Oxidative Studies for the Degradation of Organic Dyes

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ORGANIC DYES

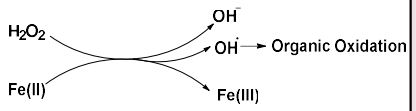
Dyes found in wastewater from textile or food industries damage ecosystems via discoloring water and filtering sunlight. These dyes are often designed to resist photodegradation, resulting in incredibly persistent compounds. This currently removal is performed through bioremediation, or energy-intensive physical techniques. Some research has been performed towards chemical degradation, often resulting in a secondary pollutant. Promising results have been seen from oxidative techniques, such as Fenton Chemistry.

FENTON CHEMISTRY

Fenton Chemistry is the iron mediated production of a hydroxyl radical from hydrogen peroxide. This technique is desirable for the study of the breakdown of dyes, as a hydroxyl radical can quickly breakdown chemicals into multiple byproducts. These byproducts can then continue to be mineralized into carbon dioxide and water. This oxidative process is an incredibly efficient technique, and one of few shown to effectively break down dyes.

GOALS:
1. Confirm Fenton chemistry as a valid technique for the degradation of organic compounds
2. Use Fenton chemistry in order to degrade azo dyes

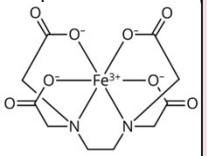
$$Fe^{II} + H_2O_2 \longrightarrow Fe^{III} + HO^{\bullet} + {}^{\ominus}OH$$



LIGAND DESIGN

Iron ligands can vary in denticity, from mono to hexadentate. An antioxidant ligand would fully bind Fe(II), such that it would be unable to be oxidized to Fe(III) for the Fenton reaction. Conversely, oxidation promoting ligands do not fully chelate iron, and therefore an Fe(II) oxidation proceeds unimpeded.

EDTA is the standardized divalent metal ligand due to its availability, and used in the hydroxyl radical assay. However, EDTA is persistent in the environment, and mobilizes heavy metals or other undesirable compounds through their dissolution.



Fe(III) - EDTA

Goal:
3. Design an Iron chelator(s) that is prooxidant & biodegradable

LITERATURE

Oviedo, C.; Rodríguez, J. EDTA: The Chelating Agent under Environmental Scrutiny. *Química Nova* **2003**, *26* (6), 901–905. https://doi.org/10.1590/s0100-40422003000600020.
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PROCESS

Assay for hydroxyl radical generation. Process is validated through positive and negative controls.

Synthesize biodegradable, nontoxic, and prooxidant ligand(s) to replace EDTA as the iron chelator.

Develop Fenton assay and confirm degradation of azo dye (Methyl Orange) with environmentally-preferred ligand .

Confirm biocompatibility and investigate breakdown products and environmental persistence.

ANALYTICAL ANALYSIS: UV-VIS Spectroscopy