Disproportionation Encyclopedia Article

Disproportionation

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Disproportionation

Literally, disproportionation is a chemical reaction in which a single metal **ion** species undergoes an internal redox reaction and forms two different products in stoichiometric quantities. It is to be distinguished from such processes as partial **combustion**, which leads to a significant variety of chemical species. A disproportionation leads to very specific compounds, of varying **oxidation** state and chemical composition.

Disproportionation is a reaction that is more characteristic of the heavier **transition elements** and the f-block elements. Thus, while the **chemistry** of platinum(II) and platinum(IV) is well developed, attempts at the synthesis of the platinum(III) species were foiled by the disproportionation reaction yielding the +II and +IV oxidation states. The synthesis of Pt(III) complexes requires extraodinary ligands and special conditions. Note that the same is not true of **palladium**, where a well-developed +III **oxidation state** has been observed, although this oxidation state is often achieved through the disproportionation of the Pd(II) species giving Pd(O) as the other product. Also, disproportionation is sometimes masked by the chemical composition of the product. TlBr3 undergoes a **reduction** to give a compound that has the formula "$TlBr_2$". This species is actually the compound $Tl^{+}[TlBr_4]^{-}$ in which both Tl(I) and Tl(III) are present.

With the actinides, disproportionation reactions are quite common. For example, plutonium(IV) in **water** spontaneously reacts via disproportionation to yield the plutonium(VI) **oxide** and plutonium(III):

$$3Pu^{+4} + 2H_2O \; PuO_2^{+2} + 2Pu^{+3} + 4H^{+}$$

Indeed, in 1M $HClO_4$ at room **temperature**, all four oxidation states of **plutonium**, Pu(III) to Pu(VI) are observed in equilibrium.