Energy Creation by Low-Voltage Electrolysis of Water Using Aqueous Solutions With Different pH Levels

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In principle, the water electrolysis proceeds under an applied voltage of 1.23 V. In practice, however, a voltage of ~2 V is necessary because of the rate-limiting effect of oxygen (O2) gas production. In this conventional method of hydrogen (H2) production, the application of an overvoltage causes a large energy loss. Inspired by the relationship in Nernst's equation that the electrode potential depends on the pH, I hypothesized that the water electrolysis can be driven at a voltage lower than 1.23 V using a solution with different pH. This study examined the water electrolysis in an electrochemical cell in which the anode and cathode are immersed in different electrolytes, as in the Daniell cell. The voltage of H2 generation under each condition was then calculated from the resultant current-voltage (I-V) plot. The results showed that the voltage of H2 generation was 1.009 V only under the condition where the electrolytes of the anode and cathode sides were sodium hydroxide and sulfuric acid, respectively. In addition, constant-voltage electrolysis at 1.230 V was conducted under the same conditions and could continuously produce H2 gas and O2 gas. Therefore, using alkaline and acidic solutions for the anode and cathode sides, respectively, is sufficient to generate H2 gas at 1.23 V, the theoretical voltage for water electrolysis. This method saves approximately 1 V of electrochemical potential compared with the conventional method. These results suggest that a new energy generation method of combining water electrolysis and hydrogen fuel cells will be feasible in the future.