Reduced Graphene Oxide Membranes for Dye Desalination

Celebration of Academic Excellence Poster

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Introduction

Membrane separation is energy-efficient and easy to operate. Dye desalination using membranes is of great interest in textile industry. In this study, reduced grapheme oxide (rGO) membranes are used to separate dye/salt mixtures. The rGO membranes have nanochannels with a size lying between those of the salt ions and the dye molecules. The rejection values of the membranes are examined under different operating conditions.

Methods and Meterials

A thin film composite (TFC) membrane of an rGO selective layer and a polymeric support layer is constructed. A dead-end cell filtration experiment is conducted to collect data for rejection analysis.

Constructing rGO membrane

- Pre-treat a commercial polymeric membrane.
- Prepare an rGO dispersion.
- Filtrate the dispersion through the polymeric membrane via vacuum assistance.

Dead-end Cell Nanofiltration Test

- Fix the rGO membrane at the bottom of the cell.
- Load the solution into the cell.
- Apply pressure to facilitate the filtration and collect the permeate.
- Apply different methods to determine the components of interest in the permeate and the retentate.

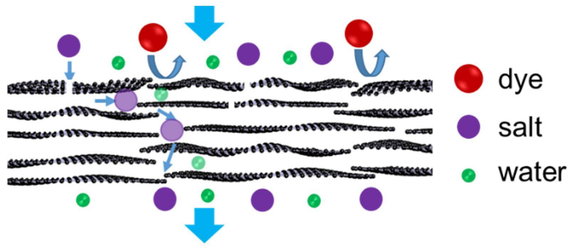

Figure 1. Filtration experiment schematic

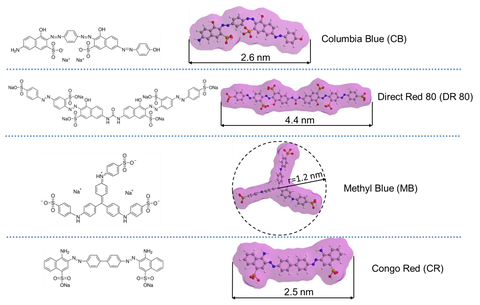

Figure 2. The chemical structure and molecular model of dye molecules

Rejection Calculation:

$$\text{Rejection} = 1 - \frac{\text{Indicator Value} * \text{Dilute Multiple of Permeate}}{\text{Indicator Value} * \text{Dilute Multiple of Retentate}}$$

The measurable indicator value is proportional to the concentration of the component of interest and is respectively:

- Electrical conductivity, for salt ions.
- Ultraviolet and visible light absorption, for dye molecules.

Results and Discussion

Figure 3 shows the light absorption spectrum curves of the permeates and the retentates of different dyes and the calculated rejection.

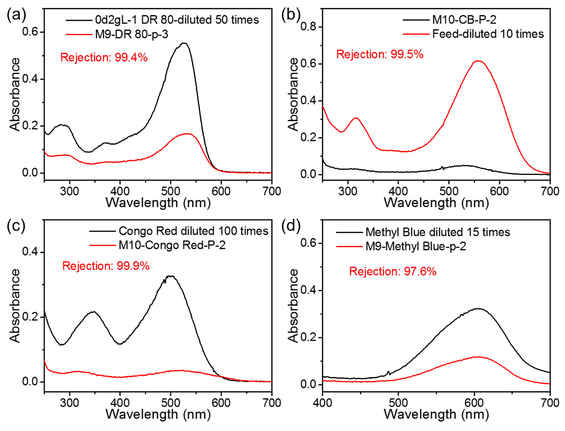

Figure 3. UV-Vis absorption spectra of DR 80 (a), CB (b), CR (c), and MB (d) before (black) and after (red) filtration through the S-rGO film

Figure 4(a) shows very high water flux through S-rGO film.
Figure 3(c) exhibits nearly 100% rejection of S-rGO for dye molecules and a negligibly decreasing trend of water permeance with the increase of dye concentration.
Figure 4(d) tells that the rejection of Na_2SO_4 is not only low but also has an apparent decreasing trend.
Figure 5(d) illustrates that the water flux is fully recovered after filtration of dye solutions.

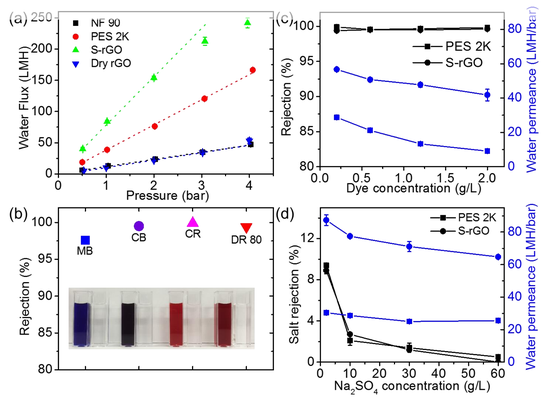

Figure 4. (a) Water fluxes at various pressures. (b) Rejection of rGO membrane for different dyes. (c) Rejection and water permeance at different DR80 concentrations. (d) Rejection and water permeance at different Na_2SO_4 concentrations.

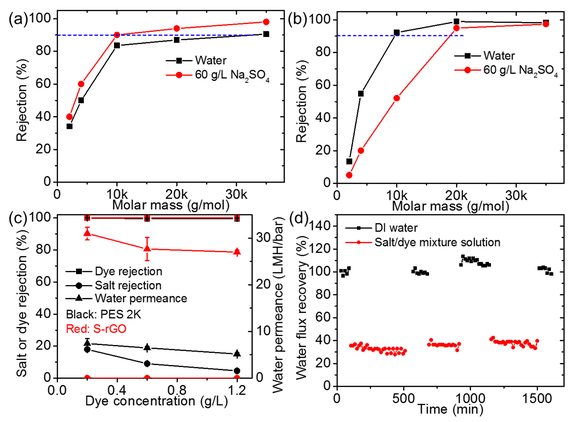

Figure 5. The rejection curve of PEG molecules with different molecular weights in water and 60 g/L Na_2SO_4 through S-rGO (a) and PES 2k (b). Rejection of rGO membrane for different dyes. (c) Separation of DR 80 and Na_2SO_4 using S-rGO composite film and PES 2k. (d) Water flux data during long-term use of the membrane.

Conclusion

The rGO membrane shows promising properties and great potential for dye desalination process, for the following various reasons:

- **High rejection for dye molecules and low rejection for salt ions:** these show its exceptional promise for dye/salt separation application.
- **Rejection for salt ions decreases with the increase of salt concentration:** the separation outcome becomes even better at high salt concentration, implying the good potential of rGO membranes for industrial application
- **Good pure water permeance:** this property indicates that the membrane can potentially process the dye/salt wastewater at a fast rate with good energy efficiency.
- **Good anti-fouling property:** this membrane allows very little dye-fouling to happen, which helps keep the flux at a high level after repeated use.

Acknowledgement

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References

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Any questions regarding this poster are welcomed!

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