RECYCLED JUTE NONWOVEN MATERIAL MODIFIED WITH PANI/TiO_2 NANOCOMPOSITE FOR REMOVAL OF METAL IONS FROM WATER

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Abstract: Water bodies polluted with heavy metal ions pose a big environmental issue. Another global concern is related to huge amounts of textile waste that is usually landfilled or incinerated. Keeping in mind that one of the pillars of the circular economy model is recycling, an effort has been made to face both environmental problems by recycling carpet fringes based on jute fibers and to manufacture nonwoven sorbent (NWS) by needle punch process, which can be utilized for the removal of heavy metal ions from water. In order to enhance the sorption capacity of NWS, it was in situ coated with polyaniline (PANI). PANI is easy to synthesize, environmentally benign and cheap polymer that possesses plenty of amino and imino groups capable to form coordinate bonds with metal ions. To overcome the problem of uneven coating of jute fibers with PANI, the synthesis was performed in the presence of TiO_2 nanostructures that control the polymerization of aniline. The effect of PANI/TiO_2 nanocomposite containing TiO_2 nanoparticles (NPs) and TiO_2 nanotubes (NTs) on the sorption of Pb^{2+} and Cu^{2+} ions was investigated. The sorption behavior of NWS was studied by discussing the influence of contact time, pH, temperature and initial concentration on the uptake of metal ions. The morphology of the fiber surface was analyzed by FESEM. Surface chemistry was assessed by FTIR spectroscopy while electrokinetic properties were evaluated by ζ-potential measurements.

FTIR spectroscopy indicated the formation of the emeraldine base form of PANI whereas FESEM proved the formation of even polymer coating all over the jute fibers. The shape of TiO_2 nanostructures did not influence the morphology and chemistry of in situ synthesized PANI/TiO_2 nanocomposite and sorption behavior, confirming their restricted role in imparting uniform polymer coating. The isoelectric points of modified samples were shifted towards higher pH values.

The pseudo-second order kinetic model fitted well with the experimental data. Experimental data best fitted Langmuir isotherm model. Modification of NWS with PANI/TiO_2 nanocomposite led to a significant increase in uptake of both metal ions, but the sorption capacities of NWS and modified NWSs for Pb^{2+} ions were considerably larger than for Cu^{2+} ions. The sorption was not significantly influenced by temperature. The influence of pH was evaluated in the pH range between pH 3.0-5.5. As expected, the largest uptakes for both metal ions were obtained at pH 5.0-5.5. This is attributed to a negative charge on the surface of NWS modified with PANI/TiO_2 nanocomposites beyond the isoelectric point, due to deprotonation of amine groups of PANI. Modified NWs could be regenerated in 0.1 M HNO_3 solution and reused at least 5 times with only a slight drop in sorption efficiency.

Keywords: *jute, polyaniline, sorption, metal ions.*

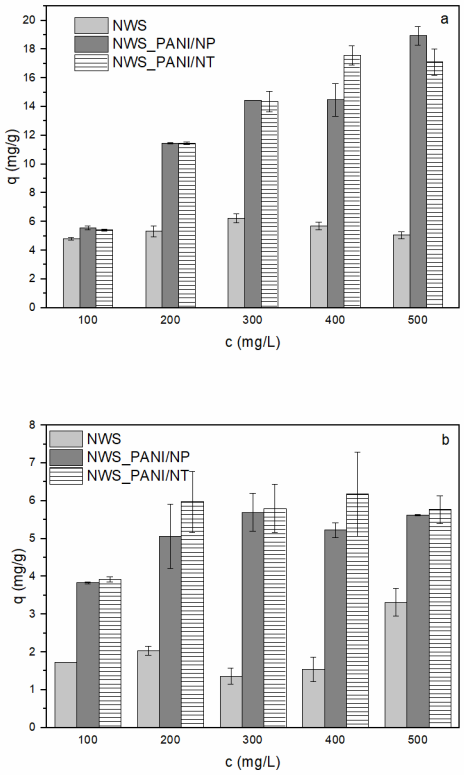

Figure 1 The influence of initial concentration on the uptake of (a) Pb^{2+} ions and (b) Cu^{2+} ions

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