PROPERTIES OF SYSTEM

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Properties of A System

- Any Characteristic of a system is called a 'Property'
- e. g. pressure *P*, temperature *T*, volume *V* and mass m
- Salient Features
  - A property is a measurable characteristic, describing the state of system
  - It has a definite value when system is in a particular state
  - It also helps to distinguish one system from another
  - The magnitude of a property depends on the state of the system and is independent of the path or route followed by a system during the process
  - A property is an exact differential
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Properties of A System

Types of Properties

- Intrinsic & Extrinsic Properties
- Intensive & Extensive Properties

Intrinsic Properties:-

- Basic Properties & cannot be defined in terms of other properties
- Values can be assigned independently
- e.g. Length, Mass, Time, Area Volume, Pressure, Temperature, Electric Current

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Properties of A System

Extrinsic properties:-

- Values cannot be assigned independently

- Characteristic of the motion or position of system

- Measured in reference to certain datum such as velocity, acceleration, potential energy, kinetic energy, enthalpy, entropy, etc.

Properties of A System

- **Intensive Properties:-** These do not depend on the extent of the system. That are independent of the mass of the system. e. g. temperature, pressure & density, generally lowercase is used (Exception *P* & *T*)

- **Extensive Properties:-** Those whose value depend on the size- or extent-of the system. Depend on the mass of the system e. g. Total Mass, Total Volume & Total Momentum, generally denoted by Uppercase (mass is a major exception)

Properties of A System

Density and Specific Gravity

- **Specific Property.** An extensive property expressed per unit mass of the system is called a specific property. e.g. Specific Volume, Specific Energy, Specific Enthalpy, Specific Internal Energy, etc.

Specific Volume (v=V/m)

Specific Total energy (e= E/m)

- **Mass Density or Simply Density.** It is a measure of the amount of working substance contained in a given volume and is defined as mass per unit volume

$$\rho = Mass / Volume = m/v \ (Kg/m3)$$

Properties of A System

- **Specific Gravity or Relative Density (SG).** It is defined as the ratio of density of a substance (*ρ*) to the density of water at 4 degree centigrade

$$SG = \rho \text{ of substance} / \rho \text{ of Water}$$

- **Specific Volume.** It is reciprocal of mass-density and is defined as the volume per unit mass of a system

$$v = V/m = 1/\rho \text{ m3/kg}$$

Properties of A System

- **Pressure. It is defined as the normal force exerted by a fluid per unit area**

$$p = F/A \ (N/m2)$$

$$F = m \times g$$
$$m = \text{volume } X \text{ density}$$
$$= A \times h \ X \ \rho$$
$$F = Ah\rho g$$

$$P = Ah\rho g/A = \rho gh \ \ (N/m2)$$

Pressure is measured in newton per square metre, which is called Pascal (Pa)

PRPERTIES OF A SYSTEM

- **Atmospheric Pressure. It is the pressure exerted by the envelope of air surrounding the earth's surface**

$$p_{atm} = 101325\ N/m3 = 1{,}01325\ bar$$

- **Absolute Pressure. The actual pressure at a given position is called absolute pressure. (*p*atm or *p*) It is measured by a barometer above the absolute zero pressure**

- **Gauge Pressure.** $P_{gauge} = P_{abs} - P_{atm}$

- **Vacuum pressure. Pressure measured below atmospheric pressure**

$$P_{vacuum} = P_{atm} - P_{abs} = -P_{gauge}$$

PRPERTIES OF A SYSTEM

- **Frequently used pressure unit is the standard Atmosphere.**

- **Standard Atmosphere. It is defined as the pressure produced by a column of Mercury 760mm in height at 0 degree centigrade (ρ= 13595 Kg/M3) under standard gravitational acceleration (g = 9.807m/s2).**

- **If water is used, a water column of about 10.3 m would be needed**

$$1_{atm} = 101325\ Pa = 1.01325\ bar$$

PRPERTIES OF A SYSTEM

- **Temperature. It can be defined as measure of hotness or coldness**

- **Two systems attain equal temperature if no changes occur in any property when they remain in contact**

- **Zeroth law of Thermodynamics. It states that when two systems are in thermal equilibrium with a third system, they in turn have thermal equilibrium with each other**

- **Zeroth law is a basis for the validity of temperature measurement, by replacing the third system by temperature measurement**

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