

Supporting Information for

Combining full-scale ozonation and biological activated carbon filtration (O₃-BAC) with pilot-scale nanofiltration (NF) to control disinfection by-product formation for treatment of Taihu lake water

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8 pages, including 4 figures, 5 tables, and supporting references

Table S1. Characteristics of the NF90 membrane used in this study [29,83].

Membrane	NF90-4040
Material	Fully aromatic polyamide active layers
Manufacturer	Dow FilmTec™
Molecular weight cutoff (MWCO)	90–180 Da
Pore radius	0.31–0.38 nm
Membrane area	7.6 m ²
Highest operating temperature	115 °F (45°C)
Highest operating pressure	600 psig (41bar)
Continuous operation pH range (35 °C)	2–11
Allowable free chlorine content	< 0.1 ppm
Salt retention	MgSO ₄ ≥ 97%

Table S2. Water quality of the raw water and effluents of each water treatment unit/process. ^a

Parameters	Raw water	SF effluent	O ₃ -BAC effluent	NF effluent
Turbidity (NTU)	2.23 ± 0.72	0.76 ± 0.70	0.31 ± 0.15	0.07 ± 0.02
pH	8.06 ± 0.11	7.70 ± 0.19	7.64 ± 0.22	6.47 ± 0.21
Cond (µs/cm)	379.24 ± 5.34	382.41 ± 3.94	381.35 ± 4.31	10.06 ± 1.05
TDS (mg/L)	189.81 ± 2.62	191.38 ± 2.01	190.88 ± 2.11	5.11 ± 0.64
TH (mg/L)	111.67 ± 8.27	111.04 ± 3.21	112.20 ± 6.81	0.27 ± 0.41
COD _{Mn} (mg C/L)	2.89 ± 0.18	1.80 ± 0.11	1.66 ± 0.20	0.32 ± 0.10
UV ₂₅₄	0.0466 ± 0.0032	0.0372 ± 0.0025	0.0286 ± 0.0079	0.0004 ± 0.0006
DOC (mg C/L)	3.17 ± 0.42	2.41 ± 0.42	2.28 ± 0.44	0.03 ± 0.05
SUVA ^b (L/mg/m)	1.50 ± 0.27	1.59 ± 0.27	1.28 ± 0.30	0.88 ± 2.52
C1 (F _{max} , R.U.) ^c	0.96 ± 0.09	0.93 ± 0.07	0.50 ± 0.12	0.02 ± 0.02
C2 (F _{max} , R.U.) ^c	0.82 ± 0.06	0.75 ± 0.08	0.42 ± 0.10	0.01 ± 0.01
C3 (F _{max} , R.U.) ^c	0.27 ± 0.01	0.22 ± 0.02	0.12 ± 0.02	ND ^d
C4 (F _{max} , R.U.) ^c	0.65 ± 0.10	0.61 ± 0.11	0.43 ± 0.12	0.15 ± 0.10
Br ⁻ (mg/L)	0.073 ± 0.006	0.065 ± 0.002	0.072 ± 0.005	0.014 ± 0.000
BrO ₃ ⁻ (mg/L)	ND ^d	ND ^d	ND ^d	ND ^d

Note: ^a All the values are all provided as mean ± standard deviation. All the samples were collected regularly during August 2020 – December 2021 ($n = 3$ for anions, $n = 14$ for fluorescence measurements, and $n = 17$ for the rest parameters). ^b $SUVA = UV_{254}/DOC$. ^c Fluorescence measurements were processed with the PARAFAC analysis and signals of the four fluorescent components (i.e., C1, C2, C3, C4) were determined from the EEM spectra. The pilot-scale NF system was operated under the flux of 20L/(m²·h). ^d ND means “not detected”.

