Advanced Oxidation Process as a type of photo catalytic removal of Maxilon blue dye (GRL) using

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Abstract

Removal of toxic textile Maxilon blue (GRL) dye from aqueous solution via utilizing TiO2 under UV irradiation. The maximum wavelength of GRL dye at 590 nm. The process of photo degradation was carry out in aqueous solutions having the dye in the presence of TiO2 (Degussa p – 25) upon UV irradiation (high pressure mercury lamp Radium 125 W). The phot catalytic process utilized the photo produced holes at the surface of TiO2 and (OH) at the solution bulk as oxidizing species of the GRL. several factor effecting the phot catalytic degradation method like primary concentration GRL, mass of TiO2 and, intensity light was studied. Data obtained revealed that the GRL percentage % is inversely proportional to its conc. The photcatalytic decomposition of dye GRL was utmost efficient in the solution at lesser primary conc., and greater intensity light.
Keywords: Maxilon blue (GRL), dye, Photo removal, irradiation, TiO$_2$, Advanced Oxidation Process

Introduction

toxic by-products [1] Heterogeneous phot-catalysis including semiconductor catalysts in light irradiation have appear potential advantages in technology of the water treatment [2] and several ecological applications [3] Due to its excellent electronic and optical properties, nontoxicity, high photo stability, and (TiO$_2$) titanium oxide has attracted considerable interest of its uses in removal of toxic gases [4], degradation of wide range of organic contaminants [5] and wastewater treatment [6]. Though, its wide band gap of 3.0–3.2 eV constrains its absorption of light to the UV region, that impairs its performance. In recent years, many Nowadays, effluent management has become one of the critical environmental challenges due to booming population and ever-increasing industrial pollution [7, 8]. Countries all over the world, especially the developing countries, are facing these problems. To achieve sustainable solution to the problem, environmental issues should receive urgent attention.

thus usefulness and significant of organic complex for improve of civilization, dealing with the contaminants has stayed a global issue due to their frequent utilized[7] in many industries like dyeing [9-11], textile [12], agriculture[13] and medicine]. Undoubtedly, the presence of trace amount of dyes in wastewater is greatly unfavorable due mainly to the fact that they are considered as the serious sources of toxic contaminants like phenol and another phenolic complex [14-20]

Classical techniques for remediation of these contaminants like landfilling, solvent extraction, , great-temp. incineration, and U.V radiation are ineffectual as they can destroy these pollutants to some extent, leaving sometimes efforts has been devoted to modify its surface and/or electronic properties to broaden its photo response of light visible in solar irradiation mainly, via metal ions doping [21] and nonmetals doping Recent studies have appear that C-modified TiO$_2$ photo catalyst exhibits an improved photo catalytic activity in light visible [22] reported that the origin of visible-light response of carbon doped TiO$_2$ is due to the presence of the dopant carbons at the oxygen sites of TiO$_2$ and the formation of C 2p states above the valence band. Similarly, theoretical confirmation via they reported that the extension of the absorption range of C doped TiO$_2$ to the region light visible should be attributed to the localization of dopant carbons at the oxygen sites.
Experimental Part:

Materials

TiO₂ Commercial powder were purchased from (Germany/sigma-Aldrich ) dye Maxillon blue (GRL) was corroborative via Hilla factory of textile dyes/ Iraq. whole chemicals utilized in this study and utilized directly. Maxilon blue GRL [C.I. Basic blue 41, chemical formula:C₁₉H₂₆N₃O₆S₂, MW: 456 g/mol, λmax 590 nm] was obtained The Maxilon Blue (GRL), dyes were provided via Al-Hilla of textile industries/Iraq. The respective chemical structures as appear in (Fig. 1). dye was chemical produce of analytical grade. Chemical structures of maxilon blue (GRL) A stander solution of 500 mg/L was prepared via dissolving (0.5 gm) as an suitable quantity of textile dye (GRL) in (1 L) D.W.

