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Photocatalytic degradation of reactive green dye by using Zinc oxide

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ABSTRACT

Photocatalytic degradation of reactive green using zinc oxide have been included in this work, which is achieved by the irradiation of suspended solution consists of different concentration of reactive blue with 0.12gm/100cm3 of mixed metal oxide semiconductor zinc oxide by using solar light. In order to study the effect of metal oxide zinc oxide in photocatalytic degradation of reactive blue, several experiments were acheived. Such as the effect of dye concentration, the effect of mass loading and effect of solution temperature.

KEY WORDS: Photocatalytic; Reactive green dye, Kinetic.

1. INTRODUCTION

In last decay, industry revolution in most of the word cause environmental contaminates. Huge types of dye uses led to pollute the surface water and groundwater., there are different methods used for water treatment in our previous work (Mashkour, 2011; Mohamed, 2011; Aljebori and Alshirifi, 2012; Alkaim, 2012, 2013, 2015; Kandiel, 2013; Alsalman, 2013; Jasim, 2013; Al-Robayi, 2014; Aljeboree, 2014; Hadi, 2014; Jabbar, 2014; Al-Gubury, 2015; Al-Gubury, 2015; Al-Gubury, 2015; Algubili, 2015; Ali, 2015; Karam, 2015; Mohammed B Alqaragully, 2015; Abdulrazzak, 2016; Al-Terehi, 2016; Aljeboree, 2016; Fairooz, 2016; Kamil, 2016). Advanced oxide processes (AOP) method can be used to wastewater treatment. It has been ability to convert the pollutants into the harmless materials (Hussein, 2008; Hussein, 2013; Jafar, 2013; Kami, 2014; Al-Khafaji, 2015). In (Al-gubury, 2016) hydroxyl radicals (˙OH), this reactive radical capable of mineralizing organic pollutants(Saleh, 1974; Alkhateeb, 2005; Hussein, 2007; Hussein 2010; Matloob, 2011; Mohamed, 2011; Al-gubury, 2016). Zinc oxide semiconductor as a catalyst has the ability to remove from the wastewater a number of pollutants such as pesticides(Hussein, 2010). If the semiconductor zinc oxide irradiated by UV lamp, the electrons will promote from valance band to conduction band, producing electrons in conduction band undergo photo reduction will leave a positive hole in valance band inter photo oxidation processes.

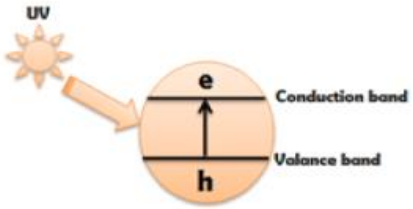

Figure.1.General mechanism of the photo catalysis on zinc oxide particle

2. MATERIALS AND METHODS

A-Chemicals: 1-Zinc oxide (ZnO): purity (99%), particle size (100) mesh, supplied by Fluka AG.
2 – Reactive green supplied by sigma – Aldrich.

B - Photo reactor and Procedure: 1-Experiments were carried out in glass photochemical reactor as shown in Fig. 2-In the outside thimble; running water was passed through the thimble to cool the reaction solution. Owing to the continues cooling done by controlled water bath, in the inside the reaction vessel will consist of 100 ml of sample under irradiation.

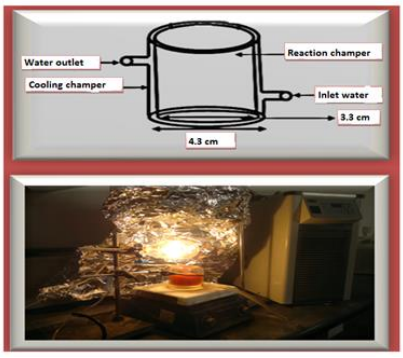

Figure.2.Main parts of the photocatalytic cell used in Photocatalytic degradation of reactive green

3. RESULTS AND DISCUSSION

The Effect of zinc oxide mass on photo catalytic degradation of reactive green: The effect of mass of zinc oxide on Photocatalytic degradation of reactive green, was studied using 40 ppm of reactive blue, flow rate of air 10ml/min, room temperature 298 K, Figure 3 shows different loaded mass of zinc oxide have been tested by the photo catalytic degradation processes of reactive green dye, as the masses zinc oxide increases until reach to the mass zinc oxide 0.12 gm/100cm^3 photocatalytic degradation of reactive green gradually increases then photocatalytic efficiency decreased. This may be attributed to the light absorption will be limited only to the first layers of reactive green and the other layers of solution do not receive light photons. Moreover at higher zinc oxide loading a light scattering will attained, this lead to decrease the photon intensity (Krishnakumara, 2011). The mass of zinc oxide0.12gm/100cm3gives the optimum photocatalytic degradation efficiency which is equal to 88.68 %. The results of the change in photocatalytic degradation efficiency (P.D.E%) with catalyst concentration plotted in Figure 4 .

