UTeM
UNIVERSITI TEKNIKAL MALAYSIA MELAKA
OPENCOURSEWARE

INTRODUCTION TO MECHANICAL ENGINEERING
BMCG 2423
THERMODYNAMICS : BASIC CONCEPTS

Dr. Mohd Afzanizam Mohd Rosli[1], Dr. Mohd Zaid Akop[2]

[1]afzanizam@utem.edu.my , [2]zaid@utem.edu.my

Lesson Outcome

At the end of lesson, students will be able to:

- use important terms of thermodynamics.
- differentiate several processes take place in thermodynamics system.

Fundamental Quiz

- What is the equilibrium **temperature** for the hot tea in the cup after being poured with certain amount of cold fresh milk?
- How long is it takes for the hot tea to be cold down to **room temperature**?

Applications

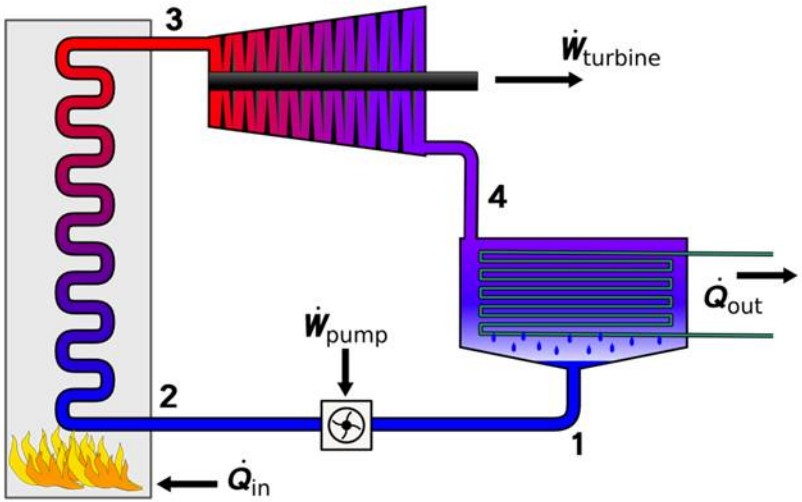
- How much is the work done by the steam engine in moving the locomotive?

Applications

- What is the efficiency of the cooling system used for this tower?

What is Thermodynamics?

- ✓ Thermodynamics is the science of energy, that is dealing with the ways in which energy is being stored within an object.

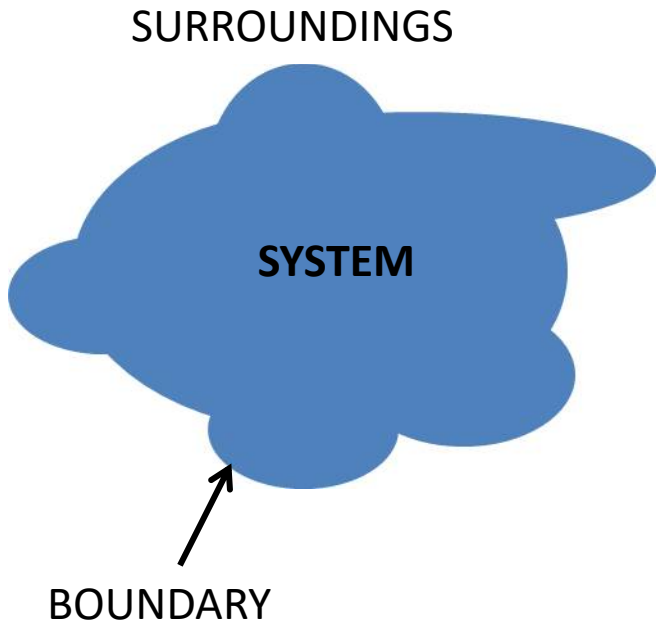


- ✓ In energy transformations, **heat** and **work** movements are involved.

