1.5 Thermodynamic system

1.5.1 System, Boundary, and Surroundings

System, A system is a finite quantity of matter or a given region of space chosen for study (Fig.1.1).

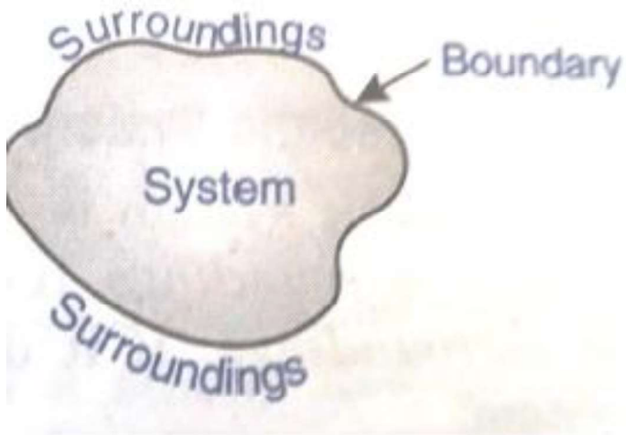


Fig. 1.1 The system

Boundary: The actual or hypothetical envelope enclosing the system is the boundary of the system. The boundary may be fixed or it may be moving, as and when a system containing a gas is compressed or expanded. The boundary may be real or imaginary.

Surroundings: are those things outside the system.

1.5.2 Closed system

In a system in which mass does not cross the system boundary, but energy may cross the system boundary (Fig.1.2). Closed system is also known as control mass.

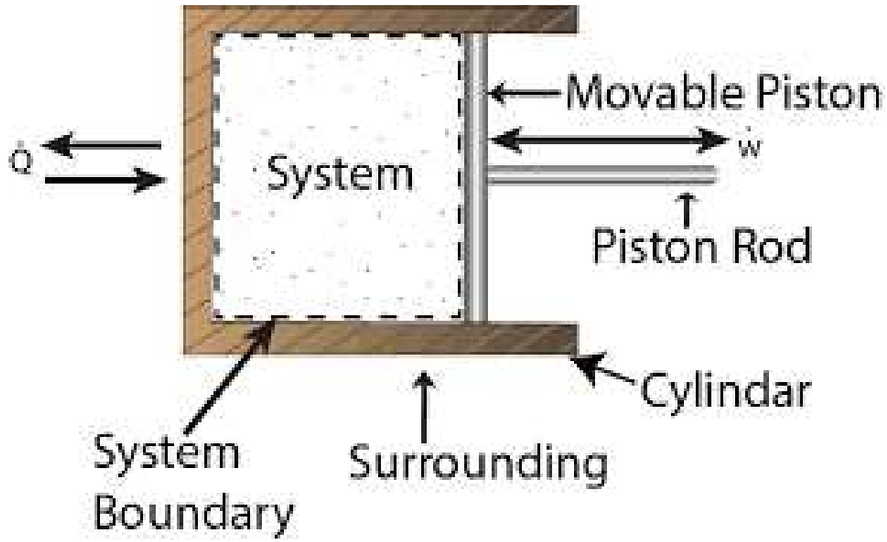


Fig. 1.2 Closed system

1.5.3 Open system

Any system in which both mass and energy may cross the system boundary (Fig.1.3).

