Supporting Information

A novel multi-stage microbial desalination cell for simultaneous desalination and enhanced organics and nitrogen removal from domestic wastewater

Kuichang Zuo, Fubin Liu, Shiting Ren, Xiaoyuan Zhang, Peng Liang,* Xia Huang**

State Key Joint Laboratory of Environment Simulation and Pollution Control, School of Environment, Tsinghua University, Beijing, 100084, P.R. China

**Corresponding author, Tel: (+86-10) 62772324; E-mail: xhuang@tsinghua.edu.cn*

**Co-corresponding author, Tel: (+86-10) 62796790; E-mail: liangpeng@tsinghua.edu.cn*

Number of pages: 7

Number of figures: 8

Number of tables: 0

MATERIALS AND METHODS

Analysis and calculations. The concentration of COD, total nitrogen, and NH_4^+-N of wastewater were measure using colorimetric method (5B-3C, Lianhua, China). The MDC voltage (U) across the external resistance (R_{ex}) were automatically measured and recorded every 5 min suing a data acquisition system (DAQ2213, ADLINK, China). Current (I) was determined according to Ohm's law: $I = U/R_{ex}$. Power density (P) and internal resistance (R_{in}) were obtained from polarization curve, and the power density were calculated based on the MDC sectional area. The conductivity of the concentrate and wastewater were automatically measured and recorded every 5 min with a conductivity meter (Inlab 731, Mettler Toldeo, USA). The desalination efficiency (DE) in wastewater and salt recovery efficiency (RE) in salt water were calculated based on corresponding conductivity change as follow:

$$DE = \frac{C_{\text{was,inf}} - C_{\text{was,eff}}}{C_{\text{was,inf}}} \quad (1)$$

$$RE = \frac{C_{\text{con,i}} - C_{\text{con,f}}}{C_{\text{con,i}}} \quad (2)$$

where $C_{\text{was,inf}}$ and $C_{\text{was,eff}}$ (mS/cm) are the conductivity of wastewater influent and effluent (or effluent of each chambers) respectively, $C_{\text{con,i}}$ and $C_{\text{con,f}}$ (mS/cm) are the initial and final conductivities of the concentrate, respectively.

Coulombic efficiency (η) were utilized to evaluate the percentage of coulombs contained in wastewater to produce electricity:

$$\eta = \frac{8\int I\mathrm{d}t}{\mathrm{F}\cdot\Delta\mathrm{COD}\cdot Q\cdot t} \quad (3)$$

where F is Faraday's constant (96485 C/mol), ΔCOD is the COD change (g/L) of wastewater, Q is the flow rate of wastewater, t is operation time.

Current efficiency (CE) was utilized to evaluate the percentage of current being used to remove salt from wastewater (CE_{was}) or to recover salt in concentrate (CE_{con}):

$$CE_{was} = \frac{\mathrm{F}(C_{was,inf} - C_{was,eff}) \cdot Q \cdot t}{\mathrm{M} \cdot \int I dt} \quad (4)$$

$$CE_{con} = \frac{\mathrm{F}(C_{con,f} - C_{con,i}) \cdot V_{con,f}}{\mathrm{M} \cdot \int I dt} \quad (5)$$

where M is the molecular weight of salt, which was regarded to be all existed in the form of NaCl (M: 58.5 g/mol) in this study.