- ✓ Fundamental law: Principle of ***Conservation of Energy***: *Energy cannot be created or destroyed, but can only be transformed from one form to another.*

System, Surroundings and Boundary

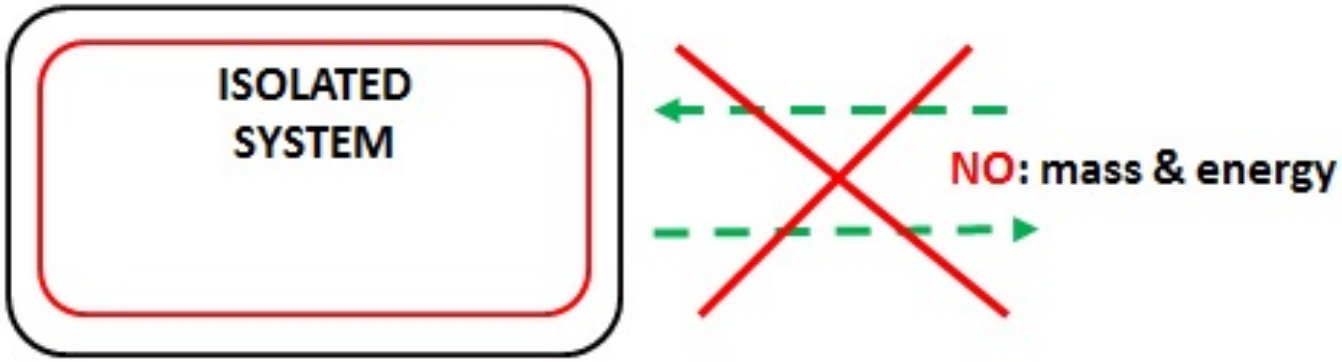
- ✓ **System**: A quantity of matter or a region in space which is chosen to be studied.
- ✓ **Surroundings**: The mass or region which falls outside the studied system.
- ✓ **Boundary**: The real or imaginary surface or limit that separates the studied system from its surroundings or environments.



Type of system (Isolated system)

- ✓ Isolated system – mass and energy can't cross selected boundary

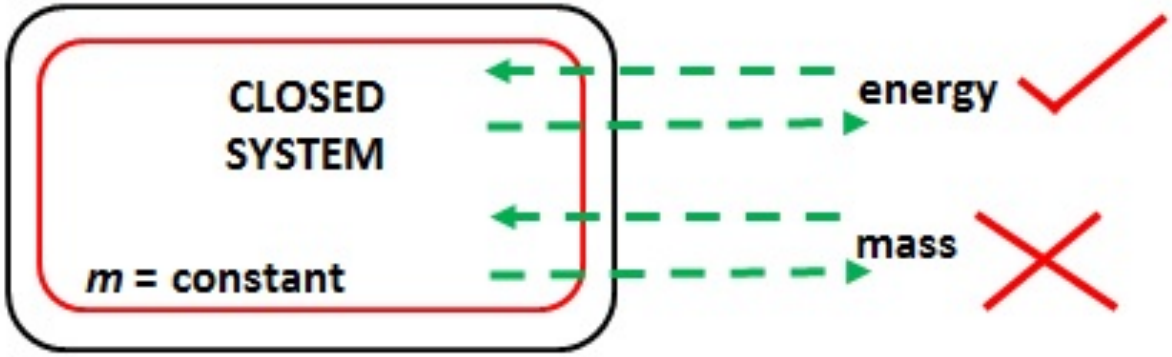
- ✓ Example (approximate): Well insulated thermos bottle contained hot tea.



Type of system (Closed system)

- ✓ Isolated system – only energy can cross selected boundary

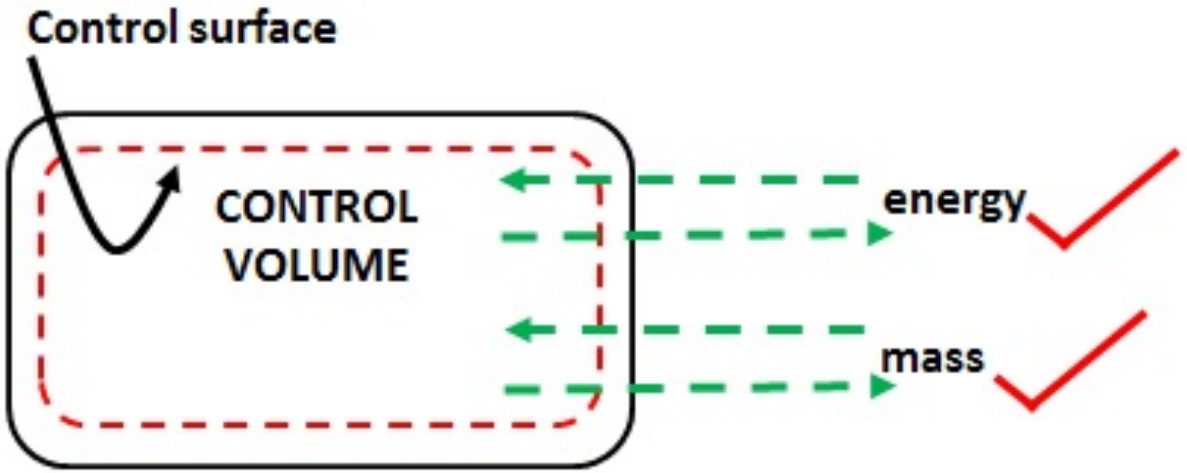
- ✓ Example: a tightly capped cup of tea



