Density (ρ) and Specific Volume (v)

►From a macroscopic perspective, description of matter is simplified by considering it to be distributed continuously throughout a region.

►When substances are treated as continua, it is possible to speak of their intensive thermodynamic properties "at a point."

►At any instant the density (ρ) at a point is defined as

$$\rho = \lim_{V \to V'} \left(\frac{m}{V} \right) \qquad \textbf{(Eq. 1.6)}$$

where V' is the smallest volume for which a definite value of the ratio exists.

Density (ρ) and Specific Volume (v) (1 of 2)

- Density is mass per unit volume.
- Density is an intensive property that may vary from point to point.
- SI units are (kg/m^3).
- English units are (lb/ft^3).

Density (ρ) and Specific Volume (v) (2 of 2)

- Specific volume is the reciprocal of density: $v = 1/\rho$.
- Specific volume is volume per unit mass.
- Specific volume is an intensive property that may vary from point to point.
- SI units are (m^3/kg).
- English units are (ft^3/lb).

Specific volume is usually preferred for thermodynamic analysis when working with gases that typically have small density values.

Pressure (p)

►Consider a small area **A** passing through a point in a fluid at rest.

►The fluid on one side of the area exerts a compressive force that is normal to the area, F_{normal}. An equal but oppositely directed force is exerted on the area by the fluid on the other side.

►The pressure (p) at the specified point is defined as the limit

$$p = \lim_{A \to A'} \left(\frac{F_{\text{normal}}}{A} \right) \qquad \textbf{(Eq. 1.10)}$$

where A' is the area at the "point" in the same limiting sense as used in the definition of density.

Pressure Units

- SI unit of pressure is the **pascal**:

  1 pascal = 1 N/m^2

- Multiples of the pascal are frequently used:
  - 1 kPa = 10^3 N/m^2
  - 1 bar = 10^5 N/m^2
  - 1 MPa = 10^6 N/m^2
- English units for pressure are:
  - pounds force per square foot, **lbf/ft^2**
  - pounds force per square inch, **$lbf/in.^2$**