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ORIGINAL PAPER

Removal of organochlorine pesticides by chitosan loaded with silver oxide nanoparticles from water

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Abstract Silver oxide nanoparticles embedded chitosan beads were studied to remove pesticides from water. A simple and an effective approach was used in regard to preparing AgO nanoparticles on the surface of chitosan. The chitosan–AgO nanoparticles (CS–AgONPs) composite was characterized by infrared spectroscopy (FTIR), X-ray diffraction, and scanning electron microscopy. The CS–AgONPs composite beads were optimized to remove maximum permethrin as the model pesticide, with amount of sorbent, agitating time, initial concentration of pesticide, and pH parameters. In optimum conditions, room temperature, pH 7, and the CS–AgONPs beads could recover 99 % pesticides of permethrin solution (0.1 mg L-1) which were characterized by using UV spectrophotometer at 272 nm. In comparison with the pure chitosan, the removal capacity of CS–AgONPs beads has been increased to 49 %. The CS–AgONPs composite beads have high capacity as an adsorbent which could explore a new biocompatible and eco-friendly strategy for pesticide removal, and appears to be the new promising material in water treatment application.

Keywords AgO nanoparticles · Chitosan · Permethrin · Adsorption

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Introduction

Permethrin (Fig. 1), (3-phenoxyphenyl)-methyl(+)cis-trans-3-(2,2-dicloroethenyl)-2,2-dimethylcyclopropane-carboxylate, is a common synthetic neurotoxin pyrethroid insecticide (Linnett 2008; Arayne et al. 2011).

After we have used these pesticides on earth, the rivers, lakes, and ultimately the oceans then it was filled the role of the final reservoirs for these pollutants. Hence, all plants and organisms living in water will be affected (Cheevaporn et al. 2010).

In water and wastewater treatment applications, chitosan, poly[β-(1→4)-2-amino-2-deoxy-D-glucopyranose], has been used as an absorbent as well as primary coagulant or flocculent (Hu et al. 2009; Saifuddin and Dinara 2011; Haroun et al. 2013). However, it is necessary to develop methods for enhancing the adsorption capacity of chitosan for the practical application (Wang and Wang 2008; Zhu et al. 2012; Wen et al. 2012). Functional groups of chitosan, hydroxyl (–OH) and amino ($–NH_2$), are responsible for the reactivity of this polymer as an excellent natural adsorbent and its powerful adsorptive capacity (Wan Ngah and Fatinathan 2010; Fana et al. 2012; Altaher 2012; Sugashini and Begum 2013).

Metal oxide particles such as AgO have been used in many functions in the various polymeric materials to improve the permanence of polymeric products. For example, when more resistance is important in applications then the addition of nano particles could increase the stiffness, toughness, and service life of polymeric materials (Sung et al. 2003).

Despite excellent performance of chitosan based materials which are considered in many fields of adsorption, a few studies have been accomplished about its application in pesticide removal. Yoshizuka et al. (2000) has prepared

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