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Microbial dynamics and performance in a microbial electrolysis cell-anaerobic membrane bioreactor

Key words: MEC-AnMBR; COD removal efficiency; Methane production; Membrane fouling; Microbial mechanism

College of Environmental and Resource Sciences, Zhejiang University

Main limiting factors for AnMBR applications

Sludge floc, Dissolved organic matter, Inorganic salt, Colloidal particles

Adsorption, Sedimentation, Enrichment

influence

- Reduce membrane flux
- Shorten membrane service life
- Increase operating cost

Construction and performance of MEC-AnMBR

Reactor construction

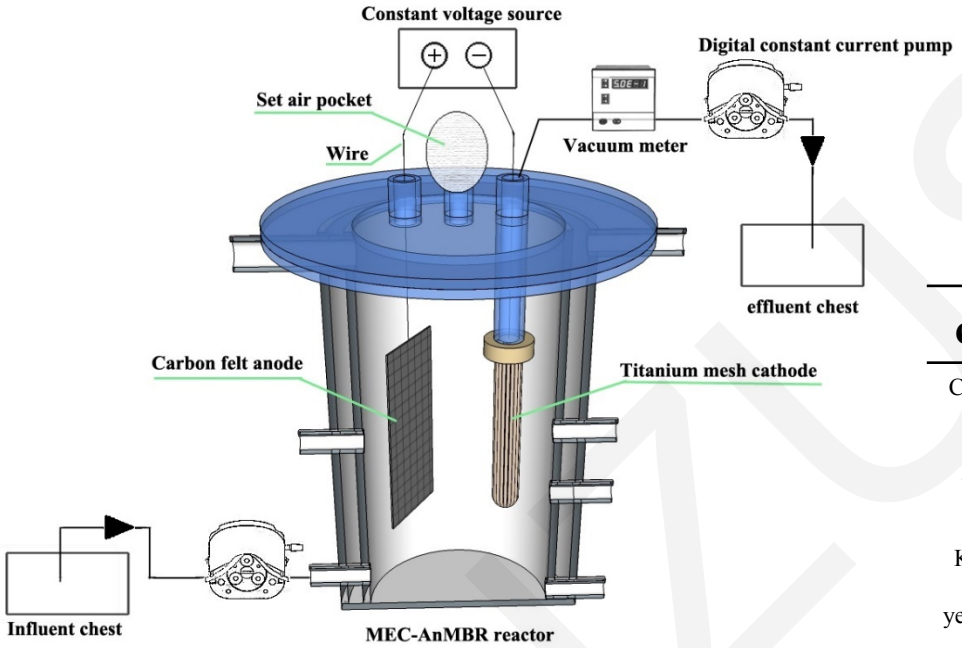


Fig. 1 The configuration of the reactor.

High-concentration organic synthetic wastewater

composition		trace elements composition			
CH_3COONa	12.83 g/L	NTA	1.5 g/L	$ZnCl_2$	0.13 g/L
NH_4Cl	0.96 g/L	$MgSO_4$	3.0 g/L	$CuSO_4 \cdot 5H_2O$	0.01 g/L
KH_2PO_4	0.22 g/L	$MnSO_4 \cdot H_2O$	0.5 g/L	$AlK(SO4)_2 \cdot 12H_2O$	0.01 g/L
yeast extract	0.1 g/L	NaCl	1.0 g/L	H_3BO_3	0.01 g/L
tryptone	0.1 g/L	$FeSO_4 \cdot 7H_2O$	0.1 g/L	Na_2MoO_4	0.025 g/L
microelement	1ml/L	$CaCl_2 \cdot 6H_2O$	0.1 g/L	$NiCl_2 \cdot 6H_2O$	0.024 g/L
		$CoCl_2 \cdot 6H_2O$	0.1 g/L	$NaWO_4 \cdot 2H_2O$	0.025 g/L

