

Supplementary Materials

Achieving stable partial nitrification through synergistic inhibition of free ammonia and salinity on nitrite-oxidizing bacteria

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Text S1 Essential trace element compositions in the synthetic wastewater

In addition to $\text{NH}_4^+\text{-N}$ and alkalinity, essential trace elements were supplied in the three reactors, and the compositions were as follows: 5 mg/L $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, 2 mg/L $\text{Fe}_3(\text{SO}_4)_2$, 0.5 mg/L H_3BO_3 , 0.4 mg/L ZnCl_2 , 0.4 mg/L $(\text{NH}_4)_6\text{Mo}_7\text{O}_{24} \cdot 4\text{H}_2\text{O}$, 0.4 mg/L $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$, 0.5 mg/L $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$, 0.3 mg/L $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$, 0.4 mg/L $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ and 0.4 mg/L $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$. All chemicals used in this study were of analytical reagent, and purchased from Sinopharm Chemical Reagent Co. Ltd., China.

Table S1 Concentration of $\text{NH}_4^+\text{-N}$ and salinity in typical wastewaters

Wastewater source	$\text{NH}_4^+\text{-N}$ (mg/L)	Salinity	Reference
Metal refinery	1000–1400	12–22 g NaCl/L	(Tsuneda et al., 2006)
Petroleum refinery	36 ± 4	2.5–15 g MgCl_2 /L	(Abner Rocha Lebron et al., 2021)
Landfill leachate	300–8100	3.2–7.8 g Cl ⁻ /L, 0.6–4.2 g K ⁺ /L, 1.3–13.0 g Na ⁺ /L, 2.4–230.2 g Ca ²⁺ /L	(Qian et al., 2024)
Landfill leachate	1975	23.9 g NaCl/L	(Yang et al., 2023)
Desulfurization progress	231	4.9 g Cl ⁻ /L, 4.9 g Mg^{2+} /L, 1.0 g Na ⁺ /L, 0.8 g Ca ²⁺ /L	(Cheng et al., 2021)
Desulfurization progress	335 ± 11	12.1 g Cl ⁻ /L, 8.0 g Mg^{2+} /L, 2.0 g Ca ²⁺ /L, 7.9 g Na ⁺ /L	(Li et al., 2021)
Fishery processing	44000	13–17 g NaCl/L	(Zhang et al., 2014)
Coal chemical industry	35–38.5	58.5 g NaCl/L	(Zhao et al., 2022)

Table S2 MLSS and MLVSS of 3 PN-MBRs during operation

Time (d)	MLSS (g/L)			MLVSS (g/L)		
	PN-MBR1	PN-MBR2	PN-MBR3	PN-MBR1	PN-MBR2	PN-MBR3
0		3.75			1.78	
6	2.16	2.30	2.44	1.35	1.48	1.56
14	2.19	1.76	2.50	1.26	0.92	1.30
24	2.20	1.57	2.89	1.31	0.86	1.42
30	2.21	1.94	3.31	1.43	1.01	1.83
38	2.39	2.12	3.64	1.52	1.12	1.89
48	2.69	2.30	4.00	1.71	1.25	2.01
58	2.83	2.44	4.05	1.85	1.56	2.21

