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Chemical Enhanced Backwashing for Controlling Organic Fouling in Drinking Water Treatment Using a Novel Hollow-Fiber Polyacrylonitrile Nanofiltration Membrane

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Supplementary Materials

Tables

Table S1. Membrane module characteristics and operating conditions

PAN-NF Membrane	Parameter
Size of module	Inner diameter: 0.8 mm Out diameter: 1.55 mm Length: 1 inch
Configuration	Inside-out hollow fiber
Nominal membrane size	582.0 cm^2
Nominal membrane pore size	0.009 μm
Membrane materials	Polyacrylontitrile (PAN)
Operating pressure	5.0 bar

PAN-NF: polyacrylonitrile-nanofiltration

Table S2. Parameters of raw water samples from a water-treatment plant at Jakarta, Indonesia

Parameters	Concentration
TOC (mg/L)	5.2
DOC (mg/L)	3.3
UV_{254} (cm^{-1})	7.0
Hardness (as $CaCO_3$, mg/L)	46.8
Ca^{2+} (mg/L)	13.7
SO_4^{2-} (mg/L)	17.7
Na^+ (mg/L)	12.8
SS (mg/L)	200

TOC: total organic carbon; DOC: dissolved organic carbon; UV_{254}: Ultraviolet-visible light absorbance at a wavelength of 254 nm; SS: suspended solid

Figures

1. Scanning electron microscopy (SEM) morphologies

The SEM morphologies of the PAN-NF HF membrane before and after modification are presented in Figure S1. The pristine PAN-UF HF membrane (Figure S1a and b) exhibits visible pores. The modified PAN-NF HF membrane (Figure S1c and d) shows the formation of a barrier layer to reduce the pore size of the membrane. The barrier layer reduced the pure water permeability of the PAN-NF HF membrane compared to the pristine HF membrane, thus contributing to better filtration efficiency.

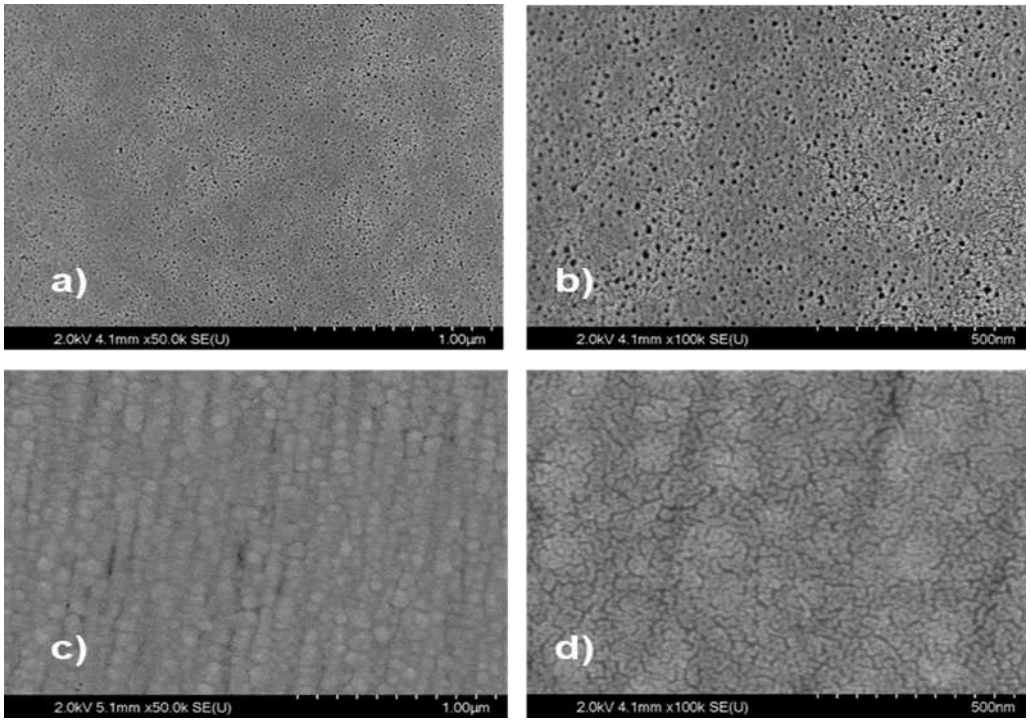

Figure S1. SEM images showing the inner surface morphology of (a) pristine PAN-UF HF membrane at a magnification of 1.0 μm, (b) pristine PAN-UF HF membrane at a magnification of 500 nm, (c) novel PAN-NF HF membrane at a magnification of 1.0 μm, and (d) novel PAN-NF HF membrane at a magnification of 500 nm.

