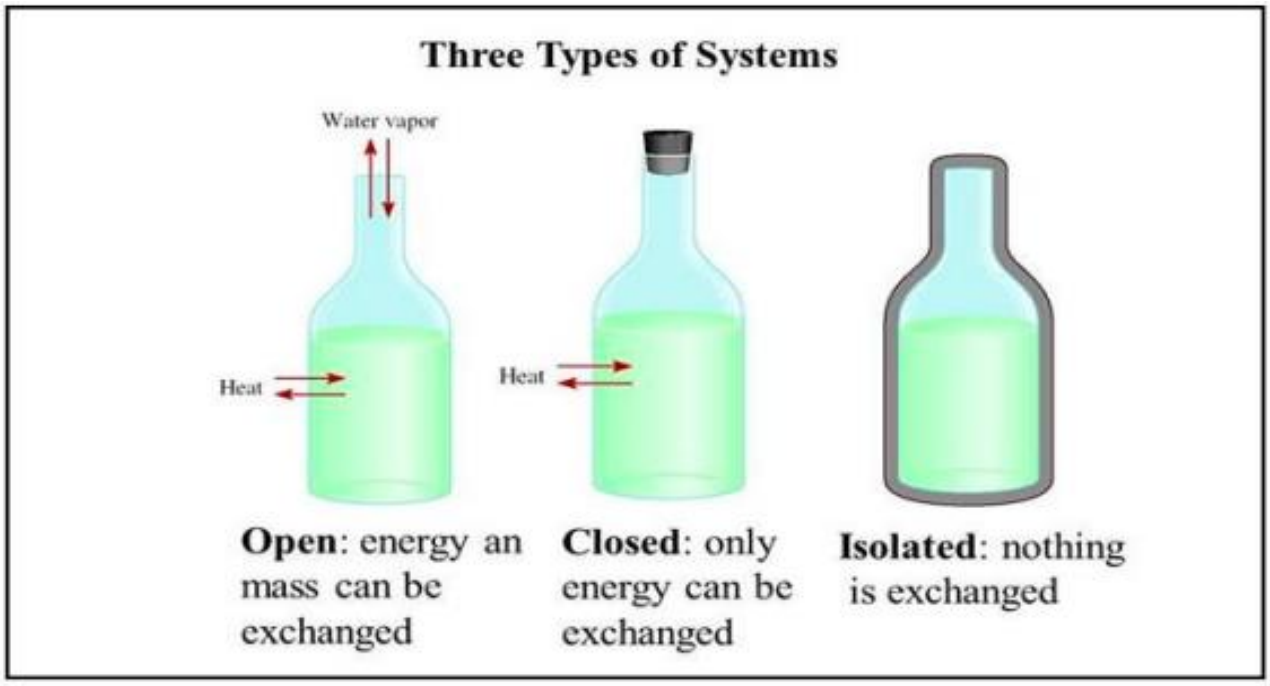


Types of systems in thermodynamics Systems are divided To several types:

1-**Open System:** A system that allows the exchange of both material and energy between the system And the surrounding medium.

2-**Closed System:** Allows only energy exchange between the system and the surrounding medium as heat or work .

3-**Isolated System**: Is not allowed to transfer any energy and material between the system and the surrounding medium.



he system is said to be **homogenous**: if it contains a single phase and is said to be **heterogeneous** if it contains more than one phase, The gas phase is always homogenous because the gases are combustible with gas ,In the case of liquids, the system is either homogenous or heterogeneous depending on the viability of the liquids.

Thermodynamic Equilibrium

It can be divided into three types:

A) Mechanical Equilibrium: The resultant internal forces of the system equal zero.

B) Chemical Equilibrium: This type of equilibrium occurs when it does not occur change in the concentration of matter with time.

C) Thermal Equilibrium: This type of equilibrium occurs when equal the temperature of the system with the surrounding medium this equilibrium represent the zero law of thermodynamics ,Which states that(if two systems are in equilibrium with a third system, the two systems are in a state balance with each other).

D) Thermodynamic Equilibrium : The determination of the types of achieving the three types of equilibrium above and can be described by thermodynamic coordinates (P. V, T).

Thermodynamic coordinates

The properties or coordinates of the system are pressure(P), volume (V) and temperature (T). The most important property among the three coordinates is that each coordinate is a function of the other two coordinates, i.e.