Type of system (Open system)

- ✓ Isolated system – energy and mass can cross selected boundary

- ✓ Example: an open cup of tea



Properties of a system

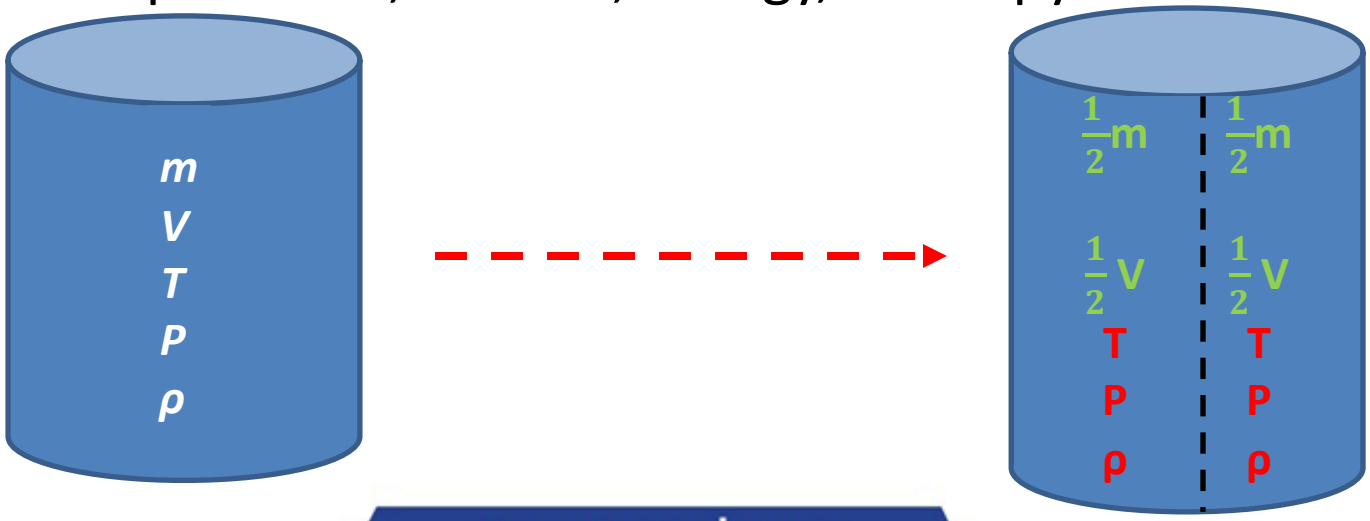
- Properties of a system is a measureable characteristic of a system that is in equalibrium.

✓ Intensive – independent of the amount of mass

Examples: temperature, pressure, density

✓ Extensive – depends with the mass

Example: mass, volume, energy, enthalpy

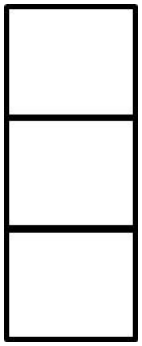


Properties of a system

- Specific properties – The ratio of any extensive property over the system.
- It is called an average specific value of that property (also known as intensives property)

Specific volume, $\nu = \frac{V}{m}\left(\frac{m^3}{kg}\right)$ Total energy, $e = \frac{E}{m}\left(\frac{J}{kg}\right)$

Box with 3 sections after equilibrium



Extensive: Total:

