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A Microbial Fuel Cell-Based Detection System for the Heating Value of Sludge



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Aug. 11-13, 2014, San Antonio, USA

Contents

- Background
- Experiments and results
- Conclusions



Sludge and utilization



wastewater



River sidement

Water
Organics
Inorganics











fertilizer

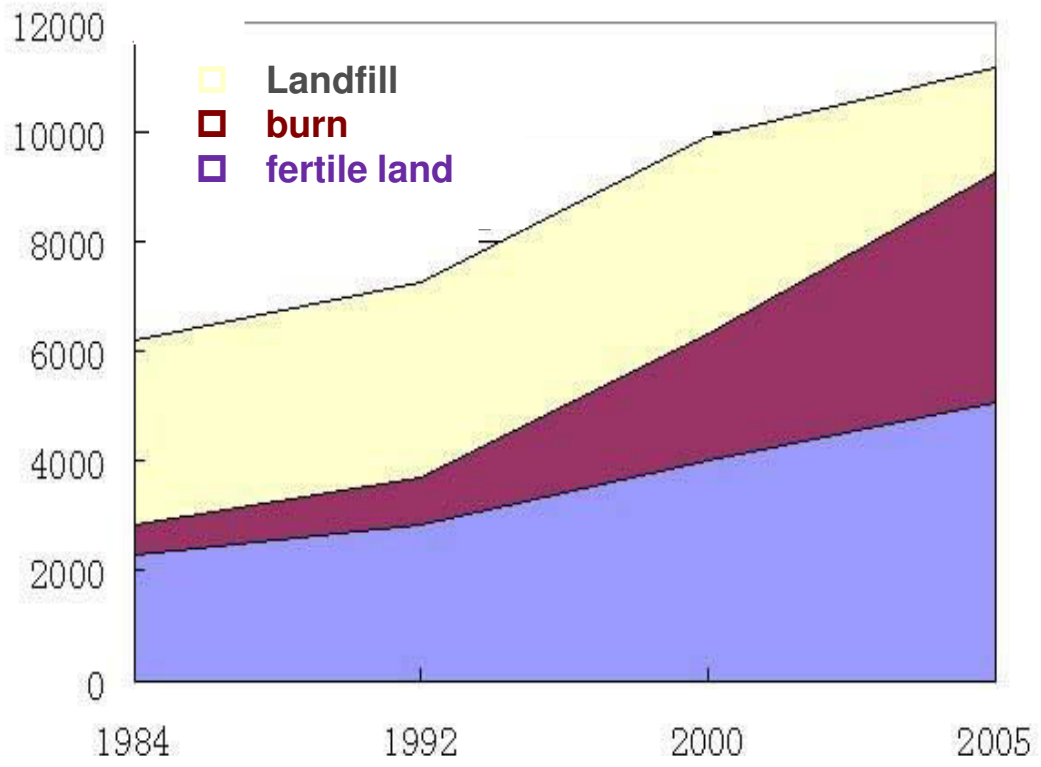


Building materials



fuel

Sludge and utilization



Amount increased >10%

Utilization depends on heating value

It is highly needed to first and quickly know the heating value of sludge before used it

Present method for measuring the heating value of sludge methods



oxygen bomb

element analysis



industrial analysis

Proximate analysis based multiple regression models

- special apparatus
- complicated measurement steps
- long detection time.

New technology:microbial fuel cell

Heating value of sludge----TCOD of sludge

↓

TCOD---SCOD

↓

Microbial fuel cell----SCOD

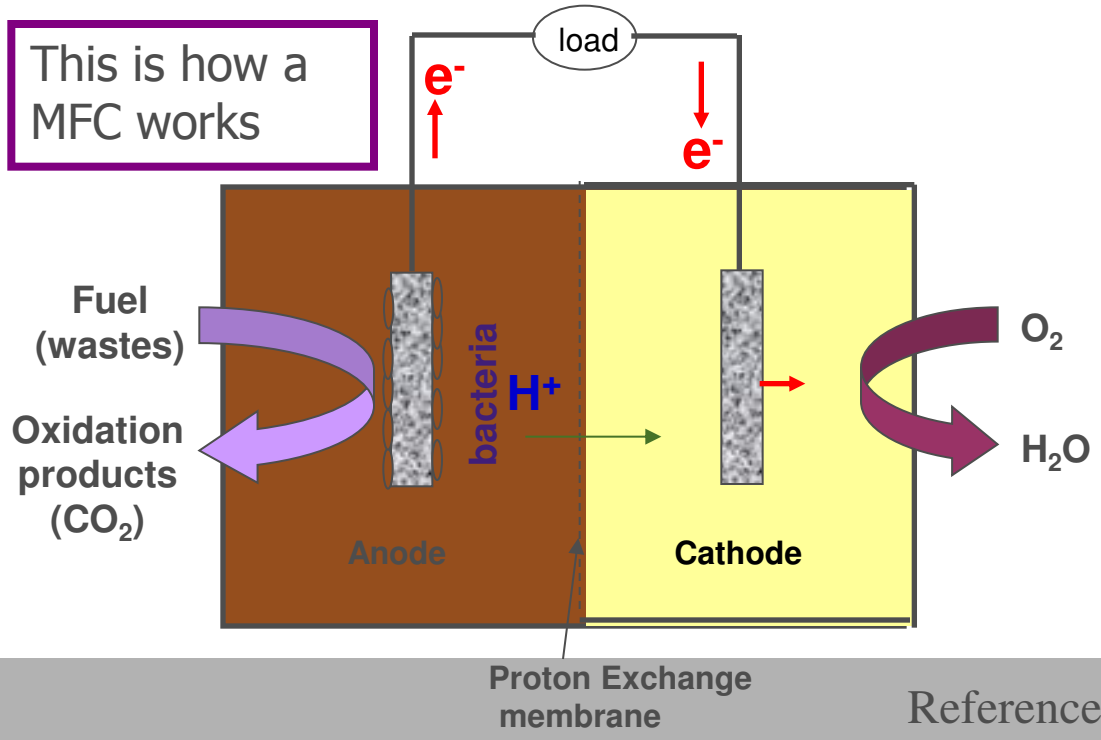
↓ ?

