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Original Research Article

The Power Effect of Zinc Oxide and Solar Lamp on the Degradation of Orange G Dye Industrial

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Abstract: By conducting multiple tests, the photo degradation of the orange G dye used in industries such as investigating of varying the weight used zinc oxide as a metal oxide. The best weight used of oxide was 0.13 g/100ml as a result of obtaining the largest catalytic decomposition of the dye. It was verified that the effect of different concentration of the dye on the decomposition process. It was found that 30 ppm was the best concentration in which the largest possible amount of catalytic decomposition of the dye took place, in addition to the effect of using different volume of ethanol in the photo degradation process on the dye used. A UV-Visible spectrophotometer was used to study photo catalytic using zinc oxide as a catalyst with radiation from a 125 W mercury lamp.

Keywords: Photocatalytic, Orange G, zinc oxide.

INTRODUCTION

Liquid industrial waste poses a threat to the environment and human health due to its toxicity [1, 2]. The only factor contributing to this pollution is the usage of dyes, which are widely employed in the production of food, medications, cosmetics, paper printing, fabric dying, and other industries [3]. They are a plentiful supply of colored organic materials (Azo dyes), which are a waste product of the textile dying industry [4]. Azo dyes are so versatile and chemically stable that they account for more than half of all commonly used dyes [5]. double bond between nitrogen (-N=N-) The most common category of commercial dyes used in the textile industry are azo dyes. Decolorizing azo dye compounds using different methods was hence the topic of numerous studies [6]. Photocatalysts are one of these techniques, and they are used in a variety of environmental applications where semiconductor materials are used as a photocatalyst to generate reactive species like (•OH) to react with dye molecules under UV or visible light radiation. This technique is widely investigated due to its efficiency and small requirements for progress [7].

The reactions that ultraviolet-visible light incident on semiconductor surfaces causes are known as photocatalysis . Electrons and holes are produced by this reaction, and they serve as charge carriers while also breaking down contaminants, specifically organic dyes to create ecologically beneficial byproducts when exposed to light UV wavelengths [8]. There has been a lot of interest in semiconductor-based heterogeneous photocatalysts, like ZnO, ZnS, and TiO2, for the sustainable and renewable harvesting of solar energy to address energy and environmental issues [9].

As Fig. 1.1 illustrates, a catalyst works by altering activation barriers. A catalyst accelerates a reaction by reducing the height of an activation barrier [10].

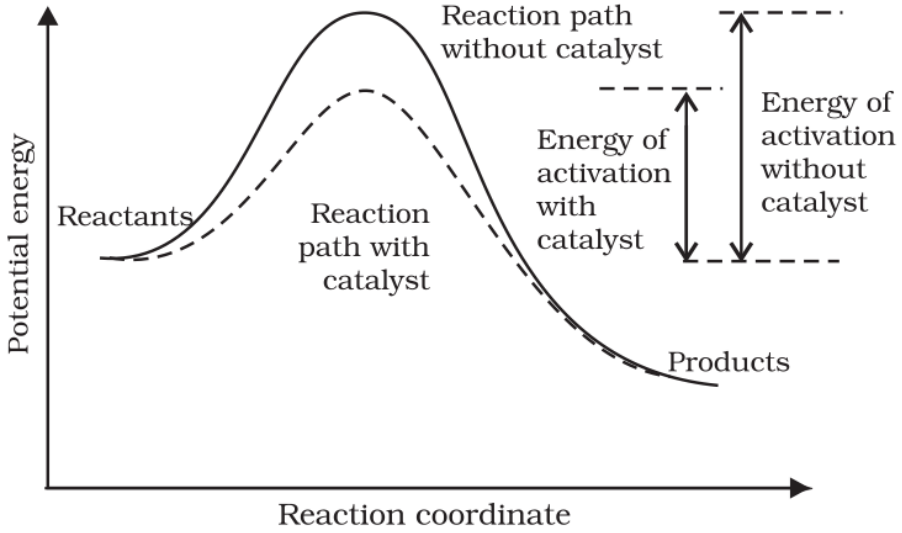

Fig. 1.1: Effect of Catalyst on Activation Energy

There are many different types of catalysts, from atoms and molecules to complex structures like enzymes or zeolites. They can also be applied to the surface of solids, in gasses, or in liquids [11]. The process of catalyst preparation greatly affects the final characteristics of the materials. Furthermore, the kind and concentration of any defects that may arise during the manufacture of the solids have a significant impact on their reactivity. As a result, a variety of factors can impact the finished product, including concentration, pH, temperature, age period, and kind of anions [12]. The following three characteristics primarily determine a catalyst's applicability for a certain industrial process [13, 14].

