MODIFIED FENTON'S OXIDATION PROCESS FOR REMOVAL OF CONGO RED DYE FROM WATER

[1]Amrutha.K.Sasi, [2]Anna Jaison, [3]Devi Ganga Lakshmi,[4]Arunjith Reghu,[5]Divya.S.Nair

[1]B-Tech student, [2]B-Tech student, [3]B-Tech student, [4]B-Tech student, [5]Assistant Professor
[1]Civil Engineering,
[1]Muthoot Institute of Technology and Science, Ernakulam, India

Abstract: Unsustainable industrialization and pollution are having long term effects on our environment. Voluntary methods of environmental performance certification and labelling for textile products and stringent rules on wastewater discharges are forcing textile processors to reuse the discharged water and chemicals. This challenge has provoked the researchers for an intensive research in new advanced treatment technologies, which are currently advancing at a faster pace to full-scale installations. Some of these processes are filtration, chemical oxidation, specialized flocculation techniques, anaerobic digestion, fixed-film bioreactors, and electrolysis and foam flotation. Despite the fact that all of these technologies are economical and efficient, like the two sides of a coin, they are also subject to limitations. This research deals mostly on the study of catalyst for Heterogeneous Fenton's process for the removal of Congo Red Dye. Optimization of reaction parameters was done using repeated applications.

***IndexTerms* – Congo red dye, Heterogeneous Fenton's process, Anaerobic digestion.**

I. INTRODUCTION

Dyes are coloured complex aromatic molecular structures which has strong substantivity to the substrate to which it is being applied and is difficult to degrade. Dye is a dominant factor in textile industry. Colour is essential for the eminence of textile industries. Dyes are able to colour water even in concentrations as low as 1mg/L. In textile water the content of dye will be higher. The colour can be recognized easily but the problem arises from the point that it becomes hazardous and toxic on its decomposition. Many chemicals used in the textile industry cause environmental and health problems. Worldwide environmental problems associated with the textile industry are typically those associated with water pollution caused by the discharge of untreated effluent and those because of use of toxic chemicals especially during processing. The effluent is of critical environmental concern since it drastically decreases oxygen concentration due to the presence of hydrosulfides and blocks the passage of light through water body which is detrimental to the water ecosystem. Congo red which is the sodium salt of benzidinediazo-bis-1-naphthylamine-4-sulfonic acid is a water soluble dye commonly found in textile water. The dye coming out as effluent causes severe issues and is a major cause of pollution. Coloured industrial effluent contains many varieties of synthetic dyes including azo dyes which are mostly toxic and mutagenic, and even carcinogenic in nature. These dyes have been known to cause an allergic reaction and to be metabolized to benzidine, a human carcinogen. Synthetic dyes such as Congo red possess physio-chemical, thermal and optical stability due to its high complexity, making its removal difficult. Thus there is an immediate urge for the treatment of textile water before being discharged. Dyes are highly stable thus its removal is of great confront.

Various recent techniques have been introduced for the removal of contaminants using chemical, biological and thermal process. Advanced oxidation process (AOP's) prove to be the most efficient method among all. The method eliminates organic content from waste water by oxidation through the reaction with hydroxyl radicals. Advanced oxidation processes (AOPs) have great consideration in removal of organic contaminants from wastewater. Fenton oxidation comes under the category of AOPs and has been considered to be an effective method for treating textile waste water. Homogeneous Fenton's process involves the precipitation of iron which is to be separated out. To overcome the disadvantages of homogeneous Fenton type processes, heterogeneous Fenton is adopted. In heterogeneous Fenton process, iron salts, were adsorbed onto the surface of supported catalysts, and in a suitable aqueous medium the reduction-oxidation reactions between Fe(II)/Fe(III) take place in presence of hydrogen peroxide which promote the formation of reactive components such as hydroxyl and hydroperoxyl radicals. These radicals then oxidise the organic compounds adsorbed on the catalyst surface. Thus, the Fe(III)/Fe(II) complex formed on the surface of support can react with H2O2 thus allowing iron ions to participate in the Fenton catalytic cycle. Microfiltration incorporated with heterogeneous Fenton's oxidation process permit the removal of organic and suspended impurities.

The present study aims at the removal of Congo red dye from textile water using modified Fenton's oxidation process followed by microfiltration in the presence of Iron activated flyash as catalyst. The effect of various reaction parameters were checked out. Based on the optimized conditions the efficiency of removal of dye from textile water is investigated.

II. MATERIALS AND METHODS

Materials which is required for catalyst preparation was purchased from Modern Scientific at Aluva. The textile wastewater was collected from nearby industry in Kochi. The catalyst chosen for the preparation was iron activated fly ash. Microfiltration unit which consist of Buckner funnel, vacuum pump, glass flask, rubber tube and whatman filter paper of pore size 11 micrometer was purchased. All the chemical substance is of reagent grade. All chemicals used in the experiment is of Merck standard.

