Adsorption of metal ions and bactericidal actions using mixed zeolites and graphene oxide-based membranes

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Adsorption by composite membranes is considered an effective and economical wastewater treatment methodology to raise the emerging problem of the clean water shortage. Recently, graphene oxide (GO) and reduced-graphene oxide (r-GO) have been considered as potential candidates for use as a barrier layer of the separation membranes due to their high surface area, chemical stability, ultrathin 2D structure and controllable surface chemistry [1]. Additionally, GO and r-GO have attracted intensive interest because of their ability to contrast the membranes fouling and/or biofouling [2] thus reducing the use of chemical treatments in water disinfection. In this work, a novel design strategy is proposed to remove metal ions from water by a nanocomposite membrane based on reduced graphene oxide (r-GO) and zeolites. The aim is to directly prepare a r-GO layer on a highly microporous mat in order combine the strong selectivity, ion exchange properties and chemical stability of zeolites materials. Graphene oxide from natural graphite flakes (Sigma-Aldrich) according with modified Hummers method and the nanocomposite membranes were synthesized in the MackGraphe Research Center laboratories. Zeolite 3A and 13X were selected for their highly hydrophilic character, high thermal stability and because they were readily available, at low cost and with a high degree of purity and crystallinity. Zeolites "milky solutions" were prepared using an ultrasonic processor (UP400S, Hielscher), diluting 50 mg of zeolites powders in 100 ml of deionized water. All materials were characterized by SEM, AFM, FT-IR, XRD, TG/DTA and WCA. The ultra-thin nano-channelled membrane r-GO/CHNs (Copper Hydroxide Nanostrands) and the nano-composite membranes r-GO/ZEO3A (zeolite 3A) and r-GO/ZEO13X (zeolite 13X) were synthetized by an innovative one-step deposition method on a nylon substrate and then employed to remove from water common cations, particularly Na^+, NH_4^+, K^+, Ca^{2+}, Mg^{2+} (always ubiquitous in natural water and wastewater effluents). Adsorption tests highlighted a strong selectivity to Mg^{2+} thus attesting that functional groups exhibited strong metal−ligand interaction ion in aqueous solutions. Further, their antibacterial activity was tested against bacterial strains representative for Gram-positive (*S. aureus* Sa2 and *E. faecalis* ATCC 29212) and Gram-negative (*E. coli* APN1, *P. aeruginosa* PaPh32 and AC12a) species. In conclusion, this method for fabrication of the composite r-GO/zeolite and r-GO/CHNs membranes may provide many new opportunities for the development of novel antimicrobial membranes, environmentally compatible, efficient in water purification technologies for waste water and industrial waste.

References

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