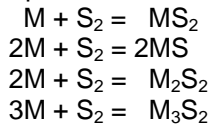


Ellingham Diagram Interpretation

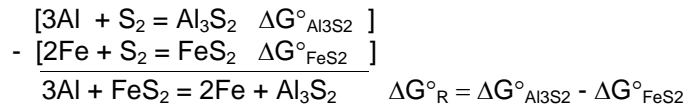
The Ellingham Diagram is a plot of the standard Gibbs energy of formation (see below) for a one mole of a particular anion (S in this explanation). Therefore, in this case every reaction is based on one mole of S₂ gas as a function of T for every sulfide.

For example:



Using one mole of S₂ makes all reactions immediately comparable.

For example if one wishes to compare the relative stability of Al₂S₃ and FeS₂, one reaction is subtracted from the other as follows:



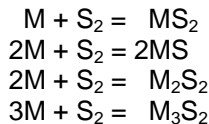
If $\Delta G^\circ_R < 0 \rightarrow$
 $\Delta G^\circ_R > 0 \leftarrow$
 $\Delta G^\circ_R = 0$ Equilibrium

However, it is much easier from a practical perspective to just think as follows:

- S goes from high chemical potential to low just as current runs from high voltage to low voltage.
- The vertical scale is also S relative potential (relative to S₂ gas at 1 atm).
- The basis of the relative state is of no consequence if we simply want to know where the S ends up.
- Since S “flows” (like current) from high to low potential, it goes to the lower sulfides.
- That is to say, the sulfides at the bottom are more stable than those at the top.
- A corollary is that the METALS at the top are NOBLE and metals at the bottom are REACTIVE.

More Info on Chemical Potential

For the reactions



The standard Gibbs energy of formation is

$\Delta G^\circ_R = -RT \ln 1/P_{S_2} = RT \ln P_{S_2}$ if the metal and the sulfide activities are both unity (or the same).

Generally, all reactions are thought of as involving the pure metal and sulfide and gases other than S₂ as being at 1 atm.

The term $RT \ln P_{S_2}$ is also known as the relative chemical potential of S₂ gas from the expression

$$\mu_{S_2} = \mu^\circ_{S_2} + RT \ln P_{S_2} / P^\circ_{S_2} \text{ since } P^\circ_{S_2} = 1 \text{ atm (more precisely fugacity = 1).}$$

Therefore, the relative chemical potential is

$$\Delta\mu_{S_2} = \mu_{S_2} - \mu^\circ_{S_2} = RT \ln P_{S_2}, \text{ which is an alternative name for the vertical coordinate of the Ellingham diagram.}$$

So, the vertical scale of the Ellingham Diagram is

$$\Delta G^\circ_R = RT \ln P_{S_2} = \Delta\mu_{S_2}$$

If one thinks of the vertical scale as the relative chemical potential, it makes it akin to “S–voltage” and S goes to the compound having the lowest S-potential just as electrical current flows to the lowest available potential. Voltage can be relative to anything – usually a stake at your home sets the ground as 0. The relative sulfur potential is set at 0 when the pressure of S₂ is 1 atm.