$V = V_1 + V_2 + V_3$

$E = E_1 + E_2 + E_3$

$m = m_1 + m_2 + m_3$

Intensive: not size independent

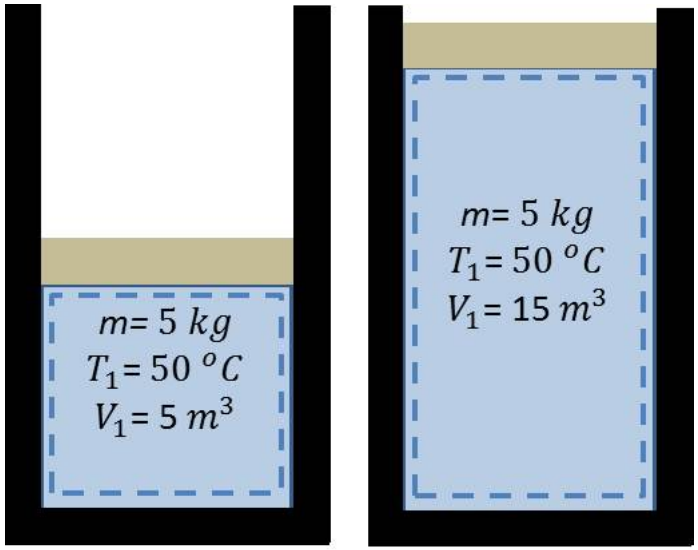
$\nu = \nu_1 = \nu_2 = \nu_3 = {}^{\nu}/_{m}$

$e = e_1 = e_2 = e_3 = {}^{E}/_{m}$

T, P

State, Equilibrium and Process

- State – a set of properties such as mass, temperature and volume that describes the conditions of a system.
- Thermodynamics equilibrium – system that maintains thermal, mechanical, phase and chemical equilibriums.

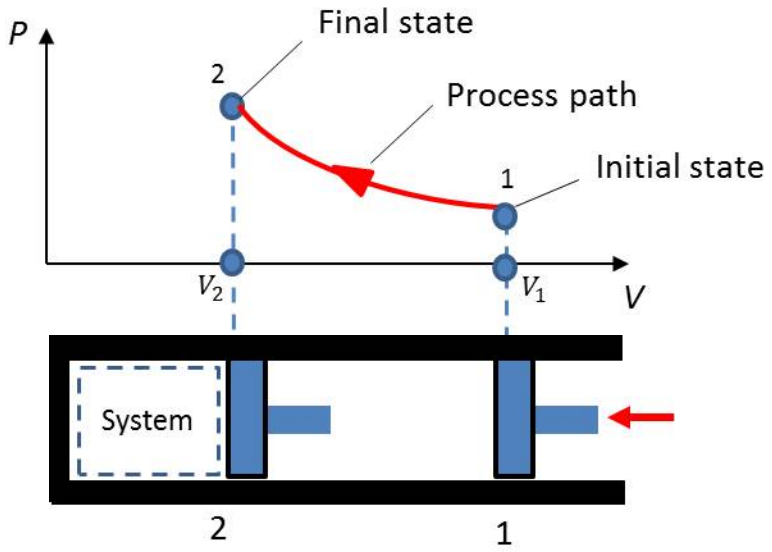


(a) State 1 (b) State 2

State, Equilibrium and Process

- Process – change from one equilibrium state to another state.

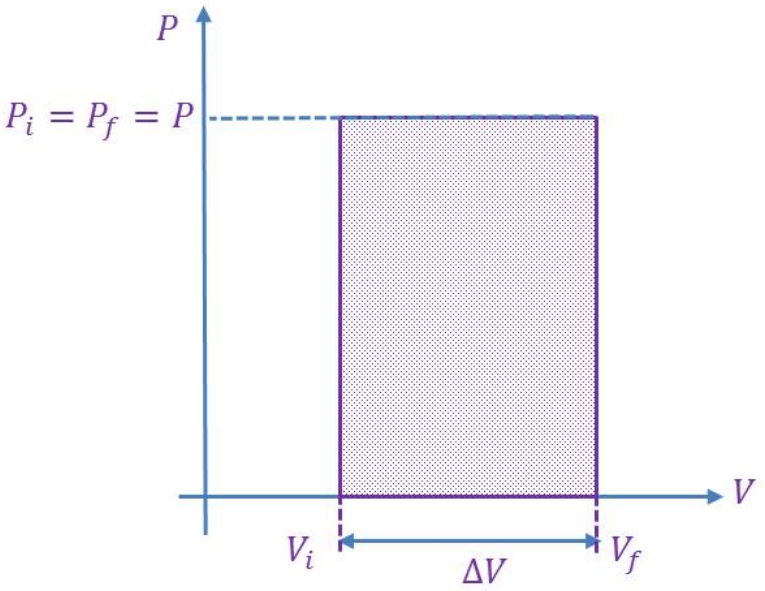
Process	Isobaric	Isothermal	Isochoric	Isentropic
Property Constant	Pressure	Temperature	Volume	Entropy



State, Equilibrium and Process

- The prefix iso – always refer to the process with a particular property maintains constant.
- isobaric process: A process with the pressure remains constant.

