Supporting information

Organic fouling of membrane distillation for shale gas flowback water desalination: an especial interest in the feed properties by pretreatment

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S1. The operational parameters on the MD flux

Temperature

The water flux linearly increase with the increase of feed water temperature. When the feed water increase from 50 to 95℃, the water flux almost increased from 6.13×10^{-7} to 3.77×10^{-6} m/s with the feed velocity increased from 0.4 (corresponding to Reynolds number of 33.68) and the cold water velocity of 12.90 cm/s (corresponding to the Reynolds number of 21.67) (Fig. S1). The flux was proportional to the vapor pressure across the membrane. According to Antoine equation, the vapor pressure of pure water (P_0) at the liquid–vapor interface exponentially increased with temperature [1, 2]. Therefore, the vapor pressure difference across the membrane increased and the driving force increased as feed temperature increased. Moreover, viscosity of feed water decrease with the increase of temperature, and thus decrease the mass transfer boundary layer thickness and increase water flux.

Velocity

The feed and permeate water temperature was respectively maintained at 5 and 95 ◦C with the cold water velocity of 12.90 cm/s (corresponding to the Reynolds number of 21.67). Under these conditions, water flux linearly increased from 3.56×10^{-6} to 5.90×10^{-6} m/s with the feed velocity increased from 0.4 (corresponding to Reynolds number of 33.68) to 1.45 cm/s (corresponding to Reynolds number of 121.85) (Fig. S2). With feed velocity further increase of to 2.24 cm/s (corresponding to Reynolds number of 188.13), the water flux only slightly increased to 6.07×10^{-6} m/s. Previous studies [3, 4] also indicated that permeate flux increased as feed velocity increased and reach an asymptotic value when feed velocity increased. The optimal cross-flow velocity was 1.5 cm/s for feed water and 12.90 cm/s for cold water.

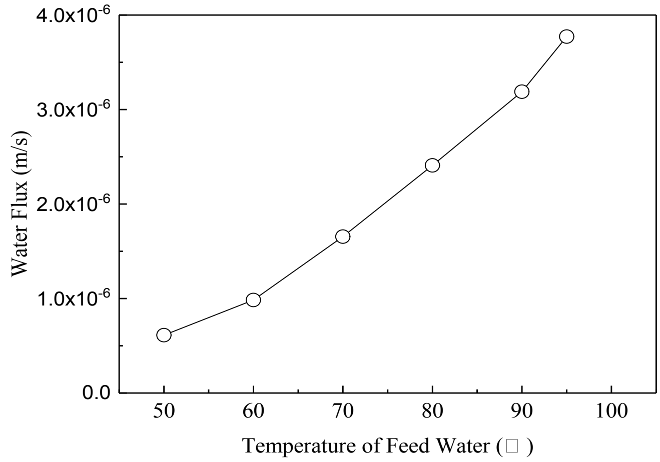


Fig.S. 1. Water flux change with the variation of feed water temperature.

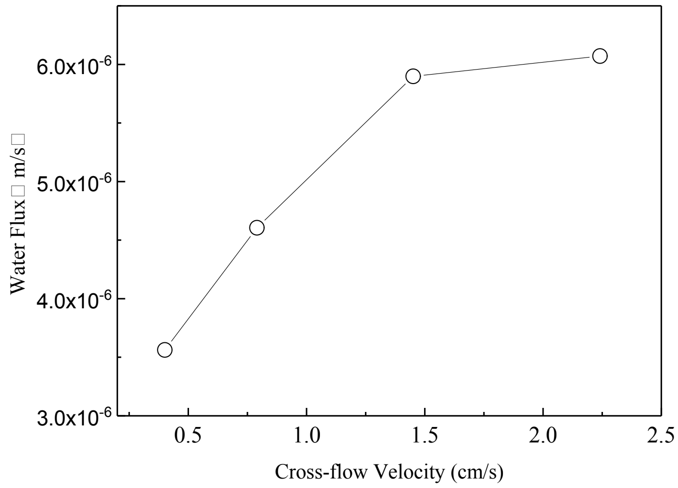


Fig.S. 2. Water flux change with the variation of cross-flow velocity of the feed water

S2. The concentration factor for MD under different scenarios.

