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TREATABILITY OF TEXTILE EFFLUENT WITH PHOTO FENTON PROCESS, UV & SOLAR RADIATION

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ABSTRACT

This study is aimed at making photo Fenton mode of treatment more accessible to Textile Industries enabling them to reap profit out of this upgrading technology. The research was carried on the untreated waste effluent of textile industry for the removal of Chemical Oxygen Demand. About 70-80% COD reduction was obtained without any pre-treatment of the waste effluent at pH 3. The Experimental conclusion shows that utmost COD removal was obtained at 6:1 of COD:H2O2 concentration ratio with both the light sources. The different molar concentrations of H2O2:Fe+2 were considered among which, the efficiency was obtained at 15:1 and 20:1. For photo degradation of organic compounds photo fenton treatment could be very useful method for resultant reaction time for the procedure states.

I. INTRODUCTION

Textile mills are the main consumers of water in the world. They uses an average water of 200000 L/ton of finished goods out of which 92% is seemed as effluent. These industries are one of the largest groups of industries which cause high pollution in terms of quality as well as in quantity. Generated wastewater comprehend different effluent coming from varied manufacturing unitary operations such as sizing, desizing, scouring, bleaching, dyeing, soaping and softening. These complex operations, subjected to frequent alteration as a result of shifting consumer's preference, are the cause of the variable volume and the wide diversity of chemical products found in these effluent. Though their distinctiveness depend on the definite operations performed, they generally in attendance SS, elevated temperature, unbalanced pH, lofty chemical oxygen demand (COD), low biological oxygen demand (BOD) and high colorization. Textile processes render multi-component wastewater which is hard to treat. This wastewater can cause serious environmental damages due to their high color, large amount of suspended solids and high chemical oxygen demand. This effluent cannot be readily degraded by conventional biological processes (e.g. activated sludge process) due to the structure of most commercial dye compounds are generally complex and many dyes are non-biodegradable, this is because of their chemical nature and molecular size. Therefore, more than a few processes have been identified to treat textile effluent but they cannot be used independently since this effluent has elevated salinity, color & non-biodegradable organics. The table 1 shows potential action of Textile effluent & their advantages and disadvantages.

Table 1. Potential action of Textile effluent & their advantages and disadvantages.

Processes	Advantages	Disadvantages
Biodegradation	Rates of elimination by oxidizable substances about 90%	Low degradability of dyes.
Coagulation& Flocculation	Exclusion of insoluble dyes	Making of sludge overcrowding filter
Adsorption on activated carbon	Organic substances and SS well condensed	Activated carbon costing
Ozone Treatment	Good de colorization	Less reduction in COD
Electrochemical processes	Unusual volume and pollution loads variation capability	Iron hydroxide sludge

The present study was carried out using a real textile wastewater without any pre-treatment from a textile industry. The raw effluent from the unit has COD in the range of 8000-12000 mg/L which is brought under limits by conventional method of treatment. The business has 2 special streams of dealing for low COD and high COD effluent. The treated low COD water is reused back in unit in floor wiping and other uses. The extreme diversity of raw materials and production schemes employed by this unit poses puzzle in assessing effluent characteristics. Multiple dyes and chemicals are used as per the project allotted as this is project based industry. Hence pollution control technologies are difficult to define. For lowering the attentiveness of Dissolved dyes and organic matters in textile effluent oxidation with Fenton's reagent is very effectual method, this condition outcome in decrease of color and Chemical Oxygen Demand of textile wastewater. Thus the aim of the study was to explore the Photo Fenton to improve the biodegradability of the wastage. There are two different photo sources were taken as study parameters to find the efficient mode of treatment. During the initial experiments it was found that the model pollutant was low degradable at COD:H2O2=2:1 and 4:1. Diverse pH values were also used to acidify the section, but after more than a few experiments it was found that the optimum pH to carry out the experiments was at 3. Therefore this was used all through the whole process.

I. METHODOLOGY

The resources and method used in this learning study are as follows. This moreover includes the categorization of the representation pollutant.

2.1 The Textile wastewater

The effluent was obtained from the collection tank of Textile unit. There are no fixed chemicals or dyes used as raw material by the unit as it is based on the type of the work allotted. The composite Chemical Oxygen Demand of raw waste is about 8000–12000 mg/L. Now, they are using conventional treatment method for the treatment of wastewater. In table 2 common characteristics of the effluent has been mentioned.

Table. 2 Common characteristics of the effluent has been mentioned.

SR. NO.	PARAMETERS	UNIT	VALUE
1	pH	--	13.44
2	Suspended Solids	mg/L	392
3	TDS	mg/L	10241
4	COD	mg/L	8999
5	BOD_5	mg/L	964

1.2 Experimental methods

In present study the investigational methods and mode of treatment are used which are mentioned as below.

