MMAE 320 Thermodynamics

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Thermodynamics

September 1, 2024

I. Relevant Quantities with Explanations

This section highlights useful reference information that is used throughout the following sections and subsections.

Working with pressure, there are three quantities we work with. *Absolute Pressure* is relative to zero pressure. *Gauge Pressure* is relative to ambient atmospheric pressure. *Absolute Pressure* (*air pressure* or *barometric pressure*) is the pressure within the atmosphere of Earth (101,325 Pa).

Pressure is the normal component of force per unit of area:

$$P = \frac{F}{A} \tag{3}$$

Density is described as mass per unit of volume:

$$\rho = \frac{m}{V} \tag{4}$$

Specific volume is described as volume per mass. It is an intensive property.

$$\nu = \frac{1}{\rho} \tag{5}$$

$$\nu m = V_{\text{volume}} \tag{6}$$

A Isobaric process is constant pressure. Isothermal constant temperature. Isochoric process is a constant volume.

II. SYSTEMS AND CONTROL VOLUMES

A. Types of Systems

A *system* is a defined quantity of matter or region in space chosen for study. A boundary of a system can be movable or fixed and its surroundings. Systems can be *open*, *closed*, *adiabatic*, and *isolated*.

An open system or a *controlled volume* exchanges mass and energy with its surrounding environment. Open systems involve some valve typically. The boundaries of a control volume are *control surfaces*.

A closed system does not exchange mass but it is able to lose energy or receive it in the form of heat through thermal contact or work performed on the system. A *closed system* or a *control mass* is a system with fixed mass, i.e., no mass can leave or enter. Volume is not required to be fixed in this type of system.

An adiabatic system is thermally isolated and thus no heat transfer occurs. It cannot receive or lose heat, but work can be performed on the system. Processes like compression/expansion are *adiabatic processes*.

An isolated system cannot exchange mass or energy and there is no contact between the system and the environment.

B. Properties of a System: Intensive and Extensive

Systems contain macroscopic physical characterises at a point in time which can be *intensive* or *extensive*. Intensive properties depend on mass and extensive properties are independent of mass (the size of a system). Intensive properties consist of pressure P, temperature T, concentration, density, melting point, boiling point, surface tension, viscosity, etc. Extensive properties consist of mass M, volume V, internal energy E or U, heat capacity, enthalpy, entropy, etc. *Specific quantities* can be derived by dividing two extensive quantities

$$\frac{\text{Extensive}_1}{\text{Extensive}_2} = \text{Intensive}_1 \tag{1}$$

which is also the way to go from an extensive quantity to an intensive one:

$$\rho_{\text{ intensive}} = \frac{m_{\text{ extensive}}}{V_{\text{extensive}}} \tag{2}$$

Specific quantities do not depend on the system size.