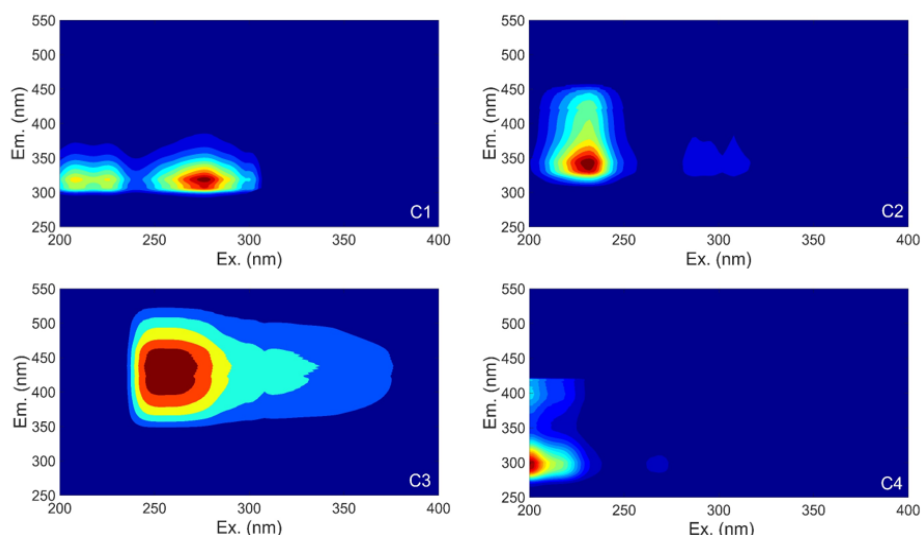


Fig. S1. Contour plots of components identified from the EEM spectra using PARAFAC analysis by pooling all the raw water and effluent samples collected during August 2020 – December 2021 ($n = 269$).

Table S3. Excitation and emission maxima wavelengths and characteristics of the four components identified by PARAFAC analysis.

Component	Ex/Em (nm/nm)	Identification	References
C1	276/318; 208(226)/318	Tyrosine-like	[45–48]
C2	232/342	Tryptophan-like	[49–51]
C3	254/438	Humic-like	[52–54]
C4	200/300	Free tyrosine	[55,56]

Table S4. Typical BSF_{THMs} values of the raw water and effluents of sand filtration (SF), ozonation (O_3), biological activated carbon (BAC) filtration, and nanofiltration (NF). Samples for each type of water were collected in March, 2021, and the values here are reported as average \pm standard deviation obtained from triplicate assays ($n = 3$).

Raw water	SF effluent	O_3 effluent	BAC effluent	NF effluent
0.083 ± 0.001	0.093 ± 0.000	0.094 ± 0.000	0.119 ± 0.001	0.049 ± 0.001

