A multifaceted aggregation and toxicity assessment study of sol–gel-based TiO₂ nanoparticles during textile wastewater treatment

Burak Yuzer, Marco Guida, Fehiman Ciner, Burcu Aktan, M. Iberia Aydin, Sureyya Meric, Huseyin Selcuk

ABSTRACT

Innovative textiles have been concern of emerging risk of nanoparticles (NPs) to human and environment. This study aimed to investigate the aggregation, removal and biological, and ecotoxicological effects of sol–gel-based TiO₂ NPs while the treatment of textile wastewater. Fe(II) and alum coagulants were applied for the removal of spiked TiO₂ NPs from textile wastewater. Particle size distribution, absorbance values (UV–vis range), and residual TiO₂ NPs were followed to define aggregation mechanism, including pH variation during treatment of wastewater. The effect of TiO₂ on activated sludge treatment was followed by monitoring of oxygen uptake rate (OUR). Ecotoxicity of sol–gel and coagulated samples was observed by Ceriodaphnia magna immobilization test. Adjustment of pH to 8 enlarged mean particle size distribution of sol–gel-based TiO₂ NPs from 30 to 450 nm. After alum and Fe(II) coagulations, average particle size distributions were observed to be 650 and 960 nm, respectively. Coagulation with alum and Fe(II) resulted over >95% removal of TiO₂ from biologically treated textile wastewater (BTTWW). The value for residual TiO₂ concentration in BTTWW was reduced from 120 μg/L to around 8 μg/L. TiO₂ NPs exhibited slight/no toxicity on the OUR while toxicity to Ceriodaphnia dubia increased in some coagulated samples, most probably due to higher residual coagulant concentrations.

Keywords: Aggregation; Ecotoxicity; Nanoparticles; Oxygen uptake rate; Sol–gel; Textile wastewater; Titanium dioxide; Treatment