Recovery of alkali solution from the sequestration of carbon dioxide using the concentrated water

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Abstract

The scale of environmental pollution, which is inevitably derived from the rapidly changing industrial and economic development, cannot be solved by the power of only several specific countries. In recent years, climate change has become a subject of global interest, and leaders from around the world have gathered together to think about the solutions in Paris. Climate change becomes a great threat to humans as well as all living things by bringing about changes in ecosystems. These visible changes include unforeseeable damage such as extreme water shortages, severe local floods, desertification due to soil loss, soaring skin cancer patients due to the depletion of the ozone layer, climate warming due to greenhouse gases such as CO₂, It is obvious that it is happening recently or be likely to happen in the future. The purpose of this study is to improve the economic efficiency through the recovery of basic solution (NaOH solution), which is a substance necessary for the sequestration of CO₂ gas using concentrated water generated through the desalination process of sea water, an alternative to the above mentioned water shortage.

The concentrated water obtained from the desalination is about 5% of Na and Cl, about twice as high as about 2.5% of seawater, and has a pH of about 8, which is weakly alkaline. Especially, the contents of Ca and Mg in the concentrated water were 800 and 2400 ppm, respectively. Therefore the concentrated water is a potential source of mineral carbonation for the sequestration of CO₂ gas. The carbonation process using concentrated water was preferentially performed the precipitation of Mg in the concentrated water as Mg-hydroxide slurry by adjusting the pH to about 10 with NaOH. After the solid-liquid separation, the pH of the supernatant was increased to about 12 again, the CO₂ is introduced into the microbubbles, and then the first CaCO₃ was precipitated. The pH of the supernatant was reduced to about 7 to 8. After the solid-liquid separation, supernatant was mixed with Mg-hydroxide slurry, pH-swing process was performed to increase the pH to about 10 and carbonation with micro-bubbles was carried out to precipitate MgCO₃.

The target substance for recovering the alkali solution is a supernatant obtained by solid-liquid separation of the finally precipitated MgCO₃ slurry. This supernatant still contains divalent cations despite the carbonation of divalent cations, such as Ca and Mg. The presence of such divalent cations is hindered the production of NaOH solution, because they block the membrane filter of bipolar electrodialysis which is a secondary electrodialysis described below. Therefore, these divalent cations were removed using an electrodialysis apparatus to recover the more pure alkali solution. In the results of chemical analysis on the solution, the contents of Ca, Mg, Na and Cl were about 9ppm, 40ppm, 30,900ppm and 44,900ppm, respectively. A bipolar electrodialysis was used to recover the NaOH solution from the solution obtained by electrodialysis. It is known that this
device is so effective in the separation and recovery of acid and alkali solutions. In result, the pH of the final solution was more than 13.6, and its concentration calculated based on the electrical conductivity was more than 1.1N, and then the alkaline solution was sufficient for use as a pH swing agent.