MATERIALS AND METHODS

Zinc oxide (ZnO) (purity (99%)), particle size (100) mesh, supplied by Fluka AG and Orange G dye supplied by sigma – Aldrich. The experiment's components were conducted in a glass cell with two separate parts. First, there is the internal component and its capacity (100 mL). In this part, the catalyst and the solution to be broken are placed together to initiate the reaction. The second part, which is the first part's circumference and where the reaction is cooled with water.

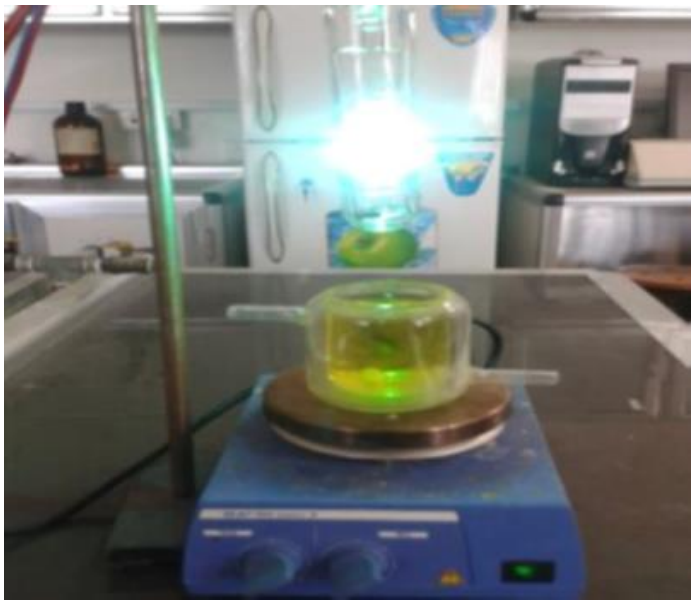

Fig. 1: Principal components of the photocatalytic cell that degrade orange dye through photocatalysis

RESULT AND DISCUSSION

1- Orange G dye Degradation through Photocatalytic: The Impact of ZnO Mass

The influence of ZnO mass on the degradation of Orange G dye by photocatalytic was investigated at a room temperature of 298 K with 30 ppm of dye and a 10 ml/min air flow rate.

As increase weight of ZnO to 0.13g/100ml, the photocatalytic of Orange G degradation gradually increases and eventually decreases. When the weight of ZnO equals 0.13g/100ml, the semiconductor can avaliable the highest possible absorption of light. Only the initial layers of orange G dye will see a decrease in efficiency of photodegradation at zinc oxide weight greater than 0.13 g/100 ml as a result of light absorption; Light photons are not received by the other layers of the solution. At high ZnO loading, light scattering diminishes photon intensity, amplifying light absorption through the initial layers of the solution and hindering light from accessing any further layers within the reaction vessel. The rate of orange G dye in photodegradation also decreases when the loading mass of ZnO decrease the optimal value of 0.13 g/100 ml. This is because a decrease in the mass of ZnO results in a decrease in surface area, which in turn causes a decrease in ZnO ability to absorb light, thereby lowering the photodegradation rate of orange G dye. Figure (2) describe the orange G dye photocatalytic degradation processes at various ZnO loaded masses [15-17].

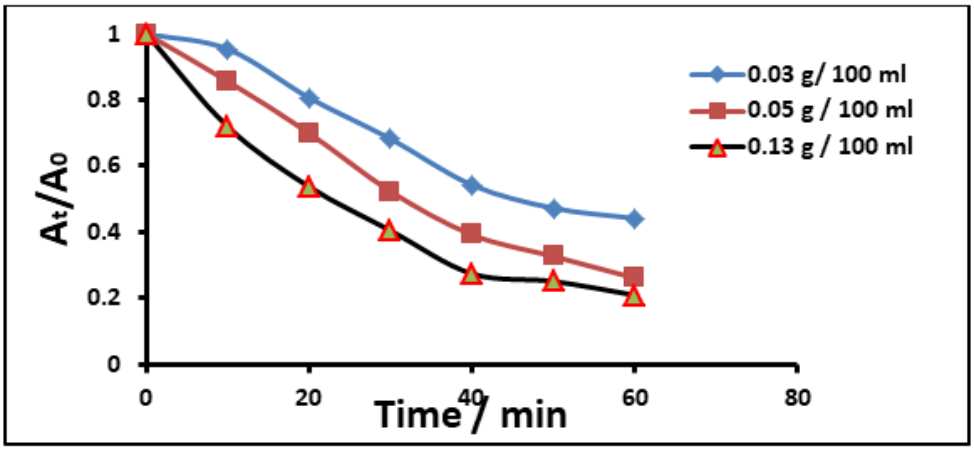

Fig. 2: The effect of zinc oxide mass on orange G dye photocatalytic degradation

2 - Orange G dye's Initial Concentration's Effect on Photocatalytic Degradation Processes