Table. 1 wastewater composition

Membrane fouling

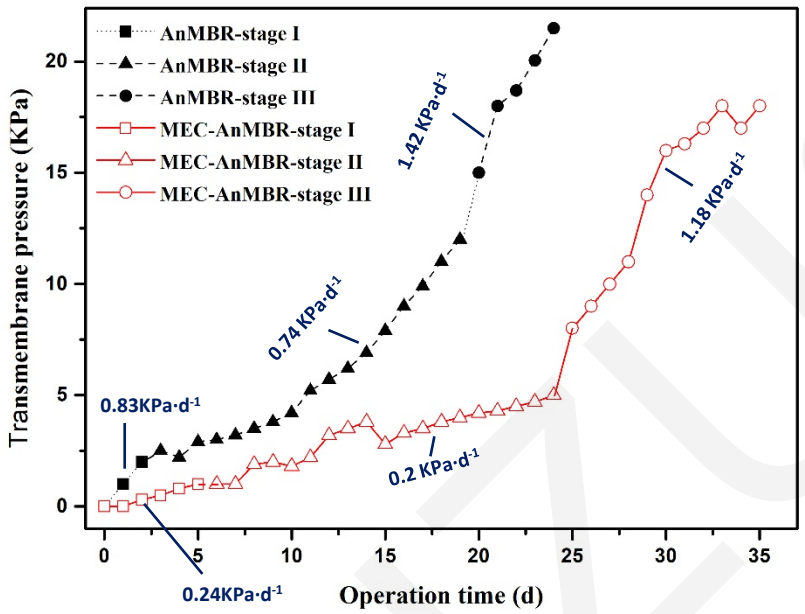


Fig. 2 The TMP development with the membrane operation period in AnMBR and MEC-AnMBR.

Three stages membrane fouling

In the first stage, the initial stage, the growth rates were 0.83KPa·d^{-1} and 0.24KPa·d^{-1}, respectively. In the second stage, the cake formation stage, the growth rates were 0.74 KPa·d^{-1} and 0.2 KPa·d^{-1}, respectively. In the third stage, the cake compaction stage, the growth rates were 1.42 KPa·d^{-1} and 1.18 KPa·d^{-1}, respectively.

Effectively alleviate membrane fouling

The membrane operational period of MEC-AnMBR was about 1.5 times longer than that of AnMBR.

Microbial community analysis

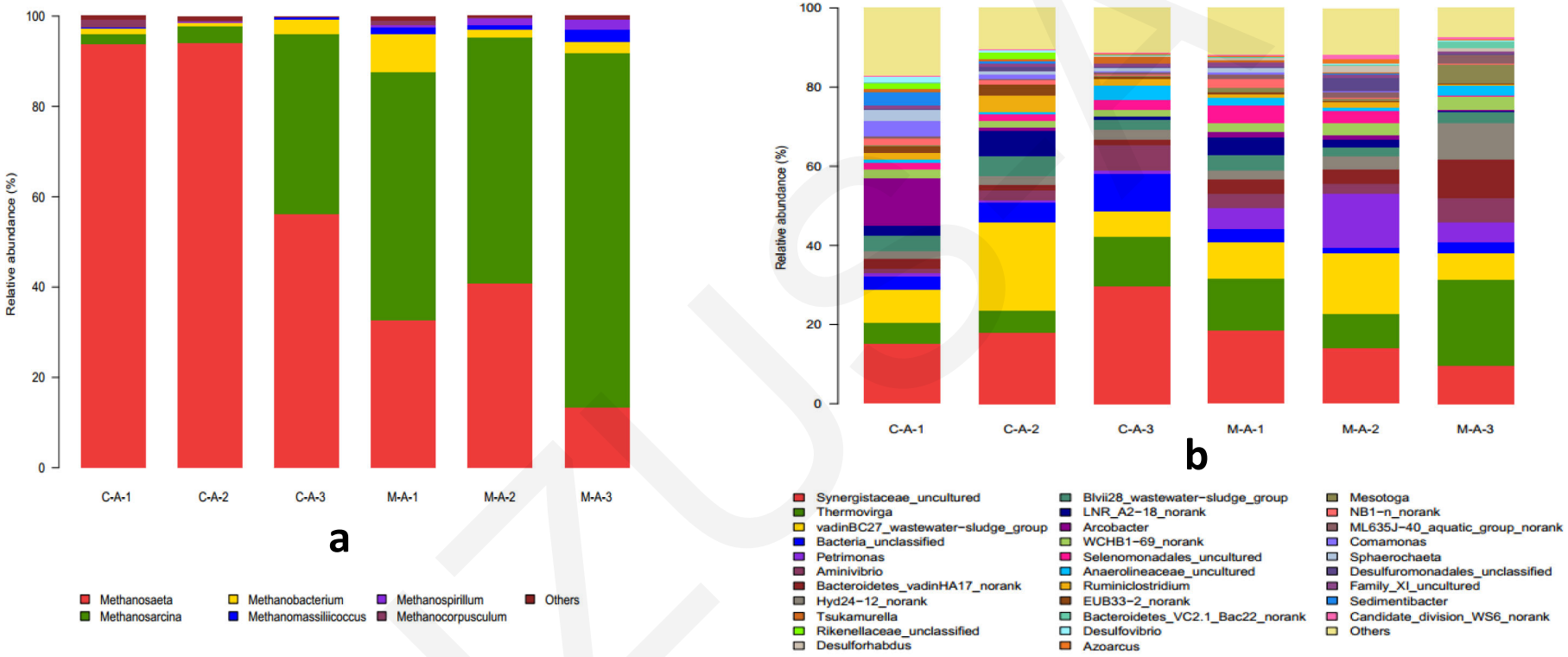


Fig. 3 The relative abundance of archaea and bacteria at the genus level in six samples: (a) archaea; (b) bacteria

High-throughput sequencing analysis showed that *Synergistaceae* and *Thermovirga* were enriched in MEC-AnMBR, and *Thermovirga* was found as the key functional microorganism.

