

Study on the enhancement of colloidal stable poly(sodium 4-styrene sulfonate) coated magnetite nanoparticles and regeneration capability for rapid magnetophoretic removal of organic dye

Abstract

BACKGROUND: A good colloidal stability of magnetite nanoparticles (MNPs) dispersion is of utmost importance for its environmentally related applications. In the present work, a water-soluble anionic polyelectrolyte, poly(sodium 4-styrene sulfonate) (PSS), was used to stabilize dispersions of MNPs in a pH-dependent aqueous medium. **RESULTS:** An excellent methylene blue (MB) dye removal efficiency at equilibrium of up to 94% has been observed by the colloidally stabilized nano-magnetites. Dynamic light scattering and electrophoretic analysis showed that the PSS-coated MNPs exhibited better colloidal stability, with an almost constant hydrodynamic diameter of ~150 nm and insignificant clustering behavior throughout the measuring time scale of 5 h. Transmission electron microscopy evidenced the success coating of PSS onto MNPs. In terms of its chemical resistance, the PSS-coated MNPs were able to tolerate a wide pH range from 2 to 10. This work depicts a simple physiochemical coating method to stabilize dispersions of nano-magnetites, which promoted a better MB adsorption capacity of PSS-coated MNPs at 14.9 mg g⁻¹ than the naked MNPs at 10.38 mg g⁻¹. The adsorption process follows Langmuir isotherm and pseudo-second-order reaction kinetics with both correlations $R^2 > 0.99$. PSS-coated MNPs demonstrated outstanding regeneration capacity for four batch adsorption cycles with an almost consistent MB removal efficiency higher than 85%. **CONCLUSION:** This in-house developed nano-sorbent has potential in economical applications with a less budgeted adsorbent replacement (at least 4 cycles of regeneration) for low-cost separation of pollutants, such as MB from polluted water.

Keywords

Adsorption; Environmental remediation; Recovery; Transmission electron microscope (TEM); Waste-water; Water treatment and waste minimization