Coagulation-Adsorption for Removal of Polystyrene Nanoplastics in Water Treatment Strategies

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Abstract

Nanoplastics (NPs) in aquatic ecosystems pose serious environmental and public health problems due to their origin of toxicity and persistent ability attracting various adsorbable contaminants on their surfaces. This study evaluated a hybrid coagulation-adsorption process in series for the removal of amidine-functionalized polystyrene (PS) NPs in water. Coagulation was first performed using Ferric Chloride, removing the PS NPs. An art from, adsorption test was conducted at varying PS concentrations demonstrating that PS NPs undergo chemical adsorption onto granular activated carbon (GAC), as evidenced by pseudo-second-order kinetics (R^2 = 0.991-0.999), showing that intra-particle diffusion was not the only rate-limiting step. Other rate-limiting steps include boundary layer diffusion and surface adsorption, both of which contribute significantly to the overall adsorption process. The process was better fit by the Langmuir isotherm model (R^2 = 0.985) than by the Freundlich model (R^2 = 0.927), indicating that monolayer adsorption might be predominated on a homogeneous surface. Nanoparticle tracking analysis (NTA) showed that coagulation, adsorption, and the combined of two removed them at 30.0%, 98.0%, and 99.4%, respectively. Turbidity and total organic carbon (TOC) revealed that they were removed in a similar manner as shown in those of NTA. The

combined treatment process could achieve the highest removal rate. It demonstrates the effectiveness of integrating coagulation and adsorption in series for PS NP removal in water treatment which highlight properly arraying unit treatment process optimally to maximize the removal efficiency.

Keywords: Adsorption; Coagulation; Granular activated carbon; Nanoparticle tracking analysis; Nanoplastics; Polystyrene; Raman Spectroscopy; Zeta potential.