

Degradation of Congo Red Color Substance in Ozonolysis with addition of ZnO/zeolite as Catalyst

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ABSTRACT

The research about the degradation of congo red color substance using the ZnO/zeolite catalyst and ozonolysis has been conducted. This research includes the production of ZnO/zeolite catalyst and its usage to degrade the congo red color substance. This research studies about the impact of the variation time of degradation, the effect of ZnO/zeolite catalyst weight, the effect of time variation towards the degradation by the addition of ZnO/zeolite catalyst, ZnO and zeolite. After that, the result after degradation in optimum condition with HPLC (High Performance Liquid Chromatography). The result of the research shows HPLC analysis of Congo red which is degraded in ozonolysis way without the addition of catalyst results in degradation percentage of 77.27%, 88.41 % in the addition of ZnO catalyst, 90.94% in the addition of zeolites catalyst, and 93% in the addition of ZnO/zeolite.

INTRODUCTION

In textile coloring process, most of the coloring substance that are used will be wasted as waste. In general, the coloring substance from textile industry is a form of organic substance which have aromatic structure, therefore it makes it difficult for it to be naturally degraded and is not environmental friendly for sure. Congo red is one of coloring substance that are most commonly used. The existence of congo red coloring substance in water environment could damage various living creature because of the character of congo red substance that is highly toxic. The accumulation of congo red in ones body could cause disturbance in liver, kidney and neuron function Therefore, the method to solve this waste problem is necessary.[1-3]

Various effort has been done to manage the waste, such as the sedimentation and active mud method. Those method have their flaw, like how it requires relatively wide installation processing area, mud active process runs for a long time, and the production of new waste which requires next process. One alternative to answer that problem is advanced oxidation process. Advanced oxidation process will break down the dangerous organic substance without producing new waste. The advanced oxidation methods are including photolysis and ozonolysis. Some methods that can be used to minimalized the concentration of coloring substance in textile industrial waste are including biological method, coagulation method, electrocoagulation, adsorption, ozonation and chlorination. [4][5]

The study that is developinb is the usage of ZnO to degrade organic substance in waste. ZnO is an effective catalyst to degrade toxic organic substance. This is proven by several research like the congo red coloring substance that is degraded to 99,40% by using the active charcoal ZnO catalyst in photolysis way, the MGO coloring substance is degraded to 93.61% after tge photolysis is done by using UV/ ZnO / phenton reagen, Sipermitrin substance is degraded to 73% in ozonolysis way by using TiO₂ / zeolite as catalyst. [6]

Based on that, degradation process of Congo Red coloring substance in ozonolysis way by addition of ZnO/ zeolite hasn't been done, therefore this research is conducted to know the percentage of congo red coloring substance that can be degraded by using ozonolysis method without the addition of catalyst, with the addition of catalyst ZnO/ Zeolite, ZnO and Zeolite, also detection of product that is formed by using HPLC.

MATERIALS AND METHODS

Equipments and materials

Equipments which were are Spectrophotometer UV – Vis (Shimadzu) Machine, HPLC (Shimadzu), X- Ray Diffraction (X Pert Pro Pan Analytical), Ozone maker (Hanaco), Centrifuge, Stirrer magnetic, Furnace, Analytical Neraca, Centrifuse, and glass tools.

Material are congo red coloring, aquabidest, Zeolite, ZnO, NaCl, AgNO, Methanol

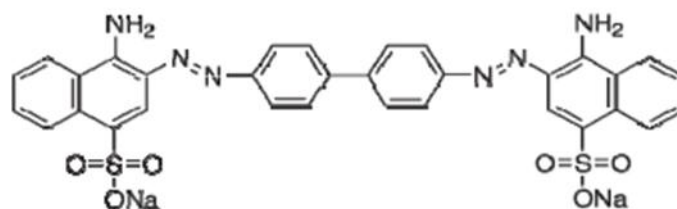


Fig.1 Structure of Congo Red

The determination of Absorption spectrum from various concentration of Congo Red

Some variation of congo red concentration is made by dilluting stock solution into 5; 10; 15; 20; 25; and 30 mg/L. Then the measurement of spectrum is done towards 5 variation of that solution concentration by using spectrophotometer UV – Vis.