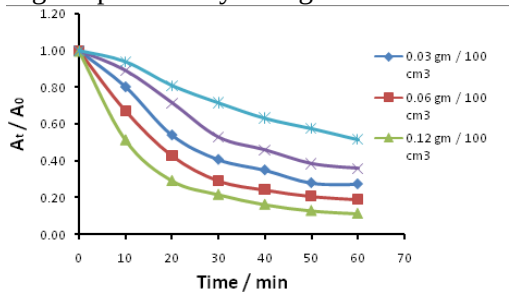

Figure.3.The effect masses of zinc oxide on Photcatalytic degradation of reactive green

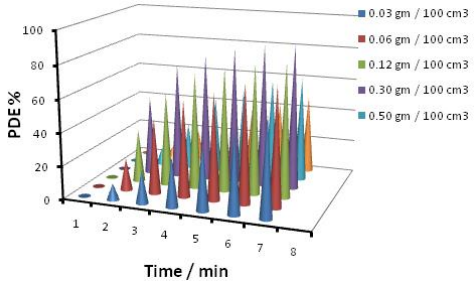

Figure.4.The change of Photocatalytic Degradation Efficiency with irradiation time of different types of catalyst

The Effect of initial reactive green concentration on photo catalytic degradation processes :A serious of experiments have been done , the effect of change initial (40 – 100 ppm) on photocatalytic degradation process of reactive green was studied using 0.12gm / 100 cm^3 , the light intensity equal to 8.22 mW/cm^2, and temperature equal to 298 K . The results are plotted in Figure 5. It has been observed that the rate of photocatalytic degradation gradually decreases with the increasing of initial reactive green concentration. This behaviour could be explained, the concentration 40ppm was the optimum concentration to cover the largest area of the zinc oxide particles, therefore absorbed maximum exciting photons to generate higher concentration of the activated titanium dioxide semiconductor. Another reason for this behaviour is the strong absorption of light by the reactive greenin the sample which contain high concentration that 40ppm,reactive green on 0.12 gm /100cm^3 of zinc oxide. The excess of reactive green prevent the penetration of light through the successive layers of reactive green on the zinc oxide surface is weak to generate the required excited state of the reactive green on zinc oxide(Miao, 2014). The concentration of reactive green 40ppm gives the optimum photocatalytic degradation efficiency which is equal to 94.14%. The results of the change in percentage photocatalytic degradation efficiency (P.D.E %) with concentration of reactive green plotted in Figure 6.

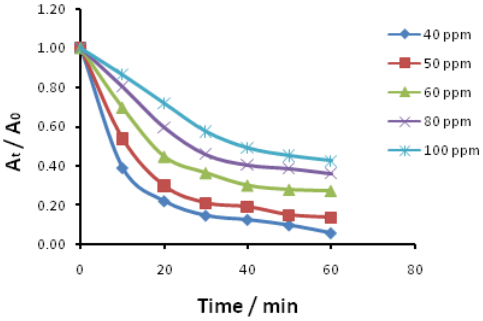

Figure.5.The change of (A_t / A_0)with irradiation time at concentration of reactive green

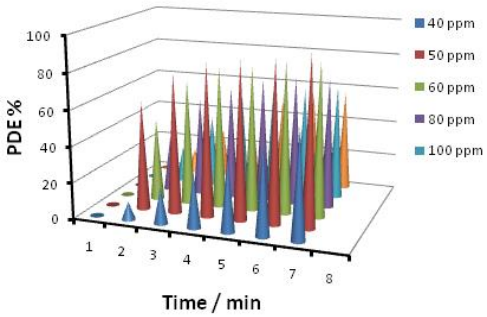

Figure.6.The change of percentage Photocatalytic Degradation Efficiency (PDE %) with irradiation time of different types of concentration of reactive green.

