Chapter 3

Evaluating Properties

What are the Properties?

Temperature
Pressure

What are the Properties?

Temperature
Pressure
specific volume

What are the Properties?

Temperature
Pressure
specific volume
internal energy

What are the Properties?

Temperature
Pressure
specific volume
internal energy
enthalpy

What are the Properties?

Temperature
Pressure
specific volume
internal energy
enthalpy
entropy

Learning Outcomes

- Demonstrate understanding of key concepts . . . including phase and pure substance, state principle for simple compressible systems, p-v *and* T-v graphs, saturation temperature and saturation pressure, two-phase liquid-vapor mixture, quality, enthalpy, and specific heats

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- Apply energy balance with property data.

Learning Outcomes, cont.

- Locate states on p-v, T-v and other thermodynamic diagrams T-h, for example.

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- Retrieve property data from Tables A-1 through A-23.

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- Locate states on p-v, T-v and other thermodynamic diagrams T-h, for example.
- Retrieve property data from Tables A-1 through A-23.
- Apply the ideal gas model for thermo-dynamic analysis, including determining when use of the model is warranted.

Phase

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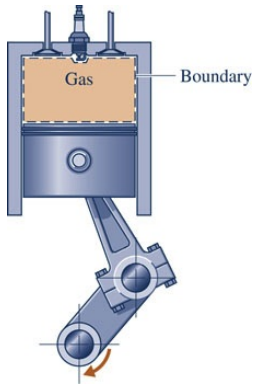
- Homogeneity in physical structure means that the matter is all *solid*, or all *liquid*, or all *vapor (gas)*.
- **Examples**:
  - The air we breathe is a gas phase consisting of a mixture of different gases.
  - Drinking water with ice cubes contains two phases of water: liquid and solid.
  - Vinegar and olive oil salad dressing contains two different liquid phases.

Pure Substance

- A substance that is uniform and invariable in chemical composition.
- A pure substance can exist in more than one phase, but its chemical composition must be the same in each phase.



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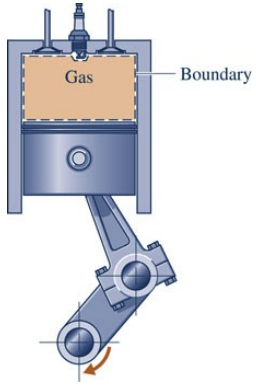
- A pure substance can exist in more than one phase, but its chemical composition must be the same in each phase.
- **Examples**:
  - Drinking water with ice cubes can be regarded as a pure substance because each phase has the same composition.
  - A fuel-air mixture in the cylinder of an automobile engine can be regarded as a pure substance until ignition occurs.



State Principle for Simple Compressible Systems

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  - Some are related by definitions – **for example**, density is $1/v$ and specific enthalpy is $u + pv$ (Eq. 3.4).

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  - Some are related by definitions – **for example**, density is $1/v$ and specific enthalpy is $u + pv$ (Eq. 3.4).
  - Others are related through expressions developed from experimental data.
  - Some intensive properties may be independent in a single phase, but become dependent when there is more than one phase present.