Industrial Waste water Treatment and Reuses for Agricultural Purpose

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Abstract: In the present study, the treatment of industrial wastewater and reuses for agriculture purpose. The photocatalytic degradation of dyes like bismarck brown Y dye has been used as technique for treatment in a batch reactor under solar light in heterogeneous slurry utilizing various concentrations of ZnO as photocatalysts semiconductors. Parameters has been studied (catalyst type, catalyst concentration, pH of dye solution and dye concentration at the beginning). The results show that the best dose of ZnO is 0.80 g/l , and the optimum pH is 10. The percentage removal of chemical oxygen demand (COD) of the dye solutions was higher than that of the degradation of dye for the same conditions of catalyst. Treated wastewater reuse in agriculture is a common practice in the Mediterranean countries and there is a considerable interest in the long-term effects of treated wastewater on crops intended for human consumption. This paper studies the fundamentals of agricultural irrigation using treated wastewater and the status of industrial wastewater reuse in Iraq with studies related to the effects on soils and plants.

1. Introduction

Different dyes containing wastewaters reached to nearly 35% of the industrial effluents and this can be observed obviously in China[1]. So the environmental problems as results of wide manufacturing and employment of dyes have been brought large interests [2]. The treatment processes of this wastewater stay presents a roughly technical challenge to reach the emission standard in spite of various wastewater treatment processes such as physical–chemical and biological ways have been constituted in most of the textile manufacturing plants in China, [1,2]. Azo dyes representing about 70% of all textile dyestuffs produced so it can be considered one of the important reasons that are disobedient to biodegradation and their textures are complicated and extremely varied in the effluents [3]. A considerable problems in treatment plants caused by dyes presents in textile industry wastewaters since those compounds are complex to degrade by biological methods. Some of the effective chemical and physical methods state a high activity of color removals such as coagulation–flocculation, advanced oxidation and electrochemical methods [4–6]. All these methods have operational problems such as high sludge formation in chemical ways in addition to that more expensive. Adsorption can be considered an unattractive method for degradation objective because of the cost of adsorbent and
regeneration requirement. However, recent studies specified the possibility of using some natural or low-cost adsorbents for color removal such as wood, ash and soil [7–8].

The water quality of treated wastewater depends to a great extent on the quality of the industrial wastewater water supply, nature of the wastes added during use, and the degree of treatment the wastewater has received. Wastewater quality data routinely measured and reported at the wastewater treatment plant are mostly for treated effluent disposal or discharge requirements in terms of gross pollution parameters [e.g., biochemical oxygen demand (BOD), chemical oxygen demand (COD), suspended solids (SS)] that are of interest in water pollution control. In contrast, the water characteristics of importance in agricultural and landscape irrigation are specific chemical elements and compounds that affect plant growth or soil permeability. Not all these characteristics are measured or reported by wastewater treatment agencies as part of their routine water quality monitoring program[9].

The aim of this work, is to remove the bismarck brown Y under solar light with various concentration of semiconductors catalyst ZnO by varying process parameters such as (photocatalyst dose, concentration, pH, and feed concentration) to choose the optimum condition for all catalysts.

2. Experimental Part
2.1 Materials

Material was exported from the original company the details of these materials as shown in table 1. It was used the bismarck brown Y dye as contaminated material this dye used in textile. Table 2 shows the chemical and physical properties of bismarck brown Y dye.

| Material                      | Chemical Formula | Company \ Country | Purity |
|-------------------------------|------------------|-------------------|-------|
| Zinc Oxide Commercial         | ZnO 81.38 (g/mol)| Merck \ Germany   | 99 %  |
| Hydraulic Acid                | HCl 36.46 (g/mol)| Merck \ Germany   | 99 %  |
| Sodium Hydroxide              | NaOH 40 (g/mol)  | Merck \ Germany   | 99 %  |
| Distilled Water               | H₂O 18 (g/mol)   | Local Production  | 100 % |

| Chemical Formula | Chemical Structure | Molecular Weight | Absorption Maximum in Water | Appearance   |
|-----------------|--------------------|------------------|----------------------------|--------------|
| C₁₈H₁₈N₈·2HCl   | ![Chemical Structure](image) | 419.33 g/mol     | 468 nm                     | Dark brown powder |
2.2. Preparation of Feed Solutions

The different amount (10, 20, 40 and 60) mg of bismarck brown Y dye to be dissolved in one liter of distilled water at room temperature. In order to prepare feed dye solutions with different pHs (2, 4, 6, 8, 10 and 12), the several drops of prepared solutions of (0.1 M) of HCl and NaOH to be added for varying pH of dye solution.

2.3. Reaction Vessel

Photochemical degradation reaction of the solution compound occurred in the insulation walled reaction vessel to keep the temperature constant this reaction vessel has (800 ml) volume and it was instilled under solar light. The mixing of the solution at all period time of each experiment using a magnetic stirrer (a type of BOECO MSH-330N Germany). When the water circulating in the jacketed wall reactor, the temperature was kept steady during the reaction time.

