

Promoting Practical Application of Hydrogen Production/Utilization Technology

(Research of FY 2019-2022)

1. Purpose

This study aims to establish a treatment process by RMFC. RMFC is a complex of a microbial fuel cell (MFC) and hydrogen production technology by Reverse Electro Dialysis (RED-H₂), which recovers energy from wastewater as hydrogen, and enables “wastewater treatment,” “reduction of sludge generation,” and “energy production.”

The study is joint research with Yamaguchi University.

2. Outcomes of This Year

RMFC technology is a complex of the following two elemental technologies. The system supplying electric power required for MFC technology to RED-H₂ technology enables organic matter decomposition and water electrolysis (hydrogen generation.)

Figure 1 describes principle and features of RMFC technology.

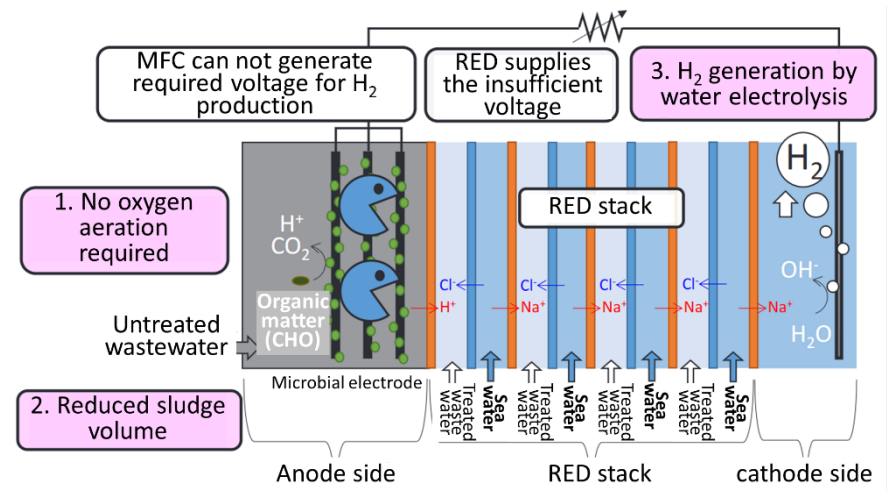


Figure 1. Principal and features of RMFC technology

① RED-H₂ technology:

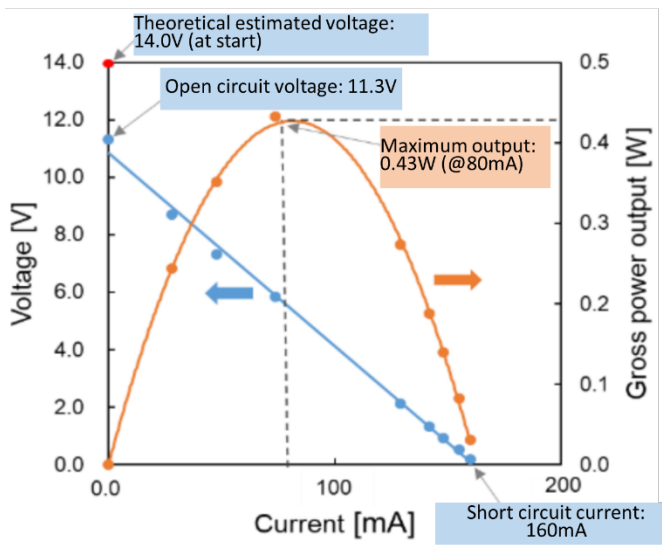
Based on reverse electrodialysis technology, generated electromotive force from the salinity difference energy makes electrolysis to produce hydrogen. (Feasibility study adopted by B-DASH 2016)

② MFC technology:

The anode side which has electrodes fixed with microorganisms of electroactive species digests the organic matter in the sewage and produces energy. At the same time, the cathode side produces hydrogen by water electrolysis. Since microbial electrodes do not generate enough voltage, an external power supply is required.

(1) A small MFC test system was fabricated to measure the electrical behavior and evaluate the decomposition rate of organic matter under anaerobic conditions.

- The current increased until the sixth day after the test started, and then decreased. Digestible organic matter is limited by the type of



microorganism loaded on the electrode. The current decrease may be due to the decrease in the digestible organic matter.

(2) A small RED-H₂ test system was fabricated to test the hydrogen production and electric power generation characteristics (Figure 2.)

Figure 2. V-I curve and P-I curve of the small RED-H₂ device

- The test used a sodium chloride solution with a concentration 10 times that of seawater to generate hydrogen in a short time. As a result, it was confirmed that the maximum power output was 4.3W.

(3) Natural sludge was applied to the microbial electrode of MFC to evaluate its behavior for one week.

- It was confirmed that the treatment rate of the microbial electrode part was about 10 times lower than the current density (treatment rate) of the small RED-H₂ system. Therefore, it was found that the establishment of RMFC technology required to improve the efficiency of microbial electrode.

3. Future Schedule

Based on the results of this year, the RMFC will be improved in its microbial electrode section and the area of microbial electrode will be substantially increased. The system will be used for wastewater treatment to confirm its sludge digestion capacity, amounts of sludge generation and hydrogen production. Based on the research, RMFC technology aims to develop a revolutionary wastewater treatment process that require no electric power for aeration, drastically reduces the amount of sludge, and produces energy such as hydrogen compared to the current activated sludge process.

Keywords: **Hydrogen utilization, Reverse Electro Dialysis (RED), Microbial Fuel Cell (MFC), RMFC**