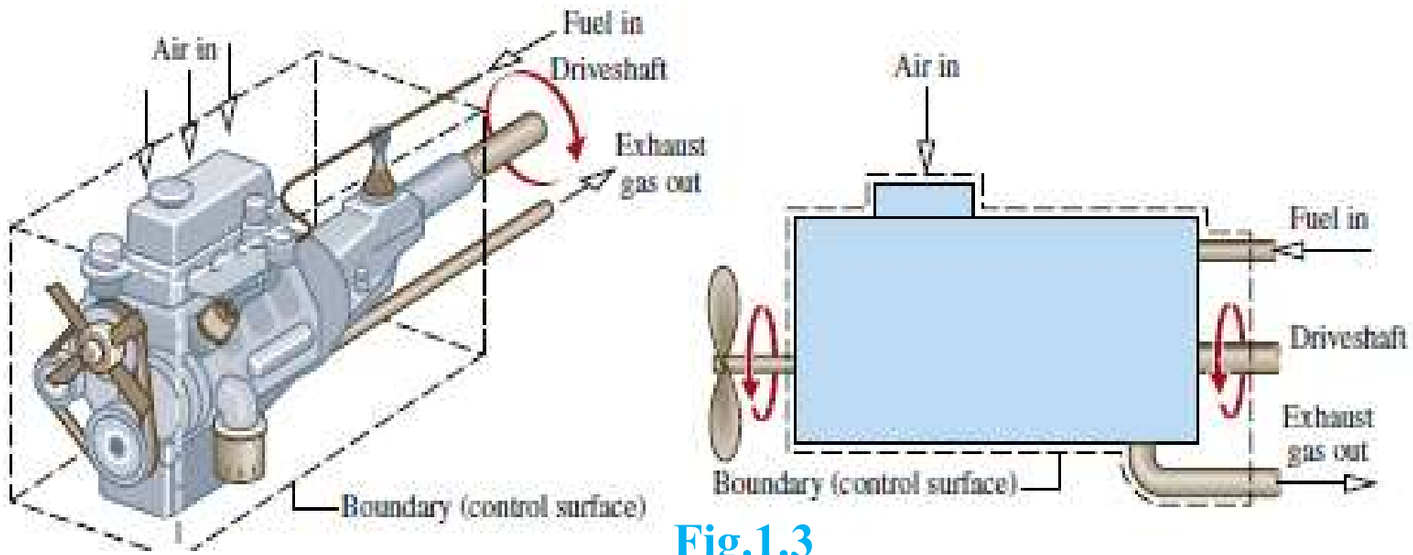


Fig.1.3

1.5.4 Control volume and Control surface

Some authors call an open system a control volume and its boundary a control surface.

1.5.5 Non-flow and flow processes

The processes undergone by the fluid in a closed system are described as non-flow processes, whereas those undergone by the fluid in an open system are referred to as flow processes.

1.5.6 Isolated system

Any system in which neither mass nor energy crosses the system boundary (Fig. 1.4).

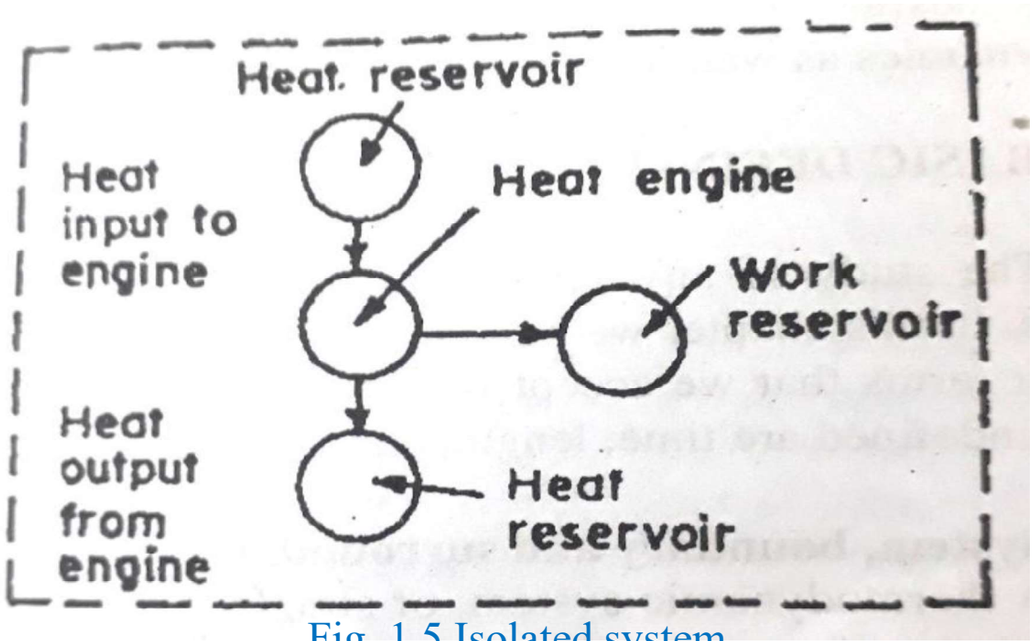


Fig. 1.5 Isolated system

1.5.7 Adiabatic system

A system which thermally insulated from its surroundings is called an adiabatic system. It can exchange work with its surroundings. If it does not, it becomes an isolated system.

