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Reduction of Organic Pollutant by AOP

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ABSTRACT

Dye is a chemical compound that used in various industries such as textile, inks, and photographic industries production. Reduction of reactive red dye (HE3BN) from simulated wastewater was examined in this study by using NiO as a photocatalyst.

Various factors have influenced the performance of photocatalyst process in removing reactive red dye such as solution pH, influent concentration of dye and amount of catalyst(NiO). In this study the optimal values of these parameters that give the most efficient removal or reactive dye were estimated. The results displayed that NiO is a reliable substance to remove reactive red dye (HE3BN) by photocatalysis process and the optimal values of solution pH, initial concentration of dye, and amount of NiO were 8, 25ppm, and 1.5g, respectively which gave 96.9% of dye removal efficiency.

Keywords : Photocatalyst, AOP, Nickel Oxide, Reactive Red Dye

I. INTRODUCTION

Nowadays, pollution of water bodies such as rivers, lakes, and oceans is a widespread problem that impacts safe water worldwide which consequently jeopardizes humanbeing health (Transito et al., 2015).

Traditionally, the textile industry uses an enormous amount of water and approximately 2% of dyes that are directly discharged into textile effluents, and of those 10% are wasted during the dying process (Chantes et al., 2015).

Dye contaminants can have serious impacts on the environment. Textile dyes in wastewater are of significance not just as they are aesthetically displeasing, but also since they are correlated with health hazards, thus it is important to examine strategies for the safe removal of these toxic pollutants (Sweeny et al., 1994).

There are many conventional methods that used to remove dye from contaminated water such as coagulation and flocculation, chemical precipitation, ion exchange, adsorption , biological treatment but they cannot be individually enough to remove dye from wastewater(Gosavi and Sharma, 2013).

Alternative to traditional approaches, 'Advanced Oxidation Processes' (AOPs) are already developed on the basis of the generation of highly reactive species such as hydroxyl radicals.

In exchange for conventional techniques to remove dye from polluted water, some powerful oxidants such as hydroxyl radicals were used to develop the Advanced Oxidation Processes(AOPs). In which, most of the organic contaminants can be easily oxidized. Heterogeneous photocatalysis emerges as a promising solution to environmental contaminants of the aquatic environment (Al-Anbari et al., 2017a). Many semiconductors were used as a photocatalytic to reduce textile dye such as TiO2 (Salman, 2014), ZnO (Al-Anbari et al., 2017 b, Al-Anbari et al., 2017c, Zuafuani and Ahmed, 2015, Mashkour et al., 2011, Kiransan et al., 2015) V2O2 (Al-Anbari et al., 2017a), ZrO2 (Neppolian et al. ,2002) Fe3O4(Al-Anbari et al., 2016).

In this study, nickel oxide (NiO) was used as a photocatalyst to remove Reactive red HE3BN dye from synthetic wastewater by using UV lamp in a batch reactor. In addition, the highest dye removal efficiency was targeted by examining different values of the main variables (pH, dye concentration, catalyst dosage).

II. MATERIALS AND EXPERIMENTAL SET-UP

2.1 Materials

The pollutant used in this study (reactive red dye HE3BN) was provided in a powder form by Al-Kut textile factory which located southern of Baghdad, Iraq. Different weights of dye were used to prepare the simulated wastewater. The selected amount of dye was dissolved in 1L of distilled water. As such, analytical grade reagents of NiO, H2SO4 and NaOH with no further purification have been used.

2.2. Experimental set-up

AOP have been conducted by preparing a simulated suspension of reactive red dye, and NiO has been used as a photocatalysis.

The laboratory reactor used to remove HE3BN red reactive dye is a cylindrical beaker of 1000ml with a working volume of 500mL and a UV-lamb as the source of light. A magnetic agitator has often been used to stir the solution in the reactor.

In a standard photocatalytic run, beaker was filled with 500 mL of the artificial solution containing the required dye concentration and NiO, then this suspension was agitated to measure the concentration of dye for approximately 30 minutes. The UV lamb was turned on during magnetic agitation of this suspension. Samples were withdrawn from this beaker at equal interval times and filtered through 0.45 μm membrane filter. The dye concentration was measured in filtered samples by using spectrophotometer.

pH of solution was varied as follow: 4, 6, 8, and 10 by using 0.1N NaOH and 0.1N H2SO4 to study the effect of solution pH on the removal of dye.

The catalyst dose was taken as follow: 0.5, 1 and 1.5 gm . Finally, the effect of initial concentration of dye was also varied as follow: 25, 50,75 and 100 mg/L.

