Role of hydrogel: as photocatalytic for decolonization dye from aqueous solution

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Abstract

The photocatalytic method to removal color of methyl red (MR) dye from aqueous solutions in the presence of hydrogel has been studied with the utilize of artificial UV-A light source. The properties of the hydrogel / cds were studied using techniques (FESEM, TEM, and TGA).The effects of several factors, like time of irradiation, amount of hydrogel, initial concentration of MR dye onto photo-catalytic degradation were studies . The rate of de-colorization was found to increase remarkably with increase time of irradiation. Under best conditions from pH=5.4 and temperature at 25 ^{o}C , the extent of removal color of MR dye was 100% after 1hr of irradiation at concentration 15 mg/L . And found the initial rise in rate of MR degradation with increase in quantity of hydrogel is due to increase in number of active sites on the hydrogel of photo catalyst the rate of degradation, and photo-degradation capacity is rising with increasing light intensity.

Keyword: Hydrogel, Dye , Methyl Red, Photocatalytic , Advanced oxidation processes

Introduction

Pollution is one of the main problems that cause an imbalance in the ecosystem and threaten human life, so nowadays it is necessary to have clean water in the presence of large quantities of sewage water[1, 2]. Water pollution is increasing in all industrialized countries, as it affects the human system, as it was found that the most dangerous and toxic compounds, such as heavy metals, medicines, oils and dyes, where organic dyes were produced in many different local industries such as textiles, papers, plastics, foodstuffs and cosmetics. Where the use of these harmful pollutants has led to the pollution of water and the environment, where there are several ways to treat these dangerous pollutants [3, 4]. Different technique like, precipitation, ozonation, oxidation, ion exchange, membrane filtration, coagulation, reverse osmosis, photo-catalytic Dyes are among the most important and dangerous toxic pollutants found in drinking water, as very large quantities of liquid waste containing dyes are discharged. Where about 10-15% of the dyes are discharged during the process of dyeing fabrics, textiles and papers every year [5-8]. As the water that contains the liquid waste of dyes is very irritating as it blocks the passage of sunlight and this causes disturbance to the aquatic ecosystem and living organisms [9-11]. In this study, SA-g-(PAA-co-AM)/CdS hydrogel, was used as an effective adsorbent in de-colorization dye from aqueous solution. Several factors affecting the advanced oxidation processes were studied, like effect of concentration MR dye, mass of SA-g-(PAA-co-AM)/CdS hydrogel catalyst, and light intensity .

Experimental Part

Experiments of the photo catalytic:

The photocatalytic activity of the Nanocomposite catalyst was estimate via the degradation of MR dye. All experiments carry out in a 250ml beaker. The reaction beaker was placed under ultraviolet light, taking into account the distance between the surface of the solution and the light source. Before each test, to obtain accurate results, the lamp is heated for ten minutes. Therefore, a weight of 0.08 g of Nanocomposite was added to MR dye solution with a capacity of 200 ml , and the experiment was initially conducted for (10) minutes known as the so-called adsorption.

Effect of several factor like quantity of (0.05–0.1g L^{-1}), MR dye concentration (5–20 mgL^{-1}) , The PDF% of MR and apparent rate first order constant were estimation in equation 1:

$$\mathrm{PDE}\ (\%) = (C_0 - C_t)/C_0 \ \mathrm{x}\ 100 \qquad (1)$$

Where, C^o : Primary Concentration and Ct concentration of photolysis (mgL^{-1}) .

Results and discussion:

Characterization of Hydrogel nanocomposite

The FESEM technique used to study the properties and morphology of SA-g-(PAA-co-AM)/CdS Nano-composite before and after loading the CdS compound, as shown in (Figure 2(a,b)). It was observed that the hydrogel possess ball-shaped clusters, while after loading the CdS compound on the hydrogel, the surface becomes more rough, and small spherical clusters resulting from the loading of the CdS compound [12-15]. Figure 2(c) appear TEM image SA-g-(PAA-co-AM)/CdS Nano-composite, where CdS was observed embedded inside the hydrogel. The TGA technique of hydrogel, as shown in Figure 2(d), A loss weight was found in range temperature of 25–600 °C, of which 4.914% occurred at low temperatures about 200 oC attributable to evaporation water. The final one, at 360-575 °C, is related to the reduction of compound CdS , and the materials include about 24.86 wt% of hydrogel [16, 17].

Initial MR dye concentration

The dependence of photocatalytic degradation capacity on the MR dye concentration was studied; at pH 5.4, mass of SA-g-(PAA-co-AM)/CdS Nano-composite 0.08 g , light intensity 1.7 mW/cm2 , and range of concentration about 5 -20 mg /L as shown in Figure 3.. This behavior of photo catalytic degradation indicates a first order expression up to MR dye concentration.

