Effective removal of Pb(II) ions by electrospun PAN/Sago lignin-based activated carbon nanofibers

ABSTRACT

Heavy metal pollution, such as lead, can cause contamination of water resources and harm human life. Many techniques have been explored and utilized to overcome this problem, with adsorption technology being the most common strategies for water treatment. In this study, carbon nanofibers, polyacrylonitrile (PAN)/sago lignin (SL) carbon nanofibers (PAN/SL CNF) and PAN/SL activated carbon nanofibers (PAN/SL ACNF), with a diameter approximately 300 nm, were produced by electrospinning blends of polyacrylonitrile and sago lignin followed by thermal and acid treatments and used as adsorbents for the removal of Pb(II) ions from aqueous solutions. The incorporation of biodegradable and renewable SL in PAN/SL blends fibers produces the CNF with a smaller diameter than PAN only but preserves the structure of CNF. The adsorption of Pb(II) ions on PAN/SL ACNF was three times higher than that of PAN/SL CNF. The enhanced removal was due to the nitric acid treatment that resulted in the formation of surface oxygenated functional groups that promoted the Pb(II) ions adsorption. The best-suited adsorption conditions that gave the highest percentage removal of 67%, with an adsorption capacity of 524 mg/g, were 40 mg of adsorbent dosage, 125 ppm of Pb(II) solution, pH 5, and a contact time of 240 min. The adsorption data fitted the Langmuir isotherm and the pseudo-second-order kinetic models, indicating that the adsorption is a monolayer, and is governed by the availability of the adsorption sites. With the adsorption capacity of 588 mg/g, determined via the Langmuir isotherm model, the study demonstrated the potential of PAN/SL ACNFs as the adsorbent for the removal of Pb(II) ions from aqueous solution.

Keyword: Carbon nanofibers; Activated carbon nanofibers; Sago lignin; PAN; Adsorption; Heavy metal removal; Adsorbent; Pb(II) ions