**Acid Equilibria**

\[
\ce{SO42-(aq)+ H2O(l) <=> HSO4-(aq) + OH-(aq)}\]

with \(K_b = 1 \times 10^{-12}\)

\[
\ce{HSO4-(aq) + H2O(l) <=> H2SO4(aq) + OH-(aq)}\]

with \(K_b = 1 \times 10^{-15}\)

Sulfate ion is a very weak base, while \(\ce{HSO4^{-}}\) is a fairly strong acid, with \(K_a = 0.01\). On the other hand, \(\ce{H2SO4}\) is a very strong acid. Because it is such a weak base, sulfate ion undergoes negligible hydrolysis in aqueous solution.

**Solubility**

Most sulfates, including those of \(\ce{Na^{+}}\), \(\ce{K^{+}}\), and \(\ce{NH4^{+}}\), are soluble in water. Exceptions that are insoluble are white lead(II) sulfate and white barium sulfate:

\[
\ce{BaSO4(s) <=> Ba2+(aq) + SO42-(aq)}\]

with \(K_{sp} = 1.4 \times 10^{-8}\)

\[
\ce{PbSO4(s) <=> Pb2+(aq) + SO42-(aq)}\]

with \(K_{sp} = 1.1 \times 10^{-10}\)

Formation of white \(\ce{BaSO4}\) upon addition of \(\ce{Ba^{2+}}\) to a solution of \(\ce{SO4^{2-}}\), even if it is acidic, is a reliable test for sulfate. Other insoluble sulfates are those of calcium, strontium, and mercury(I).

**Oxidation-Reduction:**

Sulfate is a very weak oxidizing agent. Since sulfur is in its maximum oxidation number in sulfate ion, this ion cannot act as a reducing agent.