2. Zeta potential of PAN-NF HF membrane

The charge of the PAN-NF HF membranes was determined in terms of the zeta potential. Figure S2 shows the variations in the zeta potentials of the pristine PAN-UF HF membrane and modified PAN-NF HF membrane. At all pH, the virgin PAN-NF HF membrane exhibits a stronger negative charge than the pristine PAN-UF HF membrane. As the pH increased from 3 to 10, the zeta potential of the PAN-NF HF membrane increased from −5 to −32.8 mV, while that of the pristine PAN-UF HF membrane increased from 2 to −20.68 mV.

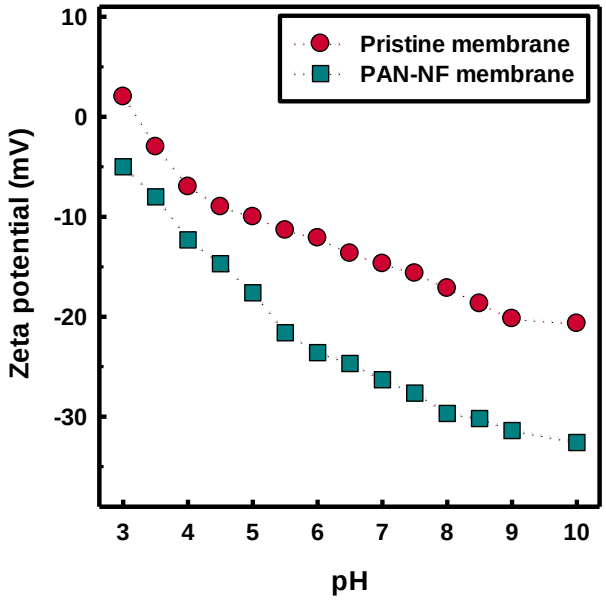

Figure S2. Variation in the zeta potential between the pristine and modified PAN-NF HF membrane.

3. Contact angle measurements

Figure S3 shows that the modified PAN-NF HF membrane exhibits slightly higher hydrophilicity than the pristine HF membrane. The water contact angle of the modified PAN-NF HF membrane is 48.3°, while that of the pristine membrane is 58.5°. Previous studies reported that a low water contact angle of the membrane surface indicates high hydrophilicity. The hydrophilic nature of the membrane surface results in strong fouling resistance, leading to reduced membrane fouling.

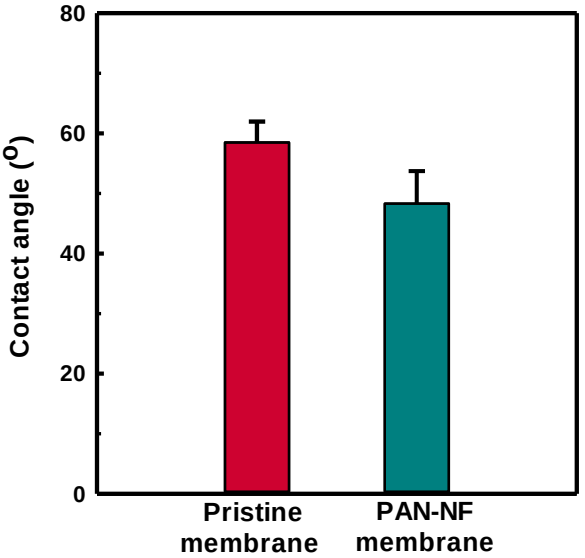

Figure S3. Water contact angles of the pristine and modified PAN-NF HF membranes.

