**Non-Equilibrium Thermodynamics**

Now gonna take a quick look at chemical reactions.

**Chemical Reactions**

Consider now the case of a batch of 2 chemicals mixed together, undergoing a chemical reaction, under conditions of constant energy.



What would be the rates? Well from the particle and energy balances we have:

 

where the U are related such as to conserve energy, i.e. aUa + bUb = cUc, and Qij = -Qji so that net heat transfer is zero as well. Then from the composite entropy balance we’d have:



Grouping everything together, we’d have:



But remembering the energy U condition, we can simplify a bit further to:



And so then we’d have the customary Onsager’s relations. Note that if all the temperatures are equal, then we’d have a simplification:



And so we could say,



Now for an ideal gas we have:



Supposing we’re at constant T, then we can say,



So focusing on just the dependence on concentrations, we’d have:



But in fact, I think the rate of reaction is rather,



Whatever. The formulas that come out of the NETD formalism are basically the ‘simplest consistent with the 2nd law’. And Nature doesn’t have to choose the simplest one. This is no different than how radiative heat transfer is proportional to Δ(T4), not ΔT (although as ΔT becomes small, Δ(T4) would in fact be proportional to ΔT). So sometimes Nature doesn’t pick the simplest path, but we’ll note that the actual result is still consistent with the absolute criterion that the internal entropy production be positive.