Heating value of sludge----Microbial fuel cell

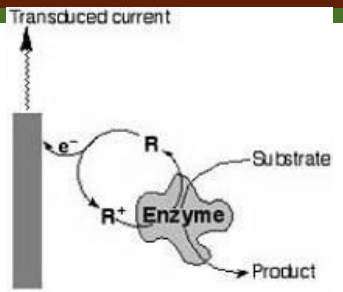
What's microbial fuel cell

A MFC is a device that use bacteria to oxidize organic matter and produce electricity. The bacteria (attached to the anode) produce electrons that travel to the cathode (current).

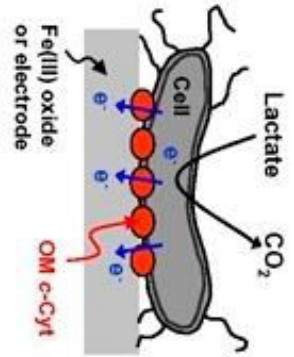
This is how a MFC works



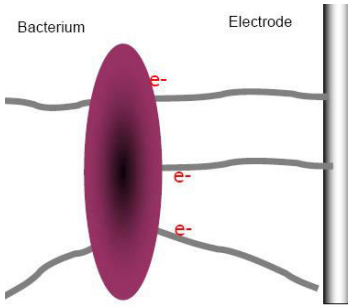
Mediater

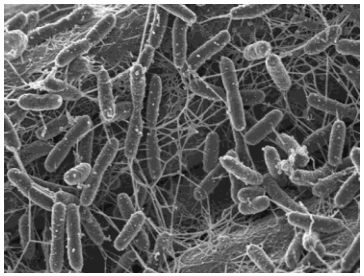


Direct