The affect of Ozonolysis time towards Congo red degradation

The 20 mg/ L congo red solution is inserted into 5 glass tubes with volume of 20 ml each. After that, each is ozonolysized with various of time of (5- 50) minutes, where degradation is done by adding ozone into the solution. The result of ozonolysis is measured by using spectrophotometer UV/ Vis. After that , the calculation of degradation percentage is held.

The affect of adding the concentration of ZnO/ zeolite towards congo red degradation

The 20mg/L congo red solution is inserted into 5 glass tubes with volume of 20ml each. After that, each of them is added with ZnO/ zeolite as much as (5- 25) mg. The solution that has been added by catalyst later are ozonolysized. The result of ozonolysis is centrifused for 10 minutes to separate the filtrat from catalyst. The filtrat is measured by using Spectrometer UV – Vis. After that the calculation of its degradation percentage is held.

The affect of time towards the degradation of congo red with the addition of ZnO/ zeolite, ZnO and zeolite catalyst.

The 20 mg/L of congo red solution is inserted into 5 glass tubes with volume of 20 ml each, then added 15 mg ZnO/ zeolite, . After that, each of them is ozonolysized with various of time (5- 50) minutes where degradation is done by adding ozone into solution. The result of ozonolysis is measured by Spectrophotometer Uv/ Vis. After that the calculation of degradation percentage is held. Then, do the same procedure with other catalyst ZnO 1.7 mg and Zeolite 13.3 mg.

Detection of Degradation result of Congo Red using HPLC

The detection of congo red coloring substance degradation is done by using HPLC method. This analysis is done to optimum weight usage of ZnO/ zeolite catalyst, ZnO and zeolite. The detection is done by using HPLC.

RESULTS AND DISCUSSION

Determination of Congo Red Maximum Absorption

The measuring of congo red maximum absorption is done in area with wave length of 200-700 nm. Picture 2 shows with the increase of concentration, the wavelength that is obtained is 498nm. With this, can be said that Congo Red absorbs UV ray in length of 498nm. For next degradation process seen from this linear spectrum, therefore the concentration that is used is 20 mg/L.[6]