The catalyst was prepared by dissolution of 6g of standard $FeSO_4.7H_2O$ in 20 ml of distilled water. Fly ash was added to the solution under suitable condition. Orbital shaker was opted for stirring the solutions. The mixture thus obtained was placed in water bath at temperature of 100^0C until complete evaporation of water takes place. The sample thus obtained was oven dried at a temperature of 100^0C overnight to obtain the required catalyst. Dye solution was prepared by addition of 30 mg congo red dye into 1L distilled water. 30 ppm dye solution was taken and following parameters were varied to obtain the optimized condition and the following are varied parameters such as: catalyst concentration, pH, reaction time and H_2O_2 concentration.

The experiment was carried out in Erlenmeyer flask of capacity 500 ml and the sample of 100ml was taken. To this, required quantity of catalyst was added and then thoroughly mixed. Given volume of H_2O_2 concentration was added to it. Then this experimental setup was kept in orbital shaker for varying time intervals and thereby this sample is transferred into microfiltration setup which consist of buckner funnel, vacuum pump, glass flask, rubber tube and whatman filter paper and it is filtered. Filtered sample was collected and its COD and absorbance were measured. Several trials were done for the varied parameters in order to obtain optimized value for the maximum removal.

III. RESULTS AND DISCUSSIONS

3.1 Effect of reaction time

Reaction time was varied as 10, 20,30,40,50 and 60 minutes. Dye removal percentage and COD removal percentage was found for each value of reaction time. From the obtained values, 30 minutes was selected as the optimised reaction time.

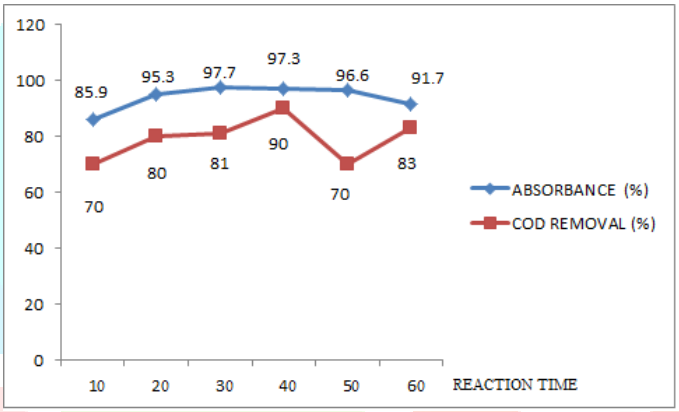

Fig.3.1 Results of Tests on Textile waste water treated using Iron activated flyash as Catalyst.

3.2 Effect of H_2O_2 Concentration

H_2O_2 Concentration was varied as 1,2,3,4 and 5 ml per 100 ml dye solution. Dye removal percentage and COD removal percentage was found for each value of H_2O_2 Concentration. From the obtained values, 2 ml was selected as the optimised H_2O_2 Concentration.

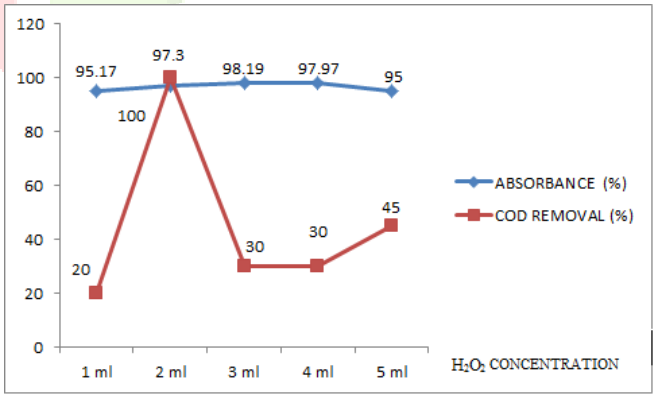

Fig.3.2 Graph showing variation of Absorbance percentage and COD removal percentage with respect to H_2O_2 Concentration.

3.3 Effect of Catalyst Concentration

Catalyst Concentration was varied as 100,200,300,400,500 and 600 mg per 100 ml dye solution. Dye removal percentage and COD removal percentage was found for each value of Catalyst Concentration. From the obtained values, 300 mg was selected as the optimised Catalyst Concentration.

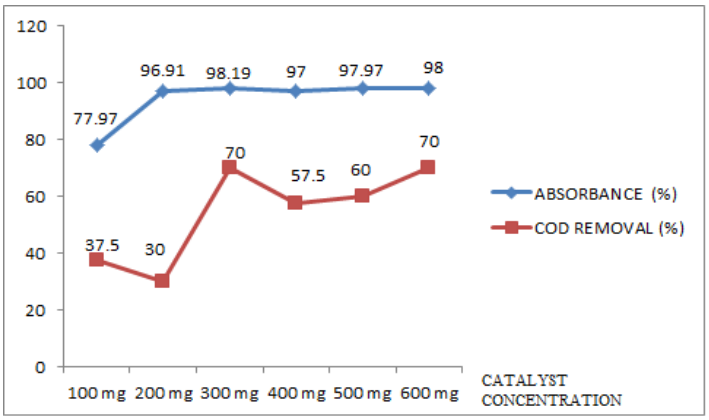

Fig.3.3 Graph showing variation of Absorbance percentage and COD removal percentage with respect to Catalyst Concentration.

