

Oxidative Degradation of waste water from dye industry by oxone

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Abstract:

Waste water from textile industry is highly colored and of a complex and variable nature. Due to their refractory nature it is matter of environmental concern. A substantial amount of dyestuff is lost during dyeing process in textile industry, which poses major problem for industry as well as threat to environment. Hence waste water treatment of dye bath is needed. It involves electrodegradation, photocatalytic degradation and oxidative degradation etc. The waste water treatment of dye bath involve degradation and removal of color by oxidation processes. These oxidative processes are useful for the treatment of waste water from the textile industries which allows it for reuse. In the present work oxidation of dyes by peroxomonosulphate (oxone) was undertaken and mechanism of the reaction is deduced. It was observed that the process is useful for various dyes like methylene blue, malachitegreen, crystal violet etc. The oxidative degradation also removes the color of the water from dye industry.

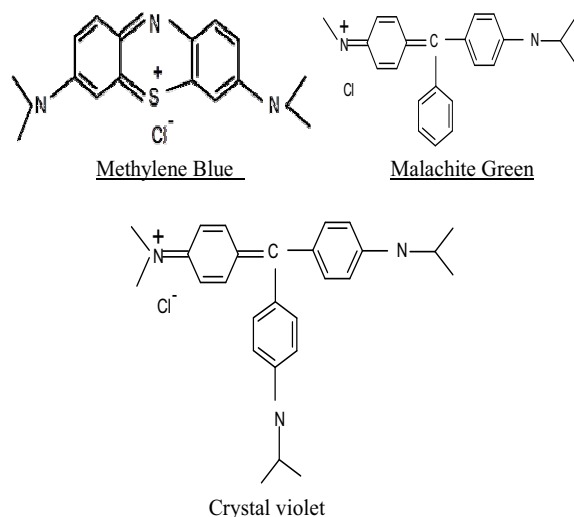
Keywords: electrodegradation, photodegradation, oxidativedegradation

Introduction:

A substantial amount of dyestuff is lost during dyeing process in textile industry, which poses major problem for industry as well as threat to environment (Zollinger *et.al.*, 1987). Hence waste water treatment of dye bath is needed. In the present work oxidative degradation of dyes by peroxomonosulphate (oxone) was undertaken and mechanism of the reaction is deduced. It was observed that the color is removed completely.

Material and methods:

Reagent grade chemicals and doubly distilled water were used throughout the work. The solution of respective dyes (BDH) were prepared by dissolving in distilled water. The solutions of Oxone (Lancaster) were freshly prepared and standardized iodometrically. The reaction was studied under pseudo-first order condition at constant temperature. The reaction was initiated by mixing the thermostated solutions of respective dyes and oxone. The reaction mixture also contained required amount of sulphuric acid and doubly distilled water according to need of reaction conditions. For methylene blue the reaction was followed by measuring the absorbance of methylene blue at 661 nm in an Elico SL 159 UV-VIS spectrophotometer. For crystal violet, the reaction was followed by measuring the decrease in absorbance of crystal violet at 588 nm as a function of time. For malachite green the reaction was followed by measuring the decrease in absorbance of malachite green as a function of time.



Results and Discussion

Methylene blue: (MB), an intense blue dye, is used as staining and sensitizing agent in biological reactions (Kohen *et. al.*, 1983). It is also used as catalyst, as a polymerization inhibitor, and as a complexing agent (Cizek and Studlarova, 1984). An oscillatory reaction between MB and sulfide has been reported by Burger and Field (Burger and Field, 1984). In literature vanadium (v) catalyzed oxidation of methylene blue by potassium bromate has also been carried out. The study of oxidative degradation of dyes is important in view of waste water treatment of textile industry. Therefore, the study of oxidation of MB by oxone was carried out to understand the probable mechanism. The product analysis was found to be Azure A (Killan and MacNeal, 1926). Therefore, from the stoichiometric study the dark blue precipitate obtained in the present study was also assumed as Azure A.

Malachite Green: MG is active against the oomycete *Saprolegnia*, which infects fish eggs in commercial aquaculture, and other fungi. Furthermore, MG is also used as a parasiticide and antibacterial. It is a very popular treatment against *Ichthyophthirius* in freshwater aquaria. The principal metabolite, LMG, is found in fish treated with malachite green, and this finding is the basis of controversy and government regulation. It was concluded that malachite green caused carcinogenic symptoms, but a direct link between malachite green and liver tumor was not established (The Wikipedia, free encyclopedia).

The oxidation product of malachite green is found same as crystal violet that is benzoic acid and diphenylquinone-4,4'-(bis)dimethylimine as reported earlier in the oxidation of malachite green by peroxydisulphate ion (International Journal of Chemical Kinetics, 1992).

Crystal violet: Methyl violet 10B has six methyl groups. It is known in medicine as Gentian violet (or crystal violet) and is the active ingredient in a Gram stain, used to identify bacteria. Gentian violet destroys cells and can be used as a disinfectant. It is poisonous to some or most animals, including dogs and cats, and should never be used as a wash for animals' skin. 10B also inhibits the growth of many Gram positive bacteria, except streptococci. When used in conjunction with nalidixic acid (which destroys gram-negative bacteria), it can be used to isolate the streptococci bacteria for the diagnosis of an infection. Methyl violet also binds to DNA. This means it can be used in cell viability assays in biochemistry. However, this binding to DNA will cause replication errors in living tissue, possibly leading to mutations and cancer.

Methyl violet is a mutagen and mitotic poison; therefore concerns exist regarding the ecological impact of the release of methyl violet into the environment. Methyl violet has been used in vast quantities for textile and paper dyeing, and 15% of such dyes produced worldwide are released to environment in wastewater. Numerous methods have been developed to treat methyl violet pollution. The three most prominent are chemical bleaching, biodegradation, and photodegradation. Chemical bleaching chemical bleaching is achieved by oxidation or reduction. Oxidation destroys the dye completely

Mechanism

The ion pair formed undergoes internal oxidation and reduction to produce a labile cyclopropane derivative (I) with a positive charge on the tertiary carbon atom. This labile cyclopropane derivative, a strong electrophile is attacked by a water molecule, with consequent release of proton in solution. Cyclopropane ring opening occurs due to the strain on the ring as well as restoration of aromaticity

to the quinoid ring systems. The subsequent rapid reaction with another water molecule result in formation of dimethylaminobenzoic acid and the intermediate II (N,N,N',N'-tetramethylbenzidine). Such intermediates are reported in related malchite green oxidation by various oxidizing agents (Jonnnalagadda and Mushinga, 1992). The intermediate II further react with another oxidant to give one of the final product diphenylquinone-4,4'-(bis)dimethylimine. Thus the oxidative degradation of the dyes and waste water from dye industry is possible.

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