HEAT
&
ENERGY TRANSFER

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DIMENSIONS AND UNITS

- **Dimensions.** Dimensions in mathematics are the measure of the size or distance of an object or region or space in one direction. Any physical quantity may be characterized by Dimensions

- **Unit.** The reference standard used to measure the dimensions of a physical quantity is called a *Unit*

- **SI**. The single universally accepted system of units throughout the world and a system of measurement called the International System of Units (SI Units)

ENERGY AND HEAT TRANSFER

- **Energy.** It is defined as capacity to do work
  - It is measured in kJ in SI and kcal in MKS units

  - **Sources of Energy.**

    - Transitional Energy
    - Capital Energy
    - Celestial Energy
    - Stored Energy

  - **Classification Energy.**

    - Primary and Secondary Energy
    - Commercial and Non-commercial Energy
    - Renewable and Non-renewable Energy

ENERGY AND HEAT TRANSFER

- **Forms of Energy. Energy can exist in numerous forms, such as Internal, Thermal, Electrical, Mechanical, Kinetic, Potential, Wind and Nuclear Energy**
  - **In Thermodynamics Two Groups**

    - **Stored Energy e.g. P E, K E, Internal**
    - **Transit Energy**
      - **Energy in transition**
      - **Energy possessed by the System**
      - **Capable of crossing the boundaries**
        e.g. Heat Energy and Work Transfer
- **Potential Energy. Energy that system possesses as a result of its elevation in a gravitational field is called potential energy**

  PE = mgz (joules)

ENERGY AND HEAT TRANSFER

- **Kinetic Energy. Energy that a system possesses, as a result of motion relative to some reference is called *Kinetic Energy***

$$KE = \frac{1}{2} mv2 \text{ (joules)}$$

- **Internal Energy. The internal of a system is the energy stored within the body resulting from the kinetic and potential energy of the molecules**

$$U = K + P \text{ (joules)}$$

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ENERGY AND HEAT TRANSFER

- **Mechanical Energy. It can be defined as a form of energy that can be converted directly and completely into mechanical work by an ideal mechanical device**
  - **K E & P E are the common forms of mechanical energy.**
  - **Thermal (heat) energy is not a form of mechanical energy since it can not be converted to work directly and completely**
  - **Mech energy of flowing fluid on a unit mass basis (e_{mech}) is**

$$(e_{mech}) = pv + v2/2 + gz$$

- ***pv*** **is the flow energy**
- ***V2/2 i*****s KE**
- ***gz*** **is PE**

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ENERGY AND HEAT TRANSFER

- **Flow Energy.**

  - **(a) Pressure of a flowing fluid is also associated with its Mechanical Energy**

  - **(b) Pressure itself is not a form of energy but a pressure force acting on a fluid through a distance produce work, call flow work in the amount P/ρ per unit mass**

  - **(c) *Flow work* is expressed in terms of fluid properties and it is convenient to view it as part of energy of a flowing fluid and call it *Flow energy***

  - ***(emech) = Flow Energy + K E + PE***
  - **= P/ ρ + ½ V2 +gz**

ENERGY TRANSFER BY HEAT

- **Energy can cross the boundary of a closed system in two distinct forms *HEAT & WORK***

- **Heat. It is a transfer form of energy that flows between two systems (or a system and its surroundings) by virtue of the temperature difference between them**

Q_{1-2} – Heat transfer from state 1 to state 2
in joules or kilojoules in SI units
in Calories (cal) or kilocalories in MKS units

q = Q /m (*kJ/kg*)
q – Heat transfer per unit mass of a system

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ENERGY TRANSFER BY HEAT

- Heat is energy in transition
- It is recognized only if it crosses the boundary of a system
- In Thermodynamics Heat simple means Heat Transfer
- Heat is transferred by three mechanisms;-
  - (a) Conduction
  - (b) Convection
  - (c) Radiation
- Heat Transfer per unit time is kJ/s i.e. kW

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ENERGY TRANSFER BY WORK

- Energy interaction between a System & its surroundings
- Energy interaction not due to temperature difference is work
- Work is the energy transfer associated with a force acting through a distance
- The work done per unit time is called Power kJ/s or kW
- Heat transfer to a system or work done by a system is +ve
- Heat transfer from a system or work done on a system is –ve
- A quantity that is transferred to or from a system during an interaction is not a property since the amount of such a quantity depends on more than just the state of a system

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HEAT AND WORK

- **Similarities**
  - Both are recognised at the boundaries of a system
  - Both are Boundary Function
  - System possesses energy, but not heat or work
  - Both are associated with process, not a state
  - Unlike properties, heat and work has no meaning at a state
  - Both are path functions (Their magnitude depends on the path followed during the process as well as the end state)

HEAT AND INTERNAL ENERGY

- In Thermodynamics, heat and internal energy are two different forms of energy
- Internal Energy is property and heat is not
- Internal energy is associated with a state, while heat is associated with a process
- Heat or Heat energy is defined as a form of energy in transit
- Heat is a path function
- Heat is a directional quantity, and its specification requires magnitude and direction

- Heat transferred to a system is considered positive
- Heat transferred from a system is considered negative

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ENERGY AND HEAT TRANSFER

- **Specific Heat. It is defined as heat energy required to change the temperature of the unit mass of a substance by one degree**

$$C = 1/m\ (d' Q/dT) = d'q/dT$$

- **Heat Capacity. The product of mass and specific heat is defined as heat capacity of the system. It is measured in kJ/K or kJ/degree centigrade**

ENTHALPY

- **Enthalpy. Enthalpy is a concept used in science and engineering when heat and work need to be calculated.**

  - When a substance changes at constant pressure, enthalpy tells how much heat and work was added or removed from the substance.
  - Enthalpy is similar to energy, but not the same.
  - Enthalpy is a property of a thermodynamic system, defined as the sum of the system's internal energy and the product of its pressure and volume.
  - It is a convenient state function standardly used in many measurements in chemical, biological, and physical systems at a constant pressure

$$H = U + pV$$

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Conservation of Energy

- Fundamental law of nature
- During an interaction, energy can change from one form to another but the total amount of energy remains constant.
- Thus energy cannot be crated or destroyed.
- Balance Energy.

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