ARC '16

مؤتمر مؤسسة قطر
السنوي للبحوث

QATAR FOUNDATION
ANNUAL RESEARCH
CONFERENCE

Towards World-class
Research and Innovation

Energy and Environment Pillar

http://dx.doi.org/10.5339/qfarc.2016.EEPP2605

Removal of Lead Ions from Aqueous Solutions Using Polyaniline Polystyrene Nanocomposites

Jolly Bhadra, Noora Jabor Al-Thani, Abdullah Alashraf Abul Baker

Qatar University, QA

Email: jollybhadra@qu.edu.qa

Background and objectives

Water pollution is an issue of grave importance worldwide, especially in countries that boast of a large number of industries. High concentration of heavy metal ions such as lead, nickel, etc are often found in industrial waste water and can have adverse affects on human health. Over the years a variety of methods, both physical and chemical ones, are reported to have been used for removal of heavy metal ions from water such as filtration and advanced oxidation [1, 2], etc. Adsorption is among the most widely used techniques due to its simplicity, reasonable operational conditions and cost-effective nature. The primary physical property of any absorbent is its surface area and structure. PANI is used due to the presence of primary and secondary amines functional groups which absorb heavy metals. However, due to poor solubility of PANI in common solvents it is made into composite with polystyrene which has strong mechanical properties. In this study a PS/PANI nanocomposite was prepared using the casting method; the composite was then investigated for its heavy metal ion absorption potential.

Methodology

PANI is obtained using dispersion polymerization by the usual technique defined in the literature [14, 15]. In order to prepare PANI/PS a mixture of toluene and sulfuric acid is used to get the composite. 0.05 g polystyrene, 0.95 g PANI mixed in 13:13 ml sulfuric acid and toluene solution and stirred at room temperature for 4 hours. The composite is kept on petri disc overnight and dried samples were heated at 50°C for 3 hours. Sulfuric acid was removed by washing the precipitate with distilled water and then dried again at 50°C for 3 hours to obtain the desired composite.

Cite this article as: Bhadra J, Al-Thani NJ, Abul Baker AA. (2016). Removal of Lead Ions from Aqueous Solutions Using Polyaniline Polystyrene Nanocomposites. Qatar Foundation Annual Research Conference Proceedings 2016: EEPP2605 http://dx.doi.org/10.5339/qfarc.2016.EEPP2605.

Results and discussions

SEM & FTIR

The morphology and structure of the obtained nanocomposite was studied by Scanning electron microscopy (SEM), and the functional groups were characterized by Fourier Transform Infrared Spectroscopy (FTIR). The SEM images of pure PANI and PANI/PS composite are shown in Figure 1 (a–b). The SEM image of pure PANI doped with HCl shows a predominantly fibrous morphology with fibers of uniform diameter of 93 nm. However, PANI/PS composites show very different morphologies. PANI/PS images show some nanoscale structures where PS are coated on the surface of PANI nanofibril structure. From the SEM images, it is clear that PANI/PS composite shows presence of a large surface area required for adsorption.

Figure 2 shows the FTIR spectra of pure PANI, pure PS and PANI/PS composite. FTIR spectroscopy is a powerful tool for analyzing the molecular structure and the chemical interactions of the constituent polymers. The appearance of new peaks in the composite FTIR spectra along with changes in existing peaks directly indicates the chemical interaction between polymers. The obtained values are in good agreement with theoretical prediction.

Adsorption Tests

Table 1 tabulates the adsorption results of pure PANI and PANI/PS composites. From the results, it is clear that PANI/PS composites show the best removal efficiency because of the presence of high surface area due to its fiber morphology. Therefore, the remaining adsorption studies are done only on PANI/PS composites. The following sections describe the effect of contact time, pH, metal loading and composite dosages of the PANI composites on the removal efficiency of Pb from aqueous solution.

Effect of contact time

The effect of time on the adsorption process of PANI nanocomposite was obtained by plotting the removal efficiency of Pb against time (Figure 3). For the solution containing 50 ppm of Pb the maximum adsorption was reached in a short period of time and the composite adsorbed approximately 90% of the metal ion. The kinetics of the uptake of metal ion is related to the explicitness of the interaction between the metal ion and the polymer composite matrix.

Effect of pH

The pH of the solutions showed significant effect on the adsorption process. The effect of pH on the adsorption process of nanocomposite is represented in Figure 4, where the adsorption coefficient was determined over the pH range 2–9, using 0.2 g PANI nanocomposite and 50 ppm Pb solution. It is clear that the maximum adsorption of metal ion took place for the solution with pH 2–6, and decreased at higher pH values. In our study, the pH of the prepared Pb solutions were adjusted to pH 5.

Effect of metal loading

The study of initial metal ion concentration on the sorption characteristics of the polymer nanocomposite is analyzed in the concentration range 30–100 ppm of the metal ion. The adsorption, as it can be seen in Figure 5, is increasing rapidly with the increase in the initial concentration of Pb until 70 ppm. Beyond this concentration, the rate of increase in the adsorption is slow most probably because the adsorption sites are already saturated.

Effect of composite dosage

Figure 6 illustrates the effect of PANI composites weight on the adsorption of metal ions. Varying amounts (0.1–0.5 g) of sorbent are added in 100 mL 50 ppm Pb solution under optimized conditions. From the graph, it is obvious that as the adsorbent concentration increases the removal efficiency of Pb in PANI/PS composite also increases. This is because the increase in adsorbent concentration provides greater surface area for adsorption and as a result it can hold more metal particles.

Conclusion

This work illustrates the preparation and adsorption property of pure PANI and PANI/PS composites. The synthesis of PANI nanocomposite has been successfully performed by in situ polymerization method and the incorporation of the PANI in PS was confirmed by FTIR. The SEM images of PANI and its composites confirmed the nanometer size range of PANI fibers. Adsorption performance of PANI and its nanocomposites has been studied for the removal of Pb from aqueous solution. Among the two adsorbents, PANI/PS shows 95% removal efficiency. The adsorption capacity of PANI/PS for Pb increases with initial metal concentration and composite dosages. Maximum adsorption was observed for pH 5, hence all the measurements are done at that pH. In conclusion, PANI/PS nanocomposite could be a good candidate for efficient Pb-removal from wastewater and for the deep-purification of pollutant water.

Reference

[1] S. S Madaeni, Y. Mansourpanah, Filtration & Separation, 40(6) (2003). 41–46.

[2] T. Kurbus, Y. M. Slokar, A. M. Le Marechal, D.B. Voncina, Dyes and Pigments, 58(2), (2003) 171–178.

[3] J. Stejskal, R. G. Gilbert, Polyaniline. Preparation of a conducting polymer, Pure Appl. Chem., 74 (2002) 857–867.

[4] N. Gospodinova, L. Terlemezyan, Conducting polymers prepared by oxidative polymerization: polyaniline, Progress in Polymer Science, 23 (1998) 1443–1484.