Softening of seawater and desalination brines using grafted polysaccharide hydrogels

Mohamed H. Sorour a, Heba A. Hani a,*, Hayam F. Shaalan a, Marwa M. El Sayed a, Mayyada M.H. El-Sayed a,b

aChemical Engineering and Pilot Plant Department, National Research Center, El-Bohouth Street, Dokki, Giza, Egypt, email: hi_heba2@yahoo.com (H.A. Hani)
bChemistry Department, American University in Cairo, New Cairo, Cairo, Egypt

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ABSTRACT

This paper investigates the potential of using polysaccharide hydrogels as softeners for saline solutions of seawater and reverse osmosis desalination brine. Grafting of acrylamide onto alginate and chitosan was conducted using microwave (MW) and ultraviolet (UV) irradiation techniques. The produced hydrogels: alginate (Alg-UV and Alg-MW) and chitosan (Ch-UV and Ch-MW) were characterized using X-ray diffraction and scanning electron microscopy. Hydrogel products were tested for their swelling behavior in distilled water and saline solutions, and their calcium and magnesium adsorption capacities in the pre-swollen and dry forms were measured in saline solutions. Swelling in distilled water was found to exceed that in saline solutions by 16.7-21-fold. Maximum attained swelling ratios in distilled water were 168 and 173 g/g for Alg-UV and Ch-MW grafted acrylamide hydrogels, respectively. Dry hydrogels had relative selectivity toward calcium adsorption in seawater and magnesium adsorption in brine. Furthermore, pre-swollen hydrogel manifested favorable adsorption for calcium and magnesium when compared to dry hydrogel at the same adsorbate volume. For both dry and pre-swollen hydrogels, maximum calcium adsorption capacities were 54 and 34 mg/g from seawater using Alg-MW and UV-prepared alginate and chitosan hydrogels, respectively. Maximum magnesium adsorption capacities from brine were 280 and 316 mg/g using dry alginate and chitosan hydrogels, respectively, prepared by MW technique. Magnesium adsorption capacities of the prepared hydrogels in brine were higher than those of tested commercial resins. It is concluded that alginate- and chitosan-grafted acrylamide hydrogels are promising softeners for saline solutions.

Keywords: Softening; Seawater; Brine; Hydrogel; Polysaccharide; Salt recovery

*Corresponding author.


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