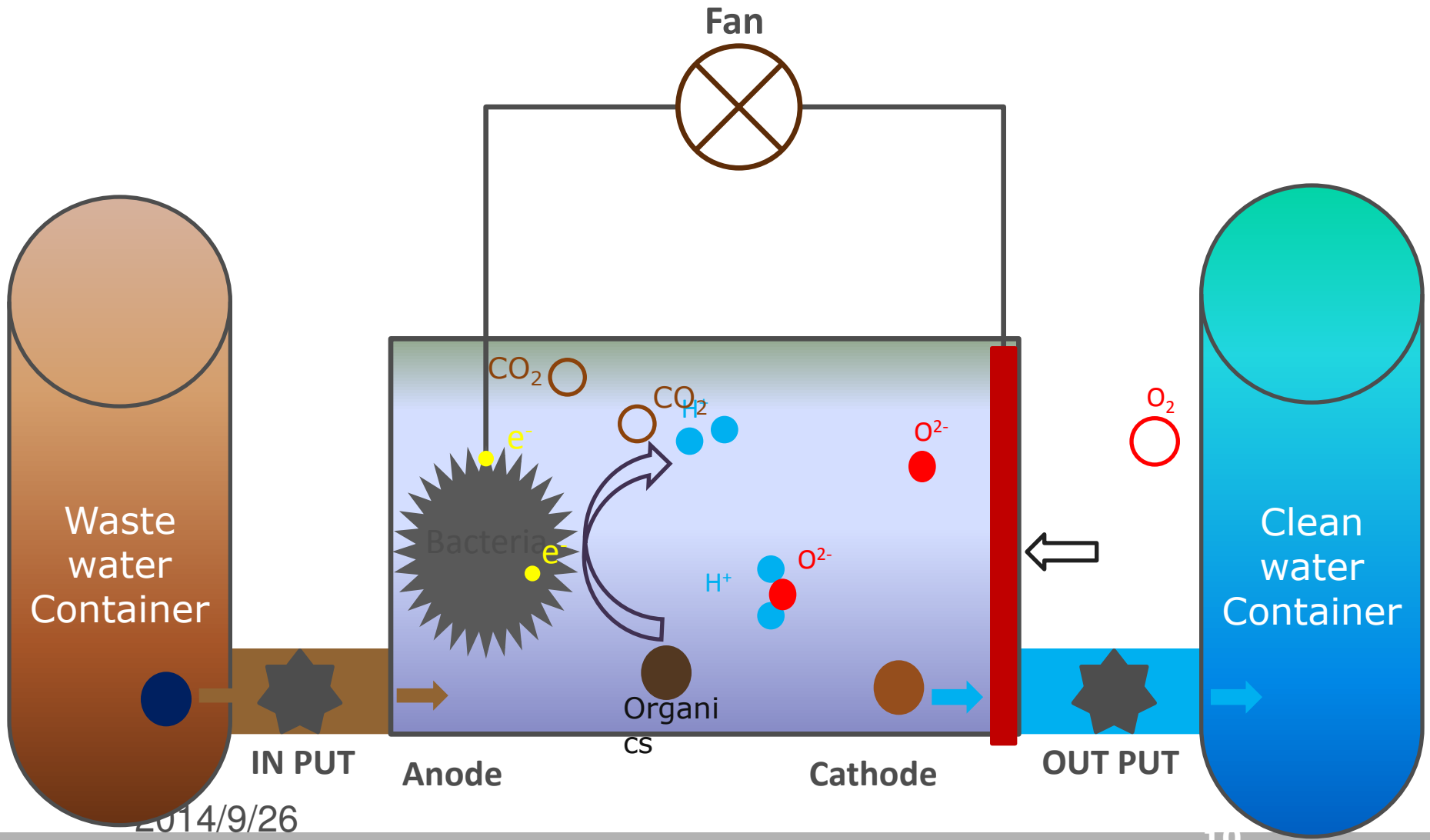
Nanowire



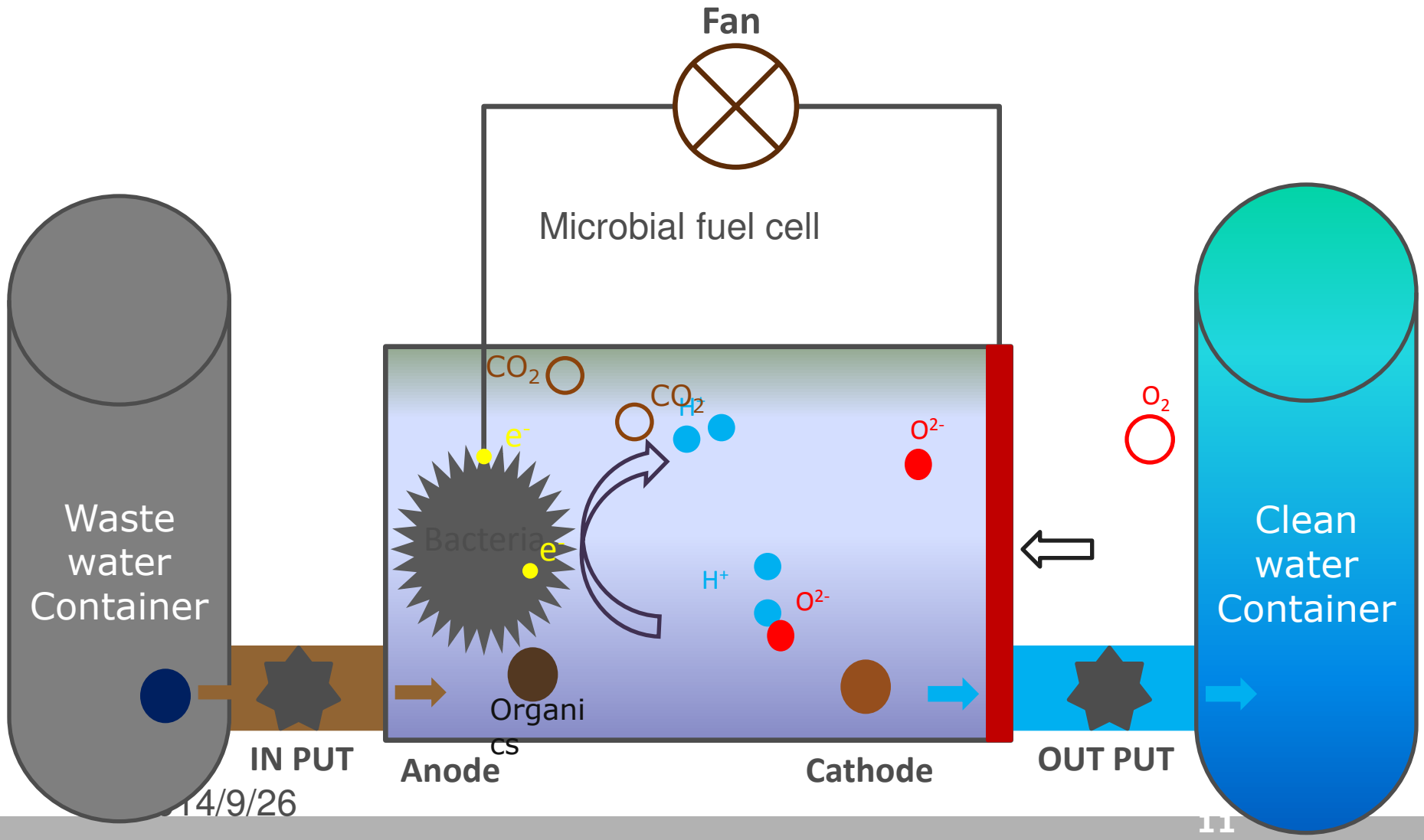


Reference: Liu et al., *Environ. Sci. Technol.* 2004

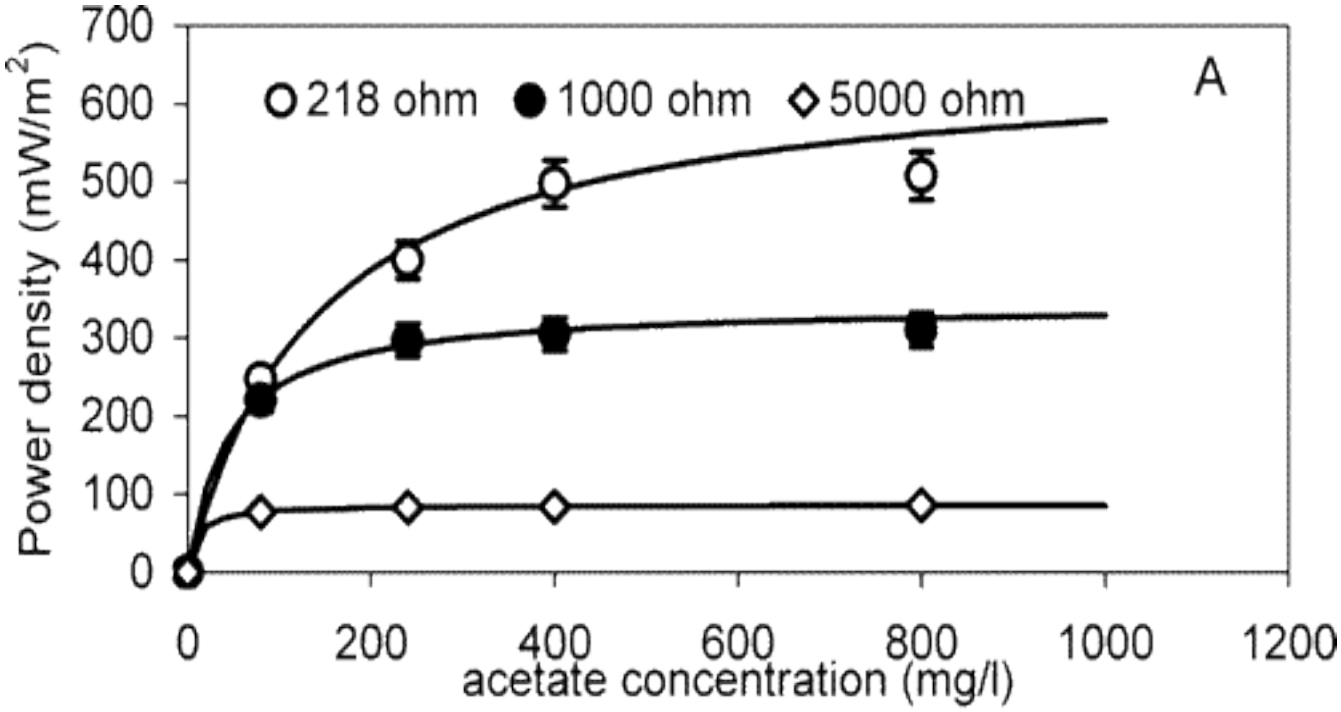
Application : treat wastewater and recovery energy



