F-74	Keywords	Y1	material or part	Z4	electricity	E21	ceramic products

AGC Inc.

Ion-Exchange Membrane for the Production of Caustic Soda

Features

The AGC Group has satisfied the ever-changing needs for environmental considerations and safety of the methods for the production of caustic soda. Caustic soda is an essential industrial chemical required in manufacture of various products including synthetic fibers, paper and pulp, and detergent. It is produced by electrolyzing the raw material, a solution of sodium chloride. Mercury (in the mercury method) and asbestos (in the diaphragm method) were used for its production in the past. However, as discharge of these materials in the environment might become a cause of pollution, the Government of Japan requested the manufacturers of the products mentioned above to develop new production methods in the early 1970's.

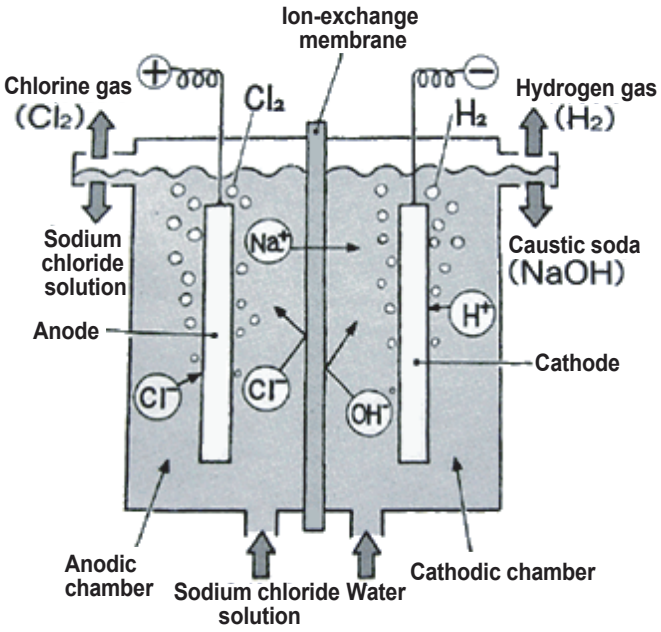
In response to this request, the AGC Group began the development of the ion-exchange membrane method, a method to produce caustic soda and chlorine by electrolyzing sodium chloride solution in the presence of a selectively permeable ion-exchange membrane which only allows certain ions to pass through it, in 1974. AGC Inc. developed a fluorine-based ion-exchange membrane for the production of caustic soda, "FLEMION™"*, a highly durable activated cathode which could realize significant energy saving and a electrolyzing technology using them in 1975.

* One of the products by the FORBLUE™ Family, AGC Group offers unique, eco-friendly solutions for separating various chemicals under the FORBLUE™ Family.

Basic Concept or Summary

The ion-exchange membrane method, the diaphragm method and the mercury method have been used for producing caustic soda, chlorine and hydrogen by electrolyzing sodium chloride solution (in the electrolysis soda industry). As only the ion-exchange membrane method is used in Japan, the principle of the electrolysis of sodium chloride solution in this method is explained in the following.

In the ion-exchange membrane method, sodium chloride solution is divided in the anodic and cathodic sides by an ion-exchange membrane made of special resin. The ion-exchange membrane used in this method has a specific characteristic of allowing only cations (positively-charged ions) to pass through it while not allowing anions (negatively-charged ions) to do so.

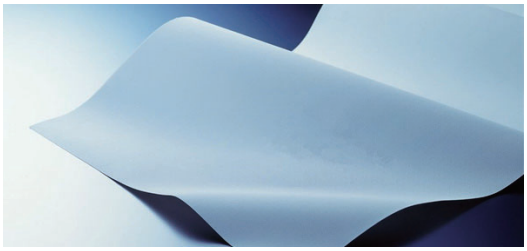


As shown in the figure on the right, chlorine, caustic soda and hydrogen are produced by electrolyzing sodium chloride solution with the electricity applied to the solution through the electric terminals while sodium chloride solution and water are supplied to the cathodic and anodic chambers, respectively, in the ion-exchange membrane method.

As the anodic chamber is filled with sodium chloride solution, there are sodium ions (Na+) and chloride ions (Cl-) in the chamber. When electricity is applied to the solution, movement of the ions will occur. Since Na+ ions are cations, they will move from the anodic chamber, through the membrane and into the cathodic chamber, while Cl- ions will remain in the anodic chamber, since they are anions. Then, they will move to the anode, release electrons and become chlorine gas (Cl_2) on the anode.

Meanwhile, part of water supplied into the cathodic chamber has been broken down to hydrogen ions (H+) and hydroxide ions (OH-). When electricity is applied to the solution, hydrogen ions will move to the cathode, acquire electrons on the cathode and become hydrogen gas (H2). Meanwhile, the hydroxide ions will move toward the anodic chamber. However, their movement will be blocked by the ion-exchange membrane and they will remain in the cathodic chamber with the sodium ions which have moved from anodic chamber. As a consequence, there will be a solution of caustic soda (NaOH) generated in the cathodic chamber.

Source: http://www.jsia.gr.jp/explanation_03.html



FLEMION™

"FLEMION™" is an ion-exchange membrane for the production of caustic soda highly evaluated by its users as being a "membrane which works well with extremely low voltage electricity and, thus, is suitable for energy conservation."

Effects or Remarks

This ion-exchange membrane method (membrane method) is characterized by not only the fact that no hazardous materials are used in it but also the fact that it enables significant energy conservation. The AGC Group has realized approx. 40 % of energy reduction compared with the mercury method and the diaphragm method in the caustic soda production, taking advantage of this characteristic.
The AGC Group has not only developed a new method of caustic soda production but also improved and upgraded "FLEMION™" itself. As the production of caustic soda from sodium chloride solution made from poorly refined raw materials which contains significant amount of impurities is on the increase in certain areas recently, the group developed "FLEMION™ F8080" in 2011 which can be used with voltage lower than the voltage used for the previous membranes and, thus, consumes less electric power and which is strongly resistant to impurities in sodium chloride solution. Developed the "FLEMION F-9010™" achieving lower voltage and power consumption, and launched it commercially in 2019.

Installation in Practice or Schedule

Domestic The technology used in the ion-exchange membrane method has been developed into one of the technologies which represent the technological excellence of Japan, with assistance and efforts made by many people involved in the development including those in the government. Its use in the commercial production began in 1979. The ion-exchange membrane method became the only caustic soda production method used in Japan in 1999. This technology, which has many advantages including high quality and energy conservation, is being exported to various countries in the world.

Overseas Overseas, the ion exchange membrane method is mainstream, while the diaphragm method and mercury method are still used occasionally. Moreover, as the Minamata Convention on Mercury came into effect, caustic soda production using the mercury method will be banned by 2025. For this reason, it is expected that more and more manufacturers will switch to the ion exchange membrane method in the future.

Photo credit: AGC Inc.

Contact: **AGC Inc.**
AGC Chemicals, FORBLUE Division, FLEMION Business Group
Tel: +81-3-3218-5031
URL: https://www.agc-chemicals.com/jp/ja/fluorine/products/forblue/