

DECOLORIZATION OF AZO DYE TEXTILE ACID BROWN 75 BY ADVANCED OXIDATION PROCESS AND OPTIMIZATION OF OPERATING PARAMETERS.

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Abstract

The photooxidation of textile dye Acid Brown 75 (AB75) was investigated with the goal of determining a rate expression for the decolourization kinetics using H₂O₂/UV with a high Hg UV lamp. The effects of reaction pH, applied H₂O₂ dose and temperature have been studied. The increase of initial dye concentration decreases the removal rate. Decolourization is complete in a relatively short time (10 min.). It was not significantly influenced by temperature. Natural pH (6,8) was found to favour the degradation rate. As the initial concentration of H₂O₂ increased, the rate of decolourisation increased. Consequently, was determined the relationship between of decolourisation rate constant (k_{obs}) and initial concentration of H₂O₂ at constant UV light intensity as: $K_{obs} = 0,77[H_2O_2]_0^{0,39}$. The experimental results indicated that the kinetics of both oxidation processes fit well by pseudo-first order kinetics.

Keywords: Dyeing wastewater; Azo dyes; Advanced oxidation processes (AOPs)

Introduction

Azo dyes are synthetic organic colorants, characterized by chromophoric azogroups (–N=N–). Currently, there are over 3000 azo dyes in use worldwide and they account for 65% of the commercial dye market. These dyes offer a wide spectrum of colours and are used for colouring a variety of consumer goods, such as leather, clothes, food, toys, plastics and cosmetics. However azo dyes are highly recalcitrant to conventional wastewater treatment processes. Biological treatment of wastewater is often the most economic alternative. However due to its complex structure most of the dyes are resistant to biodegradation. During the last decades new methods for wastewater purification, the called Advanced Oxidation processes (AOPs), have received considerable attention (Ahlstrom *et al*, 2005).

Methods

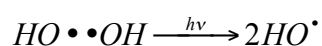
The irradiation experiments were carried out in a cylindrical photoreactor Heraeus Noblelight (Kleinnosheim, Germany) with a total volume of 850 cm³. The UV irradiation source was a 150 W high-pressure mercury vapour lamp TQ 150 Heraeus Noblelight.

Toxicity of the phototreatment effluent was analyzed by Bacterial Bioluminescence Standard Test 8050B, (Eaton *et al*/1998), using a Microbics M500 photometer (Carlsbad, CA).

The initial dye concentrations was usually 1,8 10⁻⁵ M, within the range of typical concentrations in textile wastewaters, except in experiments where the effect of initial concentration was studied. The remaining dye was monitored using a spectrophotometer UV/VIS Jenway, model 6505 by continuously recording the absorbance of the substrate in the spectrophotometer at a wavelength of 430 nm, where has an absorbance maximum. The dissolved oxygen was monitored using an oximeter Crison, model OXI45. The temperature of the irradiated solutions was checked continuously. Samples were taken at predetermined time intervals to measure pH.

Results and discussion

The primary experiments were carried out under the following conditions: a) dye solution with H₂O₂ in dark; b) self photolysis of dye solution; c) dye solution with H₂O₂ and UV light. The results demonstrated that neither H₂O₂ nor UV alone was able to appreciably decolorize. UV irradiation can cause discoloration of the solution. Nevertheless, irradiation times required to obtain a clean solution are prohibitive, thus UV irradiation alone cannot be used as an effective procedure for removal of AB75 from water. This process can be substantially improved in the presence of H₂O₂, (Behnajady *et al.* 2006). The combination of UV/ H₂O₂ was, more effective in the decolourization of the dye. This can be related to the production of hydroxyl radicals, a powerful oxidizing agent generated from the photolysis of H₂O₂ by UV light, following the reaction:



This radical is a very powerful and non-selective oxidant, able react with inorganic, as well with aliphatic, or aromatic organic compounds making possible the degradation of the dyes, (Galindo *et al* 1998).

The increase of initial dye concentration decreases the removal rate. Decolourization is complete in a relativity short time (10 min.). It was not significantly influenced by temperature. Natural pH (6,8) was found to favour the degradation rate. As the initial concentration of H₂O₂ increased, the rate of

decolourisation increased. In order to observe the effect of oxidant concentration on the rate of degradation in UV/ H₂O₂ process, experiments were carried out by varying the dose of H₂O₂ from 3 to 60 mM. At low H₂O₂ concentrations, formation of HO· radicals is the kinetic determining step. H₂O₂ cannot generate enough hydroxyl radicals and the oxidation rate is logically slow. The decolourisation rate of AB75 in aqueous solution increases with increasing the initial H₂O₂ concentration. But when initial concentration of H₂O₂ is >37 mM, the decolourisation rate decreases with the increase of initial H₂O₂ concentration (see Fig.1). This behaviour is proof of the existence of an optimal dosage in H₂O₂, (Ince *et al*1997).

Consequently, was determined the relationship between of decolourisation rate constant (k_{obs}) and initial concentration of H₂O₂ up to 37 mM at constant UV light intensity as: $K_{obs} = 0,77[H_2O_2]_0^{0,39}$.

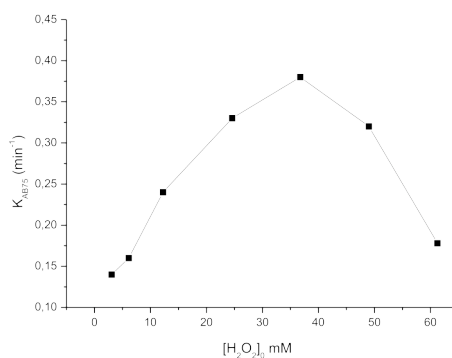


Figure 1. Effect of the concentration in hydrogen peroxide on the efficiency of photocatalytic degradation of AB75.

Conclusions

The UV/H₂O₂ process is a the effective and rapid method for discolouration of dilute aqueous azodye solutions that permit degraded in solution $1,8 \cdot 10^{-5}$ M of the AB75 and $3,6 \cdot 10^{-2}$ M in H₂O₂ at dissolution natural pH and room temperature in 10 minutes with a UV polychromatic radiation. This process does not generate toxic subproducts. The kinetics of the degradation depends on the H₂O₂ initial concentrations, and on the pH of the solution. Temperature does not have a significant influence. The rate of decolourisation increased linearly with the increase of initial concentration of H₂O₂. It is determined the optimum molar ratio of H₂O₂ to dye for the process.

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