Treating wastewater for recovery of energy



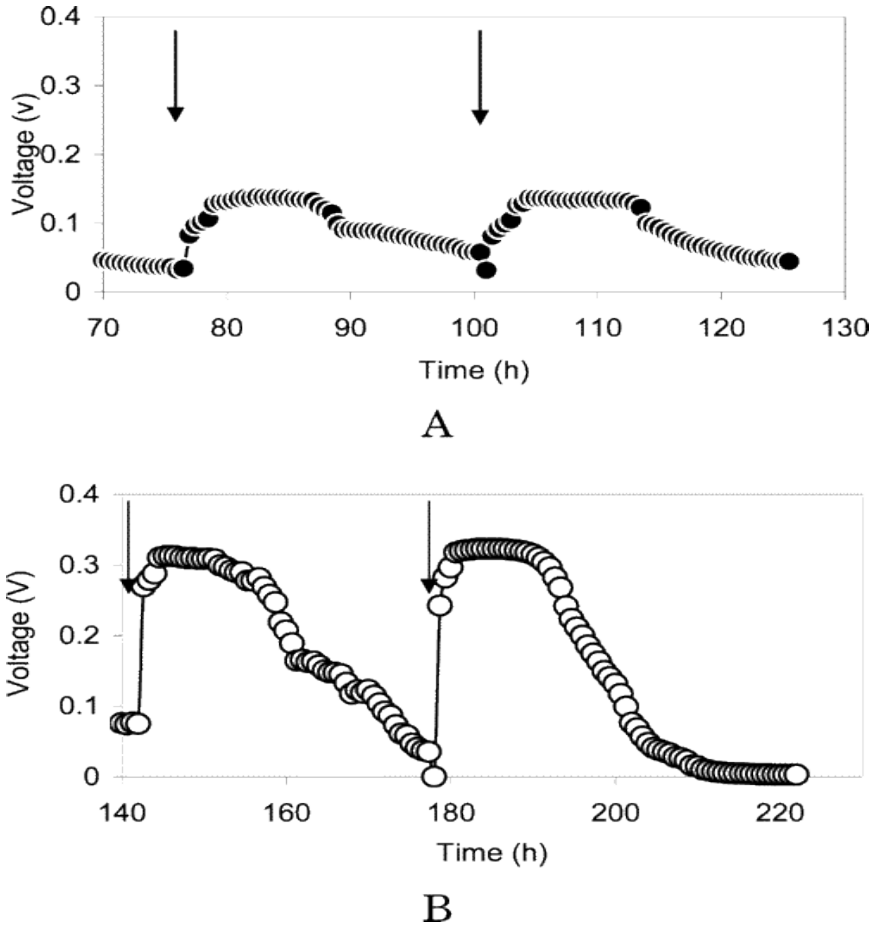
MFC:Power and COD removal

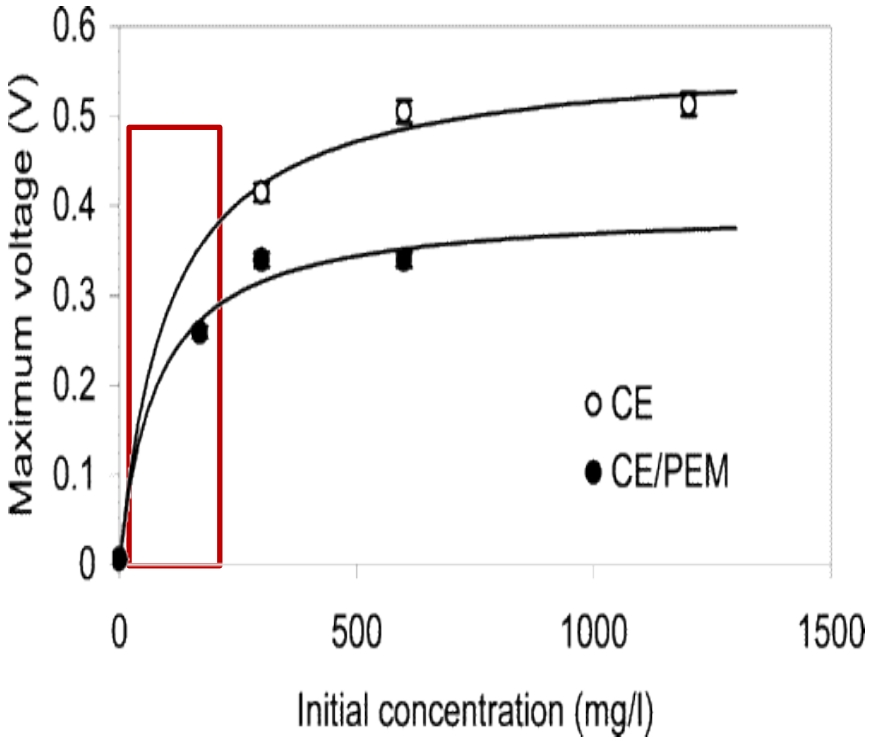


- **Power generation related to the COD, specially in low COD region**

Hong et al, EST, 2005

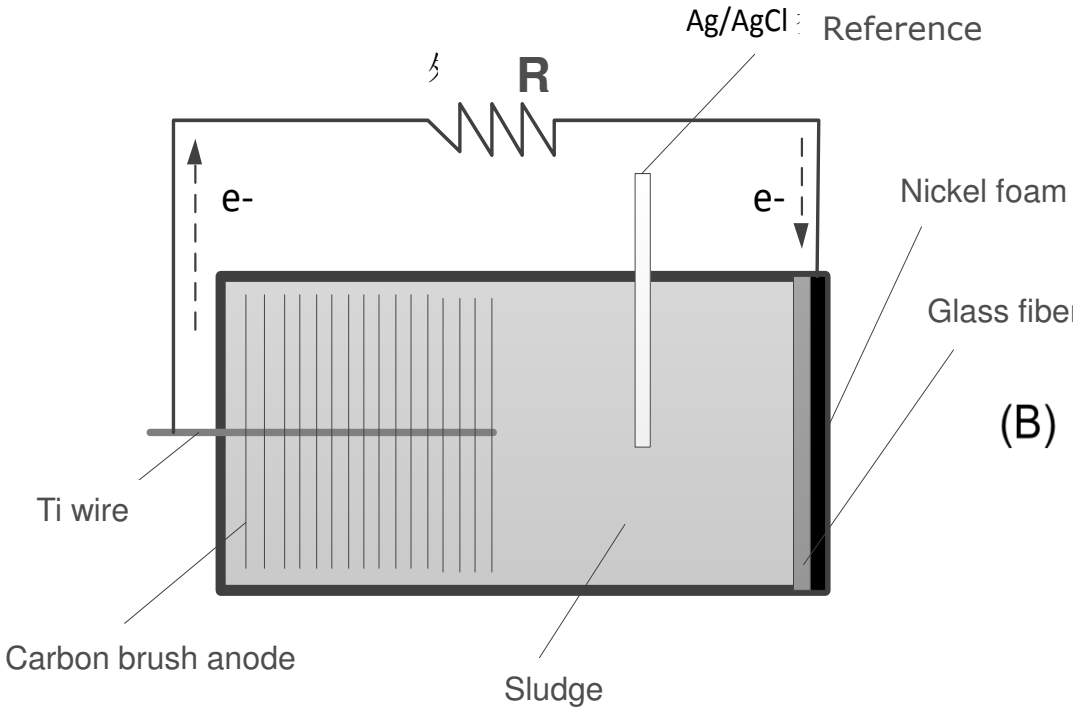
Voltage of MFC ---SCOD



