Development of Electrochemical Systems for Prevention of Biofouling

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Marine biofouling is commonplace in immersed marine structures, including cooling systems of seawater cooled power plants and heat exchangers. Disposal of attached macroorganisms is cost effective and attachment of macroorganisms deacreases energy transfer rates. We have focused on the use of an electrochemical disinfection method and applied this technique for prevention of marine biofouling (Fig.1).

In this study, we have developed electrochemical systems for prevention of biofouling that consist of an electrochemical reaction monitoring unit, a power control unit and a remote control and monitoring unit (Fig.2). Titanium nitride plate or titanium plate was used as the working electrode. Iron plate and silver-silver chloride were used as the counter and reference electrode, respectively. Generation of chlorine and hypochlorite was not observed using titanium as the working electrode. Fig. 3 shows the field experiment outline for electrochemical prevention of biofouling.

Field experiments were conducted in several places in Japan in Nagasaki, Tokyo Bay, Chiba, and Aomori (pacific ocean side). Application of a constant current of 100mA/m^2 enabled complete prevention of biofouling for over one year using both types of working electrodes. After 2 years of seawater flow in intake channel of Matsuura Thermal Power Stations of Kyushu Electric Power Inc., the wet weight of attached organisms were 10,826g/m^2. In contrast, the wet weight of organisms attached on the titanium nitride electrode and titanium electrode was 206 g/m^2 and 38 g/m^2, respectively (Fig. 4). Generation of oxygen free radicals is the most probable cause of prevention of biofouling. Therefore, it was shown that application of the constant current of 100mA/m^2 using the developed electrochemical system is useful for prevention of biofouling.

Acknowledgement
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References

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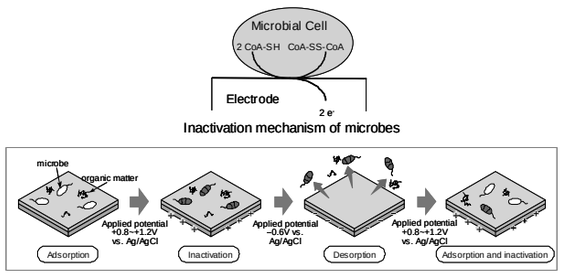
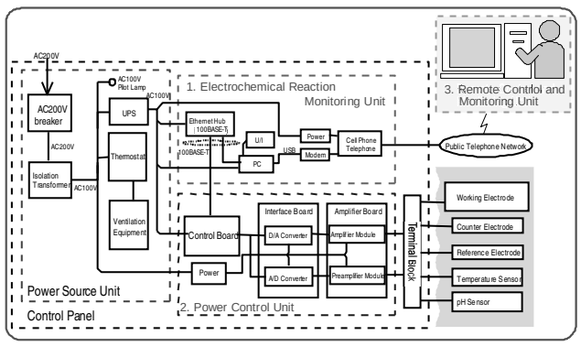
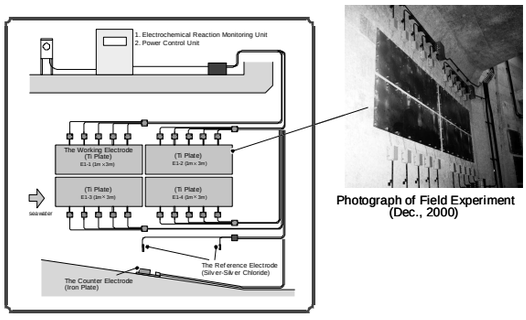


Fig. 1 Mechanism of electrochemical inactivation based on direct electron transfer between cell and electrode, and its application for prevention of marine biofouling [Ref. 1, 2, 3].



1. Electrochemical Reaction Monitoring Unit: scheduled potential control, error monitoring
2. Power Control Unit: voltage output control, multi-plate control
3. Remote Control and Monitoring Unit: data transmission, remote programming

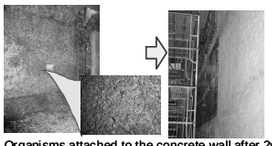
Fig. 2 Electrochemical system for prevention of biofouling.



Photograph of Field Experiment (Dec., 2000)

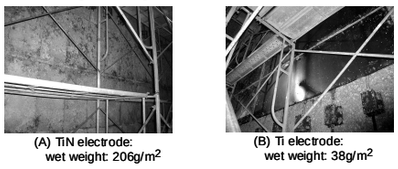
1. Electrochemical Reaction Monitoring Unit
2. Power Control Unit
3. Remote Control and Monitoring Unit

Fig. 3 Field experiment outline for electrochemical prevention of biofouling. Field Experiment was performed in the Matsuura Thermal Power Stations of Kyushu Electric Power Co., Inc.(Nagasaki).



Experiment Place: Matsuura Thermal Power Stations (Nagasaki)
Period: Dec., 2000−Nov., 2002
Working Electrode A: Titanium Nitride (TiN)
B: Titanium (Ti)
Constant Current: 100mA/m²

Organisms attached to the concrete wall after 2years
wet weight: 10,826g/m^2



(A) TiN electrode:
wet weight: 206g/m^2

(B) Ti electrode:
wet weight: 38g/m^2

Fig. 4 Photographs of titanium nitride electrode (A) and titanium electrode (B) after 2 years seawater flow.