Journal of Engineering and Applied Sciences 13 (5): 1042-1045, 2018
ISSN: 1816-949X

Treatment of Textile Industries Wastewater by Advance Oxidation Process

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Abstract: The industry of textile exhausts large volume of water by different wet processes. The enormous amounts produces of textile waste water heavily charged with un-consumed dyes and other compounds. These dyes involve some kinds of structural of dyes such acidic, basic, reactive and dyes with metal complex structure. Dyes (and their derivatives) represent a class of organic pollutants that perhaps have a toxic property, so, it needs to a special treatment not depend on biodegradation only. The present of dyestuffs in industry of textile waste water causing noteworthy problems in treatment of plants those compounds are difficult to degrade with traditional method. In the present study, we study the removal of dyestuff under advance oxidation process by degradation of dyestuffs under UV light with TiO_2 as a photocatalyst. There are many parameters have been effected by a process like (concentration, pH and initial dyestuff concentration). The results show the optimum conditions for total treatment are (photocatalyst concentration is 175 ppm; pH = 11 and initial dyestuff is 30 ppm).

Key words: Textile wastewater, degradation, dyes, photocatalysis, special treatment, pollutants

INTRODUCTION

Almost textile industries are poisonous and difficult in decomposition because of extremely colored dye effluents. Acute environmental contamination problems caused by some dyes that releasing different poisonous into the aqueous phase. Reverse osmosis and ultrafiltration are an important part of some techniques that can be used to remove colors from textile effluents. As well as all these processes are non-devastating sharply, so, the un-decomposed item only transports into sludge (Ali *et al*., 2011, 2016). Usage enormous dyestuffs quantities through the dying steps of the textile-producing process is main reason for color in the textile industry. Ineffective dyeing operations usually effect insignificant dye residuals being presented in the final dyehouse effluent in hydrolyzed or unfixed forms. Apart from the aesthetic problems relating to colored effluent, dyes also absorb sunlight with high efficiency, thus absolutely threatening the whole ecosystem by blocked the photosynthetic activity of aqueous plants (Kansal *et al*., 2010, 2011). Regular requirements along with an increased public demand for color-free effluent require the implying of a depolarization stage in wastewater treatment plants. The textile waste water of high amounts of (COD) are found as toxic to life of biological. The concentrated colors cause many problems to the life of aquatic and make the water unfit using at the down stream sides of the removal point. The above adverse are prevented the effects of the textile industry waste waters are needed to be discharged and treated (Garcia-Montano *et al*., 2008).

The AOPs (Advanced Oxidation Processes) are currently considered as an effective treatment of the dye removal and COD reduction of textile wastewater. Although, AOPs are including differents reacting systems, their mechanisms are characterized by the situ generations for nonselective Hydroxyl radicals (HO, E° = 2.8 V) and high reactive, able to oxidize and mineralize almost all organic compounds to CO_2 and inorganic ions (Vilar *et al*., 2011; Yonar, 2011). AOPs involve also, both photocatalytic (containing ultraviolet light or ultrasound) and nonphotocatalytic (dark) operations. AOP_s represent as a significant destructive method of removing most of the inorganic and organic contaminants involving reactive colors.

MATERIALS AND METHODS

The suitable dye used in this experiment was eosin yellowish, all the important properties, absorption spectra and structure are given in the following. Titanium PC-105

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was presented by millennium inorganic chemicals and was applied as delivered without current purification. At the preparation of different mixtures double distilled waters were used. For 1 M HCl or 1 M NaOH, the pH value of the mixtures was regulated.

Tools and instruments: Photocatalytic degradation runs were achieved in 2000 mL Pyrex glass cell in UV chamber consists of 8 UV tubes each of 18 W with 365 nm wavelength. The intensity of UV light was estimated by UVA light meter and it was first noted equally to 0.5 mW/cm^2. For obtain uniform mixing of the solution in the vessel, a magnetic stirrer was used int the experiment. The dispersions were stirred magnetically in dark for 25 min$_s$ before exposure to irradiation to involve the establishment of desorption/adsorption equilibriu. pH values of solutions were measured using WTW pH-720 digital pH meter. The jacketed wall reactor was used to ensure temperature stability constant during the time of reactions by circulating water through it and by UV, the spectra were taken via. spectrophotometer. Chemical oxygen demand COD for real textile wastewater measured by (HANNA HI 9146) instrument, (HANNA HI 93703) used for TOC measurement and (Milwaukee 802829) used for another water analysis measurement.