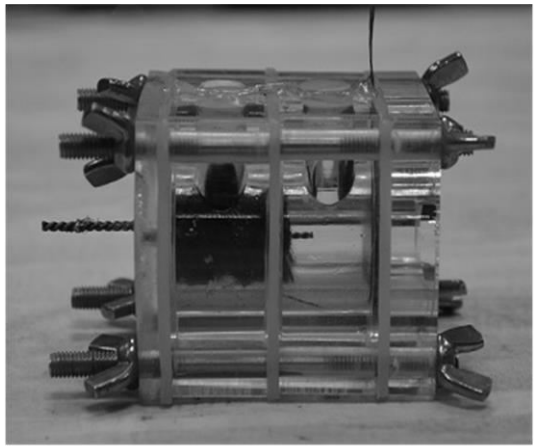


Hong Liu, et al, *Environ. Sci. Technol.*, **2004**, *38* (14), pp 4040-4046

Experiments



(B)



Single chamber MFC

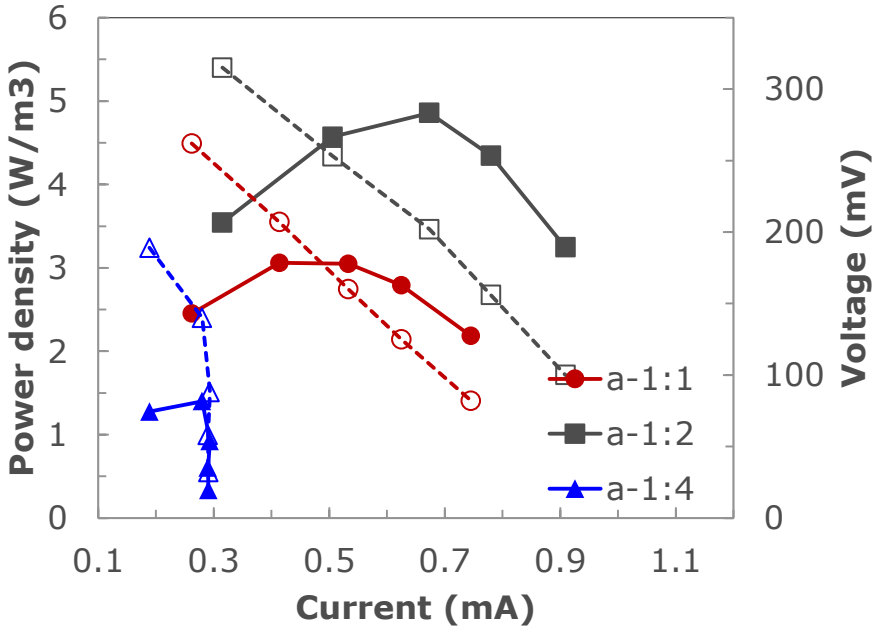
four kinds of sludge with different heating values :1674, 1838, 1762, 1892 J/Kg ; and COD: 3960, 6040, 4498, 6247 mg/L, respectively。

