

**24AG301- APPLIED THERMODYNAMICS AND THERMAL
SYSTEMS IN AGRICULTURAL ENGINEERING**

**UNIT 1 BASICS OF THERMODYNAMICS FOR
AGRICULTURAL MACHINERY**

HANDLED BY

MS SWETHA S



ME-3391 - ENGINEERING THERMODYNAMICS

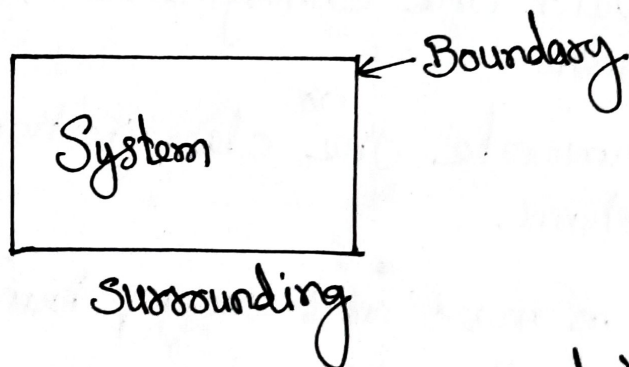
UNIT-1 BASICS, ZEROth AND FIRST LAW

Review of Basics - Thermodynamic systems, Properties and processes Thermodynamic Equilibrium - Displacement work - P-V-diagram. Thermal equilibrium - Zeroth law - Concept of temperature and temperature scales. First law - application to closed and open systems - steady and unsteady flow processes.

1. a Explain the terms System, Boundary and surrounding
- b. Discuss the following, System, Surrounding and Boundary.

System:-

A system is defined as the region of space or a finite quantity of matter considered for thermodynamic study



Surrounding:-

The surroundings are the space and the matter that lie external to the system boundary. The surrounding can interact with the system, but it is separated from the system by the boundaries.

Environment:-

The term environment is used to identify larger

portion of the surrounding that lie sufficiently away from the boundaries of the system.

Boundary :-

The system and the surroundings are separated by a boundary. It may be fixed or movable and real or imaginary one. It has zero thickness. It will not occupy any volume or mass in space.

Permeable boundaries allow the mass transfer to occur. The mass transfer cannot occur across impermeable boundaries.

A diathermal boundary allows the heat transfer to occur across it as in the case of thin metal walls. Adiabatic boundary - No heat transfer occurs.

Universe :-

A system and surrounding together is called as universe.

2. a. Explain the classification of thermodynamic systems

b. Enumerate the ^{or} classification of thermodynamic systems.

1. Based on mass and energy transfer

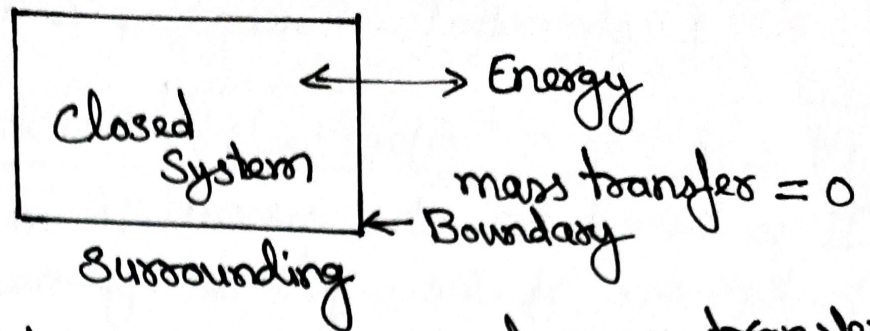
Closed System :-

It is a system across whose boundary there is only energy transfer but there is no mass transfer.

As there is no mass transfer across its boundaries, a closed system has a fixed quantity of matter. Thus it is also known as a fixed mass or

Control mass or non flow system.

Ex: water boiled in a cooker.

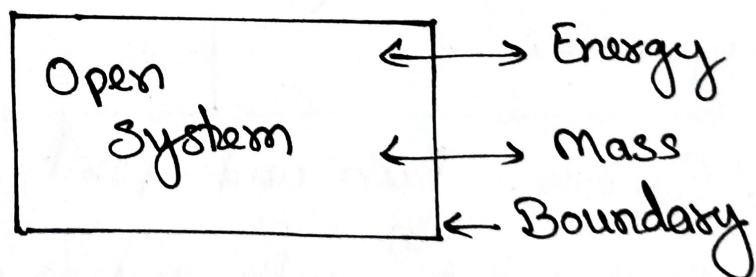


Open System:-

A system in which both energy and mass transfer takes place across the boundary is called as open system.

Ex: Air compressor, water pump, turbine etc.

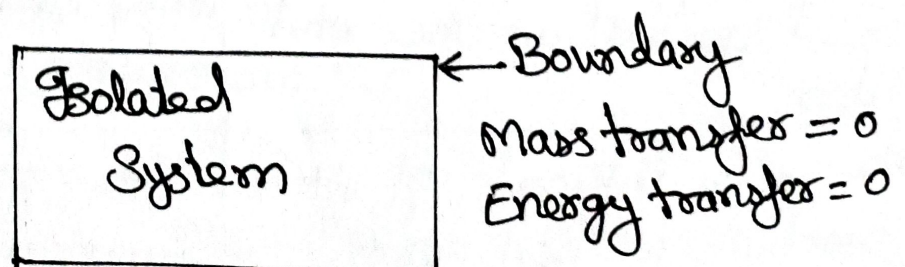
Control volume is a volume of fixed shape, size and orientation, with mass and energy transfer across its boundaries. The surface of a control volume is referred to as control surface. Control volume and control surface form the basis of analysis for a open system.



