

Electrospun polyacrylonitrile/lignin/poly(Ethylene Glycol)-based porous activated carbon nanofiber for removal of Nickel(II) ion from aqueous solution

ABSTRACT

The issue of heavy metal contamination has caused a great deal of concern among water quality experts today, as it contributes to water pollution. Activated carbon nanofibers (ACNFs) showed a significant ability in removing heavy metals from the wastewater. In this study, polyacrylonitrile (PAN) was blended and electrospun with an abundant and inexpensive biopolymer, lignin and a water soluble polymer, poly(ethylene glycol) (PEG), by using an electrospinning technique to form nanofibers. The electrospun nanofibers were then investigated as a precursor for the production of porous ACNFs to study the removal of nickel(II) ions by adsorption technique. PEG was added to act as a porogen and to create the porous structure of carbon nanofibers (CNFs). CNFs were prepared by thermal treatment of the electrospun nanofibers and followed by activation of CNFs by thermal and acid treatment on CNFs. Attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR) spectral analysis of the ACNFs showed a strong absorption peak of the C-O functional group, indicating the increase in the oxygenated compound. Field emission scanning electron microscopy (FESEM) images concluded that the ACNFs have more porous and compact fibers with a smaller fiber diameter of 263 ± 11 nm, while the CNFs are less compact and have slightly larger fiber diameter of 323 ± 6 nm. The adsorption study showed that the ACNFs possessed a much higher adsorption capacity of 18.09 mg/g compared with the CNFs, which the amount adsorbed was achieved only at 2.7 mg/g. The optimum adsorption conditions that gave the highest percentage of 60% for nickel(II) ions removal were 50 mg of adsorbent dosage, 100 ppm of nickel(II) solution, pH 3, and a contact time of 60 min. The study demonstrated that the fabrication of ACNFs from PAN/lignin/PEG electrospun nanofibers have potential as adsorbents for the removal of heavy metal contaminants.

Keyword: Adsorption; Carbon nanofiber; Activated carbon nanofibers; Nickel(II) ion; Electrospinning; Selective dissolution