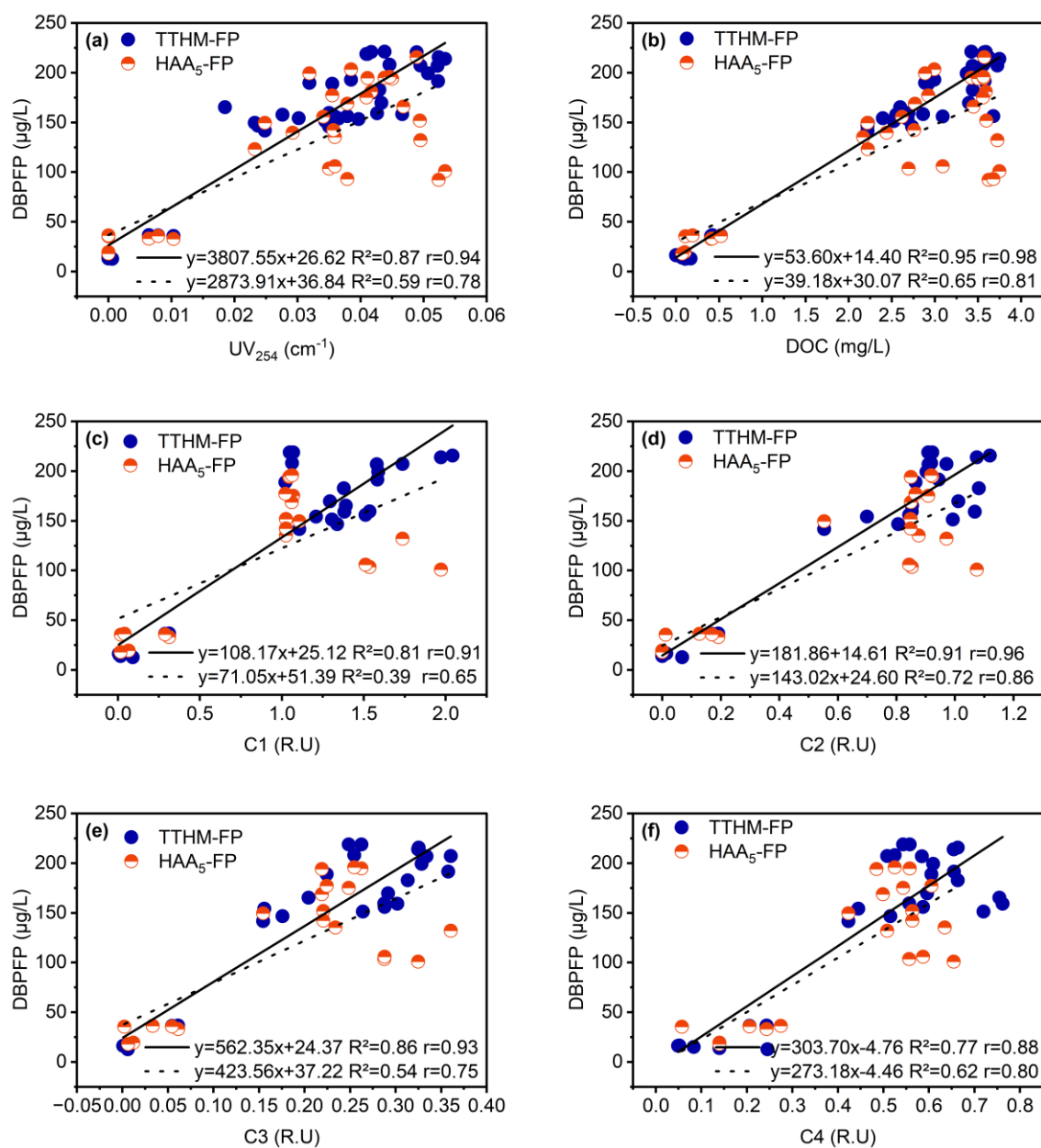


Fig. S2. Plots of total THM formation potential (TTHM-FP) and HAA₅ formation potential (HAA₅-FP) *versus* various NOM parameters, including (a) UV₂₅₄, (b) DOC, (c) EEM C1, (d) EEM C2, (e) EEM C3, and (f) EEM C4. Samples were collected during August 2020 – December 2021.

