Fabrication and Kinetic Evaluation of Dye Adsorption capability of Metal@rGO nanocomposites based CTA Membranes

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Abstract

Reduced Graphene oxide (rGO) and its derivatives exhibit remarkable removal abilities of water pollutants. The pollutant removal ability of the rGO materials can be enhanced by the incorporation of the metallic nanoparticles. However, the challenging collection of GO sheets and fabrication method of rGO-based materials during the adsorption process, constraint their practical uses. The restriction of the rGO-based materials on the polymeric matrix offers a solution to this problem. Therefore, three types of metal nanocomposites @rGO based CTA membranes with particular adsorption abilities and desalination capabilities were prepared by a facile blending and phase inversion technique. The metal@rGO/CTA membranes exhibited selective adsorption for azo dyes at room temperature. The adsorption parameters depicted the Langmuir and pseudo-first order kinetic order reaction. It was found that the adsorption process was directed by the inter-particle diffusion. The thermodynamic studies indicated that the adsorption reactions were spontaneous and exothermic processes. The membranes were also employed in the crossflow filtration experiment and considerable salt rejection was observed at the ordinary temperatures. These membranes were found to be effective against varying range of the pollutants and can be fabricated by the facile techniques.

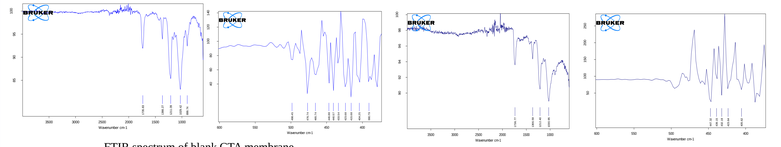
Introduction

Wastewater is the water with changed physical, chemical or biological characteristics because of some pollutants which make it dangerous for the living organisms and unsafe for various purposes (Amoatey & Bani, 2011; Sonune & Ghate, 2004). As world is running short of freshwater, it is need of the time to recycle wastewater and reduce stress on freshwater (Abdessemed, Nezzal, & Ben Aim, 2000). Through wastewater treatment most of the contaminants can be removed to make water reusable (Tchobanoglous, Burton, Metcalf, & Eddy, 1991). Several conventional methods have been used for recycling of wastewater (Crini & Lichtfouse, 2019) but these conventional methods have certain limitations. Membrane technology is the best alternative of the conventional methods (Madhura, Kanchi, Sabela, Singh, & Bisetty, 2018).

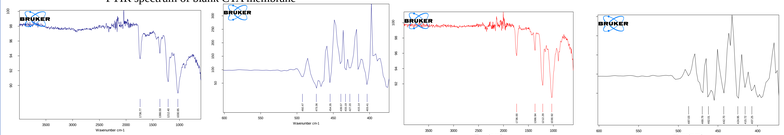
Materials and Methods

Results and Discussion

FTIR Analysis



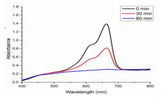
FTIR spectrum of blank CTA membrane



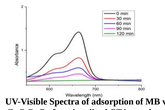
FTIR spectrum of $Sm_3Fe_5O_{12}$@rGO incorporated CTA membranes

FTIR spectrum of Fe_2O_3@rGO incorporated CTA membrane

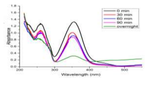
Adsorption Capacities of Membranes



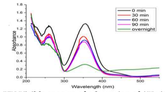
UV-Visible spectra of adsorption of MB via ZnO@rGo nanocomposites



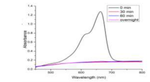
UV-Visible Spectra of adsorption of MB via ZnO@rGo functionalized CTA membrane



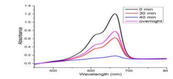
UV-Visible spectra of adsorption of AY via ZnO@rGo nanocomposites.



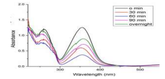
UV-Visible spectra of adsorption of AY via CTA membrane functionalized with ZnO@rGo nanocomposites



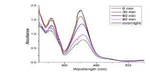
UV-Visible spectra of adsorption of MB via Samarium Ferrate@rGo nanocomposites



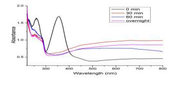
UV-Visible spectra of adsorption of MB via Samarium Ferrate@rGo functionalized CTA membrane



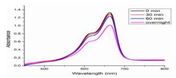
UV-Visible spectra of adsorption of AY via Samarium Ferrate @rGo nanocomposites.



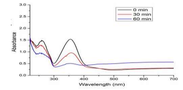
UV-Visible spectra of adsorption of AY via CTA membrane functionalized with Samarium Ferrate @rGo nanocomposites



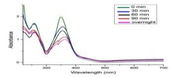
UV-Visible spectra of adsorption of MB via Ferric Oxide@rGo nanocomposites



UV-Visible spectra of adsorption of MB via CTA membrane functionalized with Ferric Oxide@rGo nanocomposites.

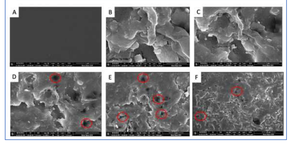


UV-Visible spectra of adsorption of AY via Ferric Oxide @rGo nanocomposites.



UV-Visible spectra of adsorption of AY via CTA membrane functionalized with Ferric oxide@rGo nanocomposites.

SEM of Membranes



Filtration Results

- CTA membrane removed the dissolved substances from feed solution thus decreased TDS value up to 70%.
- CTA based membrane functionalized with $Sm_3Fe_5O_{12}$ @rGo nanocomposites decreased TDS value up to 51%

Conclusion

In this study CTA based membranes have been fabricated with the incorporation of metallic nanocomposites. These membranes have been evaluated for their ability to adsorb organic dyes on their surface. The nanocomposites have also evaluated for their ability to degrade their dyes independently. The results of both the membranes and the nanocomposites have been compared and the kinetic analysis was also performed. The ZnO@ rGO, Fe_2O_3@rGO and $Sm_3Fe_5O_{12}$@rGO nanocomposites and the CTA membranes incorporated with these nanocomposites were evaluated against MB and AY dyes. All three nanocomposites depicted remarkable dye adsorption abilities against both the dyes and the flat curve was observed after varying time intervals. The similar activity of the nanocomposites was observed by these nanocomposites when they were incorporated matrix. The facile fabrication technique of the membranes does not alter the dye degradation ability of the nanocomposites.

References

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