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SUPPRESSION OF GREENHOUSE GAS EMISSIONS FROM SEDIMENT BY BIO-ELECTROCHEMICAL SYSTEM

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Abstract

Bio-electrochemical systems (BESs) have been attracting attention as a new way of biological energy conversion. Microorganisms interact with electrodes using electrons, which are either removed or supplied through an electrical circuit. The most-known type of BES is microbial fuel cells (MFCs).

In this study, we set up sediment MFCs (SMFCs) in laboratory, and evaluated the feasibility of the BES technology as a new remediation method to improve the properties of sediment which contains organic pollutants and/or substrates of greenhouse gas (GHG) emissions. The SMFC system utilizes the natural potential gradient between the sediment and upper oxic water, and electrons released by microbial oxidation of organic compounds flow from the anode in the sediment to the cathode in water through an external circuit.

During over 6 months of the experimental period, a certain amount of power output was generated using carbon-graphite as electrodes. The amount of electricity generation was related to the concentration of microbial biomass in the sediment. Biochemical and molecular-based microbial analysis indicated the changes in the methanogenic activities in the sediment, implying that oxidation-reduction potential in the sediment was changed by installation of the electrodes. It was also demonstrated that the relative abundance of *Geobacter* populations largely increases in the anode vicinity, suggesting that they play an important role in electricity generation in this experimental system.

In addition to this SMFC system using the natural potential gradient, the BESs, in which the electrode potentials are arbitrarily-set by potentiostat, were also constructed in order to quantitatively evaluate and optimize the suppression of GHG emissions. Methane gas emission was continuously monitored by a photoacoustic multi-gas monitor (Model 1312, Innova, Denmark). Methane gas emission from the sediment was reduced when the electrodes were set at oxidative potentials, implying that microbial activity in the soil changed by controlling the ORP in the sediments.

These results suggest that the installation of BES in the sediment could provide suppression technology for the GHG emissions from natural environment and also for controlling the decomposition of organic pollutants and environmentally toxic compounds.