12.4: Gibbs Free Energy

The Gibbs free energy G is defined as

$$G = H - TS \tag{12.4.1}$$

or, what amounts to the same thing,

$$G = A + PV. \tag{12.4.2}$$

As when we first defined enthalpy, this doesn't seem to mean much until we write it in differential form:

$$dG = dH - TdS - SdT \tag{12.4.3}$$

or

$$dG = dA + PdV + VdP. \tag{12.4.4}$$

Then, either from equations 12.1.5 ($dH = TdS + VdP + \sum XdY$) and 12.5.3 or from equation 12.4.3 ($dA = -SdT - PdV + \sum XdY$) and 12.5.4, we obtain

$$dG = -SdT + VdP + \sum XdY \tag{12.4.5}$$

That is to say that, if the temperature and pressure are constant, the increase in the Gibbs function of a system is equal to the reversible work (other than *PdV* work of compression) done on it. Conversely, if the temperature and pressure are held constant, and a machine is used to do external work (which may include but is not limited to *PdV* work of expansion), the Gibbs function decreases by the amount of reversible (i.e.useful) work done by the machine other than the *PdV* work of expansion.