Using 0.13 g/100 ml, 8.22 mW/cm2 of light intensity, and 298 K of temperature, many studies have been conducted to examine the effect of changing the initial (30 - 70 ppm) on orange G dye photocatalytic degradation. Figure 3 displays an explanation of the results. As increase the initial concentration of orange G dye, so does the decrease in the rate of photocatalytic. The 30 ppm was best concentration to comprise the most area of ZnO particles, which is why it absorbed the maximum amount of exciting photons to produce a greater concentration of activated ZnO semiconductor, which could explain this behavior. Orange G dye, which is present at a high concentration of 30 ppm in the sample on 0.13 g/100 ml of zinc oxide, is another variable contributing to this behavior. When an excess of orange dye obscures light and makes it difficult for light to pass through subsequent layers of orange dye on the ZnO surface, The orange dye adsorbed on ZnO is unable to reach the wanted excited state [18-20].

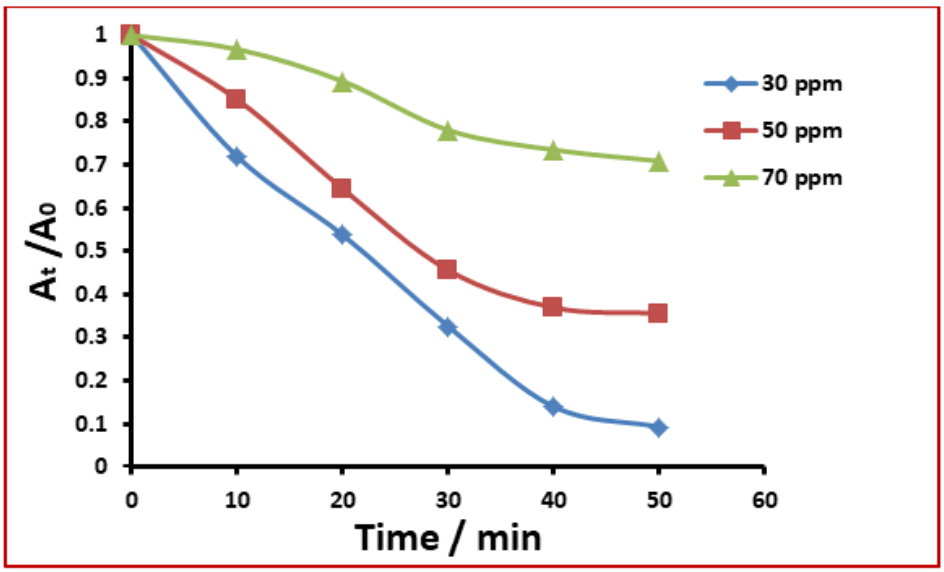

Fig. 3: The differences in (At / A0) with exposure time at orange G dye concentration

The 83.54% is highest achievable photo degradation efficiency achieved at a concentration of 30 ppm of orange G dye. Figure 4 shows how the concentration of orange G dye affects the photocatalytic degradation's (P.D.E.) efficiency.