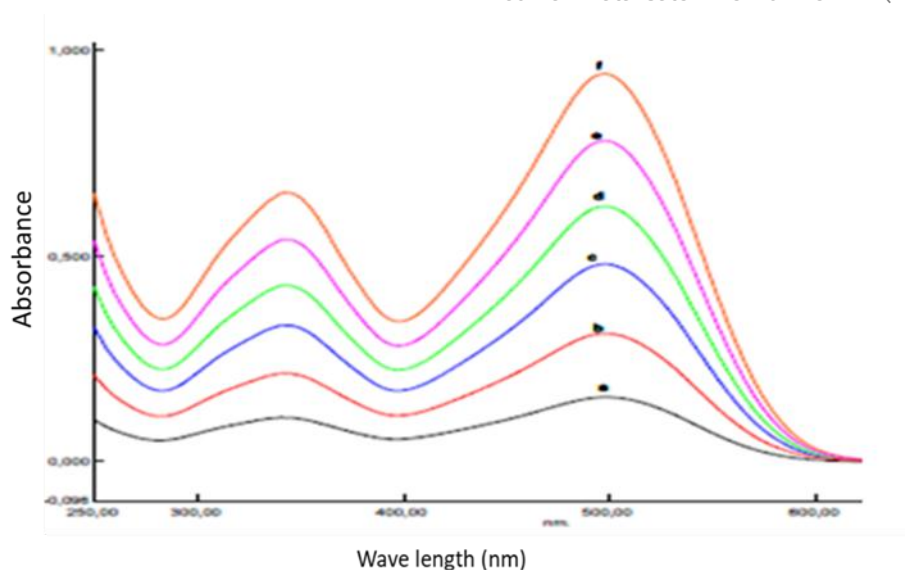


Fig. 2 Spectrum of Congo Red

Effect of degradation time

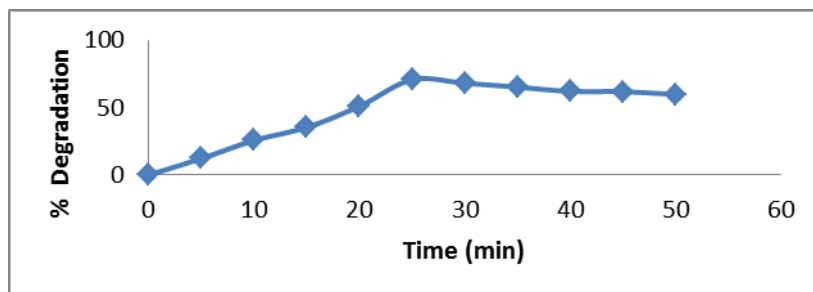


Fig. 3 Effect of degradation time to degradation percentage of congo red

Fig.3 shows that happens the increase of degradation percentage of congo red substance 20 mg/L by the addition of ozonolysis time, because the longer the ozonolysis time the more OH radical that plays role in degrading sipermetrin substance. The most optimum time is 25 minutes with percentage of degradation of 70.72% because with more addition of time the increase of degradation percentage is not as significant.

The affect of catalyst concentration towards degradation

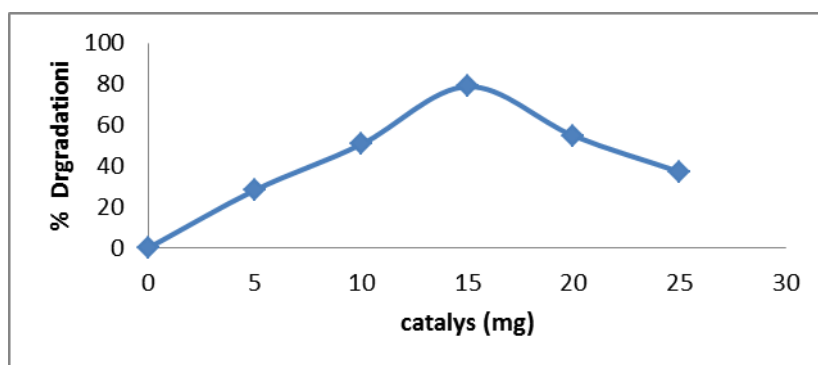
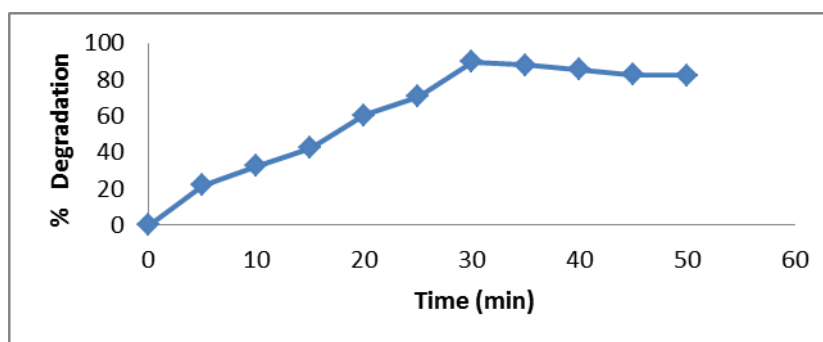


Fig. 4 Effect of Catalyst

Fig. 4 shows that the optimum number of ZnO/ zeolite catalyst to degrade 20ml of Congo red 20 mg/L is 15 mg with percentage of degradation up to 78.74% during ozonolysis time. This is the most optimum condition for the addition of ZnO/ zeolite because in the next addition, 20 mg percentage us decreasing up to 54.69%. This is due to the saturation of solution that happens which cause the solution became turbid therefore the absorbance of solution getting bigger. This condition will make solution separation from catalyst becoming difficult which cause the large absorbance.

