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-H_2), which recovers energy from wastewater as hydrogen, and enables "wastewater treatment," "reduction of sludge generation," and "energy production" (Figure 1.)

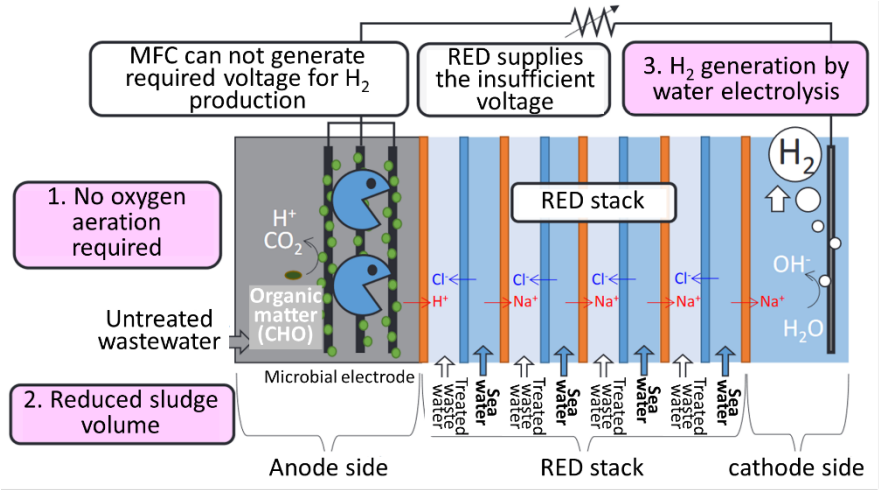

Figure 1. Principal and features of RMFC technology

The study is joint research with Yamaguchi University.

2. Achievements of past years

2019: Each performance of MFC and RED-H_2 was evaluated.

3. Outcomes of This Year

1. Figure 2 describes the transition of MFC's current values and inflow COD_{Cr} concentration. It showed the average 1.3mA output after day 25. The translation ratio of organic matter's total reduction to electricity was an average of 0.8.

2. Observing biological membranes grown on the surface of the electrodes with a confocal laser scanning microscope found no uneven distribution of living and dead cells. On the other hand, microbiome analysis verified photo election emission bacteria, including the *Geobacter* genus or *Paludibacter* genus, among the bacterial species multiplied after the power generation test.

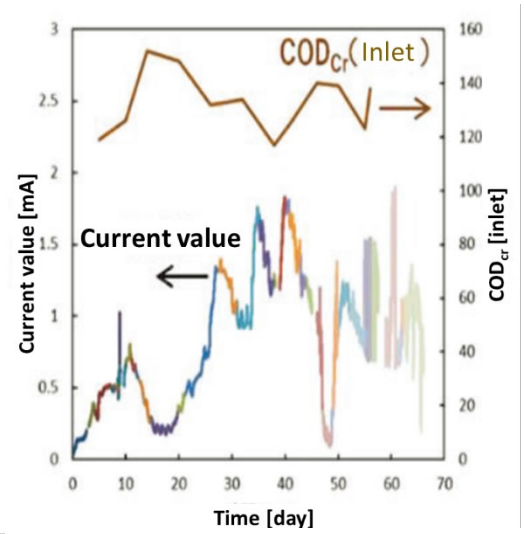

Figure 2 Transition in current value of MFC and COD of primary settling effluent

3. Researchers conducted the power generation characteristic evaluation test of seawater using an ion exchange membrane for RED to estimate stack variable logarithm combined anion and cation exchange membranes required for hydrogen generation. Assuming that the necessary electromotive force for hydrogen generation was 1.5V (RMFC: electrode area of 800cm^2, 40mA), an estimated 13 pairs were required.

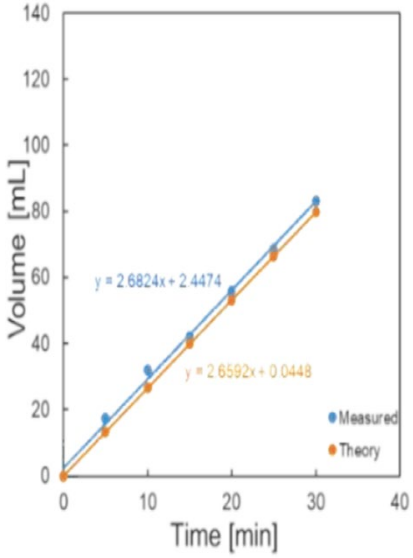

Figure 3 Experiment result of hydrogen generation (RED-H_2 system)

4. Figure 3 describes a relationship between operation time and hydrogen generation when using seawater and solution imitating surface flow water at the RED-H2

with an ion exchange membrane for RED. The conversion efficiency of current and hydrogen defined by the ratio of hydrogen generation test value and theoretical value was 102%, which is equivalent to the theoretical value.

3. Future Schedule

This year's study has established the RED-H2 system's stack logarithm required for the RMFC formation and verified the RED-H2 system enabled hydrogen generation equivalent to the theoretical value. In the future, researchers will find the operating condition that stabilizes the current value of MFC for the first settling tank effluent to configure the RMFC system and evaluate its process.

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