Development of an Eutrophication Prevention System that Generates H2 Gas by Low-voltage H2O Electrolysis

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Eutrophication is a serious problem in many water bodies around the world. Eutrophication is caused by an accumulation of nutrient salts, such as nitrogen and phosphorus, which then stimulate excessive plant growth. An effective method for removing these salts, which are derived from human activities, such as agricultural production and sewage generation, has not yet been developed. In this study, we developed a system that was capable of the following: (1) Power generation using a battery in which the anode, cathode and electrolyte solution were comprised of iron, carbon and contaminated water, respectively. (2) Hydrogen (H2) generation by electrolysis of contaminated water. (3) Reduction and removal of nitrate ions by generating H2. In (1), 100% of the phosphate ions were removed from the contaminated water, and phosphoric acid was collected from the precipitate. The surface area of the electrodes of the electrolytic device was expanded by using carbon fiber and the distance between electrodes was narrowed to a thickness of one cation exchange membrane. As a result, in (2), H2 was generated efficiently by electrolysis at a voltage of less than 1 V, even from neutral contaminated water by oxidation-reduction of iron ions. The removal of nitrate ions and H2 generation were enhanced when contaminated water was pumped in near the cathode. Finally, in (3), the nitrate ions in contaminated water were reduced to nitrogen gas (N2) and were removed from water. Given the simplicity of the device, we consider that it is a promising technology for remediating rivers, lakes and other surface water bodies in developing countries. In addition, this system can cheaply and safely remove nitrogen and phosphorus from septic tanks.

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