Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Information

Study on Fouling Mechanism and Cleaning Method in the Treatment of Polymer Flooding Produced Water with Ion Exchange Membrane

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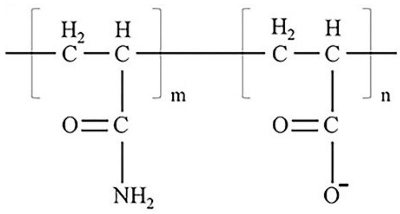
1. Properties of HPAM

Table S1 Properties of HPAM used in this study

Parameters	HPAM
Molecular weight	500000Da
Chemical structure	
Purity	≥99%
Hydrolysis degree	35%

2. Measurement of zeta potentials

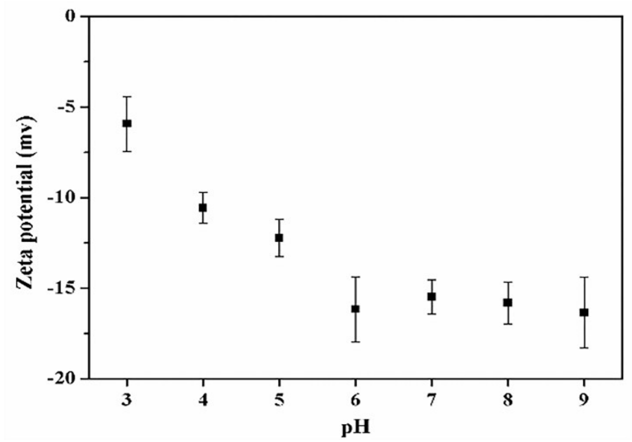


Fig. S1. Zeta potentials of HPAM under different pH values (in NaCl solution).

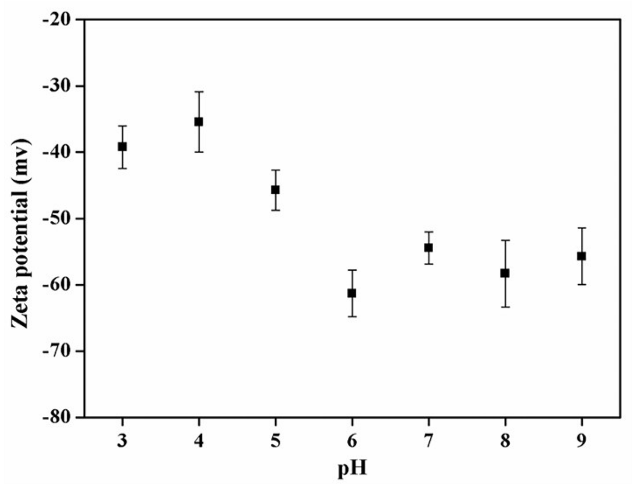


Fig. S2. Zeta potentials of oil emulsion under different pH values (in NaCl solution).

Zeta potentials of virgin and fouled AEMs were measured and the results were shown in table S2. The AEM was positively charged owing to the quaternary ammonium groups. The membranes turned to be negative after fouling and oil-HPAM-inorganic fouled membrane owned the strongest electronegativity, which could be explained by the negative foulants of HPAM and oil emulsion on the membrane.

Table S2 Zeta potentials of membrane surface (pH=9)

AEM	Virgin	HPAM fouled	HPAM-inorganic fouled	Oil-HPAM-inorganic fouled
Zeta potential (mV)	6.46±0.24	−1.65±0.09	−2.01±0.10	−18.75±1.56