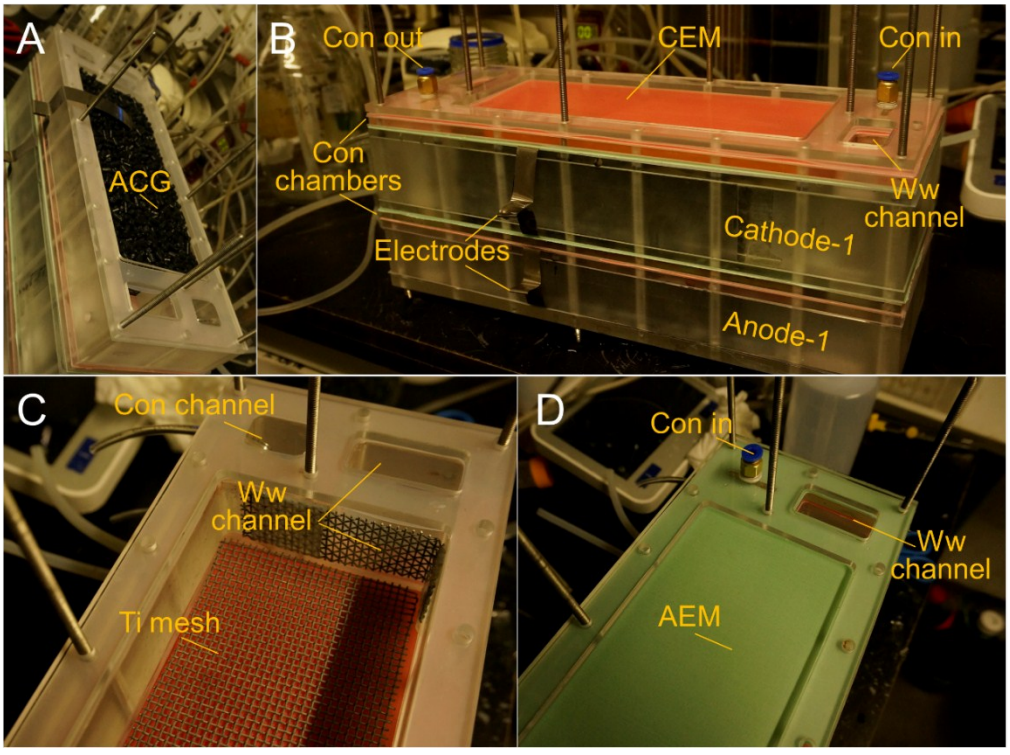

Figure S1 Fabrication of the M-MDC. (A) activated carbon granules in the electrode chambers; (B) over all view of the M-MDC; (C) Titanium meshes in the electrode chambers; (D) AEM in the concentrate chamber. ACG: activated carbon granular;

CEM: cation exchange membrane; AEM: anion exchange membrane; Con: concentrate; Ww: wastewater.

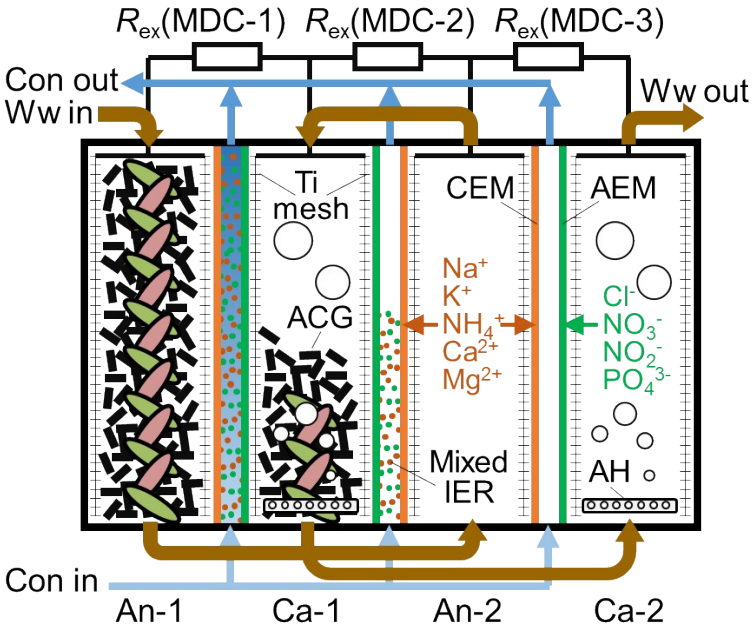

Figure S2 Schematic of the M-MDC operated with AACC mode. Ww: wastewater; Con: concentrate (or cocnetrate chamber); ACG: activated carbon granular; Mixed IER: mixed ion exchange resins; CEM: cation exchange membrane; AEM; anion exchange membrane; AH: areation head; An: anode; Ca: cathode.

