RB5 Dye Removal Using Activated Carbon Under UV Irradiation

Kim, Emily (School: Jericho High School)

Dye effluent from the fast fashion and textile industry contributes to 17-20% of global industrial pollution. Azo dyes, the largest class of textile dyes, possess great threats to the environment due to their high toxicity and recalcitrancy. Yet, conventional azo dye removal methods suffer from low efficiency, toxic byproducts, and high costs. This study investigated the decolorization and degradation of a model azo dye Reactive Black 5 (RB5) using activated carbon (AC) under UV irradiation with Langmuir-Hinshelwood (LH) kinetic modeling. After AC incubation and UV light inclusion or exclusion, UV-visible spectroscopy and Raman spectroscopy were employed to determine changes in RB5's concentration in solution and chemical structure, respectively. Decreased absorbance peaks at 310 nm and 596 nm revealed simultaneous decolorization and degradation of RB5 over time with AC under UV irradiation, and Raman peak changes at 494 cm^-1, 1296 cm^-1, and 1425 cm^-1 revealed aromatic rings, naphthalene rings, and azo bonds as the primary sites of chemical change in RB5. RB5 removal efficiency was calculated to be ~92% with 0.1 g/L of AC and 120-minute UV light exposure. The LH kinetic modeling suggested that AC served as both an adsorbent and photocatalyst under UV irradiation, facilitating the formation of reactive radicals to promote RB5 degradation. Overall, AC and UV light used in combination provided an effective and inexpensive method of RB5 removal, addressing limitations of conventional methods. The design of a large-scale reactor and a process to recycle AC following treatment will be required for industrial implementation.

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Third Award of $1,000