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Review Article

A Review on Studies and Research on Dye Decomposition and Treatment

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ABSTRACT

Synthetic dyes are widely used in industries. Various dyes such as methylene blue, azo dyes are used for various applications. The effluent containing dyes is a serious global problem because of its properties and toxicity. The removal and decomposition of dyes can be carried out by various chemical methods, oxidation, ozonation as well as photochemical methods. Adsorption is also effective way for dye treatment of wastewater. Various investigators have carried out investigation on dye removal and decomposition. Various aspects such as affecting parameters, isotherms and kinetics have been studied and the results have been reported. The current review summarizes the research and studies on dye decomposition and treatment for water containing dyes.

Key words: decolourization, kinetics, isotherm, oxidation, concentration.

INTRODUCTION

Wastewater treatment for removal of various pollutants is becoming increasingly important area of investigation. The presence of various pollutants calls for specific treatment for removal of specific pollutant. The wastewater may contain organic matter, heavy metals, dyes, phenolic compounds and various biological species. Various physical, chemical and biological methods can be used for removal of organic matter from wastewater. [1-4]

The removal of heavy metal can be carried out by biological methods such as activated sludge process and trickling filters. [5-8] Adsorption can be used for removal of organic matter very effectively. [9-12] Adsorption also finds application in removal of heavy metals from wastewater. [13-15] The removal and decomposition of dyes is also widely investigated area of research Current review summarizes research on dye decomposition and treatment.

Research and Studies on Dye Decompositin and Treatment

Abo-Farha carried out an investigation on photocatalytic degradation of monoazo and diazo dyes in wastewater on nanometer-Sized TiO_2. [16] He investigated homogeneous photocatalytic degradation of the two azo dyes with UV/H_2O_2 process. He observed the rate of disappearance of azo dye spectrophotometrically. He observed that that the rate of decolorization rises by increasing the initial dosage of H_2O_2 up to a certain critical value at which it is maximum and beyond which it is inhibited. Also the reaction followed first order kinetics. They also observed that the rate of photocatalytic degradation depends on dye structure, dye concentration, TiO_2 concentration and pH of the medium. Oakes and Gratton investigated the oxidation of Methyl Orange and substituted arylazonaphthol dyes by peracids in aqueous solution. [17] They carried out kinetic and product analyses

have been made of the oxidation of an activated azo dye, 4-(4-sulfophenylazo), Ndimethylaniline (Methyl Orange, 1). They observed that the dimethylamino group has a lower affinity for protons (pKA~2); formation of the ammonium ion results in a weaker absorption peak centred at 320 nm at lower pH.

Ameta et.al investigated photocatalytic decomposition of malachite green. [18] They used Lead chromate powder as a photocatalyst for the decomposition of malachite green dye in aqueous solution. They observed that the rate of decomposition was affected by different parameters such as pH, amount of photocatalyst, concentration of malachite green and intensity of light. An investigation on treatment of textile industrial dyes by simple ozonation with water recirculation was carried out by Poznyak et.al. [19] In their investigation, three textile dyes were destroyed by ozone in water solution. They observed decomposition of dyes by simple ozonation at the initial pH of the aqueous colorants solutions. They observed that the ozonation of dyes solutions has not any influence on the coloration quality in 6 times water recirculation for DR28 and BG4, and in 8 times water recirculation for RB5.They also found that dyes are completely destroyed in ozonation with the formation of final products (malonic and oxalic acids).

Salehi et. al. carried out investigation on kinetics in catalytic removal of methylene blue with TIO_2 nanopowder. [20] In their investigation, they carried out degradation of methylene blue as a dye pollutant in the presence of TiO_2 nanopowders using photolysis and sonolysis systems separately and simultaneously. Also they ascertained effect of different parameters such as catalyst dosage, initial concentration of dye, UV power, pH and type of catalyst on the removal efficiency. They observed that basic pH is proper for the photocatalytic removal of the dye. The kinetic data followed the pseudo-first order model.

Achmad et.al. carried out an investigation on adsorption of direct dye onto a novel green adsorbent developed from uncaria gambir extract. [21] They chemically modified Uncaria gambir extract for the purpose of developing a novel green adsorbent. They observed that the kinetics of adsorption of Direct Red 23 followed a pseudo-second-order kinetic model. The adsorption process of Direct Red 23 was found to be endothermic and spontaneous.