Isolated system:-

If a system can exchange neither energy nor matter (mass) across its boundaries to the surrounding it is called an isolated system

Ex:- Thermo flask.



3. a. Compare Macroscopic and microscopic approach
or
b. Differentiate Macroscopic and microscopic approach.

Macroscopic Approach	Microscopic Approach.
It is based on the overall behaviour of the system	It is based on the behaviour of the molecule in the system
The macroscopic properties (such as P, V , and T) can be sensed.	The microscopic properties (such as velocity of molecules) cannot be sensed.
To describe a system only a few properties are needed	Large number of variables are needed to describe the system.
System can be described by a few simple equations	It requires many complicated statistical equations.
It is also known as classical or engineering thermodynamics	It is also known as statistical thermodynamics.

4. a. Compare Path and point functions.
or
b. Differentiate path and point functions.

Path function	Point function
The magnitude depends on the path followed during a process as well as the end states.	They depend on the state only and not how the system reaches that state.
The cyclic integral of path function is non zero	The cyclic integral of point function is zero.

It considers the direction of the processes.

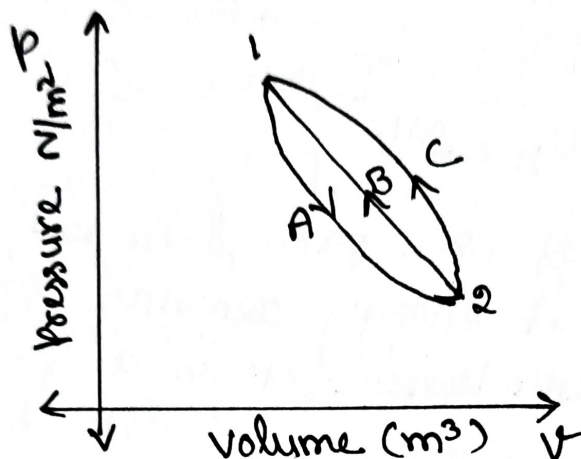
It does not consider the direction of processes.

Example: Work (W) and Heat (Q)

All properties are point functions ex: pressure, volume and temperature

5. a. Prove that the internal energy is a property.

b. Prove that the internal energy is a point function



Let us consider a system undergoes a cyclic process from 1 to 2 through A and returns back to 1 through two ways through B and C.

First cycle 1-A-2-B-1

Second cycle 1-A-2-C-1

For first cycle 1-A-2-B-1

Process A, first law of thermodynamics

$$Q_A = \Delta U_A + W_A$$

For process B

$$Q_B = \Delta U_B + W_B$$

W.K.T for a cyclic process

$$\oint Q = \oint W$$

$$Q_A + Q_B = W_A + W_B$$

$$Q_A - W_A = W_B - Q_B$$

$$\boxed{\Delta U_A = -\Delta U_B} \quad \text{--- (1)}$$

Similarly for the cycle 1-A-2-C-1

$$\oint Q = \oint W$$

$$Q_A + Q_C = W_A + W_C$$

$$Q_A - W_A = W_C - Q_C$$

$$\boxed{\Delta U_A = -\Delta U_C} \quad \text{--- (2)}$$

Compare (1) and (2)

$$\boxed{\Delta U_B = \Delta U_C}$$

Irrespective of the path followed by the two cycles the internal energy remains constant between two states. Hence it is a property of a system.

$$\boxed{dQ = du + dw}$$

6. a. State the first law of thermodynamics and list its limitations.

b. Define first law of thermodynamics ^{or} and enumerate its limitations.

First law for a cycle of a closed system :-

The first law of thermodynamics states that in a thermodynamic cycle, the net work transfer is directly proportional to the net heat transfer. It can be mathematically written as

$$\oint \delta W \propto \oint \delta Q$$

$$\oint \delta W = J \oint \delta Q, \quad J = \text{Joule's mechanical equivalent of heat}$$

$J = 1 \text{ KJ/kJ}$ in SI units, Thus

$$\oint \delta W = \oint \delta Q$$

First law for a process of a closed system.

In a thermodynamic process, the change in stored energy (E) of a closed system is a net (i.e., algebraic) difference between the heat and work transfers between the system and the surrounding.

$$\Delta E = Q - W \quad \text{or} \quad dE = \delta Q - \delta W$$

$$E = K.E + P.E + J.E$$

$$E = \frac{1}{2} mC^2 + mgZ + U$$

For a closed system the potential, kinetic energy is almost negligible. $[KE = P.E = 0]$

$$\Delta U = Q - W \quad \text{or} \quad du = \delta Q - \delta W$$

Limitations of first law of thermodynamics :-

1. First law of thermodynamics does not specify the direction of flow of heat. i.e., whether the heat flows from a hot body to a cold body or from a cold body to a hot body.
2. First law states that work and heat are mutually convertible. The work can be converted fully into heat energy but the heat energy cannot be converted fully into mechanical work. It violates the foresaid statements.