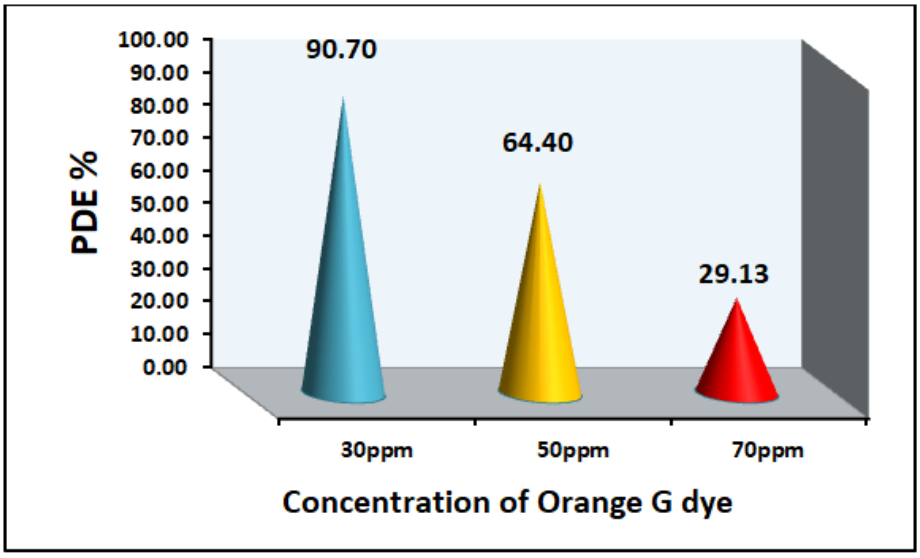

Fig. 4: The effectiveness of photocatalytic degradation varies with Irradiation time at different concentrations

Scavenger Test

The scavenger test was used to determine the active species that were mostly responsible for the photocatalytic degradation of orange G dye over ZnO. A different radical scavenger, such as ethanol, was present during the reaction, which was conducted similarly to the photocatalytic experiment. Ethanol has the ability to scavenge (•OH) and (O2•-) radicals. The orange G dye concentration used for the experiment's initial runs was 30 mg/L, and 0.13 g/L of catalyst was loaded. The results are plotted in Figure 5.

Ethanol was added to this study as a (•OH) radical scavenger. Due to the high rate constant of interaction between (•OH) radicals and ethanol, ethanol has been utilized extensively as a scavenger of (•OH) radicals to assess the oxidation mechanism. As can be shown, radical scavenging lead to the suppression of the photocatalytic activity that broke down the orange G dye [21].

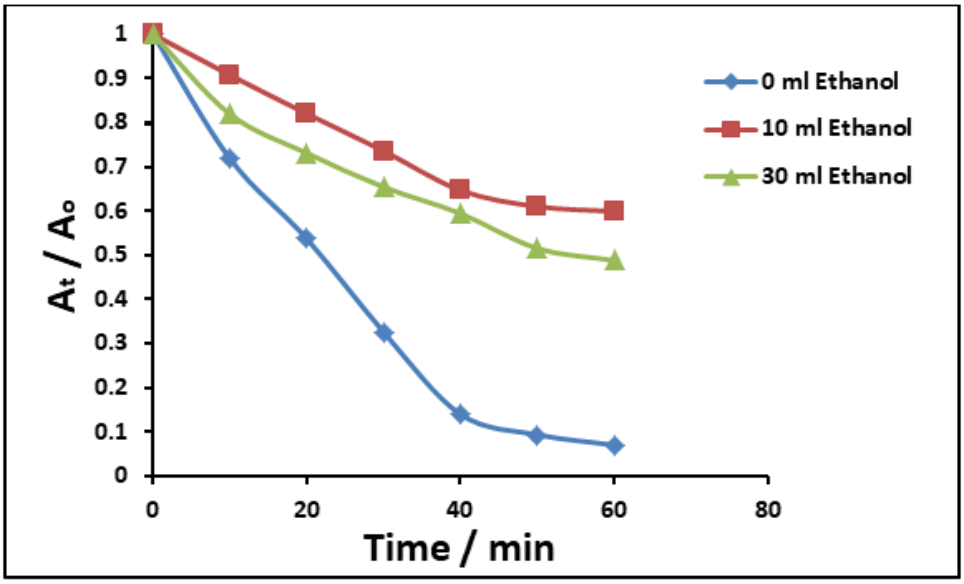

Fig. 5: The ethanol effect on degradation of orange G by use photocatalytic

CONCLUSION

Orange G dye can be broken down using semi-conducting materials such as zinc oxide with the help of photolysis to achieve better results by crushing. The best weight of the catalyst was chosen, which is equal to the weight of ZnO 0.13

g/100 ml as a result of providing the highest possible absorption of light. Photodegradation of the dye decreases when the loading mass reduces ZnO as a result of the decrease in its surface area, which in turn leads to a decrease in its ability to absorb light, thus reducing the rate of photodegradation of the orange G dye. The dye concentration of 30ppm was the highest concentration that was broken down because high concentrations of the dye lead to a reduction in the photodegradation process due to the blocking of light and makes it difficult for light to pass through subsequent layers of orange dye on the ZnO surface. Also, the widespread use of ethanol as a radical scavenger (•OH) to evaluate the oxidation mechanism leads to the suppression of the photocatalytic activity that breaks down the orange G dye. These results can be used to serve as a basis for future research at the experimental levels in the laboratory and in industries concerned with the use of dyes as a basis in them.

Conflict of Interest: No conflict of interest is associated with this work.

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