RESEARCH ARTICLE

Role of SA-g-(PAA-co-AM)/CdS Hydrogel: As Photocatalytic for Decolonization Methyl Red Dye as a Pollutant from Aqueous Solution

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ABSTRACT

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

Keywords: Advanced oxidation processes, Dye, Hydrogel, Methyl red, Photocatalytic.

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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 large quantities of sewage.[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. About 10–15% of the dyes are discharged during dyeing fabrics, textiles and papers every year.[5-8] The water containing the liquid waste of dyes is very irritating as it blocks the passage of sunlight and causes disturbance to the aquatic ecosystem and living organisms.[9-11] This study used SA-g-(PAA-co-AM)/CdS hydrogel as an effective adsorbent in de-colorization dye from an aqueous solution. Several factors affecting the advanced oxidation processes were studied, like the effect of concentration MR dye, mass of SA-g-(PAA-co-AM)/CdS hydrogel catalyst, and light intensity.

Experimental Part

Preparation SA-g-(PAA-co-AM)/CdS Nano-composite

Preparation of hydrogel nanocomposite that have 0.5 g in 500 mLfrom sodium alginate (SA) and 0.1 g of CdS with stirring 1-hour at 25ºC , and added 3 mL of acrylic acid (AA), 0.5 g acryl amide AM in 5 mL DW and stirring for 10 minutes, then added 0.03 g KPS ,0.05 g MBA in 1-mL DW, processes take place in the presence of N2 to form free radicals, put in a water bath for 4hr at 75ºC. The SA-g-(PAA-co-AM)/CdS nanocomposite cut, and washed several times and dried in an oven at 60°C about 24 hours (Figure 1).

Experiments of the Photocatalytic

The photocatalytic activity of the SA-g-(PAA-co-AM)/CdS Nanocomposite catalyst was estimated *via* the degradation of MR dye.

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Figure 1: Image SA-g-(PAA-co-AM)/CdS Nanocomposite

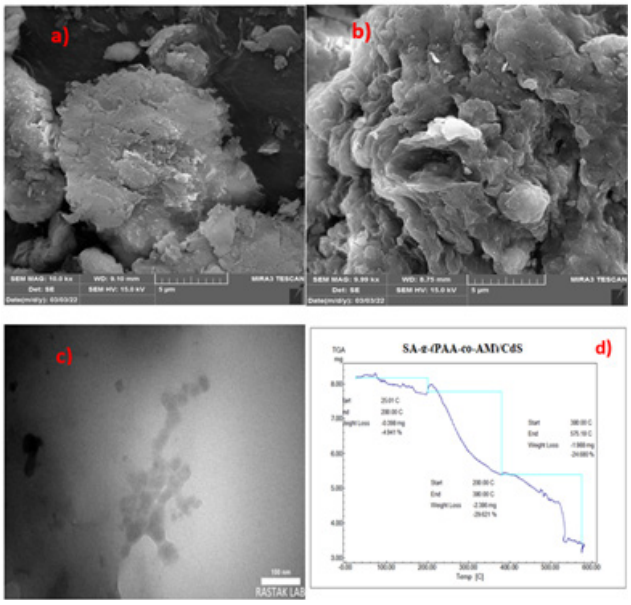

Figure 2: FESEM a) SA-g-(PAA-co-AM), b) SA-g-(PAA-co-AM)/CdS Nano-composite, c) TEM SA-g-(PAA-co-AM)/CdS Nano-composite , d) TGA of SA-g-(PAA-co-AM)/CdS Nano-composite.

All experiments carry out in a 250 mL beaker. The reaction beaker was placed under ultraviolet light, considering the distance between the solution's surface and the light source. Before each test, the lamp is heated for ten minutes to obtain accurate results. Therefore, a weight of 0.08 g of SA-g-(PAA-co-AM)/CdS 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 the 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 estimated in equation 1:

$$PDE\ (\%)=(C_0-C_t)/C_0 \times 100 \qquad (1)$$

Where,: 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 nanocomposite before and after loading the CdS compound, as shown in

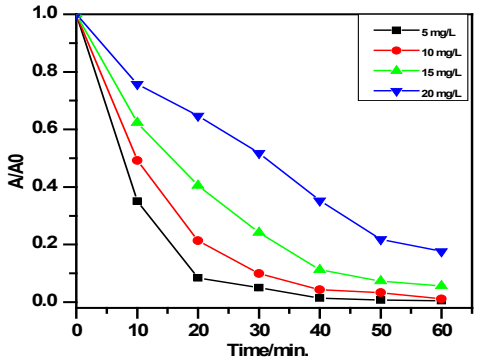

Figure 3: Effect Photo catalytic degradation by SA-g-(PAA-co-AM)/CdS Nanocomposite at several concentrations of MR dye.

(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) shows TEM image SA-g-(PAA-co-AM)/CdS Nanocomposite, where CdS was observed inside the hydrogel. The TGA technique of hydrogel, as shown in Figure 2(d), A loss weight was found in range temperature of 25 to 600°C, of which 4.914% occurred at low temperatures about 200°C attributable to evaporation water. The final one, at 360 to 575°C, is related to 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 nanocomposite 0.08 g, light intensity 1.7 mW/cm^2, and range of concentration about 5–20 mg/L as shown in Figure 3. This behavior of photocatalytic degradation indicates a first-order expression up to MR dye concentration.

