Metallic Sodium in Water Compared with Sodium Chloride in Water

Metallic Sodium Reaction with Water

The overall reaction of metallic sodium in water is

$$2Na(s)+2H_2O(l)\Rightarrow 2Na^+OH^-(aq)+H_2(g)+364\,kJ$$

(364 kJ of heat is released when 2 mols of sodium metal reacts with water.)

Here (s) indicates solid phase, (l) indicates liquid phase, (g) indicates gaseous phase, and (aq) stands for aqueous indicating that the substances are in a water solution.

The sodium floats on the water and the heat produced by this reaction melts the sodium producing tiny balls of liquid sodium which react even more rapidly with the water.

The hydrogen gas produced by this reaction can then ignite and burn with oxygen in the atmosphere releasing even more energy. As the H_2(g) reacts with the oxygen in the air, an additional 286 kJ/mol is released because

$$2H_2(g)+O_2(g)\Leftrightarrow 2H_2O(l)+572\,kJ$$

(572 kJ of heat, sound, and light are released when 2 mols of H_2 gas react with O_2 gas.)

Electrolysis of Water Aided by Ordinary Table Salt NaCl

We did our electrolysis of water using Epsom salt $MgSO_4$ to aid the current flow. The electrolysis produced hydrogen H_2 and oxygen gas O_2 as desired. If we had instead have used ordinary table salt NaCl, chlorine gas Cl_2 would have been produced instead of oxygen gas. Chlorine is quite poisonous. When a railroad tank car full of chlorine derails, a wide area around it is evacuated. When inhaled, chlorine gas forms hydrochloric acid in the lungs. It was used as a chemical weapon in World War I and also recently in Syria.

So why can we put NaCl on our food?

When NaCl salt is dissolved in water, the reaction is

$$Na^+Cl^-(s)+3.9\,kJ\Leftrightarrow Na^+(aq)+Cl^-(aq)$$

(3.9 kJ/mol of heat is absorbed as NaCl is dissolved in water.)

The **sodium in the salt was already ionized** and its electron has been taken by the chlorine which has a stronger attraction for the electron than does the OH^- part of the water molecules. The water molecules therefore remain together. The sodium doesn't burn and chlorine gas is not produced.

This very different behavior for sodium in water is because in the case of sodium metal, the sodium has its outer electron and then releases it in a reaction whereas in the case of table salt, the sodium is already an ion having lost its outer electron to the chloride in an earlier reaction.