3. Adsorption experiment

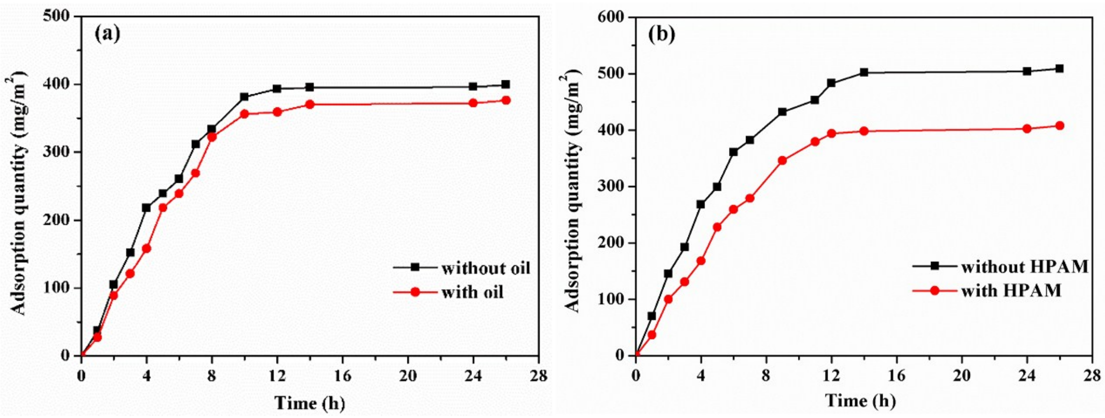


Fig. S3. Adsorption of the foulants: (a) HPAM; (b) oil emulsion in different solutions.

4. Scanning electron microscopy

As AEMs were fouled more seriously according to the results of membrane resistance, morphologies of AEMs before and after fouling in different feed solutions were analyzed by the scanning electron microscopy. SEM images of HPAM, HPAM-inorganic, oil-HPAM-inorganic fouled AEMs indicated that the membrane fouling aggravated with the increase of the complexity of the feed solutions, which was in accordance with the results of membrane resistance and desalination performance .We could clearly observed that all AEMs were fouled compared with the virgin membrane and the membrane suffered the most serious fouling after ED experiment in oil-HPAM-inorganic solution, which was in accordance with the results of charge measurements (see Fig. S3). Chemical cleaning experiments were conducted to recover the membrane performance. Base cleaning, acid-base cleaning, and acid-base-SDBS cleaning were found to be the most effective cleaning methods for HPAM, HPAM-inorganic, and oil-HPAM-inorganic fouling, respectively. SEM images in Fig. S5 showed the cleaning effects by comparing the fouled membranes before and after cleaning.