4. Application of CEB in the PAN-NF HF membrane

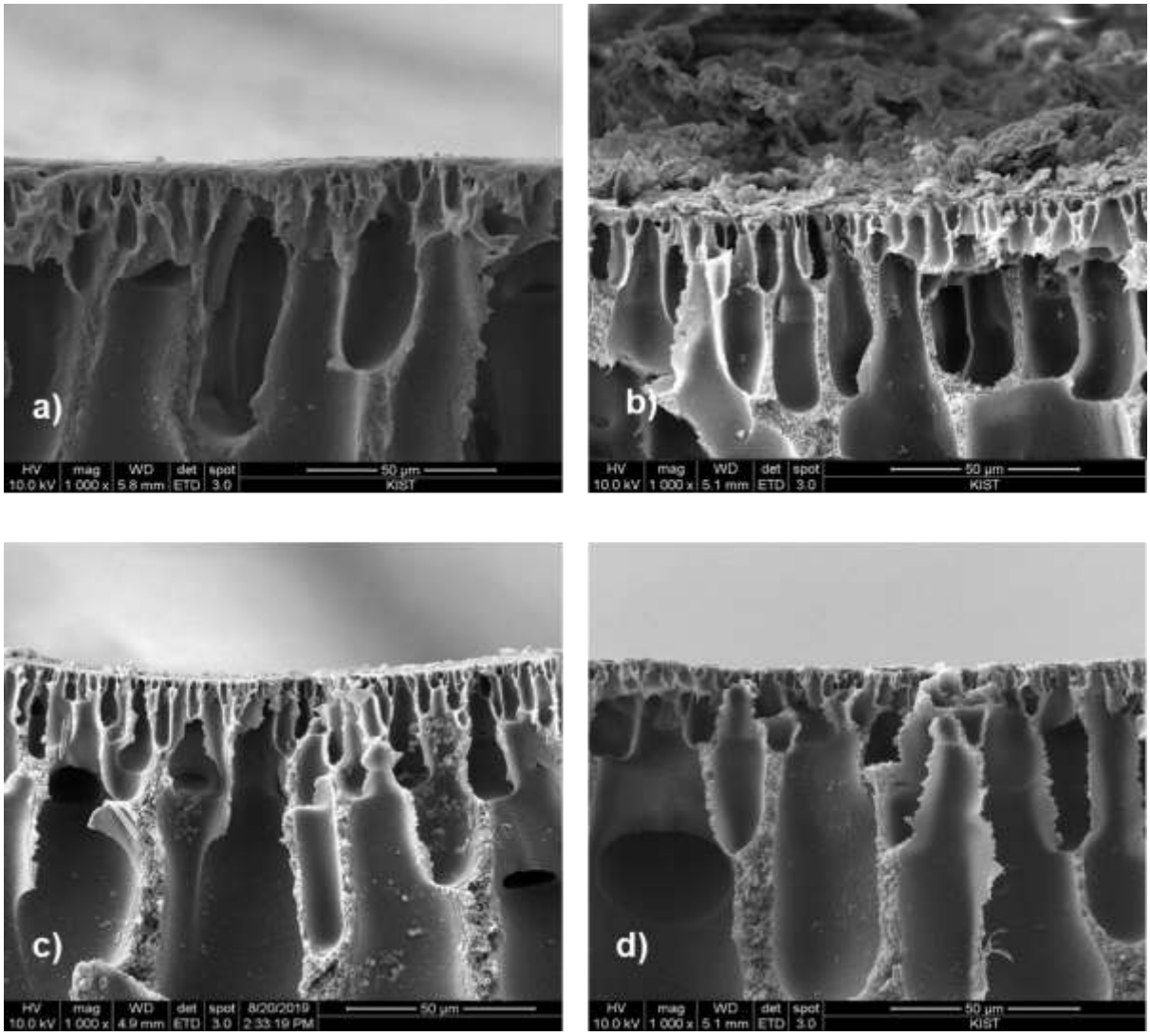

Figure S4. SEM images of the inner surfaces of the (a) virgin PAN-NF HF membrane, (b) PAN-NF HF membrane fouled by raw water from the water-treatment plant in Indonesia, (c) PAN-NF HF membrane after backwashing with 1 mg/L NaClO, and (d) PAN-NF HF membrane after backwashing with 10 mg/L NaClO.