GC/MS Validation and the Kinetics of Dye Degradation by Titania Nanoparticles

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Water scarcity continues to threaten populations worldwide, especially in less developed countries where industries tend to establish factories. As a result, many developing areas lack clean water because of dye runoffs from textile production. To combat dye pollution, titanium dioxide nanoparticles have been identified as a cost-effective method to treat colored water. Due to titania's photoreactive properties, the nanoparticles can break down organic dye molecules after being activated with UV light. Unfortunately, concerns over the nanoparticles' long activation period and lack of prior studies about the breakdown products after titania treatment challenge the real-world application of this method. This study compared 5 nm, 15 nm, 40 nm, and 100 nm anatase titania particles' reaction time with methylene blue (MB) and methyl orange (MO) dyes, and evaluated the dyes' structure after the treatment. The smaller particles were hypothesized to be more efficient because UV light penetrates deeper, activating a greater percentage of their volume. Equal masses of each sizes were added to both dye solutions, and irradiated with two 365 nm UVA flashlights for 150 minutes. The light absorbances of each sample were analyzed afterward. The 5 nm particles performed the best when degrading both MB and MO. GC/MS evaluation was performed on methylene chloride extractions of the clarified MB and MO solutions. No fragments of MB or MO were detected through GC/MS, demonstrating that the titania NPs can efficiently destroy 100% of the organic dyes after 150 minutes. The NPs also remained effective after 3 rounds of reclamation.

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