1.6 Macroscopic and Microscopic

The system can be studied from a macroscopic or a microscopic point of view.

Macroscopic approach: the macroscopic approach to thermodynamics is concerned with gross or overall behavior. This is sometimes called classical thermodynamics.

Microscopic approach: the microscopic approach to thermodynamics, known as statistical thermodynamics is concerned directly with the stricter of matter.

1.6.1 Macroscopic System Analysis

The analysis of the systems at the continuum level (i.e molecular dimensions and time scales do not enter into the analysis). This is the domain of classical and non-equilibrium thermodynamics.

1.6.2 Microscopic system analysis

The analysis of the systems at the atomic level. This is the domain of statistical thermodynamics.

1.7 Thermodynamic equilibrium

A system is in ***thermodynamic equilibrium*** if the temperature and pressure at all points are the same.

1. Thermal equilibrium: the temperature of the system does not change with time and has the same value at all points of the system.
2. mechanical equilibrium: there are no unbalanced forces within the system or between the surroundings. The pressure in the system is the same at all points and does not change with time.
3. chemical equilibrium: no chemical reaction takes place in the system and the chemical composition which is the same throughout the system does not vary with time.

1.8 Properties of systems

A property of a system is a characteristic of the system which depends upon its state, but not upon how the state is reached. There are two types of property :

1. Intensive properties: these properties do not depend on the mass of the system. Examples, Temperature and pressure.

2. Extensive properties : these properties depend on the mass of the system . Example. Volume . Extensive properties are often divided by the mass associated with them to obtain the intensive properties. For example, if the volume of the system of mass m is V , then the specific volume of matter within the system is $V/m = v$, which is an intensive property.

1.9 State

State : is the condition of the system at an instant of time as described or measured by its properties. All properties are state or point functions.

1.10 Process

A process occurs when the system undergoes a change in a state or an energy transfer at a steady state.

A process may be :

1. non-flow process: in which a fixed mass(i.e closed system) within the defined boundary is undergoing a change in state. Example: a substance that is being heated in a closed cylinder undergoes a non-flow process.

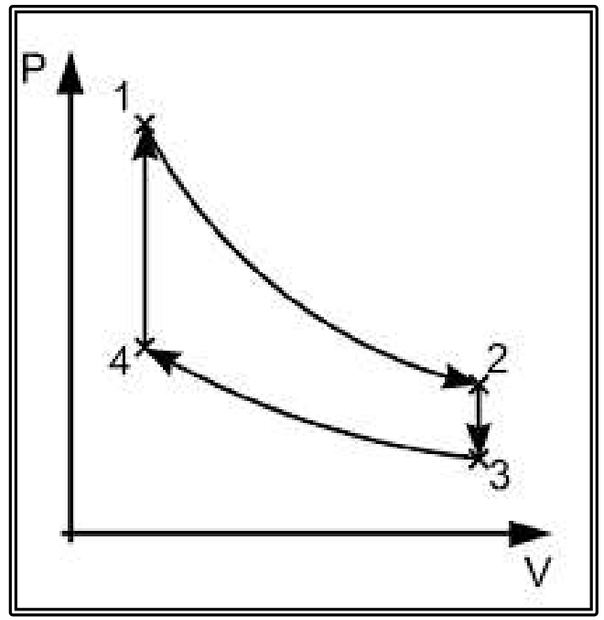
2. flow process: in which mass is entering and leaving through the boundary of an open system.

1.11 Cycle

Any process or series of processes whose end states are identical is termed a cycle.

Or

A thermodynamic cycle is a series of thermodynamic processes which returns a system to its initial state

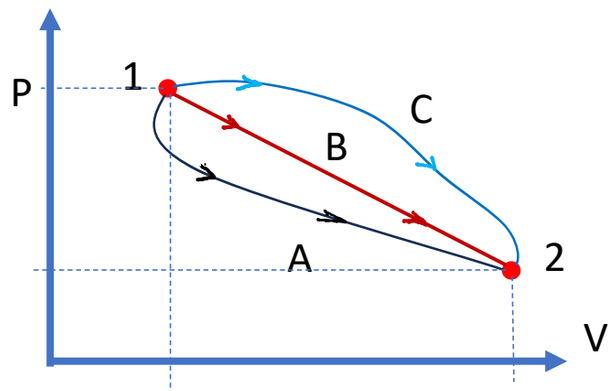


1.12. Point Function

When two properties locate a point on the graph, (coordinate axes) then those properties are called as point function.

