Source: Ghaemi, N., Madaeni, S. S., Daraei, P., Rajabi, H., Zinadini, S., Alizadeh, A., Heydari, R., Beygzadeh, M. & Ghouzivand, S. (2015). Polyethersulfone membrane enhanced with iron oxide nanoparticles for copper removal from water: Application of new functionalized Fe3O4 nanoparticles. *Chemical Engineering Journal, 263*, 101-112. https://doi.org/10.1016/j.cej.2014.10.103. 10.1016/j.cej.2014.10.103

Polyethersulfone membrane enhanced with iron oxide nanoparticles for copper removal from water: Application of new functionalized Fe3O4 nanoparticles

Negin Ghaemi [a]*, Sayed S. Madaeni [b], Parisa Daraei [a], Hamid Rajabi [b,c], Sirus Zinadini [d], Abdolhamid Alizadeh [e], Rouhollah Heydari [f], Mojtaba Beygzadeh [g], Sohrab Ghouzivand [e]

[a] Department of Chemical Engineering, Kermanshah University of Technology, 67178 Kermanshah, Iran
[b] Membrane Research Centre, Department of Chemical Engineering, Razi University, Tagh Bostan, 67149 Kermanshah, Iran
[c] Department of Civil Engineering, Razi University, 67149 Kermanshah, Iran
[d] Water and Wastewater Research Center (WWRC), Department of Applied Chemistry, Faculty of Chemistry, Razi University, Kermanshah, Iran
[e] Department of Organic Chemistry, Faculty of Chemistry and Nanoscience & Nanotechnology Research Center (NNRC), Razi University, 67149 Kermanshah, Iran
[f] Razi Herbal Medicines Research Center, Lorestan University of Medical Sciences, 68149-89468 Khorramabad, Iran
[g] Department of Energy, Materials and Energy Research Center, 14155-4777 Tehran, Iran[2] Nanoscience & Nanotechnology Research Center (NNRC), Razi University, Kermanshah 67149-67346, Iran

Abstract

Surface modification of Fe3O4 nanoparticles was performed by immobilizing silica, metformine, and amine. Mixed matrix PES nanofiltration membrane was prepared by embedding various concentrations of the modified Fe3O4 based nanoparticles. The membranes were characterized in terms of morphology and performance including investigation of SEM and AFM microphotographs, water contact angle, mean pore size and porosity measurements and determination of pure water flux as well as copper ion removal. Embedding iron oxide nanoparticles resulted in a significant rise in the pure water flux as a result of changes in the mean pore radius, porosity and hydrophilicity of the membranes. Moreover, the copper removal capability of prepared membranes remarkably increased because of improved hydrophilicity and also presence of nucleophilic functional groups on nanoparticles. The membrane fabricated with 0.1 wt.% metformine-modified silica coated Fe3O4 nanoparticles showed the highest copper removal (about 92%) due to high affinity in copper adsorption. Moreover, acceptable reusability was found for the membrane with the best performance after several times of usage/regeneration cycles usin EDTA as eluting agent.

Keywords: Nano-enhanced membrane, Iron oxide nanoparticles, Functionalized Fe3O4, Heavy metal, Copper ion removal