III. RESULTS AND DISCUSSION

2.1 Effect of pH

The value of pH of the aqueous solution is the significant variable of the photocatalytic system. Aqueous dye solution with a concentration of 25 mg.L-1 was treated by adjusting the initial pH of the solution from 4 to 10 pH. The pH of the solution was justified by the use of 0.1N H_2SO_4 and 0.1N NaOH as needed.

Figure1 illustrates the effect of the variation of pH on the removal efficiency of the dye. The results indicated that the best performance of the photocatalytic process was attained at a pH of 8.

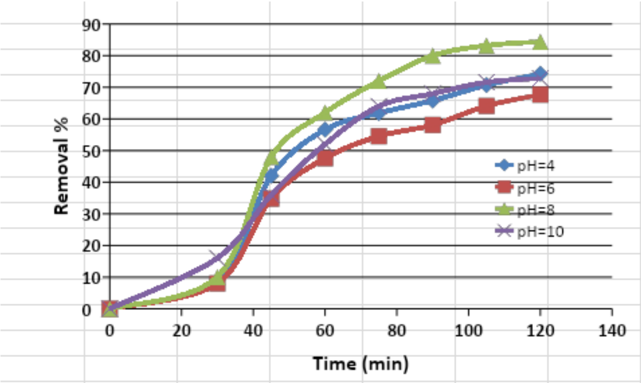

Figure (1): The effect of pH on percentage removal of reactive red (he3bn).

In Figure 1, it can be easily shown that the most suitable pH was 8.

The effect of solution pH on NiO's surface charge can be due to these effects. The zero charge point (pHpzc) for NiO was reported at pH=8.5 [Mahmood et al., 2011] in the literature. The net charge on the catalyst surface is roughly equal to zero at this pH value. At pH < pHpzc, the NiO surface was positively charged, while at pH > pHpzc it was negatively charged.

2.2 The Effect of photocatalyst mass

The effect of changing the catalyst dosage used on the dye removal ratio, where the pH is set at 8 and the original dye concentration was 25 ppm, will be outlined in this section.

four tests were conducted at various catalyst concentrations (0.5, 1 and 1.5 gm) with constant initial dye concentration, constant initial pH and constant mixing time (2hr).
The difference in the removal of reactive red (he3bn) over time at various catalyst dosages was demonstrated in figure (2).

Figure (2) specifically shows that the removal efficiency of reactive red (he3bn) increases with the rise in the mass of NiO. As the removal efficiency at 1.5g of catalyst dosage hit 96.9 percent.

The improvement in the percentage of reactive dye reduction, with an increase in catalyst dose, is attributed to the greater availability of catalyst sites or surface areas.

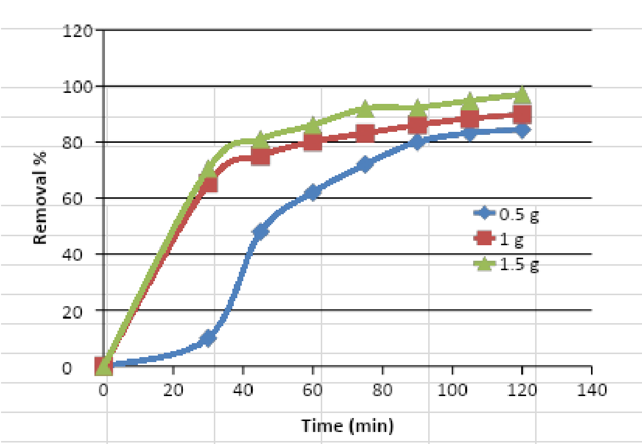

Figure (2): the effect of NiO dosage on reactive red (he3bn) removal.

2.3 The Effect of Initial Dye Concentration

Three tests were performed at various initial reactive red (he3bn) concentrations, 25, 50 and 75 ppm respectively.

For various initial dye concentrations for the above tests, the variations of the removal percent of reactive red (he3bn) with time are plotted in Figure 3.

From this figure, it becomes apparent that the removal efficiency of dye from aqueous solution decreases with the initial dye concentration increasing.

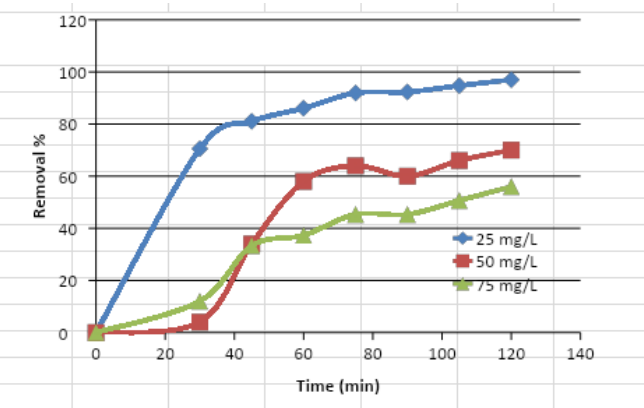

Figure (3): the effect of initial dye concentration on the percentage removal of reactive red (he3bn).

