Iron Oxide Nanoparticle-Chitosan Composites for Phosphate Removal from Water

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Extended Abstract

The control of phosphate (P) in water bodies is an important topic for aquatic environments. Phosphate is discharged into aquatic environments from various point and non-point sources, causing eutrophication when present in excessive amounts, thus posing a great threat to aquatic environments and human health due to harmful algal blooms [1]. The threshold value of total phosphorus (T-P) for eutrophication is reported to be > 0.035 mgP/L [2]. In order to prevent eutrophication in lakes and rivers, phosphate released into water bodies should be properly controlled. Various chemical and biological treatment technologies have been used to reduce the T-P concentration in water and wastewater [3]. Recently, nanotechnology-based water and wastewater treatment methods have attracted a considerable amount of attention in environmental disciplines [4–6]. For phosphate removal from aqueous solutions, nanoparticle-based adsorbents have been synthesized and tested by numerous researchers. Two approaches have been used regarding the use of nanoparticle-based adsorbents for phosphate removal. The first approach is related to directly applying nano-sized particles, whereas the second approach involves the application of nanoparticle-based composite adsorbents. Even though nanoparticles have been reported to have high phosphate adsorption capacity, they may be limited for large scale applications due to agglomeration and separation problems. In addition, nanoparticles may not be suitable for fixed-bed type applications, because they are not granular-type adsorbents and may cause hydraulic problems during wastewater treatment. In order to overcome these problems of nanoparticles, some researchers have prepared nanoparticle-based composites for phosphate removal.

In this study, iron oxide nanoparticle-chitosan composites were synthesized for phosphate removal from natural water collected from the Seoho Stream in Suwon, South Korea. Batch tests demonstrated that phosphate removal by the composites was not sensitive to pH changes between pH values of 5.0 and 9.0. During six cycles of adsorption-desorption, the composites could be successfully regenerated with 5 mM NaOH solution and reused for phosphate removal. Column experiments showed that the composites could be successfully used for phosphate removal under dynamic flow conditions. A pilot-scale field experiment was performed in a pilot plant built nearby the Seoho Stream. The natural water was pumped from the Seoho Stream into the pilot plant, passed through the chemical reactor/dissolved air flotation process, and then introduced into the adsorption tower (height = 100 cm, inner diameter = 45 cm, flow rate = 7.05±0.18 L/min) for phosphate removal by the composites (composite volume = 80 L, composite weight = 85.74 kg). During monitoring of the adsorption tower (33 days), the influent total phosphorus (T-P) concentration was in the range of 0.020–0.046 mgP/L, whereas the effluent T-P concentration was in the range of 0.010–0.028 mgP/L. The percent removal of T-P in the adsorption tower was 52.3% with a phosphate removal capacity of 0.059 mgP/g. We demonstrated that the composites could be successfully applied as adsorbents for phosphate removal from natural water.

References

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