Effect of temperature on photocatalytic degradation of reactive green: A series of experiments were carried out to study the effect of temperature on Photocatalytic degradation rate of reactive green using zinc oxide suspension at different temperature ranging from (278 – 301 k)(Ahmed, 2011). Figure 7, shows the effect of temperature on the photo catalytic degradation rate of reactive green at fixed initial concentration 40 ppm and 0.12 gm/100ml of zinc oxide as catalyst . Figure 7 indicate that the photo catalytic degradation rate of reactive green increases with increase of temperature because increase temperature cause to increase generate free radicals and this lead to decrease recombination process. From the Figure 9 the amount of activation energy 29.04 kJ / mole using Arrhenius equation.

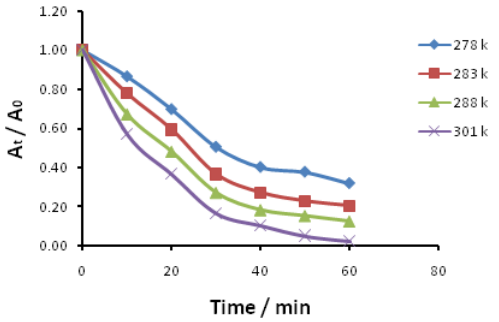

Figure.7.The change of (At / A_0) with irradiation time at different temperature for photo catalytic degradation rate of reactive greenby using zincoxide

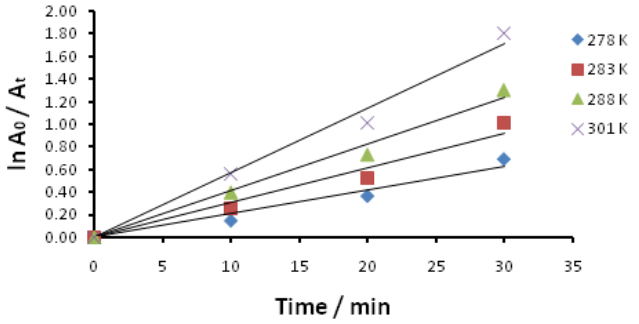

Figure.8.The change of ln (A_0 / A_t) with irradiation time at different temperature

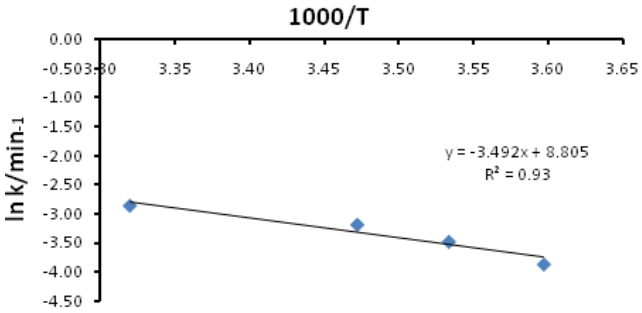

Figure.9.The change of ln K against 1000/T

4. CONCLUSION

The compound has been not degraded in case of absent of catalyst. The compound has been successfully degraded when used the catalyst with the light. The optimum condition for the Photocatalytic degradation of reactive green equal 0.12gm/100ml mass of zinc oxideand 40ppm concentration of reactive green and 8.22 mW/cm^2. The activation energy = 29.04 J/mole. The percentage efficiency of degradation reactive green equal 94.14%.

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REFERENCES

Abdulrazzak FH, Enhance photocatalytic Activity of TiO2 by Carbon Nanotubes, International Journal of ChemTech Research, 9(3), 2016, 431-443.

Ahmed S, Rasul, MG, Brown R and Hashib MA, Influence of parameters on the heterogeneous photocatalytic degradation of pesticides and phenolic contaminants in wastewater, A short review, Journal of Environmental Management, 92(3), 2011, 311-330.

Algubili AM, Alrobayi EM and Alkaim AF, Photocatalytic degradation of remozal briliant blue dye by ZnO/UV process, Int. J. Chem. Sci, 13(2), 2015, 911-921.

Al-Gubury HY and Al-Murshidy GS, Photocatalytic Decolorization of Brilliant Cresyl Blue using Zinc Oxide, International Journal of PharmTech Research, 8(2), 2015, 289-297.

Al-gubury HY, The effect of coupled titanium dioxide and cobalt oxide on photo catalytic degradation of malachite green, International Journal of ChemTech Research, 9(2), 2016, 227-235.

