Membrane distillation of high-strength saline dye solution: effects of salting-out, solution chemistry, and oxidation

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Abstract:

Membrane distillation (MD) can treat high strength solutions, achieving zero-liquid discharge, but saline organic solutions exhibit a salting-out effect [1] causing detrimental fouling and subsequent wetting. We previously showed a relationship between salting-out and MD performance, where a wetting threshold existed based on the parameter of 'methylene blue (MB) aggregate' [2]. To extend this threshold, integration of an oxidation operation with MD has a potential to mitigate fouling and wetting in MD of organics. Nevertheless, the dosage of oxidant should be carefully chosen based on industrial settings. Therefore, this work aims to explore how the addition of a small amount of an oxidant (e.g., oxone) would influence the fouling and wetting behaviour in the integrated MD system when treating concentrated saline organic solutions, where the solution chemistry and the salting-out theory will be studied to potentially extend the performance threshold.

Here, a commercial flat-sheet PVDF membrane was utilised in MD with simulated feeds containing a fixed amount of MB (3750 ppm), at respective salinities of 85 and 100 g/L NaCl. Three scenarios for each salinity have been studied, two of which contained 500 ppm oxone (with and without pH adjustment) and the third scenario involved pH adjustment without any oxone. The results further confirmed an MB aggregate mass threshold for wetting in all scenarios. There was no significant effect of oxone and solution pH on the flux decline and wetting behaviour in most cases. However, in case of lower salinity, the presence of oxone could significantly delay the wetting threshold. While the results showed that the use of partial oxidation could assist with extending the volume reduction of high strength saline dye solution, further work is required to establish the beneficial mechanism and the means to extend the application to wider process and solution conditions.

Keywords: Membrane Distillation, Salting-Out, Fouling and wetting, Oxidation, Solubility

References:

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