3.4 Effect of pH value

pH value was varied as 1,2,3,4,5,6 and 7. Dye removal percentage and COD removal percentage was found for each value of pH. From the obtained values, pH 7 was selected as the optimised pH value. Dye removal was most powerful using the first catalyst. Optimised conditions were 300 mg catalyst, 2 ml H_2O_2, pH 7 and reaction time of 30 minutes per 100 ml of dye solution. The results obtained for various tests are shown in the table 3.1.

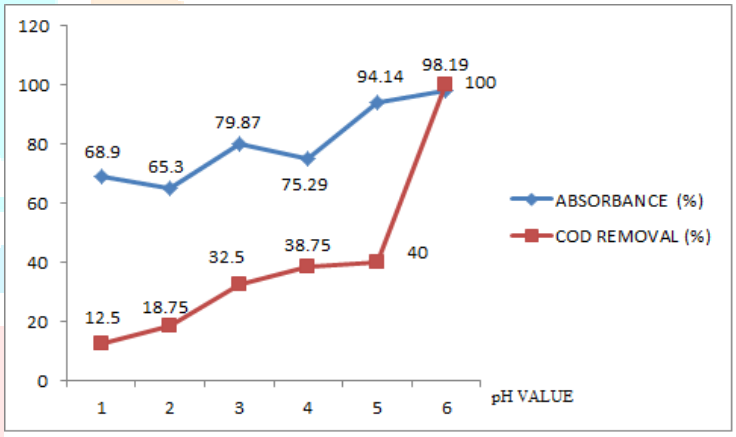

Fig No.3.4 Graph showing variation of Absorbance percentage and COD removal percentage with respect to pH value.

Table 3.4: Results of Tests on Textile waste water treated using Iron activated flyash as Catalyst.

Properties	Magnitude
Absorbance	95.18%
COD removal	33.33%
pH	8.24
Alkalinity	131mg/l
Acidity	470mg/l
Hardness	240
Chloride	27.49mg/l
Turbidity	8.8 NTU

IV. CONCLUSIONS

The microfiltration setup with vacuum pump was successfully applied for textile industry waste water treatment in this study.The experiment was carried out to determine the activity of Iron activated flyash as catalyst in Heterogeneous Fenton's process for removal of Congo red dye from textile waste water. There occurred a fairly nice removal of dye during the experiment. The results showed that the maximum removal was obtained at a pH of 7 with 300mg catalyst and 2 ml H_2O_2 concentration in 100 ml textile industry waste water. Results also showed the reusability of the catalyst to a particular limit. Thus the study proved a complete success with its efficient and economical supremacy over other methods in the area.

V. ACKNOWLEDGMENT

The authors thank Muthoot Institute of Technology and Science for the lab facilities.

REFERENCES

[1] Saini et al(2016) 'Optimization of Fenton Oxidation for the removal of Methyl Parathion in aqueous solution', Journal of Environmental Engineering, Vol No: 26, pp 216-218

[2] Filipek et al(2001): 'Use of Fenton's Reagent for Removal of Pesticides from Industrial Wastewater', *Polish Journal of Environmental Studies*, Vol. 10, No. 4,pp 207-212.

[3] Ertugay et al(2013).Removal of COD and color from Direct Blue 71 azo dye wastewater by Fenton's oxidation: Kinetic study', Arabian Journal of Chemistry.

[4] Ebrahiem et al(2013).Removal of organic pollutants from industrial wastewater by applying photo-Fenton oxidation technology, Arabian Journal of Chemistry.

[5] Sosamon et al(2017).Treatment of textile effluent using heterogeneous fenton and microfilteration, Journal of Environmental Engineering, Vol No: 12, pp 118-121.

[6] Anil.k.saroha et al(2015): 'Kinetics of Ozone Oxidation of Acid Red 131 Monoazo Dye in Aqueous Solution', ASCE, Vol No: 11, pp 114-140

[7] Elham et al(2013).Modification of Nickel Ferrite with Cationic Surfactant: Dye Removal from Textile Wastewater Using Magnetic Separation, ASCE.

[8] K. Barbusiński(2011).Use of Fenton's Reagent for Removal of Pesticides from Industrial Wastewater, Polish Journal of Environmental Studies,Vol. 10, No. 4 (2001), 207-212.

[9] Duc D.S.Degradation of Reactive Blue 181 Dye by Heterogeneous Fenton Technique Using Modified Fly Ash, Asian Journal of Chemistry, 25(7),2013, pp. 4083-4086.

[10] Ahamad et al, Removal of dye from wastewater of textile industry using membrane technology, Journal of technology, Vol. 36, 2002, pp. 31-44.

[11] Sathiyamoorthy et al, The removal of colour from synthetic textile dye effluent using Cellulose acetate reverse osmosis membrane, International Journal of Advanced Research in IT and Engineering, Vol.1,2012, pp. 25-42.

[12] N.K. Daud, B.H. Hameed, Decolorization of acid red 1 by Fenton like process using rice husk ash based catalyst, J. Hazard. Mater., Vol.1, 2009, pp. 38–44.