Al-Gubury HY, Fairooz NY, Aljeboree AM, Alqaraguly MB and Alkaim AF, Photocatalytic degradation n-undecane using couple ZnO-Co_2O_3, Int. J. Chem. Sci, 13(2), 2015, 863-874.

Al-Gubury, HY, Almaamory ES, Alsaady HH and Almurshidy GS, Photocatalytic Degradation of Aquatic Rhodamine B Solution Using Ultraviolet Light and Zinc Oxide, Research Journal of Pharmaceutical, Biological and Chemical Sciences, 6(3), 2015, 929-939.

Ali MM and Fairooz NY, Preparing and characterizing study of the photocatalytic activity of new couple semiconductor Nb2o5/Sb2O3, Research Journal of Pharmaceutical, Biological and Chemical Sciences, 6(4), (2015). 1176-1182.

Aljeboree AM, Adsorption of crystal violet dye by Fugas Sawdust from aqueous solution, International Journal of ChemTech Research, 9(3), 2016, 412-423.

Aljeboree AM, Adsorption of methylene blue dye by using modified Fe/Attapulgite clay, Research Journal of Pharmaceutical, Biological and Chemical Sciences, 6(4), 2015, 778-788.

Aljeboree AM, Radi N, Ahmed Z and Alkaim AF, The use of sawdust as by product adsorbent of organic pollutant from wastewater, adsorption of maxilon blue dye, Int. J. Chem. Sci, 12(4), 2014, 1239-1252.

Aljebori AM and Alshirifi AN, Effect of Different Parameters on the Adsorption of Textile Dye Maxilon Blue GRL from Aqueous Solution by Using White Marble, Asian journal of chemistry, 24(12), 2012, 5813-5816

Alkaim AF and Alqaragully MB, Adsorption of basic yellow dye from aqueous solutions by Activated carbon derived from waste apricot stones (ASAC), Equilibrium, and thermodynamic aspects, Int. J. Chem. Sc, 11(2), 2013, 797-814.

Alkaim AF and Hussein FH, Photocatalytic degradation of EDTA by using TiO_2 suspension, Int J Chem Sci, 10(1), 2012, 586-598.

Alkaim AF, Aljeboree AM, Alrazaq NA, Baqir S.J, Hussein F.H and Lilo AJ, Effect of pH on Adsorption and Photocatalytic Degradation Efficiency of Different Catalysts on Removal of Methylene Blue, Asian Journal of Chemistry, 26(24), 2014, 8445-8448.

Alkaim AF, Dillert R & Bahnemann DW, Effect of polar and movable (OH or NH2 groups) on the photocatalytic H2 production of alkyl-alkanolamine, a comparative study, Environ. Technol, 36(17), 2015, 2190–2197.

Alkaim AF, Kandiel TA, Enhancing the photocatalytic activity of TiO2 by pH control, a case study for the degradation of EDTA, Catalysis Science & Technology, 3, 2013, 3216–3222.

Alkaim AF, Sadik Z, Mahdi DK, Alshrefi SM, Al-Sammarraie AM, Alamgir F.M, Singh P.M and Aljeboree AM, Preparation, structure and adsorption properties of synthesized multiwall carbon nanotubes for highly effective removal of maxilon blue dye, Korean J. Chem. Eng, 32(12), 2015, 2456-2462.

Al-Khafaji NSK, Shareef HK and Al-Dahmoshi HOM, Analysis of β-lactamases among multi drug resistant Klebsiella pneumoniae in Hilla city-Iraq, Research Journal of Pharmaceutical, Biological and Chemical Sciences, 6(4), 2015, 903-907.

Alkhateeb AN, Hussein FH and Asker KA, Photocatalytic decolonization of industrial wastewater under natural weathering conditions, Asian journal of chemistry, 17(2), 2005, 1155-1159.

Al-Robayi IM, Correlation effects in He-like ions, An analysis of the ground state in momentum space, International Journal of Chemical Sciences, 12(4), 2014, 1311-1318.

Alsalman ARS, Almashhedy, LA and Hadwan MH, Zinc supplementation attenuates lipid peroxidation and increases antiperoxidant activity in seminal plasma of Iraqi asthenospermic men, Life Science Journal, 10(4), 2013, 989-997.

Al-Terehi M, al-kilabi IH, AL–Mamoori AMJ, Al-Jboori MJ, Al-Saadi AH and Zaidan HK, International Journal of ChemTech Research, 9(3), 2016, 407-411.

