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Trivalent Metal Cation Cross-linked Graphene Oxide Membranes for NOM Removal in Water Treatment

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Abstract

This paper summarizes the development and testing of novel graphene oxide (GO) membranes for the removal of natural organic matter (NOM) from raw water sources used for drinking water supply. In this work, two trivalent cations, Al^{3+} and Fe^{3+}, were employed as crosslinking agents to stack GO nanosheets layer by layer on a PVDF membrane support, in order to fabricate a suitable GO membrane. The trivalent cations greatly improve the bonding strength between the GO nanosheets through electrostatic forces and coordination bonds, and thus enhance the stability of the GO membrane; the integrity of the membrane in a range of solutions could be maintained for over a month. The initial interlayer spacing of GO nanosheets (0.80 nm) could be increased up to 0.86~0.95 nm by changing the Al^{3+} or Fe^{3+} ion concentration. It was found that the GO membrane flux ranged between 79 and 902 LMH/MPa when treating three representative NOM solutions and a real surface water. A relatively low thickness of the GO layer induced a higher flux of the GO membrane when prepared with the same cation concentration, while increasing the cation concentration resulted in a decline in flux. The flux of the Fe^{3+} cross-linked GO membrane was approximately 1.1~2.3 times that of the Al^{3+} cross-linked GO membrane, while both cation-modified GO membranes achieved a similar separation efficiency of the organic contaminants. The study has demonstrated a facile approach to the fabrication of a novel, stable GO membrane employing Al^{3+}/Fe^{3+} ions as crosslinking species, in order to utilize the excellent properties of GO and produce a GO membrane with a high flux and organic removal performance for water treatment.

Graphical abstract