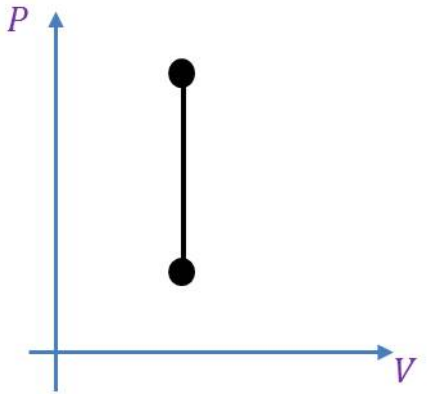
Pressure is Constant (**ΔP = 0**)



State, Equilibrium and Process

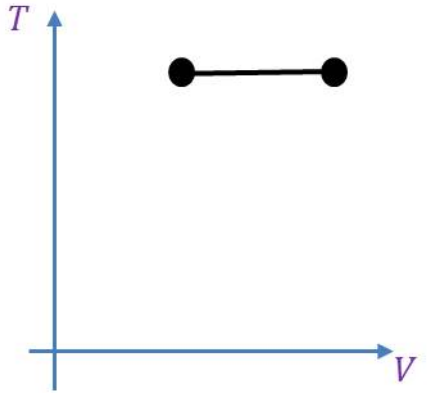
- Isochoric (isometric) process: A process during which the specific volume (V) remains constant.

Volume is Constant (**ΔV = 0**)



- Isothermal process: A process during temperature (T) remains constant.

Temperature is Constant (**ΔT = 0**)



Types of Thermodynamics Processes

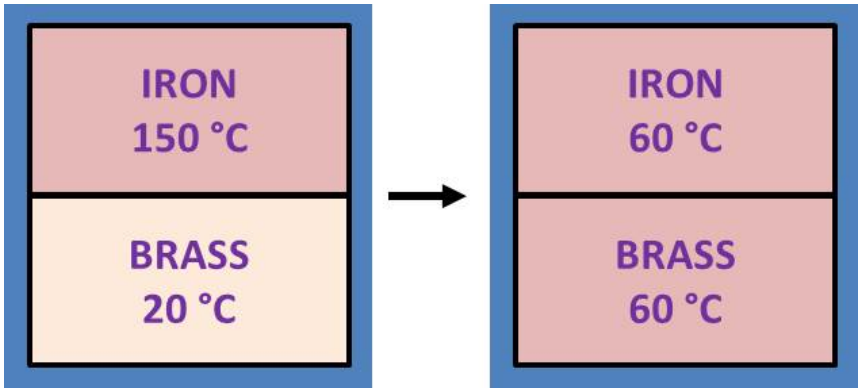
- Cyclic process – a system with given initial state goes through processes and finally reture to its initial state.
- Reversible process – a process can be reversed. It leaves no change in the system or boundary
- Irreversible process – a process that cannot be return both the system and sorrounding to their original conditions.

Types of Thermodynamics Processes

- Adiabatic process – a process that has no heat transfer out or into the system. It can be considered as well insulated.
- Isentropic process – a process where the entropy of the fluid remains constant.
- Polytropic process – a process which a gas undergoes a reversible process in which there is heat transfer, it is represented with straight line, PV^n= constant.
- Throttling process – a process in which there is no change in enthalpy, no work is done and the process is adiabatic.

Zeroth Law of Thermodynamics

" If two bodies are in thermal equlibrium with a third body, there are also in thermal equilibrium with each other."



Two bodies reaching thermal equlibrium after being brought into contact in an isolated enclosure

Application Areas of Thermodynamics

End of Lesson

Recall:

- Thermodynamics
- Conservation of Energy
- Type of system
- Intensive and extensive properties
- Process, system, boundary, state, equilibrium
- Type of thermodynamics process
- Zeroth law of thermodynamics
- Applications

References

- Rogers, G. and Mayhew, Y., 1992, **Engineering Thermodynamics – Work and Heat Transfer**, Fourth Edition, Pearson, UK.