The affect of time towards congo red degradation with the addition of ZnO/ zeolite, ZnO and zeolite catalyst



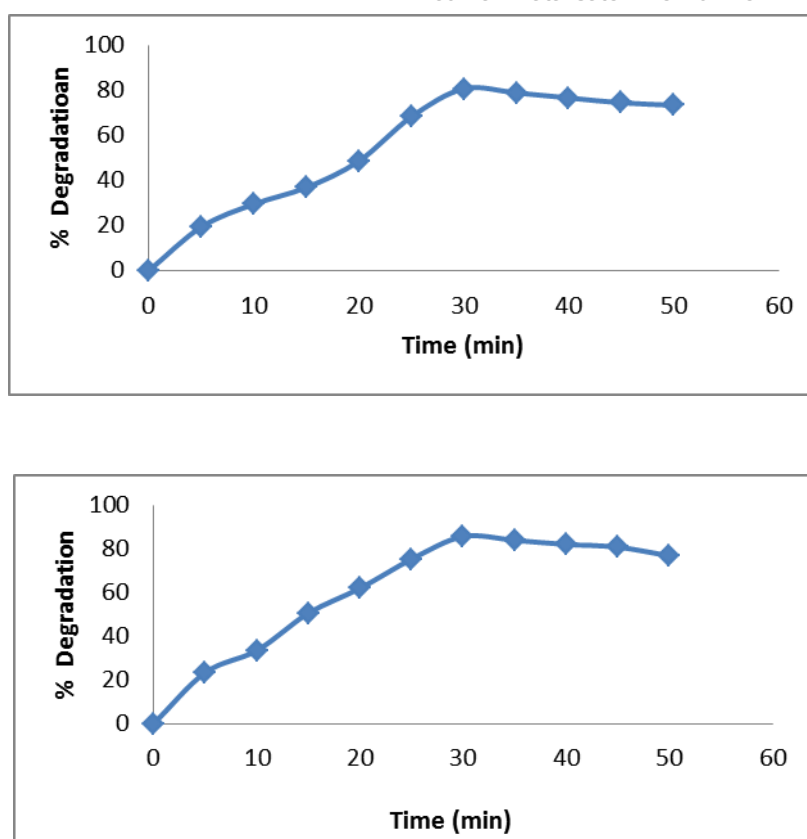
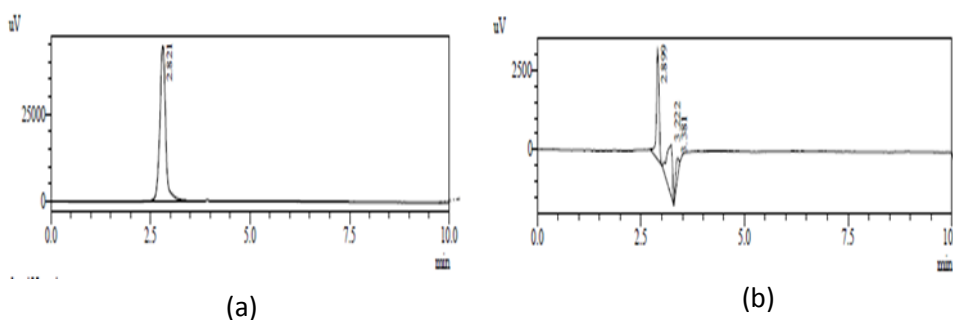


Fig. 5 Effect of Catalyst In Congo Red a. ZnO/zeolit, b. ZnO, c, zeolite

Fig.5 can be seen that the degradation percentage of congo red increase by the addition of ozonolysis time with the addition of 15mg ZnO/ zeolite catalyst. On the 30 th minutes, congo red has been degraded up to 89.78%, addotion of 1.7 mg ZnO congo red has been degraded 80.66 and addition of 13.3 mg zeolite congo red has been degraded 85.65 %. This is due to the number of OH that is produced which make it easier for congo red to be degraded. While on the other hand, the more ozonolysis time is not really significant on adding the percentage of degradation.