2.4 Photocatalytic Experiments

All photocatalytic degradation experiments were carried out under similar conditions solar light. For the reaction vessel, an open small cylinder glass of 800 ml and height of 15 cm and diameter of 10 cm was used. The suspension consisting of a mixture of 100 ml of the feed dye solution and photocatalyst was exposed to Solar light. At various time periods, the 6 ml of sample was drawn with help of syringe and then filtered over a milipore syringe filter. At that point, the decolonization rate was noticed in expressions of change in consistency at $\lambda_{\text{max}}$ of the dye and the absorption spectra of the dye solutions were recorded.

2.5 Absorbance Measurements

The absorption spectrum was recorded using double beam UV-1800 Shmadzo spectrophotometer compared with distilled water as a reference liquid and the percentage rate of degradation was noticed in terms of change in intensity at $\lambda_{\text{max}}$ of the dyes during irradiation time.

The percentage of photocatalytic degradation estimated according to the following formula:

$$\text{Photodegradation} \% = \frac{\text{Initial Absorption} - \text{Absorption at time } t}{\text{Initial Absorption}} \times 100$$

3. Results and Discussion

3.1 Best Dose of Photocatalyst

The effect of catalyst concentration on the degradation of bismarck brown Y (20 ppm) was investigated using commercial ZnO from 0.2 to 1 g/l keeping another parameters like pH, temperature, light intensity and dye concentration constant. The results in the Figure 1 showed that the degradation percentage increased with an increase in ZnO commercial concentration up to 0.8 g/l for ZnO. This observation can be explained in terms of availability of active sites on the catalyst surface and the permeation of solar light into the suspension. The total active surface area increases with increasing
catalyst dosage. At the same time, due to an increase in the turbidity of the suspension, there is a decrease in UV-light permeation as a result of increased scattering effect and hence the photoactivated volume of suspension decreases. Furthermore, at high catalyst loading, it is difficult to maintain the suspension homogenous due to particles agglomeration, which decreases the number of active sites [10,11].

3.2 Effect of pH on Solution Treatment

The wastewater is produced at different pHs, therefore, study of pH is very important on photodegradation of dye. Experiments have been done at different values of pH varying from 2 to 12 for 20 mg/L dye solution concentration and for the ZnO catalyst concentration 0.80 g/l. Figure 2 the percentage photodegradation of bismarck brown Y against values of pH. It is clearly increasing in pH up to 8 and 10 for ZnO cause increasing in photodegradation activity [12]. The utilizing of ZnO as the catalyst is more appropriate at high pH values with the textile effluent. The interpretation of pH effects on the efficiency of the decolonization is a complex subject because many reactions can be 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 importance of each one depends upon the substrate nature and pH[13].

Fig. 1 . Effect of ZnO concentration on photocatalytic degradation behavior of Bismarck brown Y dye solution
3.3 Effect of Feed Dye Concentration on Treatment

The results in Figure 3 shows for the 60 minutes irradiation time using the ZnO as a photocatalyst the photodegradation efficiency of Bismarck brown Y dye for the initial dye concentration (10, 20, 40 and 60) g/l is (100, 90, 65 and 42) % respectively.

It was noticed that the wavelength of the Solar light entering the solution decreases when the initial dye concentration of Bismarck brown Y increases, otherwise for the low concentration of initial Bismarck brown Y dye the efficiency of photodegradation increase, thereby increasing the amount of solar light pass through the solution in lower concentration [14,15].
3.4 Chemical Oxygen Demand

The experiments also show the mineralization behavior of Bismarck brown Y dye, the efficiency of chemical oxygen demand (COD) removal was studied under best conditions at 30 minutes of irradiation for ZnO. Figure (4) shows the efficiency of COD removal as a function of irradiation time. 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. More reactive hydroxyl radical species will be photogenerated because of the higher concentration of hydroxide ions in the solution of dye [16,17].
4. Wastewater Treated Properties

Table 3 shows the comparison between actual and wastewater treated properties. The results show the wastewater treated properties close to actual agriculture water that mean the wastewater treated is suitable to reuse for agriculture propose[18-20].

| Potential Irrigation Problem | Units | Degree of Restriction on Use | Actual Water | Treated Water |
|-----------------------------|-------|------------------------------|--------------|---------------|
| Salinity (affects crop water availability) | dS/m | None | Slight to Moderate | Severe | Water Treatment |
| EC | mg/l | < 0.7 | 0.7 – 3.0 | > 3.0 | 0.58 |
| TDS | mg/l | < 450 | 450 – 2000 | > 2000 | 1400 |
| Miscellaneous Effects (affects susceptible crops) | mg/l | < 5 | 5 – 30 | > 30 | 15 |
| Nitrogen (NO₃ - N) | mg/l | < 1.5 | 1.5 – 8.5 | > 8.5 | 5 |
| Bicarbonate (HCO₃) | mg/l | < 1.5 | 1.5 – 8.5 | > 8.5 | 5 |
| pH | Normal Range 6.5 – 8.4 | 7.8 |

5. Conclusions

The comparison of photocatalytic degradation efficiency and COD removal of different type of catalyst and parameters affecting on photocatalytic degradation process of bismarck brown Y dye has been examined in a batch reactor under Solar light in heterogeneous slurry the catalysts ZnO. Parameters have been studied like (catalyst type, catalyst concentration, pH of dye solution, and initial dye concentration). The results also shows the wastewater treated properties is close to water used in industrials

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