ABSTRACT

Industrialisation and urbanisation led to the contamination of groundwater and surface water to a large extent. Zero valent iron nanoparticle (Fe^0) is a promising material for water contaminants remediation due to its large surface area to volume ratio coupled with greater reactivity. However, the Fe^0 rapidly reacts with air and water and results in reduced reactivity due to oxidation and agglomeration. Our work aims to prepare modified iron-based nanoparticles with improved reactivity, stability and dispersibility without much secondary pollution. The reactivity of modified iron-based nanoparticles was evaluated by measuring the removal efficiency of hexavalent chromium and malachite green dye from water. Iron nanoparticle modification was done by depositing catalytic metal to the Fe^0 surface, encapsulating it with polymer and depositing Fe^0 on solid support. Green synthesis of Fe nanoparticles was done using plant extracts, which neither requires additional energy nor produces any hazardous by-products.

The specific objectives of our work include (1) synthesise Fe^0 and bimetallic Fe based nanoparticles using the chemical reduction method, (2) prepare chitosan stabilised Fe^0 and Fe/Ni nanoparticles, (3) develop zeolite and TiO_2 based novel composites as supporting and stabilising material for Fe^0 nanoparticles, (4) prepare Fe nanoparticles using plant extracts as green reducing agents, (5) evaluate the efficiency of synthesised nanoparticles in the removal of toxic hexavalent chromium and toxic dyes under different reaction conditions such as initial pollutant concentration, nanoparticle dosage, contact time and solution pH.

The synthesis of modified iron nanoparticles was carried out under an inert atmosphere and the collected samples were lyophilised. The characterisation of prepared nanoparticles was performed using UV-visible spectroscopy, HRTEM, EDAX, FTIR, XRD and XPS. UV-visible spectroscopy was used to analyse the remaining concentration of the pollutant after treating with Cr(VI) and toxic dyes. The degradation product of malachite green was analysed by LC-MS/MS and GC-MS/MS. The various modifications done on iron nanoparticles in our study improved the reactivity and stability of the iron nanoparticles.