Effect of pH and Doses of H_2O_2 on Degradation of 2- Toluic acid

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Abstract:

The present study was used to probe the treatment of simulated wastewater containing 2-toluic acid by photoperoxidation processes. Experiments were conducted in a batch photo reactor to examine the effects of operating variables like pH and ratio of H_2O_2/COD. A pseudo-first order kinetic model was adopted to represent the photo-oxidative degradation of 2-toluic acid. The degradation of 2-toluic acid was found to be maximum at pH 4.5 and ratio of H_2O_2/COD equal to 5.

Keywords:
2-toluic acid, photoperoxidation, pseudo-first order.

Introduction:

In recent years, various studies have reported the occurrence of a large number of pharmaceuticals in surface water, but also in ground water. Surface water and ground water are widely used as water resources for drinking water. Therefore, the widespread occurrence of pharmaceuticals may have a negative impact on purity of drinking water. Complete removal or reduction of hazardous organic pollutants present in wastewater to an acceptable level prescribed by the environmental protection agencies is of prime importance in wastewater treatment. Advanced oxidation processes(AOPs) are the most promising technologies for destroying toxic organic contaminants (Legrini et al.,1993; Kim et al.,1997; Kim et al.,1997).Consequently, AOPs are of high interest to the scientific and industrial communities involved in water treatment and have been successfully applied to the detoxification of water polluted with a wide variety of chemicals such as pesticides , phenols, hydrocarbons, surfactants, dyes and pharmaceutical wastes(Kavitha et al., 2005; Fernando et al.,1992; Anipsitakis et al., 2003; Beunrostro et al., 2000; Gogate et al., 2004; Bader et al.,1981; Lin et al.,1999).

2-Toluic acid is produced from oil industry, petroleum refining, etc. It is used as a solvent carrier in paints, inks, thinners, coatings, adhesives, degreasers, pharmaceutical products, printing industry, leather finishing industry, rubber coating industry, shoemakers, etc. 2-Toluic acid is produced as an industrial waste from olive oil distillation industries, chemical and pharmaceutical industries. The objective of this study is to degrade 2-toluic acid by photo peroxidation, to examine the effects of operating variables like pH and ratio of H_2O_2/COD and to show that it follows a pseudo-first order kinetics.

Material and methods:

Chemicals

Analytical grade 2-toluic acid was purchased from Merck, India; and was used as received without any further purification and stock solution of 0.01M of 2-toluic acid was prepared. Initial concentration of 2-toluic acid used during the experimental runs was 0.08 mM. Stock solution of H_2O_2 was prepared by diluting 30% w/v of peroxide (Qualigens) with distilled water. All stock solutions were stored in amber colored light resistant pyrex glass bottles. Sodium hydroxide (1N) and sulphuric acid (1N) were used for pH adjustments.

Experimental procedure

Batch experiments were conducted at room conditions to determine the effect of pH and H_2O_2 concentration during degradation of 2-toluic acid. All experiments were conducted out in a photoreactor (Fig. 1) equipped with low pressure mercury lamp (8W, UV-C manufactured by Phillips, Holland) placed in its centre. During the reaction, the solution was stirred by magnetic pellet to ensure its homogeneity.

Synthetic wastewater containing 0.08 mM solution of 2-toluic acid in double distilled water was used in this study. 750 ml. of this synthetic wastewater was taken in the photoreactor and irradiated with UV lamp of 8W. Various experiments were carried out using UV light with oxidant at various stoichiometric ratios of oxidant/pollutant. The overall degradation reaction was carried out for 3 h with H_2O_2 as oxidant.

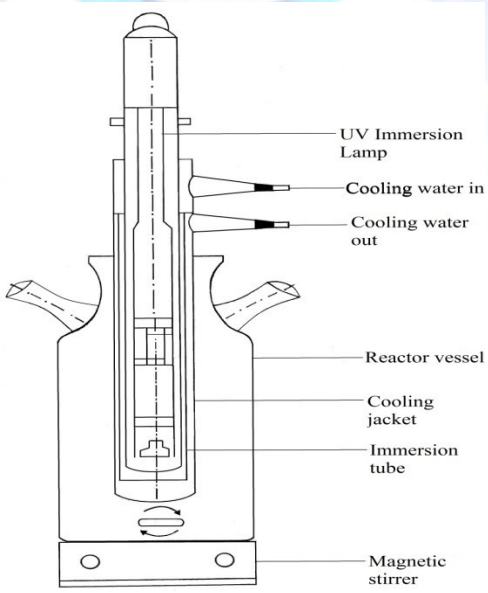

Figure. 1-Photoreactor

Analysis-

The initial pH of the solution was measured using Elico pH meter LI-120 equipped with a combined calomel-glass electrode. The H_2O_2 concentration in the stock solution and in samples was determined by

standard iodometric titration method described in Jeffery et al. (1989).The UV-visible spectrophotometric method was used for measurement of 2-toluic acid, ozone and H_2O_2 concentration in aqueous solution. A UV-visible spectrophotometer (Shimadzu UV 1800, UV Spectrophotometer) was used for this purpose. A calibration plot between absorbance and concentration of 2-toluic was plotted experimentally, which gave a high linear regression coefficient of 0.999 at 228nm (Fig. 2).