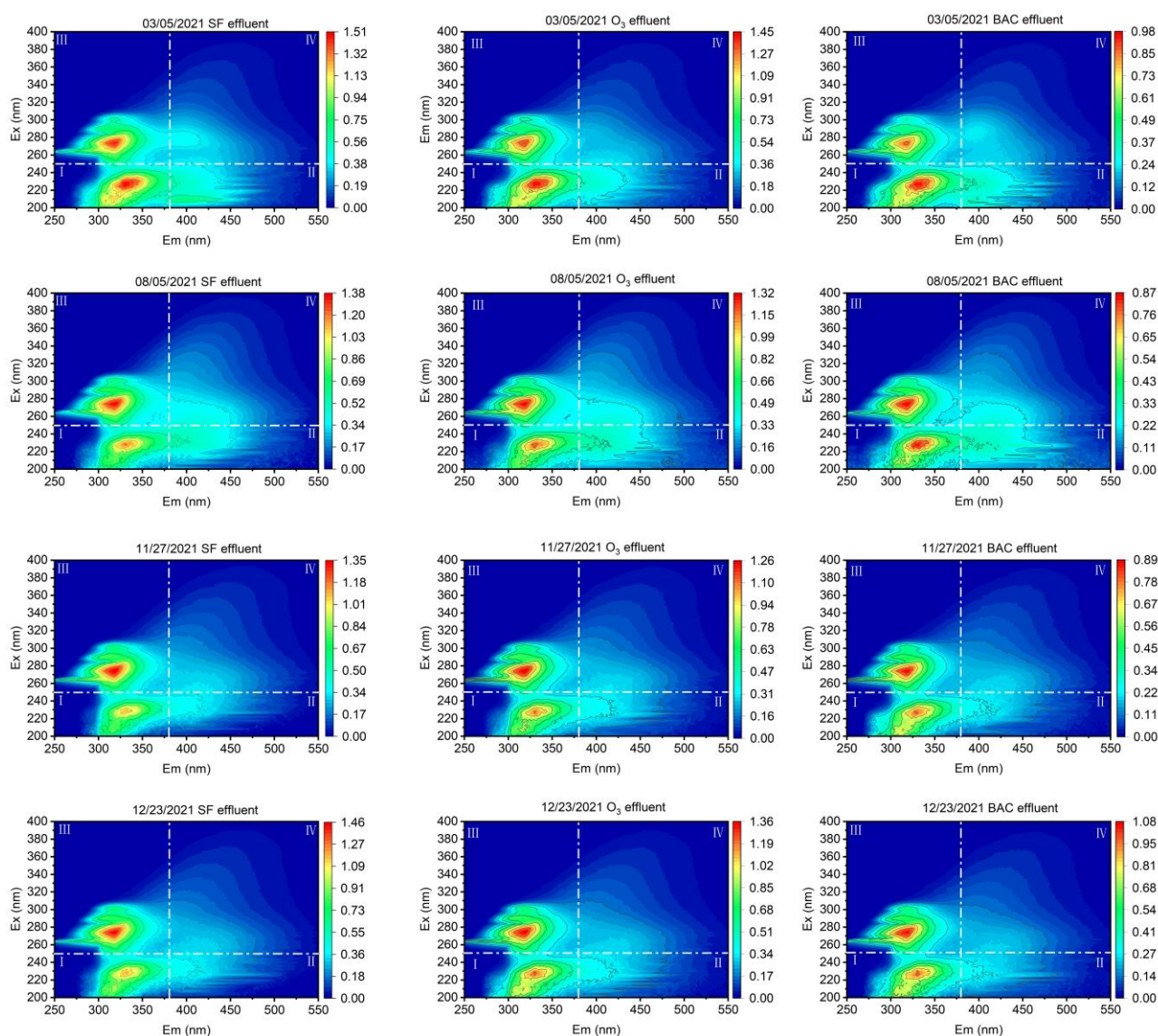


Fig. S3. EEM spectra of effluent samples of (**Left column**) sand filtration (SF), (**Middle column**) ozonation (O_3), and (**Right column**) biological activated carbon filtration (BAC) collected on selected days (Mar 05, Aug 05, Nov 27, and Dec 23, 2021) during the operation.

Table S5. FRI (in units of au.nm²) distribution for effluent samples of sand filtration (SF), ozonation (O₃), and biological activated carbon filtration (BAC) collected on selected days.

Date	Region I			Region II			Region III			Region IV		
Month/ Day/Year	SF Effluent	O ₃ Effluent	BAC Effluent	SF Effluent	O ₃ Effluent	BAC Effluent	SF Effluent	O ₃ Effluent	BAC Effluent	SF Effluent	O ₃ Effluent	BAC Effluent
03/05/2021	31359.85	29854.44	20303.23	15837.70	13190.90	10042.14	10717.17	9875.10	6377.14	6289.78	5557.52	3936.49
08/05/2021	23201.45	23981.39	16838.29	13219.86	15123.23	10288.54	10132.28	9774.38	6389.46	7126.85	6930.86	4553.36
11/27/2021	23252.22	20708.43	16195.88	8729.69	9509.11	6543.70	9774.38	9047.81	6163.70	5780.06	5271.76	3654.72
12/23/2021	22291.37	23512.50	19354.39	9611.48	10541.11	8035.69	10226.22	9653.95	7473.93	5819.54	5433.44	4136.00

