Ammonia Production From Seawater and Air by a New Method that Utilizes Renewable and Waste Energy

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In line with recent increasing interest in renewable energy solutions, ammonia (NH3) has been attracting attention as an energy carrier. However, environmental conditions often affect current renewable energy sources and are thus unsuitable for conventional NH3 production methods. Additionally, when hydrogen is used to produce NH3 via conventional methods, carbon dioxide (CO2) is generated. To overcome these problems, we developed an NH3 production method from air and seawater using renewable energy. In this research, NH3 was generated simply by venting N2 gas into a thick Na+ solution. Based on the analysis, we found microbubbles generated by creating high surface tension at the gas-liquid interface during aeration generate N•, H•, and metal Na from N2, water, and Na+, respectively, and the metal Na catalyzes the N• and H• reactions to generate NH3. When verifying this method, we discovered NH3 generation was optimized under the following three solution conditions: 1) >1 mol/L, 2) >343 K, and 3) pH 5–7. Based on these points, equipment using renewable energy and waste heat to produce NH3 by the following three processes was fabricated. I. Air was used as the N2 source, and aeration was performed by a pump powered by solar or wind energy. II. Concentrated seawater was used as an electrolyte solution, and the water temperature was maintained using solar and waste heat. III. The pH level was adjusted with CO2. Using this equipment, manufacturing costs equivalent to the Haber-Bosch process were achieved, and CO2 was fixed as sodium bicarbonate.

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