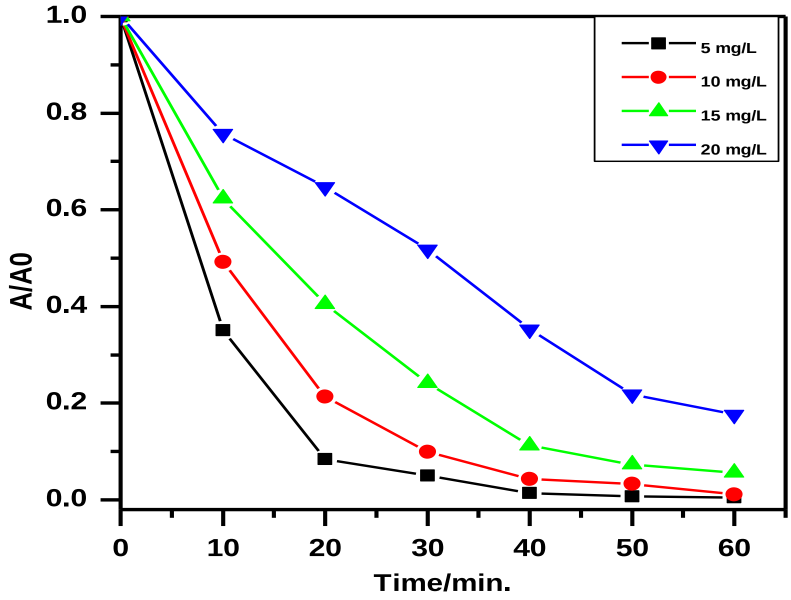

Figure3: Effect Photo catalytic degradation by SA-g-(PAA-co-AM)/CdS Nano-composite at several concentration of MR dye .

Effect of weight Nano-composite

A 0.08 g weight of Nano-composite of using to Photo catalytic degradation of MR dye. 100ml solution of dye with amount of 0.05 - 0.1 g/200ml, for 10min under dark to establish the adsorption-desorption equilibrium among the hydrogel surface and MR. The time irradiation was limited at 60 minute[18] .The solution can be measurement absorbance before and after irradiation utilizing spectrophotometer at 410 nm. As show in Figure 5.

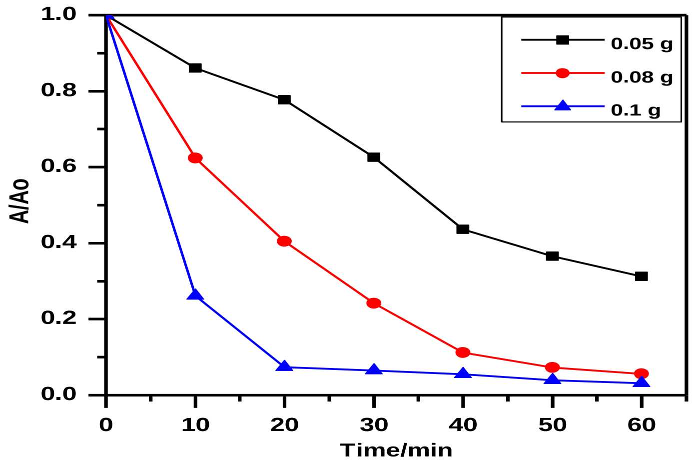

Figure 5: Photo catalytic degradation of MR at several weight SA-g-(PAA-co-AM)/CdS Nano-composite.

light intensity (L.I.)

The light intensity effect about (2.3-1.3 mW/cm2) was observed via variable of distance among source light and exposed in SA-g-(PAA-co-AM)/CdS Nano-composite surface. Photo degradation of MR dye via the light intensity effect was investigation in the presence of 0.08 g of SA-g-(PAA-co-AM)/CdS Nano-composite, concentration of MR dye 15 mg//L ,and pH 5.4 .It was that found wholly reactions still follow the first order kinetics as appear in Figure7. The photo degradation capacity increase when light intensity increase. It probably deduced, the rise of L.I caused to excited particles of SA-g-(PAA-co-AM)/CdS Nano-composite to lead hole pair electron. and photo catalysis at low light intensities (1.3 mW.cm^{-2}), decrease because of low light intensity reactions involving formation hole electron are predominant and hole electron re-combination is negligible [19, 20].

Conclusion

This study depends on the preparation of an environmentally friendly hydrogel, which is prepared from cheap and inexpensive materials. The hydrogel was adsorbed with high photo degradation efficiency of MR dye. The photo degradation capacity increase when light intensity increases the best light intensity (2.3 mW.cm^{-2}) and photo catalysis at low light intensities (1.3 mW.cm^{-2}). The rate of PDE% decreased from (98,67 to 80.76) when the concentration of dye increase. And 0.08 g the best weight of hydrogel nanocomposite to Photo catalytic degradation of MR dye.

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