**A Study on the Efficiency Improvement of Vanadium Electrolyte Solution.**

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**Highlights**

* Manufacture of electrolytic solution using glycerol as reducing agent.
* After the electrolytic solution was prepared from a low-concentration sulfuric acid-supported electrolyte, a sulfuric acid solution was added.

**1. Introduction**

One of the safest of large-capacity energy storage system is the vanadium redox flow battery.

In the vanadium redox flow Battery, the electrochemical reaction of oxidation and reduction takes place in the stack, and the energy storage is stored in an electrolyte stored in a separate electrolyte tank. The electrolytic solution accounts for about half of the cost of the vanadium redox flow battery. For this reason, the development of efficient electrolytes is essential. In this study, we have experimented to manufacture electrolytes to improve the efficiency of vanadium electrolytes[1].

The reaction formula of the anode and the cathode of the vanadium redox flow cell is as follows.

Positive electrode reaction:



Negative electrode reaction :

**2. Methods**

The preparation of the electrolyte solution was carried out in the following order.

First, V(IV) solution was prepared by using VOSO4 in a low aqueous sulfuric acid solution. Second, V (III) solution and V (V) solution were prepared from V (IV) solution using charge/discharge cell. Third, the V(V) solution is reduced to V(IV) using a glycerol reducing agent and then mixed with the V (III) solution to prepare a 3.5-valence electrolyte solution. Finally, sulfuric acid was added to the 3.5 valence electrolyte solution to prepare

**3. Results and discussion**

Figure 1 shows the electrical properties of the prepared electrolyte solution by Cyclic Votammetry(CV). Both curves show the electrical characteristic curves of a typical vanadium electrolyte. Figure 2 shows the results of charge/discharge test of the completed vanadium electrolyte solution for 50 times by adding 2M H2SO4 to the supporting electrolyte 1M H2SO4. Figure 3 shows the results of charge/discharge test of the completed vanadium electrolyte solution for 50 times by adding 1M H2SO4 to the supporting electrolyte 2M H2SO4. In the case of energy efficiency and voltage efficiency, better efficiency was obtained when the initial H2SO4 concentration was 1M.



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| Figure.1 CV curve of V (IV) electrolyte solution prepared with VOSO4 and V (IV) electrolyte solution reduced with glycerol reducing agent.  | Figure2 Charge/discharge efficiency curve for 50 cycles (1M H2SO4 electrolyte solution + 2M H2SO4 addition). | Figure 3 Figure2 Charge/discharge efficiency curve for 50 cycles (2M H2SO4 electrolyte solution + 1M H2SO4 addition). |

**4. Conclusions**

Energy efficiency increased from 83.18% to 86.68%, and voltage efficiency increased from 85.99% to 88.65%. It was confirmed that the completion of the vanadium electrolyte using a low concentration of the supporting electrolyte in the preparation of the electrolyte solution, and then the addition of the concentration of H2SO4 to the final completion of the electrolyte solution can be improved in the improvement of the energy efficiency and the voltage efficiency.

**References**

1. S. Roe, C. Menictas, and M. S. Kazacosa, Journal of the Electrochemical society 163.1(2016) A5023–A5028.