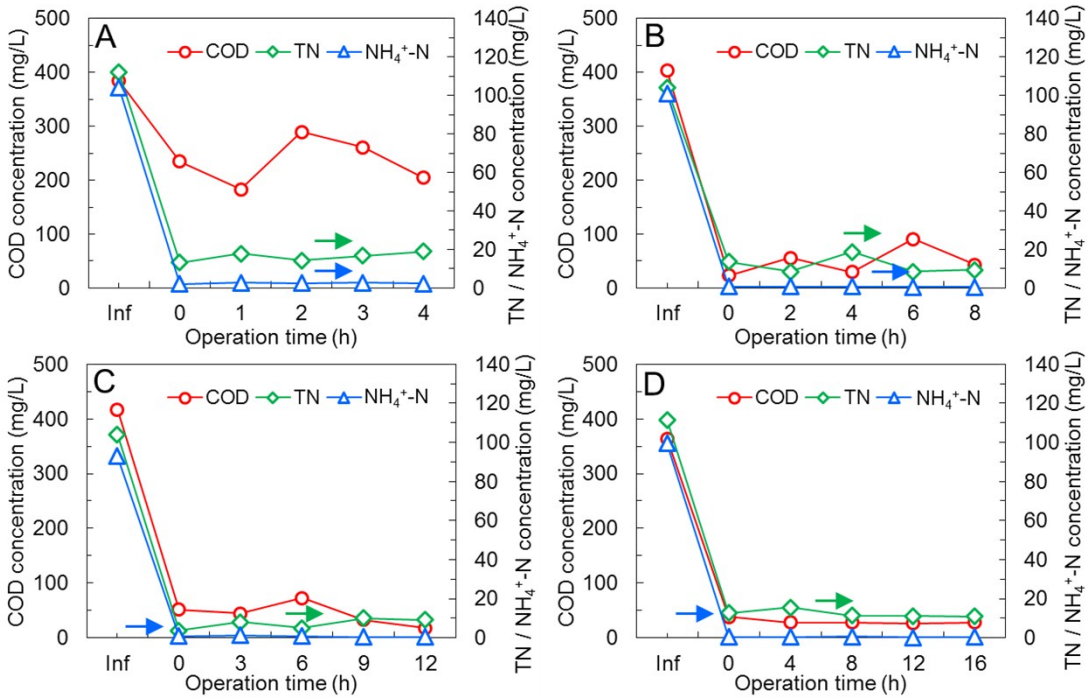

Figure S3 The effluent quality of MDC during one concentrate replacement cycle at each HRT. (A) HRT of 4 h; (B) HRT of 8 h; (C) HRT of 12 h; (D) HRT of 16 h. Inf: influent.

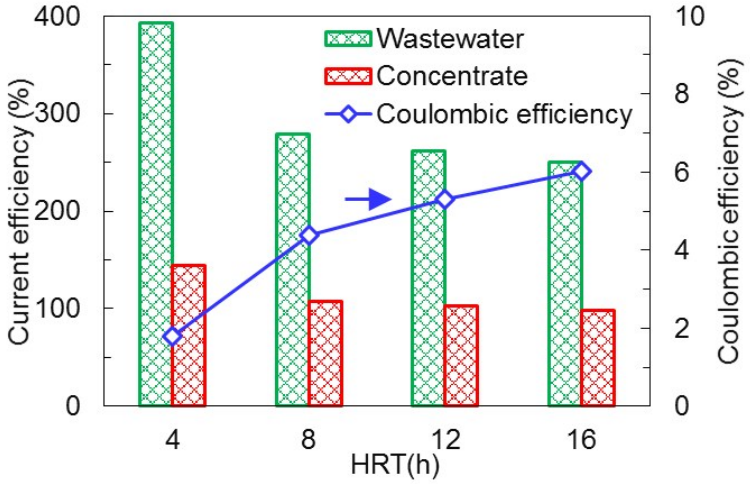

Figure S4 Coulombic efficiency and current efficiency calculated based on the removed salt from wastewater and the recovered salt in concentrate.