Detection of Congo Red Degradation Result by using HPLC



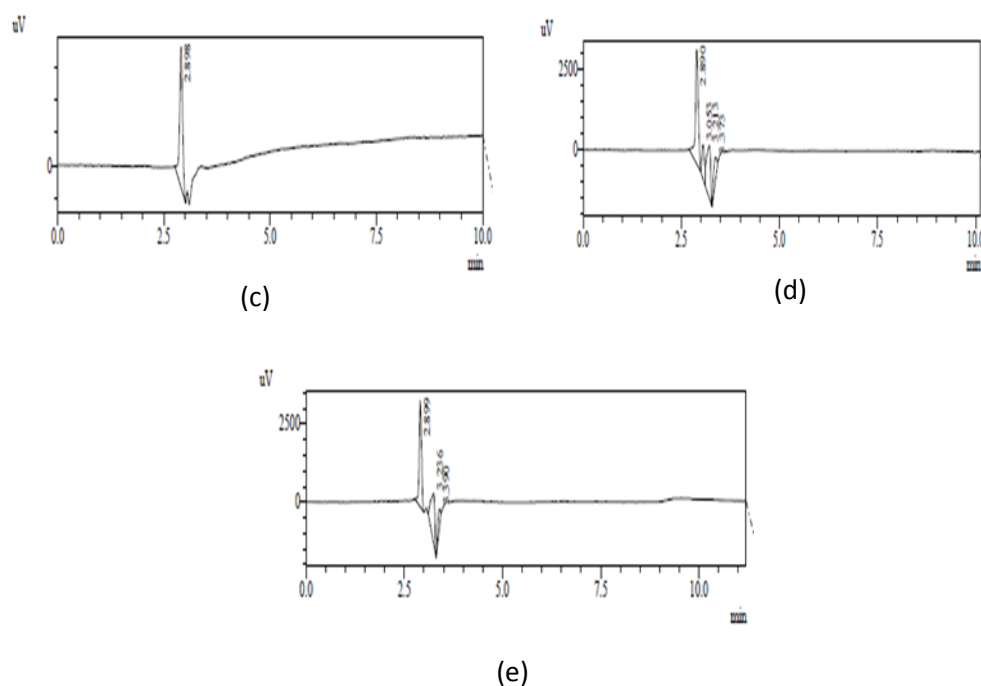


Fig.6 Representative HPLC chromatograms of Congo Red, (a) congo red (b) degradation congo red without catalyst, (c) degradation congo red usage of ZnO/zeolite catalyst (d) degradation congo red usage of ZnO catalyst , (e) degradation congo red usage of /zeolite catalyst

The decrease of surface area and height of peak that happens in Congo red solution with ozonolyzed addition of catalyst ZnO / zeolite happens due to the degradation time that is longer causing more amount of OH radical produced on the surface of catalyst. The more radical OH that is produced themore percentage of degradation.[7][8]

New peaks that are formed are fragmentation peaks from Congo red solution, which is less polar from initial Congo solution. This is because the new peak that appears, appear after the peak of Congo red solution peak. Based on HPLC reverse principle using more polar motion phase than silent phase , therefore the solution with higher polarity will come out first while solution with less polarity will be bonded longer in column. Therefore new peak that appears are less polar compared to Congo red solution. The possibility of substance that forms new peaks are fragment from the ozonolysis of Congo red substance like can be seen on. In this research, the substances that are formed after degradation is not further identified.

CONCLUSION

From the research that has been conducted, can be concluded that Congo red can be degraded by using ozonolysis method. The ability of ZnO / zeolite catalyst is having better

degradation from ozonolysis that is done without the usage without the addition of catalyst, the addition of ZnO catalyst and zeolite. This can be seen from the spectrophotometer analysis result UV Vis congo red which can be degraded in ozonolysis without the addition of catalyst results in degradation percentage of 70.72%, the addition of catalyst ZnO 80.66%, the addition of catalyst zeolite 85.65% and the addition of ZnO / zeolite catalyst 87.78%.

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