Fairooz NY, Evaluation of new couple Nb2O5/Sb2O3 oxide for photocatalytic degradation of Orange G dye, International Journal of ChemTech Research, 9(3), 2016, 456-461.

Hadi ZA, Aljeboree AM and Alkaim AF, Adsorption of a cationic dye from aqueous solutions by using waste glass materials, isotherm and thermodynamic studies, Int. J. Chem. Sci., 12(4), 2014, 1273-1288.

Hussein FH and Alkhateeb AN, Photo-oxidation of benzyl alcohol under natural weathering conditions, Desalination 209(1-3 SPEC. ISS.), 2007, 350-355.

Hussein FH, Effect of photocatalytic treatments on physical and biological properties of textile dyeing wastewater, Asian journal of chemistry, 25(16), 2013, 9387-9392.

Hussein FH, Alkhateeb AN and Ismail JK, Solar photolysis and photocatalytic decolorization of thymol blue, E-Journal of Chemistry, 5(2), 2008, 243-250.

Hussein FH, Halbus AF, Hassan HAK and Hussein WAK, Photocatalytic degradation of bismarck brown G using irradiated ZnO in aqueous solutions, E-journal of chemistry, 7(2), 2010, 540-544.

Jabbar AZ, Hadi AG and Sami F, Removal of azo dye from aqueous solutions using chitosan, Oriental Journal of Chemistry, 30(2), 2014, 571-575.

Jafar NN, Al-Dahmoshi HOM, Jeburalmamoori AM, Al-Khafajii NSK and Al-Masoudi N, Synthesis and biological activity of new derivatives of 6-chloro-5-((4-chlorophenyl)diazenyl)pyrimidine-2,4-diamine and 4-chloro-6-methoxy-N,N-dimethylpyrimidin-2-amine, Biomedical and Pharmacology Journal, 6(2), 2013, 453-465.

Jasim FA, Lafta F, Hashim A, Ali M and Hadi AG, Characterization of palm fronds-polystyrene composites." Journal of Engineering and Applied Sciences, 8(5), 2013, 140-142.

Kamil AM, Karam MA, Balakit AA and Hussein, FH, Synthesis and characterization of iron oxide nanoparticles and applications in the removal of reactive black 5H from wastewater." Research Journal of Pharmaceutical, Biological and Chemical Sciences 7(1), 2016, 1740-1751.

Karam FF, Kadhim MI and Alkaim AF, Optimal conditions for synthesis of 1, 4-naphthaquinone by photocatalytic oxidation of naphthalene in closed system reactor, Int. J. Chem. Sci, 13(2), 2015, 650-660.

Krishnakumara B and Swaminathan M, Influence of operational parameters on photocatalyticdegradation of a genotoxic azo dye Acid Violet 7 in aqueous ZnO suspensions, Spectrochimica Acta Part A, Molecular and Biomolecular Spectroscopy, 81(1), 2011, 739-744.

Mashkour MS, Al-Kaim AF Ahmed LM and Hussein FH, Zinc oxide assisted photocatalytic decolorization of reactive red 2 dye." Int. J. Chem. Sc. 9(3), 2011, 969-979.

Matloob MH, Fluoride concentration of drinking water in Babil-Iraq, Journal of Applied Sciences, 11, 2011, 3315-3321.

Miao J, Jia Z, Lu HB, Habibi D and Zhang L, Heterogeneous photocatalytic degradation of mordant black 11 with ZnO nanoparticles under UV-Vis light, Journal of the Taiwan Institute of Chemical Engineers, 45, 2014, 1636-1641.

Mohamed FF, Allah P.M, Mehdi A.P, and Baseem M, Photoremoval of Malachite Green (MG) using advanced oxidation process, Res.J.Chem.Environ, 15(3), 2011, 65-70.

Mohammed B Alqaragully, Hazim Y AL-Gubury, Aseel M Aljeboree, Fiaq F Karam, and Ayad F Alkaim, Monoethanolamine, Production Plant, Research Journal of Pharmaceutical, Biological and Chemical Sciences 6(5), 2015, 1287-1296.

Saleh JM and Matloob MH, Oxidation of titanium, tantalum, and niobium films by oxygen and nitrous oxide, Journal of Physical Chemistry, 78, 1974, 2486-2489.