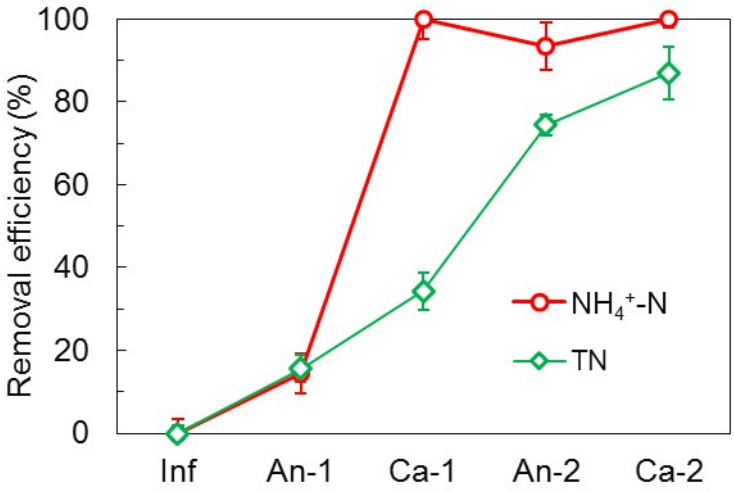

Figure S5 Removal efficiency of TN and NH_4^+-N in each chamber of M-MDC at HRT of 16 h.

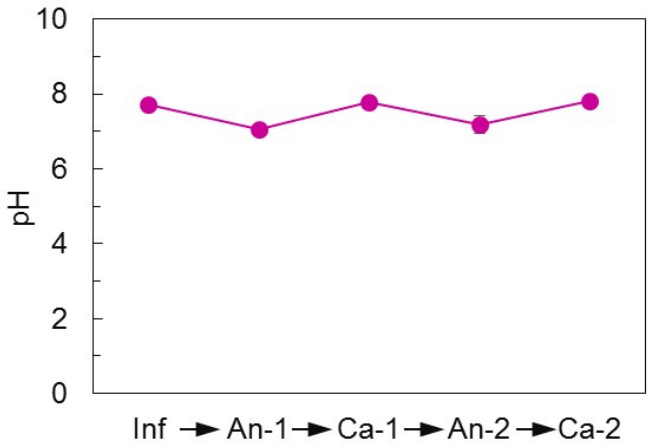

Figure S6 pH of wastewater in each chamber of the M-MDC during operation in ACAC mode.

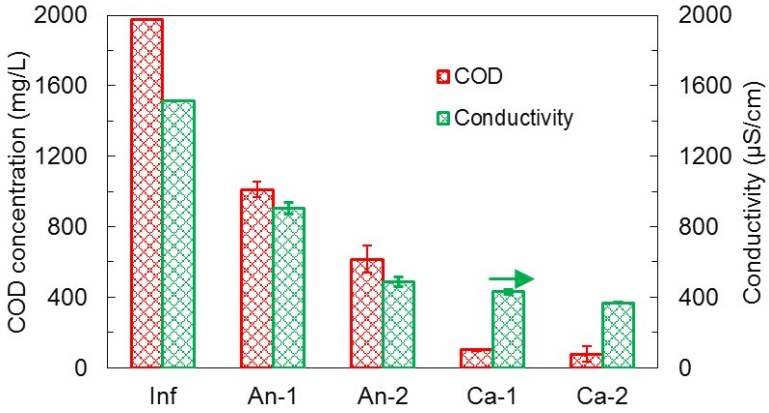

Figure S7 Effluent quality of each chamber in M-MDC when operated in AACC mode. (HRT of 64 h, adding 1.4 g/L glucose).

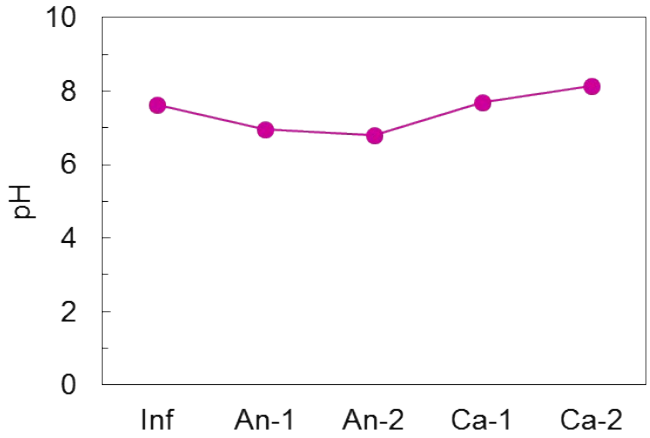

Figure S8 pH of wastewater in each chamber of the M-MDC during operation in AACC mode.