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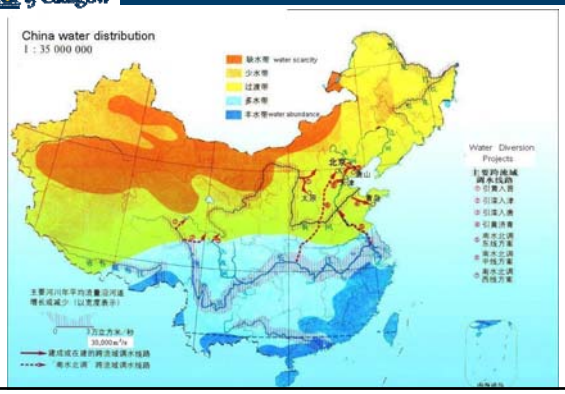
Prospective application of microbial fuel cell technology in developing countries --taking China as an example

Na Zeng

Water status of China



Content

Status in China

- Water environment
- Energy

Microbial fuel cell (MFC)

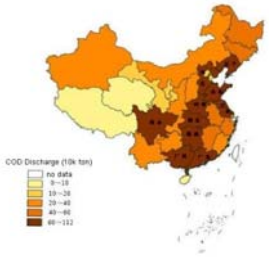
- Mechanism
- Advantages

MFC technology potential

- Application (wastewater treatment, bioremediation, biosensor)
- Scale of application (centralized WTP, household, direct device)
- Region

Water status of China

COD Discharge Distribution,2006



(Environment Statistics 2006 Annual Report, Ministry of Environmental Protection, PRC)

China Water Issue

Water deficiency

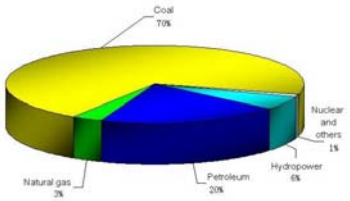
- Unbalanced distribution
- Low amount water resource per capita
  - ¼ of the world average level

Water pollution

- Industrial wastewater
- Municipal wastewater

Energy status in China

Composition of Energy Consumption in China



(BP Statistic Review of World Energy, June 2008)

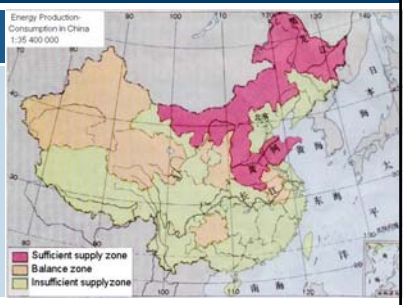
Energy

- Higher rank in energy stockpile amount in the world
- Largest number of energy consumers
- Coal plays dominant role
- Small part of renewable energy resources applied

Energy status in China

Energy Consumption Distribution

- North-South unbalance
- Coal-based energy
- Serious rural energy issue
  - -rural energy supply low commercialization
  - -western rural villagers low energy consumption
  - -about 10 million people without electricity



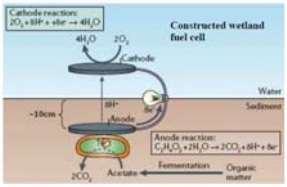
(China Central Audio-Visual Education Center Resource Center)

MFC Technology Potential

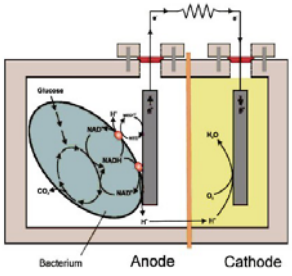
Application | Scale | Region

Application

- Wastewater treatment
  - Effluent quality
- Bioremediation
  - Sediment MFC (river, lake, coast line)
  - Constructed wetland fuel cell
- Biosensor
  - Biochemical Oxygen Demand (BOD) Sensor
  - E. Coli Sensor
  - Microelectromechanical systems (MEMS) Device



Mechanism of MFC



(Rabaey & Verstraete, 2005)

Configuration

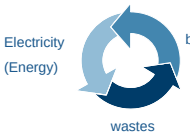
- Anode
- Cathode
- Proton exchange membrane
- External circuit

MFC Technology Potential

Application | Scale | Region

Scale

- Centralized wastewater treatment plant
  - Scale up, replace
    - Activated Sludge (AS)
    - Trickling filters (TF)
- Household scale MFC
  - Pit latrines and septic tank
  - Domestic wastes/wastewater
- Direct current devices
  - Low-voltage appliances
  - Flashlight, fan, access to internet…



MFC Advantages

Direct conversion

Energy change from chemical installed in substrate into electricity

High conversion efficiency

Biochemical reaction

Function of microbial community

No need of extra energy input for aeration

Lower operation and maintenance costs

MFCs have the potential for widespread application in locations lacking electrical infrastructures and also to expand the diversity of fuels (Logan,2007)

Off-gases

No requirement of gas treatment

- Main product is carbon dioxide(CO_2) and water(H_2O)
  - No useful energy
  - No contaminants

Fuel

A huge range of resources can be used as fuel

- Organic compounds
  - No need of high quality
    - Wastes

MFC Technology Potential

Application | Scale | Region

Region

- Well developed area
  - Wastewater treatment technology is more significant than electricity generation before power density of MFC is improved
- Electricity lacking area
  - Getting energy from wastes gives a positive aspiration
  - Novel renewable energy resource is helpful to contribute into the new rural villages
    - Less expensive than solar panels or wind turbines
    - Easier to set up

A makeshift microbial fuel cell: a bucket, waste water and a graphite sheet. Photo: Lebônê

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Conclusion

Prospective Application In China

	Northwest	Southwest	Northeast	Southeast
Development	Less developed Remote area	Less developed Remote area	Developed	Developed
Water	Deficient Less pollution	Abundant Less pollution	Deficient Serious pollution	Abundant Serious pollution
Energy	Balance	Insufficient	Sufficient	Insufficient
MFC application	DC devices in the remote area, reuse the effluent of household MFC	DC devices in the remote area, household MFC for water treatment	Centralized wastewater treatment (BOD sensor, bioreactor)	Centralized wastewater treatment, bioremediation for the polluted lakes

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