ARC '16

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http://dx.doi.org/10.5339/qfarc.2016.EEPP3335

Novel Graphene-Zinc Iron Oxide Composite to Enhance Ultrafiltration Membrane Performance for Water Treatment and Desalination

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The main target of membrane technologies such as the Ultrafiltration (UF), Nanofiltration (NF) and Reverse osmosis (RO) is to produce better filtration and separation of organic and inorganic substance from water as well as for longer life of the membrane. The phase inversion method is a well-known method to fabricate UF, NF and RO membranes for different application. The UF membrane is widely used in separation of macromolecules from solution as pretreatment stage with higher efficiency in hybrid process. The UF membrane made by pure polymer showed low flux, which affect on process performance of separation. The Polysulphone (PSF) is the most common polymer used in UF membrane which a hydrophobic material is making its surface prone to fouling due to adsorptive mechanism. This limitation of UF membranes have been solved by blended with nanoparticles incorporated membranes which showed significant enhancement on permeability, surface hydrophilicity, mechanical properties and other properties such as the selectivity. The main objective of this study to modify of UF membrane by blended with new composite nano-material for higher rejection of salt and organic substances. The graphene-zinc iron oxide composite as new nano-material was synthesized by sol gel method at low temperature of preparation. The composite was characterized using X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), transmission electron microscopy (TEM) to show the structure, morphology and particle size of nanoparticles. Thermal decomposition was determined using thermogravimetric–differential scanning calorimetry (TGDSC). The results showed that cubic system of zinc iron oxide nanoparticles with 8 nm of crystal size was obtained using XRD. The morphology using TEM showed zinc iron oxide composite graphene as layer of nanoparticles with size lower

Cite this article as: Ba-Abbad MM, Mohammad AW, Mahmoudi E, Faneer K, Benamor A. (2016). Novel Graphene-Zinc Iron Oxide Composite to Enhance Ultrafiltration Membrane Performance for Water Treatment and Desalination. Qatar Foundation Annual Research Conference Proceedings 2016: EEPP3335 http://dx.doi.org/10.5339/qfarc.2016.EEPP3335.

than 10 nm which confirmed the XRD results. The novel synthesized of zinc iron oxide nanoparticles embedded in graphene incorporated into polysulfone (PSF) with 0.5 wt. % loading which significant impact on the UF membrane properties was investigated. The effect of composite additive on membrane properties was investigated in terms of permeability, hydrophilicity (contact angle), zeta potential, porosity and pore size. However, the membrane cross section, surface, EDX and mapping were also analyzed using FESEM include EDX analyzer. This composite incorporated PSF showed significant improvement in terms of surface hydrophilicity with reduction of about 25% (reduce contact angle from 82 to 62°). This improvement confirms by increasing the zeta potential values and surface negatively charge of blended PSF with composite compared to pure PSF membrane. The permeability results showed that significant increased more than two times compared to pure PSF membrane. The phenomenon of permeability increasing was attributed to increase of porosity of blended membrane which becomes lower resistance of water permeation. Generally, the rate of pore production has been reported directly affected by rate of solvent and non-solvent exchange in phase inversion process. However, higher rejections of organic substances such as the dyes and humic acid as well as the salt such as Sodium sulfate (Na_2SO_4) were maintained using UF at low pressure. This enhancement affects on time and load of process especially when hybrid with Nanofiltration (NF) which can increase of membrane life and reduce of overall process cost. The results of this study will have bigger impact in the future for different application including for water treatment and desalination.