Analysis of textile wastewater: The conventional analysis is used to evaluate the organic content removal and measure, for examples, COD, BOD and TOC (Total Organic Carbon). The require quantity of the oxygen for biological oxidations of the organic cases are called (BOD) and are presented in an effluent. COD represents the measuring of the quantities of oxygen which needed to oxidize the inorganic and organic compounds that present in the effluent. Thus, BOD is often lower than COD and their ratios are an indications of the bio-degradability of the present of contaminants in the water. TOC is measured the organic carbon which is presented in an effluent, involving the part that can't oxidize. Addition to the organic contents, the concentration of other nutrients such inorganic ion must be measured. Specially attentions must be paid to the presences of salts in actual, sodium chloride (NaCl) which is used at high concentration which is promote the dyes binding to fabric and therefore, abundant in resulting waste water.

Irradiation runs: When 200 mL of dye solution was prepared, the photocatalyst was added to the solution and the irradiation light applicate on the suspension when it with UV light. At various times periods, the dosage was taken with small syringe then used Millipore syringe for filtering purpose. Absorption spectrophotometer of dye mixtures were evaluated and the removal rates were noticed in term of variations in intensity at (λ_{max}) of the dye. The removal efficiency percentage determined by:

$$\text{Removel efficiency}(\%) = \left(\frac{C_0\text{-}C}{C_0}\right)\times 100$$

Where:

C_0 = Initial dye concentration

C = The dye concentration after photoirradiation

RESULTS AND DISCUSSION

Effect of TiO$_2$ concentration: The degradation of eosin yellowish dye was simultaneously monitored at 516 nm in the UV/TiO$_2$ system. Eosin yellowish dye was the major dye utilized in all runs were carried out using at (30 mg/L) dye concentration and various catalyst loading 0.1-2 g/L at 120 min of irradiation. Figure 1 shows the degradation percentage of eosin yellowish for 120 min using TiO$_2$ photocatalysts. The results indicate that the optimum dose of TiO$_2$ is 1.75 g/L exhibits higher photocatalytic activity than the other concentration. A concentration of the photocatalyst was an important parameter strongly effecting the rate of photocatalytic reaction (Chan *et al*., 2011). A proportional increase in photodegradation with catalyst loading can obviously emerge in heterogeneous photocatalytic reactions. In order to avoid expecting excess catalyst and involve total absorption of active photons, the best catalyst concentration must be determined in any given photocatalytic application (Rabindranathan *et al*., 2003). In addition because of inadequate light dispersion and reduction of light penetration into the solution is noticed with excess photocatalyst loading (Raheem *et al*., 2016). The similar trend has been perceived in earlier results by azo reactivity of dyes (Lizama *et al*., 2002).

The best pH for treatment: The wastewater is produced at different pHs, therefore, the study of pH is very important on photodegradation of dye. Experiments have been done at different values of pH varying from 3-13 for 30 mg/L dye solution concentration and for the best of catalyst concentration 1.75 g/L of TiO$_2$. Figure 2 shows the percentage photodegradation of eosin yellowish against values of pH. It is clearly increasing in pH up to 11 for TiO$_2$ cause increasing in photodegradation activity (Lathasree *et al*., 2004; Lizama *et al*., 2002). The main analysis effects of pH on the activities of the degradations are a complex subject because many

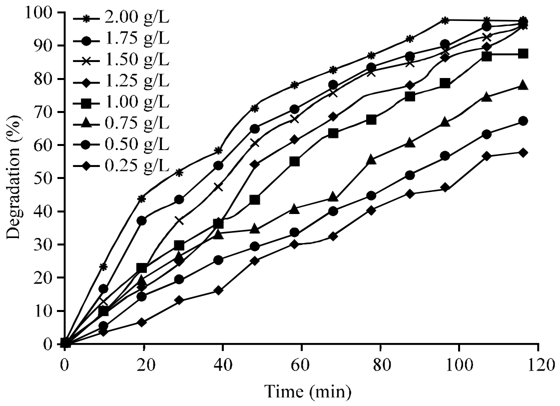

Fig. 1: Photocatalytic degradation of eosin yellowish dye using different concentration of TiO_2

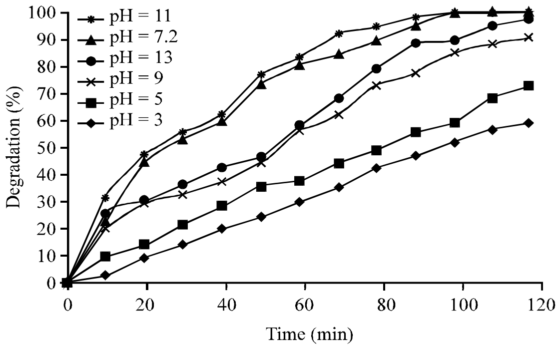

Fig. 2: Impact of pH on photocatalytic degradation of eosin yellowish dye solution 30 ppm using 1.75 g/L of TiO_2

reactions can occur to dye degradation such as "hydroxyl radical reaction, direct oxidation by the positive hole and direct reduction by the electron in the conducting band". The significance of each depends on pH and the substrates nature.