The mitigation mechanism of membrane fouling in MEC-AnMBR

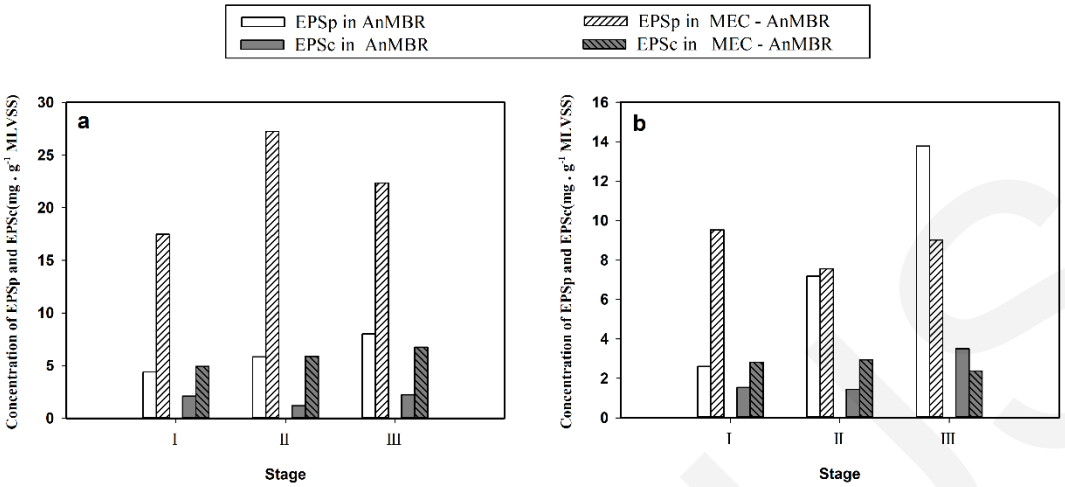
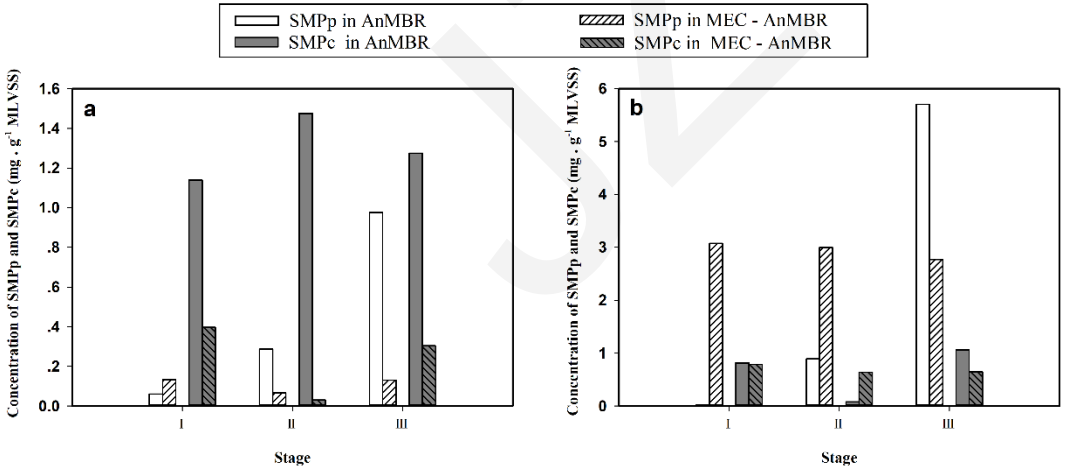


Fig. 4 The concentrations of EPSp and EPSc in the suspended sludge and membrane surface sludge of AnMBR and MEC-AnMBR: (a) the suspended sludge; (b) the membrane surface sludge.



The membrane fouling of MEC-AnMBR was greatly lessened by the slower growth of extracellular polymeric substances (EPSs) and soluble microbial products (SMPs).

Fig. 5 The concentrations of SMPp and SMPc in the suspended sludge and membrane surface sludge of AnMBR and MEC-AnMBR: (a) the suspended sludge; (b) the membrane surface sludge.