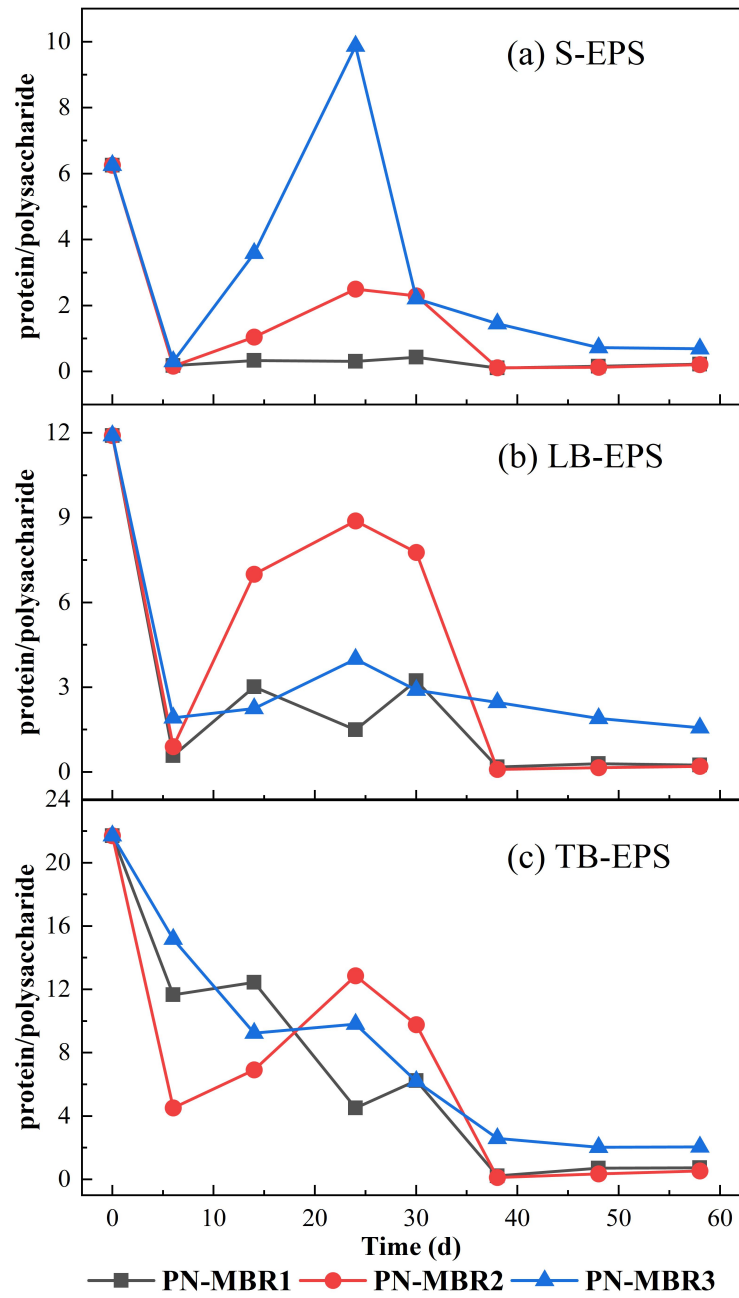


Fig. S1 Protein/polysaccharide ratios of three PN-MBRs. (a) slime extracellular polymeric substance (S-EPS); (b) loosely-bound EPS (LB-EPS); (c) tightly-bound EPS (TB-EPS).

References

- Abner Rocha Lebron Y, Barbosa Moser P, Rezende Moreira V, Rodrigues Dos Anjos Silva G, Soalheiro A, Pimenta De Souza B, Coutinho De Paula E, Cristina Santos Amaral M (2021). Osmotic membrane bioreactor (OMBR) in refinery wastewater treatment: The impact of a draw solute with lower diffusivity in the process performance. *Chemical Engineering Journal*, 406: 127074
- Cheng Q, Wu Y, Huang Y, Li F, Liu Z, Nengzi L, Bao L (2021). An integrated process of calcium hydroxide precipitation and air stripping for pretreatment of flue gas desulfurization wastewater towards zero liquid discharge. *Journal of Cleaner Production*, 314: 128077
- Li B, Yun Y, Liu G, Li C, Li X, Hilal M, Yang W, Wang M (2021). Direct contact membrane distillation with softening pre-treatment for effective reclaiming flue gas desulfurization wastewater. *Separation and Purification Technology*, 277: 119637
- Qian Y, Hu P, Lang-Yona N, Xu M, Guo C, Gu J (2024). Global landfill leachate characteristics: Occurrences and abundances of environmental contaminants and the microbiome. *Journal of Hazardous Materials*, 461: 132446
- Tsuneda S, Ogiwara M, Ejiri Y, Hirata A (2006). High-rate nitrification using aerobic granular sludge. *Water Science and Technology*, 53(3): 147–154
- Yang W, Cheng L, Liang H, Xu A, Li Y, Nabi M, Wang H C, Hu J, Gao D (2023). Efficient nitrogen removal from mature landfill leachate by single-stage partial-nitrification anammox using expanded granular sludge bed. *Journal of Environmental Management*, 344: 118460
- Zhang X N, Ferreira R B, Hu J, Spanjers H, van Lier J B (2014). Improving methane production and phosphorus release in anaerobic digestion of particulate saline sludge from a brackish aquaculture recirculation system. *Bioresource Technology*, 162: 384–388
- Zhao Y, Wang X, Yuan J, Ji Z, Liu J, Wang S T, Guo X, Li F, Wang J, Bi J (2022). An efficient electro dialysis metathesis route to recover concentrated NaOH-NH₄Cl products from simulated ammonia and saline wastewater in coal chemical industry. *Separation and Purification Technology*, 301: 122042