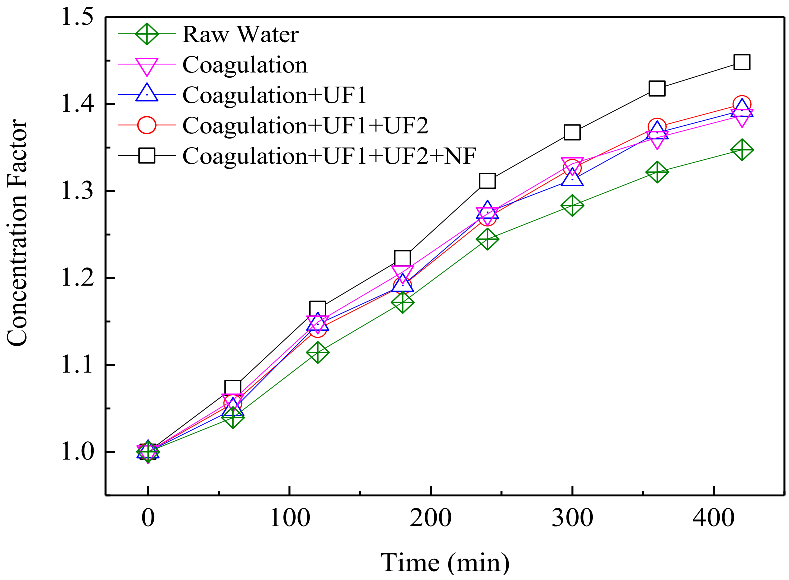
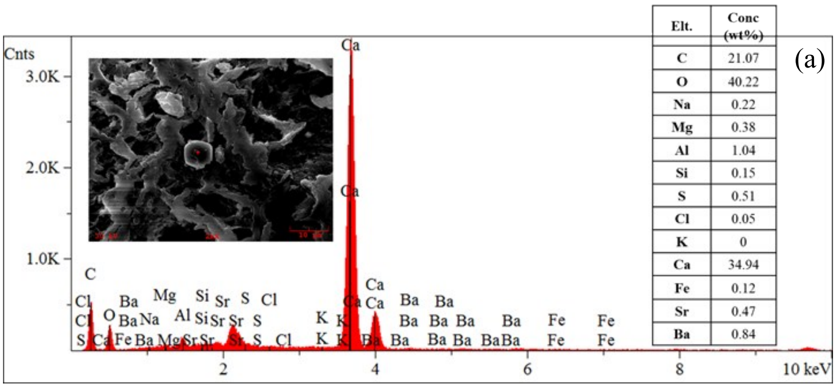
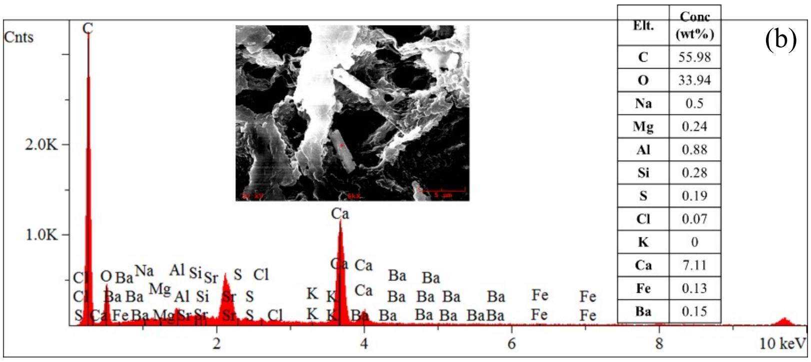
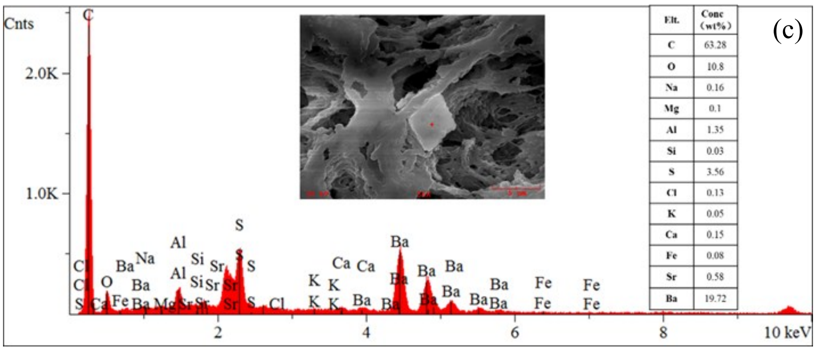


Fig.S. 3. Concentration factors of MD process with different pretreatment as the feed water.

S3. The elemental composition of crystallization on the membrane surface







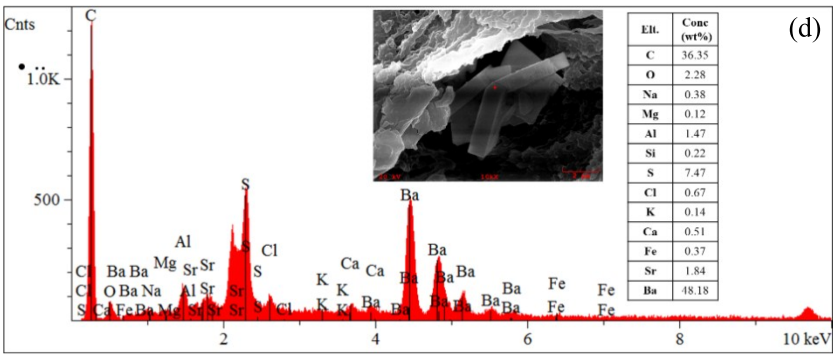


Fig.S. 4. The elements composition of the crystallization in the membrane surface (a) Raw water (b) Pretreated by coagulation (c) Pretreated by coagulation+UF1 (d) Pretreated by coagulation+UF1+UF2.

References

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