Experiments

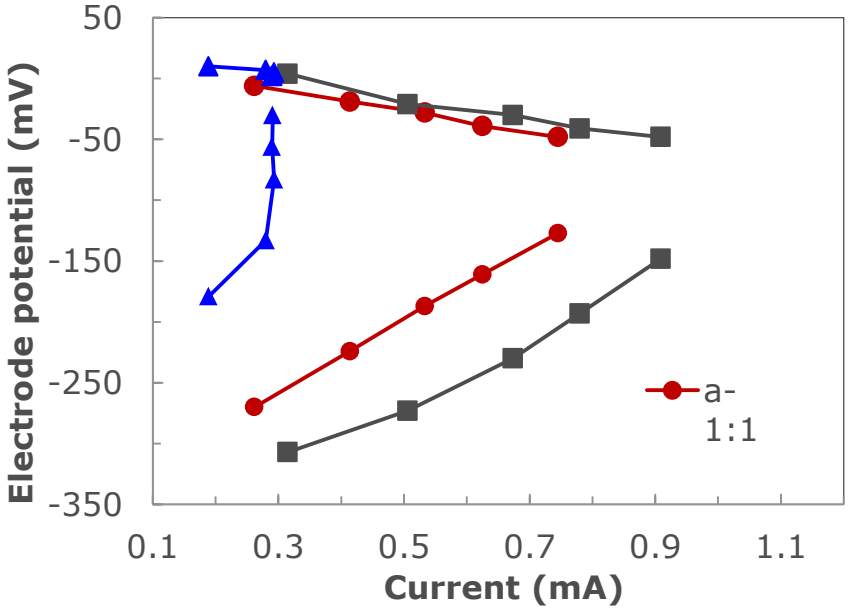
- **Inoculation:** activated sludge as inocula, batch mode, external resistance of 1000 Ω
- **Operation:** when the voltage of the MFC was less than 10 mV, the reactor was refilled fresh sludge. The above process repeated until the voltage of MFC went to a constant value.
- **Optimization external reisitance:** After start up, the reactors were conducted with ploarization and power density curves for obtaining optimization external resistance.
- **Performance:** To explore the effect of concentration of sludge on the electricity generation and the relationship between the sludge concentration and the electricity generation, two kinds of sludges were diluted with phosphate buffer solution (PBS) as the ratios of sludge to PBS: 1:1、1:2、1:4、1:8。

Results---power generation and polarization

Power density and polarization

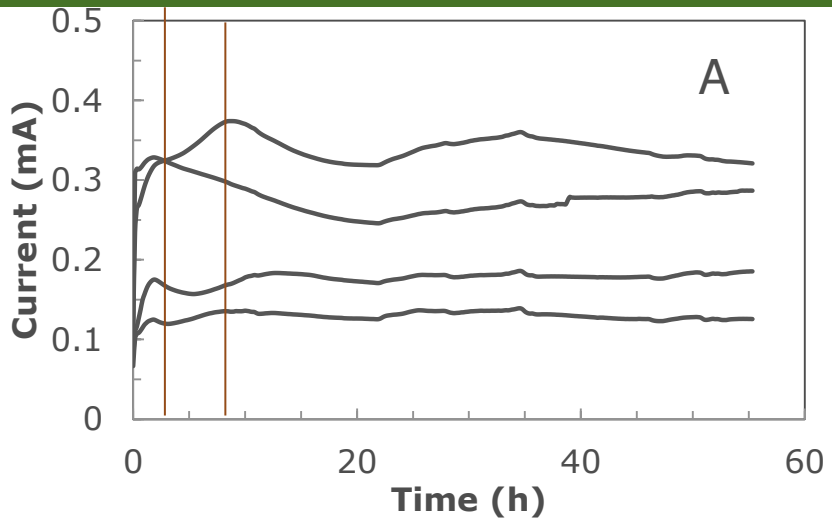


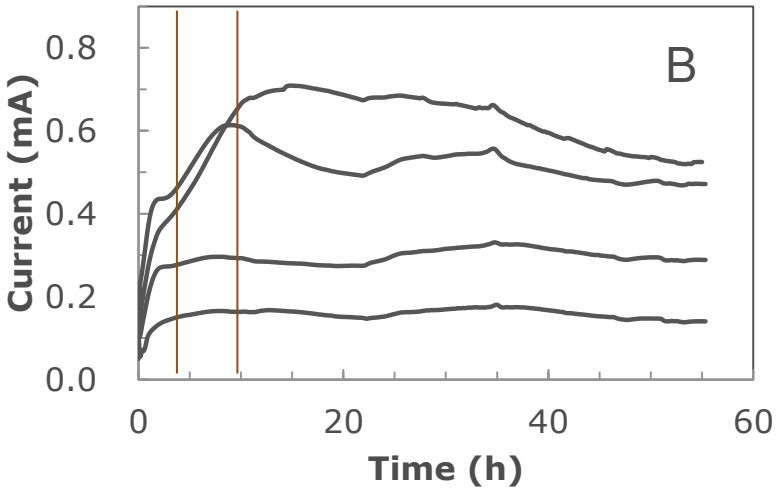
Electrode polarization



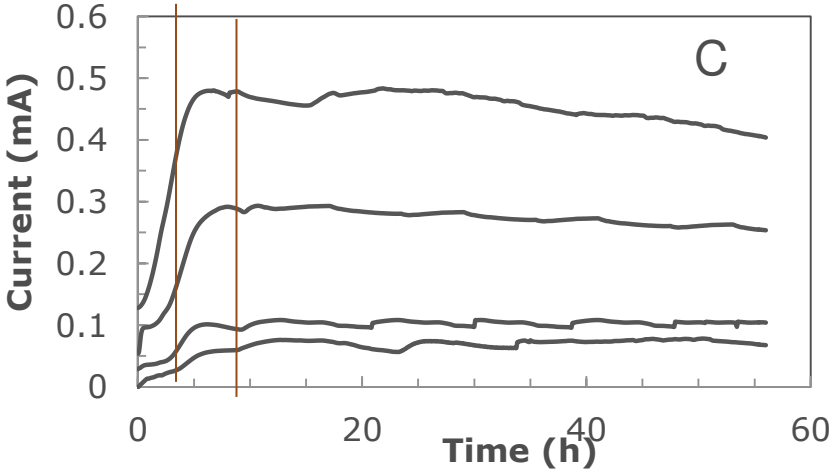
The electricity generation at different concentration of sludge mainly depends on the anode polarization.

