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UVC induced TOC removal studies of Ponceau S in the presence of oxidants: Evaluation of electrical energy efficiency and assessment of biotoxicity of the treated solutions by *Escherichia coli* colony forming unit assay

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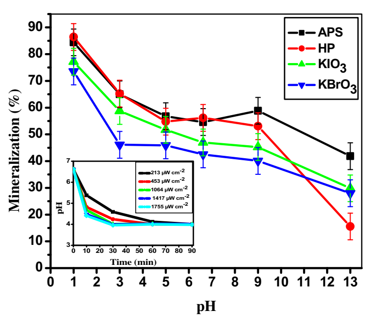
HIGHLIGHTS

- More than 50% mineralization of Ponceau S is equally by UV/H_2O_2 and UV/$(NH_4)_2S_2O_8$ in acidic to basic media.
- Efficiency for both systems follows the order: pH 1 > pH 3 > pH 5 ≈ pH 6.62 ≈ pH 9 > pH 13.
- Treatment at pH 1 is 4.2 times more economical than at pH 6.62 in terms of electrical energy consumption.
- Recommended parameters for treatment are: pH 6.62, UV intensity – 1417 μW cm^{-2}, oxidant – H_2O_2.
- Complete detoxification after mineralization is achieved when the pH is adjusted to 7.

GRAPHICAL ABSTRACT

Effect of $(NH_4)_2S_2O_8$, H_2O_2, KIO_3 and $KBrO_3$ as oxidants on mineralization of Ponceau S: [Ponceau S] = 0.05 mM; [oxidant] = 0.95 mM; exposure time = 90 min; UV intensity = 213 μW cm^{-2}. Inset: Effect of UV intensity and exposure time on initial solution pH: [PS] = 0.05 mM; [HP] = 0.95 mM; initial pH 6.62.



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ABSTRACT

Mineralization of Ponceau S (PS), an anionic azo dye, was studied using UV_{254} in the presence of hydrogen peroxide (HP) and ammonium persulphate (APS). Effect of operational variables like pH, oxidant concentration and intensity of UV light, etc. on mineralization was analyzed. Biotoxicity of the treated solutions was evaluated by *Escherichia coli* (*E. coli*) colony forming unit (CFU) assay to know the suitability of the treated solutions to be released as effluents. HP and APS show equal efficiency towards mineralization at a given pH except 13, where higher mineralization was shown by APS than HP. The pH dependency of mineralization follows the order: pH 1 > pH 3 > pH 5 ≈ pH 6.62 ≈ pH 9 > pH 13. A preliminary study involving KIO_3 and $KBrO_3$, reveals that >73% mineralization is achieved at pH 1, while it varies from 40% to 46% in the pH range of 3–9. Thus, the overall efficiency of the oxidants follows the order: APS ≈ HP > KIO_3 > $KBrO_3$ in acidic to neutral pH and APS > KIO_3 ≈ $KBrO_3$ > HP at pH 13. The cost of treatment, evaluated on the basis of electrical energy per order (EE/O) was found to be higher at pH 6.62, the natural pH of PS, than at pH 1. Considering environmental impact and cost of treatment at extreme low pH, the ideal pH of treatment should be 6.62. Most importantly, the treated solutions still possess biotoxicity even after high mineralization and we are able to reduce the biotoxicity to the extent of 90%.

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