Sodium carbonate (also known as washing soda or soda ash), Na$_2$CO$_3$, is a sodium salt of carbonic acid and is a fairly strong, non-volatile base. It most commonly occurs as a crystalline heptahydrate which readily effloresces to form a white powder, the monohydrate. It has a cooling alkaline taste, and can be extracted from the ashes of many plants. It is produced artificially in large quantities from common salt.

**Uses**

Sodium carbonate is used in the manufacture of glass (55%), pulp and paper (5%), soap, and many other chemicals (25%) such as sodium silicates and sodium phosphates. It is also used as an alkaline agent in chemical industry.

Domestically it is used as a water softener during laundry. It competes with the ions magnesium and calcium in hard water and prevents them from bonding with the detergent being used. Without using washing soda, additional detergent is needed to soak up the magnesium and calcium ions.

Sodium carbonate is also used in a photographic process known as reticulation. A film negative can be placed in a hot bath of sodium carbonate which may cause the metallic silver to clump and the emulsion to separate from the base of the film, producing a cracked and abstracted image.

Sodium carbonate is also used by the brick industry as a wetting agent to reduce the amount of water needed to extrude the clay.

**Occurrence**

Sodium carbonate is soluble in water, but can occur naturally in arid regions, especially in the mineral deposits (evaporites) formed when seasonal lakes evaporate. Deposits of the mineral natron, a combination of sodium carbonate and sodium bicarbonate, have been mined from dry lake bottoms in Egypt since ancient times, when natron was used in the preparation of mummies and in the early manufacture of glass. Sodium carbonate has three known form of hydrates: sodium carbonate decahydrate, sodium carbonate heptahydrate and sodium carbonate monohydrate.

**Leblanc Process**

In 1791, the French chemist Nicolas Leblanc patented a process for producing sodium carbonate from salt, sulfuric acid, limestone, and coal. First, sea salt (sodium chloride) was boiled in sulfuric acid to yield sodium sulfate and hydrogen chloride gas, according to the chemical equation

\[
2 \text{ NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2 \text{HCl}
\]

Next, the sodium sulfate was blended with crushed limestone (calcium carbonate) and coal, and the mixture was burnt, producing sodium carbonate along with carbon dioxide and calcium sulfide.
The sodium carbonate was extracted from the ashes with water, and then collected by allowing the water to evaporate. The hydrochloric acid produced by the Leblanc process was a major source of air pollution, and the calcium sulfide byproduct also presented waste disposal issues. However, it remained the major production method for sodium carbonate until the late 1880s.

**Solvay Process**

In 1861, the Belgian industrial chemist Ernest Solvay developed a method to convert sodium chloride to sodium carbonate using ammonia. The Solvay process centered around a large hollow tower. At the bottom, calcium carbonate (limestone) was heated to release carbon dioxide:

\[
\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2
\]

At the top, a concentrated solution of sodium chloride and ammonia entered the tower. As the carbon dioxide bubbled up through it, sodium bicarbonate precipitated:

\[
\text{NaCl} + \text{NH}_3 + \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{NaHCO}_3 + \text{NH}_4\text{Cl}
\]

The sodium bicarbonate was then converted to sodium carbonate by heating it, releasing water and carbon dioxide:

\[
2\ \text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2
\]

Meanwhile, the ammonia was regenerated from the ammonium chloride byproduct by treating it with the lime (calcium hydroxide) left over from carbon dioxide generation:

\[
\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2
\]

\[
\text{Ca(OH)}_2 + 2\ \text{NH}_4\text{Cl} \rightarrow \text{CaCl}_2 + 2\ \text{NH}_3 + 2\ \text{H}_2\text{O}
\]

Because the Solvay process recycled its ammonia, it consumed only brine and limestone, and had calcium chloride as its only waste product. This made it substantially more economical than the Leblanc process, and it soon came to dominate
world sodium carbonate production. By 1900, 90% of sodium carbonate was produced by the Solvay process, and the last Leblanc process plant closed in the early 1920s.

Sodium carbonate is still produced by the Solvay process in much of the world today. However, large natural deposits found in 1938 near the Green River in Wyoming, have made its industrial production in North America uneconomical.

Contributors

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