![Chemical structure of Maxilon blue GRL dye](image)

Fig1. Chemical structure of Maxilon blue GRL dye

Photo catalytic experiments

Whole experiments were carried out in vessel of photo-reaction in200 ml of full capacity. used mercury lamp at 125 W high-pressure at 365 nm as light source. put The beakers under the ultraviolet light preserve the distance among the light source and the solution surface via utilizer UVA-meter (Dr. Honle/Germany). before to each test, 0.3 gm TiO₂ photocatalyst was added in to 200 mL GRL solution, the mixing was stirred in dark to 30 min to let the physical adsorption of the molecules dye GRL on catalyst particles to reach at equilibrium.

Effect of several operational factor like mass of catalyst (0.5 to 3.0 g L⁻¹), intensity light (1.74 to 10.4 mW cm⁻²), and dye concentration (25–100 mgL⁻¹) on the photo degradation efficiency was studied. The removal percentage of photo-catalytic degradation of dye GRL and apparent first order rate constant was calculated utilizing the following relationships

\[
PDE (%) = 100 \times \frac{(C_0 - C_t)}{C_0} \quad (1)
\]
\[ \left( \frac{C_t}{C_0} \right) = e^{-kt} \]  

(2)

Where, \( C_0 \) and \( C_t \) are the primary and photolyzed conc. (mg/L), at the same order, P.D.E (photo catalytic degradation capacity), \( t \) is time of irradiation (min.)

**Results and Discussion:**

**Effect of mass dosage**

The influence of the photo catalyst concentration (0.5-3.0g/L\(^{-1}\)) on the photocatalytic degradation of dye in the solution with 50 mg/L dye concentration, reaction temperature = 25 °C, time = 1 h. The experimental data could be analyzed assume-first order kinetic as shown in Fig. 2.

![Figure 2: photo catalytic degradation of dye GRL at different mass dosage.](image)

The effect of adsorbent dose on the removal of GRL dye (50 mg/l) as appear in Fig. 3. The increasing of mass dosage about 0.05 - 0.3gm, the removal percentage improved of 44.9 - 88.2% after 1hour of adsorption. [23, 24] The primary rise in rate of GRL degradation in rise mass of catalyst is due to increasing active sites of the surface photo catalyst. Due to this, there is an increase in number of photo
generated electron–hole pair, that data in an rise in number of (OH\(^{-}\)) responsible of GRL degradation [25, 26].

![Graph](image)

**Fig. 3.** GRL, a) photo catalytic degradation efficiency b) degradation rate constant under different catalyst loading.

**Effect of GRL dye concentration**

Different concentrations of GRL 25-100 ppm, were selected to study the effect of initial concentration of dye onto TiO\(_2\). The amounts of dye adsorbed at pH 6, mass dosage 0.25gm and 30\(^{\circ}\)C appear in Figure 4. The primary conc. of GRL dye solution plays a pivotal part in deciding the rate of GRL degradation [26, 27]. The time dependence of photo catalytic degradation of dye under different concentrations. The experimental data could be analyzed to assume-first order kinetic[28] as shown in Figure 4
Effect of light intensity

The effect of light intensity (10.4-1.74 mWcm$^{-1}$) was observed by varying of distance between light source and exposed surface of the semiconductor. dye photo degradation by the effect of light intensity was studied in the presence of catalyst 0.25 g/L$^{-1}$, 2.42 mM dye, flow rate of oxygen 5 ML/min$^{-1}$ and pH 6. It was found that all the reactions still follow the first-order kinetics as appear in Fig.5

The rate of phot-catalytic degradation and the phot-catalytic degradation efficiency were shown in Figure. 6. it was clear from results in Fig. 6 the rate of phot-catalytic degradation and photo degradation efficiency raised with increasing U.V intensity light as more radiation is available to excite the catalyst and hence extra charge carriers are generated resulting in a greater rate of phot-catalytic removal[29-31].
Fig. 5: Photo catalytic degradation of GRL dye at different light intensities

Fig. 6: Effect of light intensity a) rate constant, b) photo catalytic degradation capacity on the photo catalytic degradation of dye GRL.
Conclusions

The obtained data appear that dye GRL can be easily degraded via a TiO$_2$ assisted method in aqueous dispersions under UV irradiation. The photo degradation of the GRL follows first order kinetics and factor such as the concentration TiO$_2$, intensity light and primary GRL conc. The phot-catalytic decomposition of dye GRL was utmost efficient in the solution at low primary conc., and great intensity light.

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