Impact of dye concentration on treatment process: The efficiency of photocatalytic removal of the eosin yellowish dye was examined at different initial dye concentration like 15, 30, 45, 75 and 100 ppm in order to check the efficiency of photocatalyst of TiO_2 at 1.75 g/L catalyst concentration. The results in Fig. 3 shows for the 90 min irradiation time using the TiO_2 as a photocatalyst the photodegradation efficiency of eosin yellowish dye for the initial dye concentration 15, 30, 45, 75 and 100 g/L is 100, 95, 75, 70 and 40%, respectively.

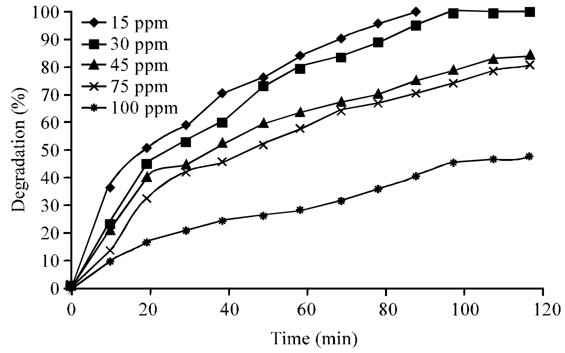

Fig. 3: Impact of feed dye concentration on photocatalytic degradation of eosin yellowish dye solution treatment using 1.75 g/L of TiO_2 and pH = 11

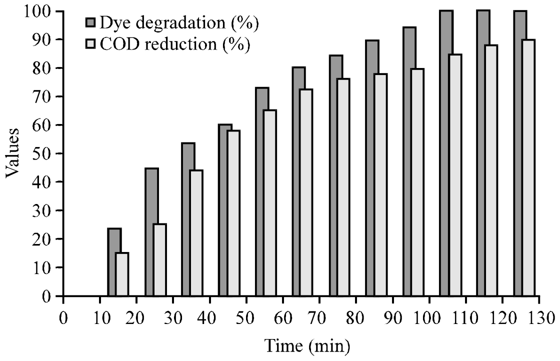

Fig. 4: Chemical oxygen demand reduction and photocatalytic degradation of eosin yellowish dye solution treatment using 1.75 g/L of TiO_2 and pH = 11

When the initial dye concentration of eosin yellowish increases, it was noticed that the wavelength of the entering UV light to the solution decreases gradually, furthermore for the low concentration of initial eosin yellowish dye the efficiency of photodegradation increase there by increasing the amount of UV light pass through the solution in lower concentration (Neppolian *et al*., 2002).

Chemical Oxygen Demand (COD) reduction: The experiments also show the mineralization behavior of eosin yellowish dye, the efficiency of Chemical Oxygen Demand (COD) removal was studied under best conditions at 120 min of irradiation for TiO_2. Figure 4 shows the effectiveness of COD removal as a functional of time of irradiation. The results also, showed the COD removal is lesser than percentage photodegradation. It indicates that it took longer irradiation time to obtain high removal mineralization of dyes. The higher concentration of hydroxide ions in the solution of dye cause more reactive hydroxyl radical groups will be photogenerated (Bhakya *et al*., 2015).

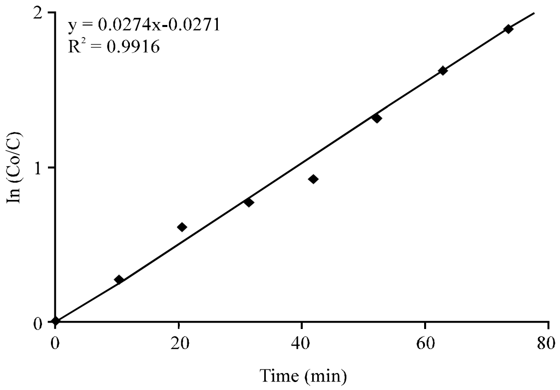

Fig. 5: Kinetic study for the degradation of eosinyellowish dye using TiO_2

Kinetic study: The disappearance of eosin yellowish dye was more clearly in Fig. 5 that shows the kinetic for 30 mg/L concentration initially. The practical values clarify that the photocatalytic removal of eosin yellowish dye with 1 g/L of commercial TiO_2 concentration represented as first order of kinetic model:

$$\ln\frac{C_0}{C} = kt$$

Where:

C_0 = The concentration at time equal zero
C = The concentration at time equal t (y = 0.0274x-0.0271)

In addition from the values of known concentration, a straight line can be noticed from the semi-logarithmic plots. The constant of correlation was calculated for the close-fitting line to $R^2 = 0.9916$.

CONCLUSION

The most purpose of utilizing to promote the ability of bioprocessing for wastewaters containing compounds with different organic materials that are difficult in bio-degradable and/or poisonous to generic micro-organisms, from here AOP_s in his situation are preprocessing methods (Rizzo, 2011).

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