Perkowski and Ledakowicz carried out investigation on decomposition of anthraquinone dye in the aqueous solution by ozone, hydrogen peroxide or UV radiation. [22] They investigated the effect of the ozone dose and concentration, as well as the temperature on decolourization at different initial dye concentrations. It was observed that low ozone concentrations enabled its better utilization in the reaction with the dye, although the process rate was slow. Also an increase of gas flow rate and ozone concentration at the reactor inlet caused a decrease of ozone consumption from 80% to 49%.They also observed that the yield of anthraquinone dye photolysis in the aqueous solution was affected by both the power of the UV lamp and the character of the light which it emitted.

Mir et.al carried out an investigation on the photocatalyzed decolorization kinetics of two azo dye derivatives, Ponceau BS and Reactive Blue 160 under a variety of conditions in aqueous suspension of TiO2 using UV light. [23] They observed that the photocatalytic decolorization of dyes under study followed pseudo first-order kinetics. They also found that the decolorization efficiency was efficient in acidic medium which gradually slowed down in the alkaline medium due to the effect of charge repulsion.

Xu et.al. carried out research on kinetics and optimization of the

decolorization of dyeing wastewater by a schorl-catalyzed Fenton-like reaction. [24] They observed that that the first-order kinetic model was more favorable to describe the decolorization under different reaction conditions than the second-order and Behnajady–Modirshahla–Ghanbery models. The behavior of water solutions of dyes under the influence of oxidizing agents was described by Mackowska et.al. [25] They found that the chemometric analysis can be successfully applied for examination of the mechanism of decolourization of dyes with the use of oxidizing agents. Wang et. al. studied the sonochemical degradation in aqueous solution of methyl violet. [26] They investigated the influence of the initial concentrations, reaction temperature and the pH of medium on the ultrasonic decomposition of methyl violet. They observed that with increasing initial concentration, the degradation rate coefficients decreased. Also it was found that the ultrasonic degradation rates of methyl violet in acidic water are higher than those obtained in neutral aqueous solution.

Trujillo-Ortega et.al studied modeling of the removal of indigo dye from aqueous media in a sonoelectrochemical flow reactor. [27] In their work, electrochemical and sonoelectrochemical treatments were evaluated as alternative methods to remove dyestuff from textile industry wastewater. They found that when the sonoelectrochemical process was applied using carbon steel electrodes, it was possible to remove up to 90% of the indigo dye. Shajahan carried out equilibrium and kinetic studies on the removal of methylene blue dye from waste water using jumbo grass (Sorghum Bicolour Sorghum Sudanefe). [28] They observed that equilibrium data were well fitted to the Langmuir isotherm, Freundlich and Temkin model. Pseudo second order and Elovich kinetic models described the kinetic behavior. They found that the raw Jumbo grass serves as low cost adsorbent for removal of methylene blue dye from waste water.

Lazaridis et.al investigated the removal of a reactive color, Cibacron Yellow LS-R, from aqueous solutions by adsorption onto hydrotalcite particles using batch rate experiments. [29] They observed that the sorption capacity is relatively high for most experimental conditions. Hydrotalcite can be considered as a suitable sorbent for this application. Montazerozohori et.al investigated kinetics of photocatalytic degradation of an organic dye in some aqueous buffer solutions using nano titanium dioxide. [30] They studied the effects of various operating parameters such as initial concentration of dye, catalyst dosage, bufferic pH and irradiation time on photocatalytic degradation. According to the Langmuir–Hinshelwood model, at all used buffer pH values, the photodegradation followed a pseudo-first order kinetics.

CONCLUSION

The dye decomposition and treatment was carried out by various investigators by using photochemical method, ozonation, adsorption and TIO_2 treatment. It was observed by various investigators that the rate of photocatalytic degradation depends on dye structure, dye concentration, TiO_2 concentration and pH of the medium. Dyes are completely destroyed in ozonation with the formation of final products (malonic and oxalic acids). In most of the cases the dye treatment process followed first kinetics.

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