Examples, pressure, temperature, volume , etc.

$\int dV = V_2 - V_1 \, (an\ exact\ differential)$



1.13 Path Function

There are certain quantities which cannot be located on the graph by a point but are given by the area or so, on that graph. In that case, the area on the graph , related to the particular process, is a function of the path of the process. Such quantities are called **path functions**.

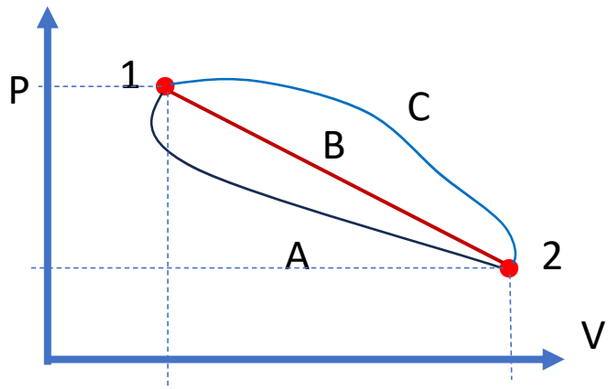
Examples, Heat , Work, etc.

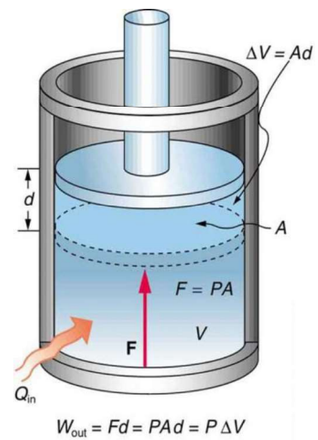
Heat and work are *inexact differentials.* Their change cannot be written as a difference between their end states.

Thus $_1Q_2 \; or \; Q_{1-2}$

Similarly, $\int_1^2 \delta W \neq W_2 - W_1 \; and \; is \; shown \; as$

$_1W_2 \; or \; W_{1-2}$





Note:

The operator $\delta \; is \; used \; to \; denote \; inexact \; differentials \; and \; operator \; d \; is \; used \; to \; denote \; exact \; differential$

1.14 Temperature

-The temperature is the thermal state of a body that distinguishes a hot body from a cold body.

-The temperature of a body is proportional to the stored molecular energy.

-A particular molecule does not have a temperature, it has energy.

ملاحظة: الجزيئة ليس لديها درجة حرارة ، تمتلك طاقة

- النظام له درجة حرارة اما جزيئة معينة داخل النظام ليس لديها درجة حرارة لديها طاقة حركية.

- الغاز مثل النظام لديه درجة حرارة

-The gas as a system has a temperature.

-Instruments for measuring ordinary temperatures are known as ***thermometers*** and those for measuring high temperatures are known as ***pyrometers.***

-It has been found that a gas will not occupy any volume at a **certain temperature**. This temperature is known as ***absolute zero temperature.***

لقد وجد أن الغاز لن يشغل أي حجم عند درجة حرارة معينة،وتعرف درجة الحرارة هذه باسم درجة حرارة الصفر المطلق

The point of absolute zero temperature is found to occur at 273·15°C **below** the freezing point of water. Then

$$Absolute\ temperature = Thermometer\ reading\ in\ ^{\circ}C + 273$$

Absolute temperature can also be represented in degree Kelvin denoted by K (SI unit).

1.15 Zeroth Law of Thermodynamics

-***Zeroth Law of Thermodynamics***: states that if two systems are each equal in temperature to a third, they are equal in temperature to each other.

1.16 Pressure

1.16.1 Definition of pressure: is define as a force per unit area. Pressures are exerted by gasses, vapors and liquids.

جهاز قياس الضغط يسجل الفرق بين ضغطين وهذا الفرق بين الضغط المسلط من قبل المائع والضغط الجوي.ambient atmospheric pressure وذلك الجهاز يستدل على الضغط اما فوق الضغط الجوي او اقل من الضغط الجوي ، اما الفوق الضغط الجوي يسمى ضغط المقياس gauge pressureوالاقل من الضغط الجوي يكون سالب negative pressureويسمى vacuum pressure