Week 2: Lecture 1

Equations of State

Perfect Gas

The defining equation for a perfect gas is

$$\frac{Pv}{T} = \frac{PV}{Tm} \quad = \quad \text{constant} \;=\; R$$

where R is a constant for a particular gas, defined as

$$R = \mathcal{R}/\hat{M}$$

and $\mathcal{R}$ the universal gas constant is 8.314 $kJ/(kmole \cdot K)$, and $\hat{M}$ is the molal mass defined as:

$$\hat{M} = \frac{m}{n} = \frac{mass}{amount\ of\ substance\ (mole)} = (kg/kmole)$$

In practice, no gases obeys this law rigidly but most gases tend towards it. An imaginary ideal gas which obeys this law is called a perfect gas.

The perfect gas assumption is viable when

- temperatures are considerably in excess of the critical temperature of the fluid
- at very low pressures

Gibb's Equation

By combining a first law energy balance and the differential form of the entropy equation we can obtain Gibb's equation

$$dQ \quad = \quad dW + dU \quad (energy\ equation)$$

$$dS \quad = \quad dQ/T$$

$$\boxed{ds = \frac{du}{T} + \frac{Pdv}{T}}$$