State Postulate

1 Overview

Recall that a state is a combination of **all** TD properties of a system. However, it is difficult to measure all properties. So we need to know how many TD properties are **independent** so we can calculate the rest.

2 State Postulate

The number of independent, intensive thermodynamics properties of a specifed (homogeneous) substance equals to:

$$\text{Number of relevant reversible work modes} + 1 \tag{1}$$

Some key words:

1. **Intensive:** explained in last chapter
2. **Specified:** known composition
3. **Reversible work modes:** Force is independent of direction and rate of changge of process. Normally there are 3 kinds: mechanical compression/expansion, electrical force, magnetic force

Normally, we restrict our interest to **simple compressible substances**, which means that have **only one** reversible work mode, which is compression/expansion. Therefore, we have 1+1=2 **independent intensive TD properties.**

3 State Relations

If we express the relationship between TD properties as an equation, we call this **state equation** or **equation of state (EOS)**, normally is $p - V - T$ relation.

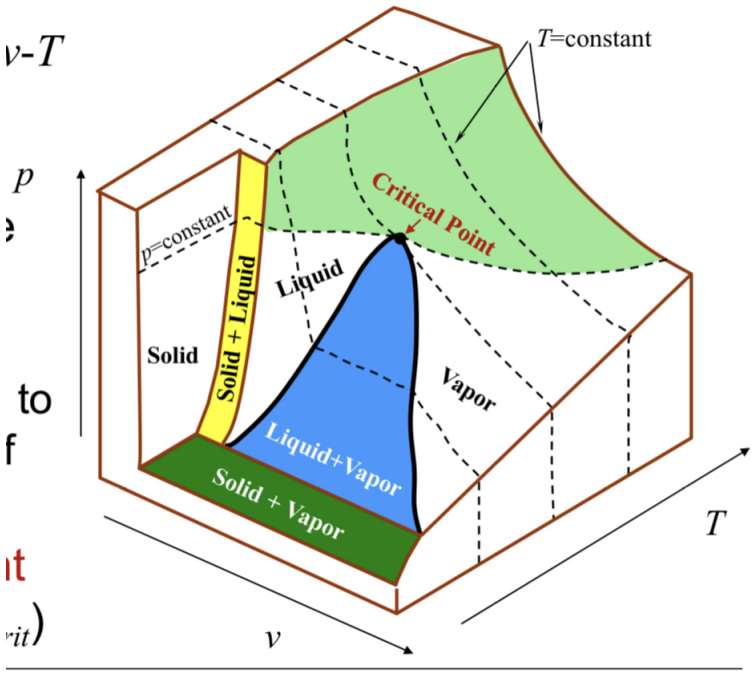

Figure 1: p, V, T diagram

However, it is hard to write simple "universal" $p - V - T$ EOS due to change of phase. **The critical point (or critical state)** refers to the unique set of conditions (temperature, pressure, and volume) at which the **liquid phase** and **gas phase** of a substance coexist in equilibrium and become **indistinguishable** from each other. In other words, above and beyond the critical point, there is no distinct phase boundary (or meniscus) between the liquid and gas phases.

Three main properties to define critical point:

1. **Critical Temperature (T_c):** The temperature above which it is impossible to liquefy a gas, no matter how much pressure is applied.

2. **Critical Pressure (p_c):** It is the highest pressure at which the substance can exist in equilibrium as both a liquid and a gas. Beyond this pressure (and above the critical temperature, the substance no longer exhibits a distinct phase boundary between liquid and gas, and it exists as a supercritical fluid.

3. **Critical Volume (V_c):** The volume of one mole of the substance at the critical temperature and critical pressure.