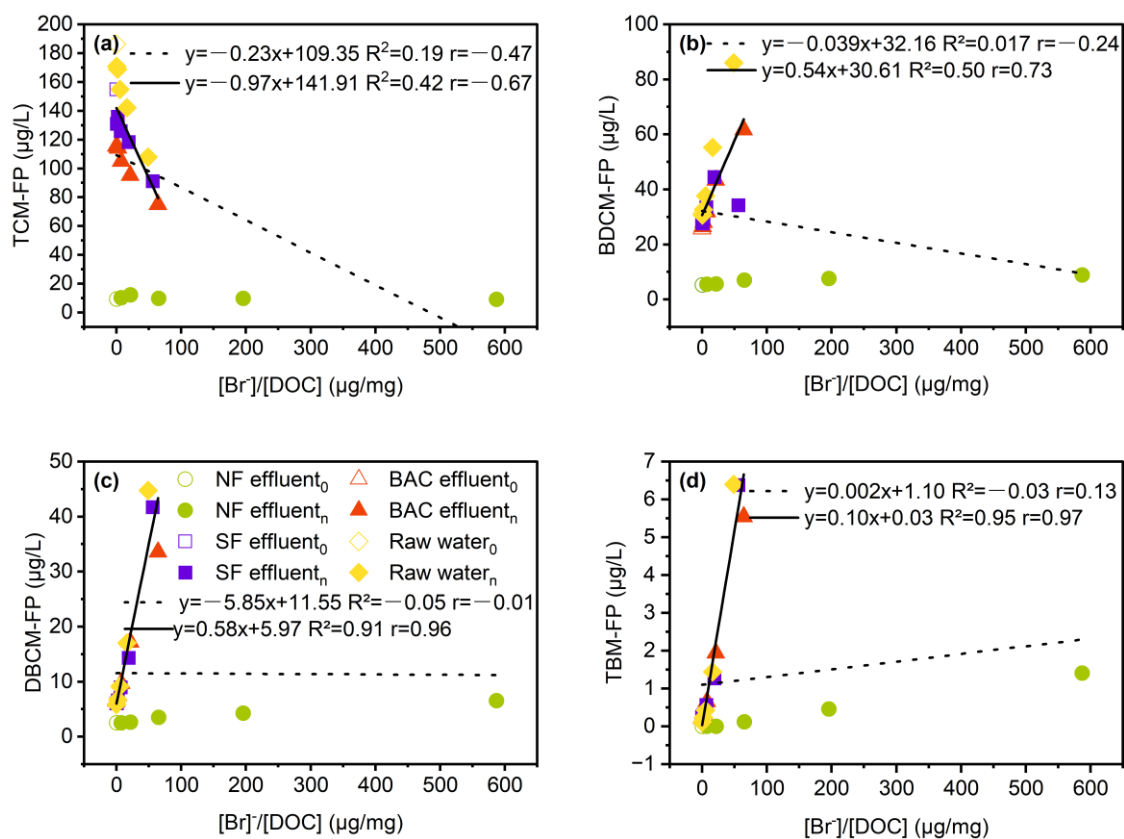


Fig. S4. Plots of (a) TCM-FP, (b) BDCM-FP, (c) DBCM-FP, and (d) TBM-FP *versus* $[Br^-]/[DOC]$ with linear regression lines. NF effluent₀, SF effluent₀, BAC effluent₀, and Raw water₀ represent water samples without spiking additional Br^- , which were collected in November 2021; NF effluent_n, SF effluent_n, BAC effluent_n, and Raw water_n represent the same samples but with spiking additional Br^- (bromide dosage, i.e., $\Delta[Br^-] = 2, 6, 18, 54$, and $162 \mu\text{g/L}$) ($n = 20$ in total). Linear regression analyses were performed by including (solid line) or excluding (dash line) samples of NF effluent₀ and NF effluent_n.

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(Note: references are listed according to their numbering in the main text)

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