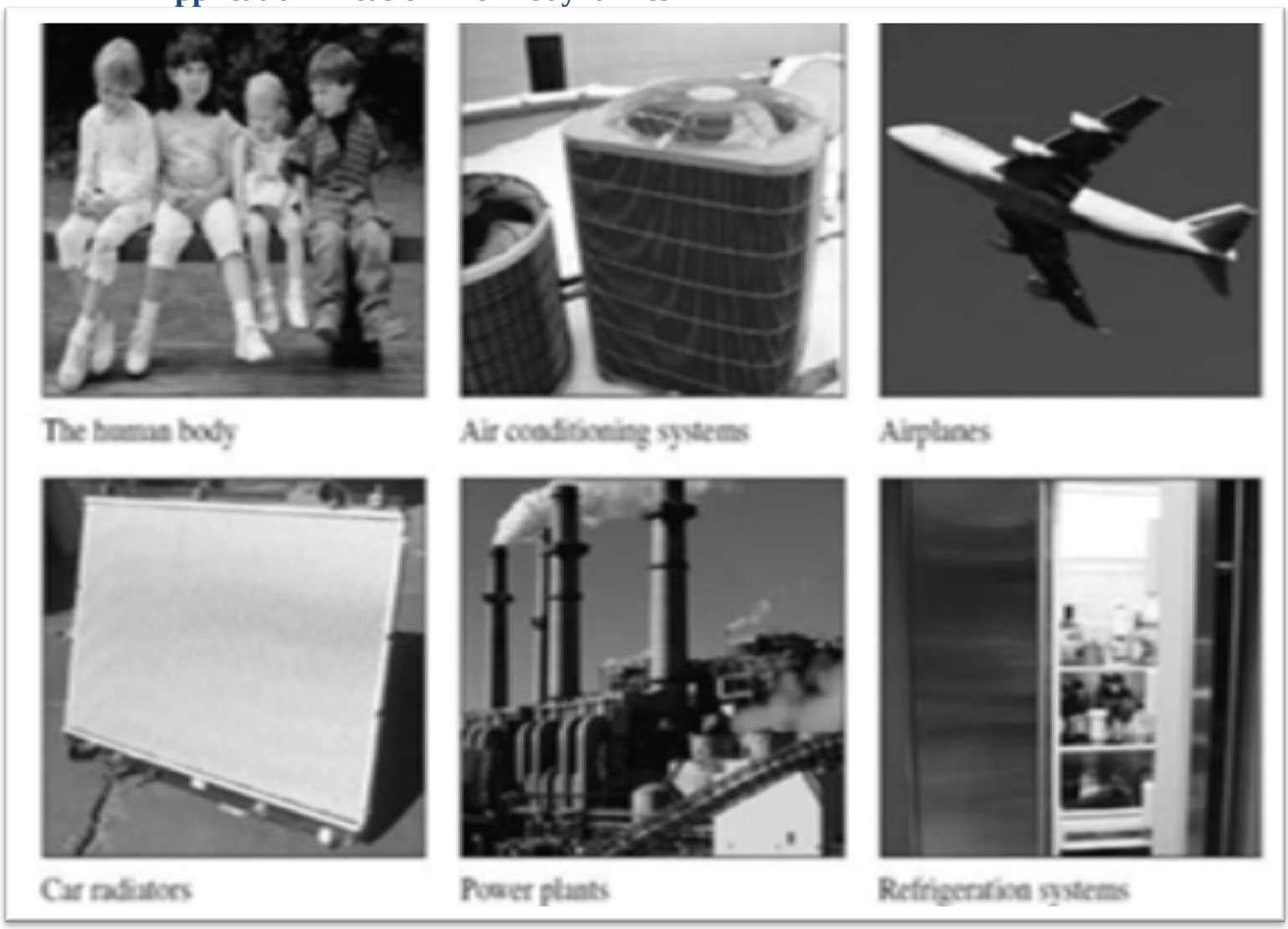
P= f (V,T) **V= f (P,T)** **T= f (V, P)**

The system properties can be classified into two categories:

1- Independent properties : are the properties necessary to determine the state of the system. Their number depends on the nature of the system. A simple system needs two independent properties to determine it. The number of properties necessary to determine the state of the system increases as the degree of complexity increases. Independent properties are chosen that are easy to measure and are suitable for the purpose of using that system.

2- Dependent properties are properties whose values are determined by independent properties. For example, if two properties, such as pressure and volume, are measured and it is necessary to determine the temperature, it is possible to determine it in terms of pressure and volume.

Application Areas of Thermodynamics



1. What is the primary focus of thermodynamics?

a) Study of energy conservation.

b) Study of mechanical energy.

c) Study of temperature and thermal energy transformations.

d) Study of chemical reactions.

e) non of them.

2. What is a real system in thermodynamics?

a) A theoretical system for solving problems. b) A substance in the universe used in experiments or practical applications .

c) A mathematical model of an energy system.

d) A system with no physical presence. e) A system that only exists in theory.

3. Which of the following is true for an ideal system in thermodynamics?

a) It is used in real-world experiments . b) It exists practically in nature.

c) It is purely theoretical and doesn't exist in reality. d) It can exchange both energy and matter e) It is made up of multiple phases.

4. What is the most important thermodynamic property among pressure (P), volume (V), and temperature (T)?

a) Pressure b) Volume. c) Temperature.

d) None of the above. e) All of them