IV. CONCLUSION

By using NiO as a photocatalyst, the important points that emerge from the AOP of reactive red dye can be described as follows: NiO can be used as an efficient catalyst to eliminate reactive red dye. PH=8, initial dye concentration=25ppm, and catalyst dose =1.5 g were the optimal conditions for decolorization rate.

V. ACKNOWLEDGMENT

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VI. REFERENCES

[1]. Transito I.S., Gonzalez A.E.J., Garcia M.L.R., Arellano C.A.P. and Gasca C.A.E. (2015). Design of a Novel CPC Collector for the Photodegradation of Carbaryl Pesticides as a Function of the Solar Concentration Ratio. Journal of Solar Eenergy, Vol. 115, May, 537-551.

[2]. Chantes P., Jarusutthirak C. and Danwittayakul S. (2015). A Comparison Study of Photocatalytic Activity of TiO2 and ZnO on the Degradation of Real Batik Wastewater. International Conference on Biological, Environment and Food Engineering, Singapore.

[3]. Sweeney EA, Chipman JK and Forsythe SJ (1994) Evidence for direct-acting oxidative genotoxicity by reduction products of azo dyes. Environmental Health Perspectives.

[4]. Gosavi V.D. and Sharma S. (2013)," A General Review on Various Treatment Methods for Textile Wastewater", Journal of Environmental Science, Computer Science and Engineering & Technology, Vol.3, No.1.

[5]. Al-Anbari R.H., Al-Obaidy A.H. and Mohammed E.A., 2017a," Solar Photocatalytic of Reactive Blue Dye in Aqueous Suspension of V2O5", Engineering and Technology Journal, Vol. 35, Part A, No. 1.

[6]. Hoffmann M. R., Martin S. T., Choi W., and Bahnemann D. W. (1995). Environmental

Applications of Semiconductor Photocatalys. Chemical Reviews, Vol. 95, No. 1.

[7]. Saien J. and S. Khezrianjoo S. (2008).Degradation of the Fungicide Carbendazim in Aqueous Solutions with UV/TiO2 Process: Optimization, Kinetics and Toxicity Studies. Journal of Hazardous Materials, Vol. 157, No. 2-3.

[8]. Salman M.S. (2014). Advanced Oxidation Processes for the Removal of Reactive Dyes from Simulated Wastewater. PhD Thesis, University of Baghdad, Iraq.

[9]. Al-Anbari R.H., Al-Obaidy A.H. and Mohammed E.A., 2017b," Toxicity Reduction of Reactive Red Dye-238 Using Advanced Oxidation Process by Solar Energy", Baghdad Science Journal, Vol. 14, No.3.

[10]. Al-Anbari R.H., Al-Obaidy A.H. and Mohammed E.A., 2017c," Decolorization and Degradation of Reactive Red Dye-238 by using ZnO", Iraqi Journal of Civil Engineering, Vol. 11, No.3.

[11]. Zuafuani S.I.S. and Ahmed L.M. (2015). Photocatalytic Decolourization of Direct Orange Dye by Zinc Oxide under UV Irradiation. International Journal of Chemical Science, Vol. 13, No. 1, 187-196.

[12]. Mashkour M., Al-Kaim A., Ahmed L. and Hussein F. (2011). Zinc Oxide Assisted Photocatalytic Decolorization of Reactive Red 2 Dye. International Journal of Chemical Science, Vol. 9, No. 3.

[13]. Kiransan M., Khataee A., Karaca S. and Sheydaei M. (2015). Artificial Neural Network Modeling of Photocatalytic Removal of a Disperse Dye Using Synthesized of ZnO Nanoparticles on Montmorillonite. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, Vol. 140, April, 465-473.

[14]. Neppolian B., Choi H., Sakthivel S., Arabindoo B. and Murugesan V. (2002). Solar/UV-Induced Photocatalytic Degradation of Three Commercial Textile Dyes. Journal of Hazardous Materials, Vol. 89, No.2-3.

[15]. Al-Anbari R.H., Al-Obaidy A.H. and Mohammed E.A., 2016," Photocatalytic activity of Fe3O4 under solar radiation", Mesopotamia Environmental Journal, Vol. 2, No.4.

[16]. Mahmood T., Saddique M.T., Naeem A. ,Westerhoff P., Mustafa S. and Alum A.," Comparison of different methods for the point of zero charge determination of NiO", Industrial and Engineering Chemistry Research, Vol.50 , No.17 , pp. 10017-10023, 2011.

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