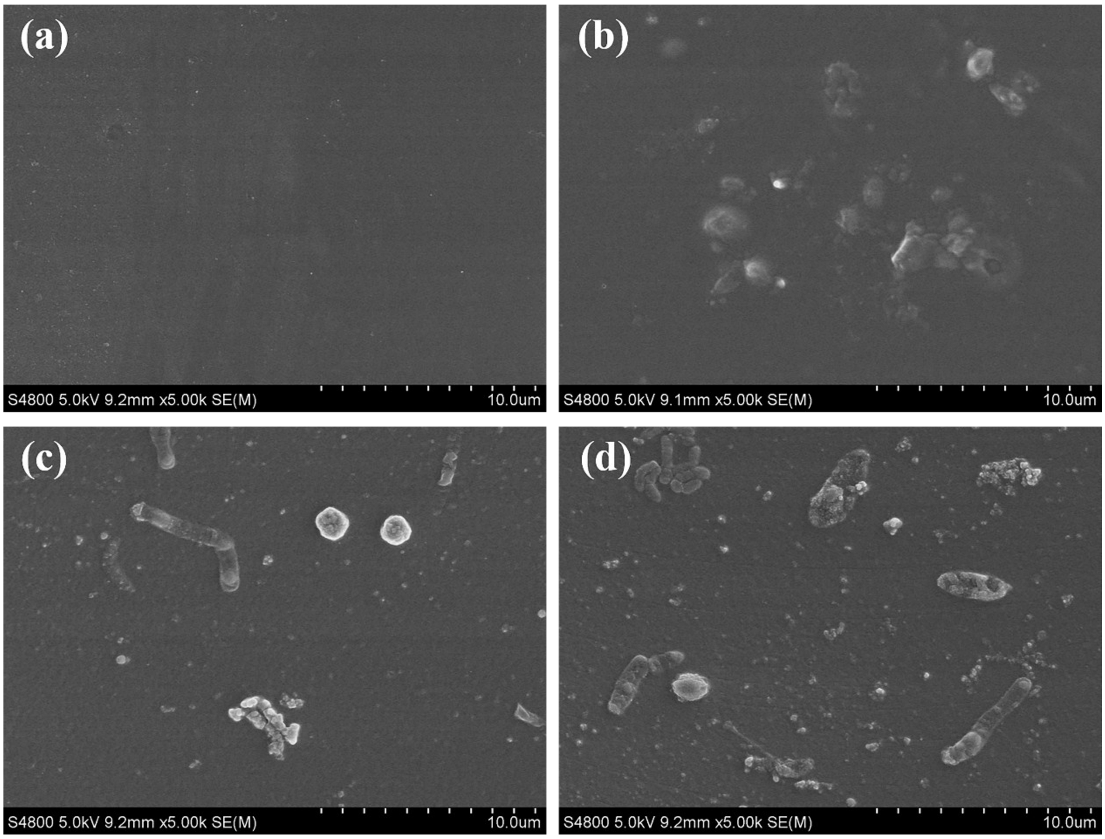


Fig. S4. SEM images of AEMs (a) without fouling; (b) fouled by HPAM; (c) fouled by HPAM-inorganic; (d) fouled by oil-HPAM-inorganic.

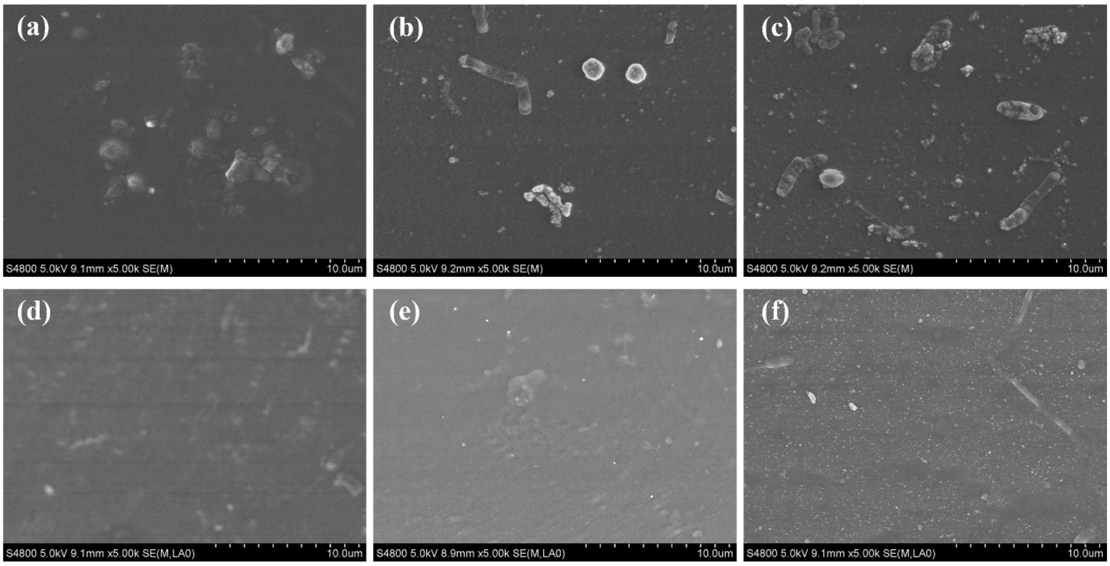


Fig. S5. SEM images of (a) AEM fouled by HPAM; (b) AEM fouled by HPAM-inorganic; (c) AEM fouled by oil-HPAM-inorganic; (d) HPAM-fouled AEM after base cleaning; (e) HPAM-inorganic-fouled AEM after acid-base cleaning; (f) oil-HPAM-inorganic-fouled AEM after acid-base-SDBS cleaning.