A Model Approach to Harvesting Energy from a Marine Environment: The Engineering of Sediment Microbial Fuel Cells with a Modified Catalyst and Diffusion Layer

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Marine sediment is a viable substrate in producing power in microbial fuel cells (MFCs); design is, consequently, the limiting factor in marine sediment MFC technology. MFCs were designed to utilize the microorganisms in the organic matter to optimize power output. A single cell MFC, “octopus” with nine 3x3 cm anodes, and “eel” with two 4x12 cm anodes were constructed with carbon paper and 30% wet-proofed carbon cloth with polytetrafluoroethylene (PTFE) diffusion layer electrodes. The multiple-anode octopus and eel models yielded significantly higher, one-way ANOVA and scheffe post-hoc test $p<0.05$, power outputs to the single cell design, demonstrating that surface area is directly related to the quantity of microconductive pili. The octopus model yielded a higher power output than did the eel, indicating the connection of wires to the anodes outweighed the effects of surface area. Carbon cloth also induces anaerobic respiration while the PTFE diffusion layer facilitates the transport of electrons, but the models with carbon paper anodes yielded a higher power output than those with PTFE carbon cloth anodes. This can be attributed to the lower potential difference and smaller current between the anodes and the cathode in the PTFE design. The multi-anode MFC designs were found to be most effective in maximizing current and power output, but the microbial interactions with the anode were more efficient in the most inexpensive model—the carbon paper octopus—due to high power density and intensity caused by the carbon paper and 9-anode circuit.

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