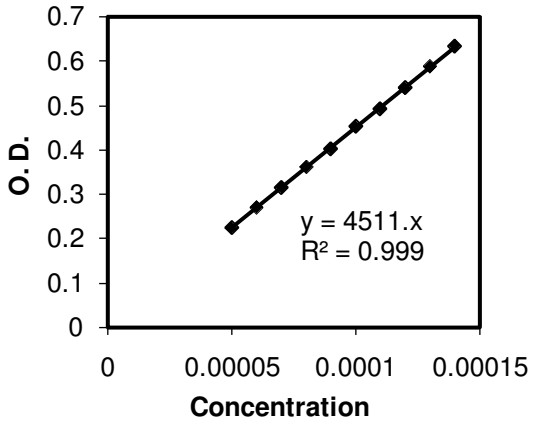

Figure. 2- Beer's law plot of 2-toluic acid

Result and Discussion:

The results of the various studies in the present investigation are presented subsequently.

Effect of pH -pH is one of the most important parameters to be studied. The rate of degradation of 2-toluic acid at different pH was observed by carrying out the experiments at different pH conditions namely plain water, 3, 4.5, 7 and 9.2. As depicted in the Fig. 3, in case of H_2O_2 /UV, the maximum degradation of 2-toluic acid was achieved at pH 4.5 and shows decreasing trend of degradation at higher and lower pH.

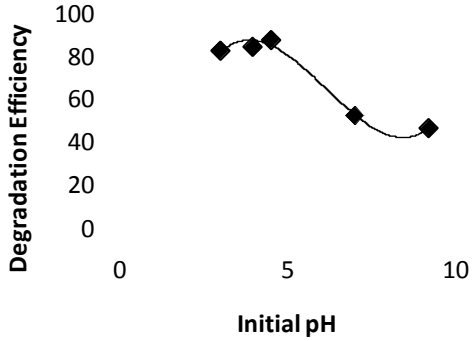

Figure. 3- Effect of initial pH on degradation efficiency for 2-toluic acid (conditions: [2TA] = 0.08 mM, H_2O_2 /COD = 5)

Effect of dose of H_2O_2/COD ratio on degradation of 2-toluic acid

By carrying out a series of experiments of 2-toluic acid (with different ratio of H_2O_2/COD namely 2, 3, 4, 5, 6); the optimum H_2O_2 stoichiometric ratio was found to be H_2O_2 /COD=5(Fig. 4).

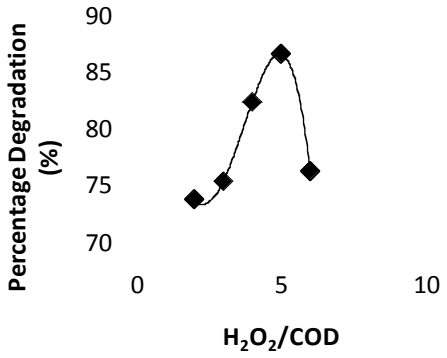

Figure. 4- Effect of initial H_2O_2/COD on degradation efficiency for 2-toluic acid (conditions: [2TA] = 0.08 mM, pH = 4.5)

The kinetic study-

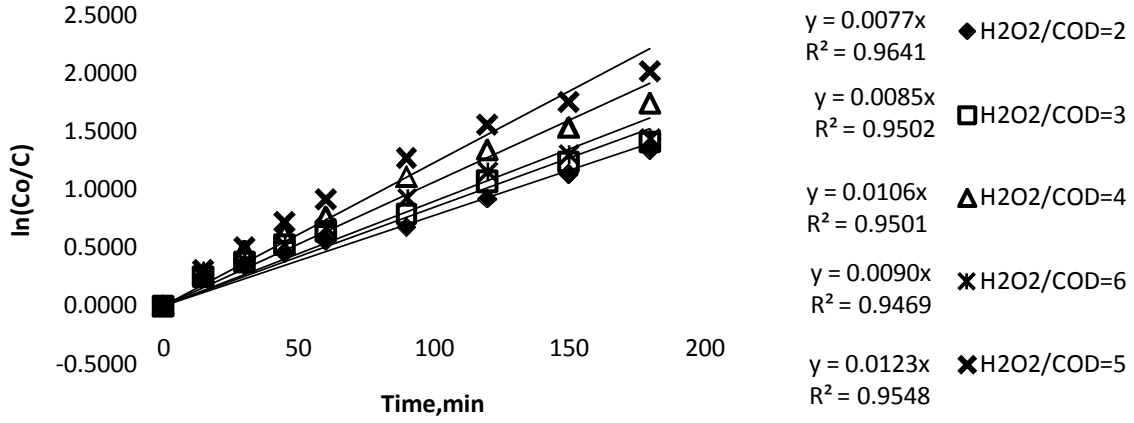

Figure. 5-Concentration decrease 2- toluic acid as a function of time

The semi logarithmic graph of the concentration of 2-toluic acid with time yield a straight line indicating the reaction is of pseudo first order (eq. A)

$$-d\,[C(x)]\,/dt = k\,.\,C(x) \quad \ldots\ldots\ldots\ldots (A)$$

Where C(x) is the concentration and k (min^{-1}) is reaction rate constant.

Conclusion:

Treatment of simulated wastewater containing 2-toluic acid by simple photoperoxidation has been evaluated in the present study. The obtained results lead to following conclusions:

The optimum operating conditions for photoperoxidation of treated water was H_2O_2/COD =5 and pH 4.5. Under this condition the maximum degradation of 88% in 3 hrs. was obtained. The present AOP studied adhered

to pseudo-first-order kinetics. This is justified since peroxide in case of photoperoxidation (UV/H_2O_2) is in excess as compared to the substrate concentration.

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