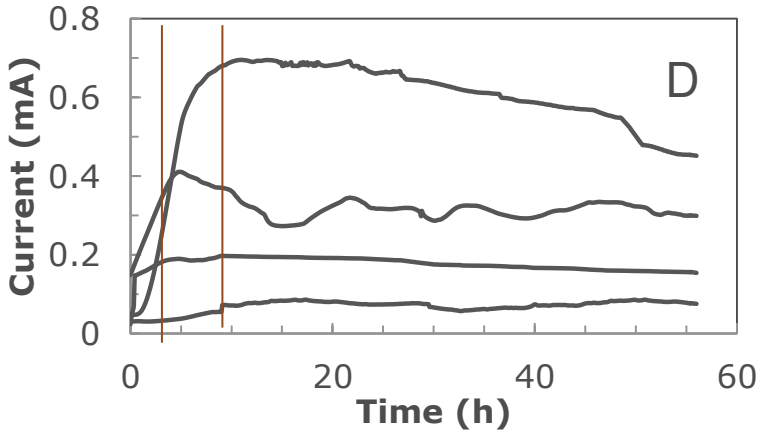
Results---current generation at different concentrations for four sludges



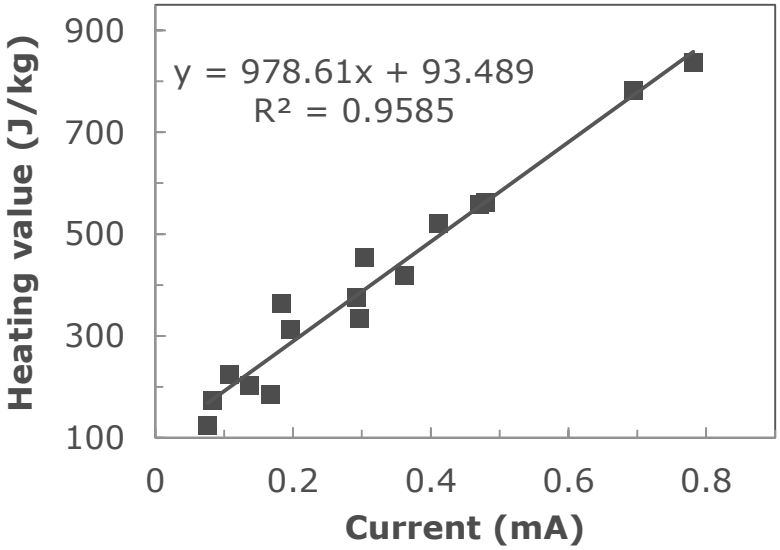


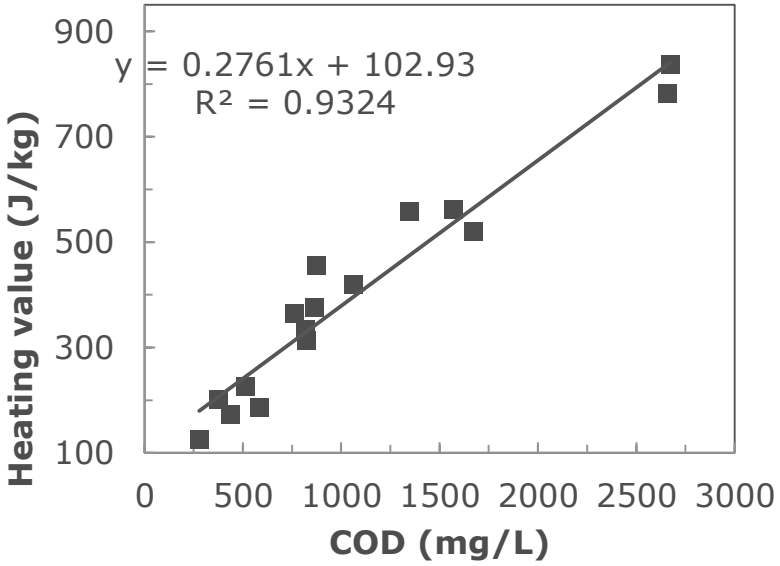
1:1
1:2
1:4
1:8





The relationship between the current and heating value





- ✓ linear relationship between the heating value and the current generated.
- ✓ linear relationship between the heating value and the COD values

Conclusions

- New detection system Based on the single chamber microbial fuel cell has sample structure, low cost and easy to be applied for fast measuring the Heating Value of sludge.

- Heating value of sludge has good linear relationship with current production of MFC, therefore, measuring the current under the certain resistance can quickly estimate the heating value of sludge.



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