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Removal characteristics of organics in bio-treated textile wastewater reclamation by a stepwise coagulation and intermediate GAC/O_3 oxidation process

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HIGHLIGHTS

- A novel hybrid process was used in reclamation of bio-treated textile wastewater.
- Stepwise coagulation and intermediate GAC/O_3 oxidation were involved.
- The excellent organics removal were achieved under appropriate conditions.
- The removal behavior was elucidated by organics characterization.

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ABSTRACT

In this study, a novel hybrid process involving stepwise coagulation and intermediate ozonation in the presence of granular activated carbon (GAC/O_3) was employed to remove effluent organic matter (EfOM) from bio-treated textile wastewater. Removal behavior of EfOM in different processes, including biodegradability, hydrophobic and hydrophilic property, and apparent molecular weight (AMW) distribution, were evaluated as well. When the polyaluminum chloride (PACl) dose of 25 mg L^{-1} as Al was used in both pre-coagulation (pH 8.0) and post one (pH 5.5), and the ozone dose of 3.1 mg O_3 mg^{-1} COD was applied in GAC/O_3 (GAC 10 g L^{-1}) lasting 5 min, the superior removal efficiencies of water quality parameters like turbidity, color, COD, DOC and UV_{254} were 95.8%, 97.5%, 88.1%, 68.7% and 90.5%, respectively. Results also showed that GAC/O_3 not only gave the efficient decolorization and DOC removal, but also enhanced the treatability of biodegradable and hydrophilic organics of AWM in 1–10 k Da by post coagulation, likely due to the effective removal of colored and hydrophobic organics in AMW > 1 k Da via pre-coagulation. Therefore, the hybrid process applying appropriate operational parameters was proved to be an attractive strategy in the wastewater reclamation.

1. Introduction

Biologically treated (bio-treated) textile wastewater is an acceptable source of water for potential process reuse. To maintain sustainable industry development and minimize the impact on product quality, extensive elimination of effluent organic matter (EfOM) should be achieved in wastewater reclamation. The combined application of physicochemical treatment processes like coagulation and ozonation are very suitable to be employed in this field, since EfOM causing color and turbidity represents a variety of recalcitrant organics ranging from low to high molecular weight [1].

Coagulation process could bring a reduction in dissolved organic carbon (DOC) of around 30–60% by increasing the coagulant dose and optimizing reaction pH, in which large organic molecules with hydrophobic property was removed preferentially [2–5]. Meanwhile, the high reactivity of ozone with chromophores and aromatic carbon has been publicly accepted [6–8]. In drinking water treatment, prior ozonation has been widespread used as a coagulation aid to destabilize and aggregate small particles and colloids, but the overdose of ozone above about 0.7 mg O_3 mg^{-1} TOC may be detrimental to the DOC removal via coagulation, by resolving some particulate organics (or organic coatings on particles) into dissolved ones and increasing the percents of hydrophilic and low molecular weight fractions [9,10]. However, in the purification of the water containing considerable hydrophobic fractions, the superior DOC and special UV absorbance (SUVA) removals would be expected by the combined stepwise coagulation with intermediate ozonation, since pre-coagulation may not only reduce the demand dose of ozone for target contaminants oxidation, but also enhance the beneficial effect of ozonation on the subsequent coagulation [11,12].

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