1 Derivative Crusher Algorithm

Derivative crusher algorithm taught by Ratindranath Akhoury

Variable	Easy to keep fixed?	Easy to measure change?
S	**Yes**, Adiabatic processes	**No**, change in S depends on change in Q, which is hard to measure
T	**Yes**, with a heat bath or feedback system	**Yes**, by using a thermometer
V	**No**, not easily, thermal expansion of the container is a byproduct of the container being thermally conductive, the volume changes with heat	**Yes**
P	**Yes**, keeping equilibrium with atmosphere	**Yes**, barometer

Table 1: T, P are the easiest quantities to measure and control, making $G(T, P)$ the easiest fundamental relationship to work with.

Looking at $G(T, P) = E - TS - PV$ more closely:

$$\left(\frac{\partial G}{\partial T}\right)_P = -S \qquad \left(\frac{\partial G}{\partial P}\right)_T = V$$

$$\left(\frac{\partial^2 G}{\partial T^2}\right)_P = -\left(\frac{\partial S}{\partial T}\right)_P \equiv \frac{C_p}{T} \qquad \left(\frac{\partial^2 G}{\partial P^2}\right)_T = \left(\frac{\partial V}{\partial P}\right)_T \equiv \kappa V$$

$$\left[\frac{\partial}{\partial T}\left(\frac{\partial G}{\partial P}\right)_T\right]_P = \left[\frac{\partial}{\partial P}\left(\frac{\partial G}{\partial T}\right)_P\right]_T = \alpha V$$

C_p is specific heat at constant pressure.
κ is isothermal compressibility.
α is volume coefficient of expansion.

1.1 Math Background

A partial derivative $\left(\frac{\partial x}{\partial y}\right)_z$ where $\{x, y, z\}$ can be any of $\{S, T, P, V, E, F, G, H\}$ can be expressed in terms of in terms of first and second derivatives of fundamental relations.