Figure 4 appear that when the concentration MR dye was increased, the rate of PDE% decreased from (98.67 to 80.76) , this happens via either reduced of holes or (OH) because the active sites will complete coverage by MR dye or a rising in the concentration of dye caused to rise in the adsorption of dye on the SA-g-(PAA-co-AM)/CdS nanocomposite, which lead to reduce in radical (OH.) generation because so low available of active site as free on the surface.[18]

Effect of Weight SA-g-(PAA-co-AM)/CdS Nano-composite

A 0.08 g weight of SA-g-(PAA-co-AM)/CdS nanocomposite of using to photocatalytic degradation of MR dye. 100 mL solution of dye with an amount of 0.05–0.1 g/200 mL, for 10 minutes under dark to establish the adsorption-desorption equilibrium among the hydrogel surface and MR. The time irradiation was limited at 60 minutes.[19] The solution can be measured absorbance before and after irradiation utilizing a spectrophotometer at 410 nm as show in Figure 5.

Figure 6 represents the percent degradation of dye against the several quantities of SA-g-(PAA-co-AM)/CdS nanocomposite. This illustrates that the percent degradation

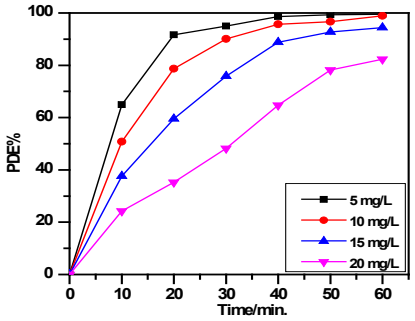

Figure 4: Effect of MR dye concentration on the PDE%.

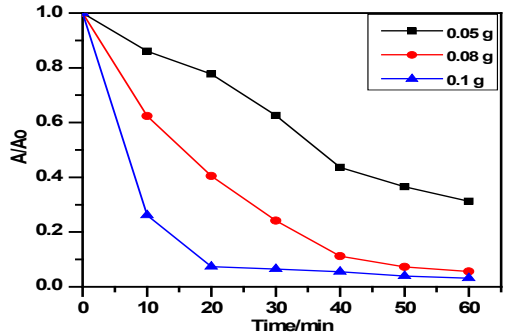

Figure 5: Photo catalytic degradation of MR at several weight SA-g-(PAA-co-AM)/CdS Nanocomposite.

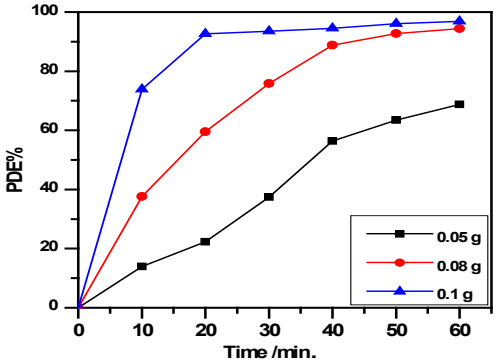

Figure 6: Effect weight SA-g-(PAA-co-AM)/CdS Nano-composite onto photocatalytic degradation MR dye

of modified hydrogel rises with an increase in SA-g-(PAA-co-AM)/CdS nanocomposite from 0.05–0.1 g/200 mL. Above this limit, there is not much change. This indicated that the active site provided for the adsorption of the substrate on the surface is limited to amount of SA-g-(PAA-co-AM)/CdS Nanocomposite 0.08 g/200 mL and after that no much change in the degradation.[20-22]

Light Intensity (L.I.)

The light intensity effect about (2.3–1.3 mW/cm^2) was observed via variable of distance among source light and exposure in SA-g-(PAA-co-AM)/CdS Nanocomposite surface. Photodegradation of MR dye via the light intensity effect was investigated in the presence of 0.08 g of SA-g-(PAA-co-AM)/CdS nanocomposite, the concentration of MR dye 15 mg/L,

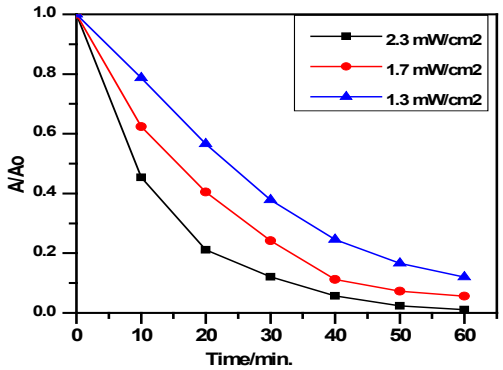

Figure 7: Effect Photo catalytic degradation at different light intensities (L.I.).

and pH 5.4. It was found that whole reactions still follow the first-order kinetics in Figure 7. The photodegradation capacity increases when light intensity increases. It probably deduced the rise of L.I caused to excited particles of SA-g-(PAA-co-AM)/CdS nanocomposite to lead hole pair electron. and photocatalysis at low light intensities (1.3 mW.cm^{-2}), decrease because of low light intensity reactions involving the formation hole electron are predominant and hole electron re-combination is negligible.[21,23]

CONCLUSION

This study depends on preparing an environmentally friendly hydrogel prepared from cheap and inexpensive materials. The hydrogel was adsorbed with high photodegradation efficiency of MR dye. The photodegradation 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 increased. And 0.08 g is the best weight of hydrogel nanocomposite to photocatalytic degradation of MR dye.

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