1.2.1 Photo Fenton treatment

The model pollutant at pH 3.0, without removal of precipitates, was used for Fenton's treatment.COD: H_2O_2 ratio of 2:1, 4:1 and 6:1 were considered. H_2O_2: Fe^{+2} molar ratios of 15:1, 20:1, 25:1 and 30:1 were used in both the procedures. The procedure initiate with mixing of $FeSO_4.7H_2O$ crystals and then slowly dropping H_2O_2 drop wise with continues stirring. The reaction of mixture is then exposed to the light source (UV light and solar radiations), hence the actual degradation of organic pollutants initiates. The reaction was allowed to run for 3 hours (180 minutes). The samples were collected at different time and intervals to study the change in the removal efficiency. There are different times at which samples were collected such as 90, 120,150 and 180 minutes. After the completion of reaction, pH was adjusted to 9 by NaOH and followed by addition of acidic media to adjust pH at 7.0.

1.2.1.1 Photo Fenton Treatment with UV light

The process usually includes the use of low-pressure UV lamps with a principal wavelength of 254nanometer. As the highest absorption of ozone molecules is at 253.7 nm, to produce UV light at wavelength of 200-280 nm hence the light source normally used is a medium-pressure mercury lamp wrapped in a quartz sleeve. Then after the representation pollutant with Fenton's reagent is packed in ultraviolet batch reactor representation comprise of two mercury tubes of 14 watts. This experiment was carried out in a reactor of capacity 1000 ml as shown in the figure 1. The model quantity 250 ml was used. The experimental setup was placed on the magnetic stirrer at continue stirring speed and temperature at 25°C.

For treatment of effluent with UV light following is the batch reactor used.

Figure 1: UV Photo Reactor

2.2.1.1 Photo Fenton Treatment Solar Radiation

This experiment was carried out in a glass beaker of capacity 500 ml. 250 ml volume of the effluent sample is used. The experimental setup is placed under the sunlight as per the provisions shown in the Figure 2. The intensity of sunlight was surpluses by collecting it at a single point using magnifying glass. Additional ice jacket was employed around the reactor to maintain the temperature and ice was added up at regular intervals to maintain the temperature at 25°C. The temperature was verified at formal interval of time. The stirring speed was also kept same as that of the Photo Fenton Process with UV Light.

For treatment of effluent with the help of solar radiation are as per following preparations.

Figure 2: Solar Photo Fenton Reactor

2.5 Analytical methods

Chemical Oxygen Demand (Closed reflux titrimetric method) was achieved as procedure given in Standard Methods (APHA). The other parameters like BOD_5, Total Dissolved Solids, Suspended Solids and Chlorides were also determined. The standard procedure of APHA was taken as reference.

I. MODELING AND ANALYSIS

Modeling and analysis work is includes in result and discussion part.

II. RESULTS AND DISCUSSION

This part include the consequences strained from the trial efforts.

3.1 Photo Fenton's treatment with help of UV Light and enhancement in biodegradability

Table 3 shows change in COD value after Photo Fenton's treatment addition with UV light. The table shows the data of the high COD elimination at precise absorption and molar ratio and mentioning the response time at which greatest COD removal was obtained. It can be shown from Table 3 that utmost COD reduction obtained in this case is 73%. After achieving utmost COD reduction (%), the scavenging process of Fe^{+2} takes place in the later stage where COD increases rapidly. It is relevant from the results that utmost COD reduction is obtained at COD: H_2O_2= 6:1. Comparative representation of efficiency of COD removal at COD:H_2O_2=6:1 and H_2O_2/Fe^{+2} molar concentrations at 15:1, 20:1,25:1 and 30:1 with UV light is shown in Figure 3.

Table 3: Utmost COD removal at COD/H_2O_2 concentration ratio and H_2O_2:Fe^{+2} molar ratio with respective reaction time. (With UV Light)

Sr. No.	COD:H_2O_2 attention ratio	H_2O_2:Fe^{+2}	Highest COD subtraction with UV Light (%)	Reaction time at which utmost Removal is achieved. (min.)
1	2:1	15:1	6	90
2		20:1	28	120
3		25:1	55	120
4		30:1	65	90
5	4:1	20:1	40	120
6		25:1	51	90
7		30:1	37	150
8	6:1	15:1	37	120
9		20:1	74	90
10		25:1	24	90
11		30:1	31	90

3.2 Photo Fenton's action with solar radiations and upgrading in biodegradability

Table 4 shows vary in COD value behind Photo Fenton's treatment with Solar Radiation. The table includes the data of the highest COD elimination at exacting concentration and molar ratio and mentioning the reaction moment at which highest COD removal was obtain. The outcome from Table-4 demonstrates that COD decrease obtained in this case is 79-80%. After achieving Utmost COD reduction (%), the scavenging process of Fe^{+2} takes place in the later stage where COD increases gradually. The outcome represent that utmost COD drop is obtained at COD: H_2O_2= 6:1.Comparative depiction of efficiency of COD elimination at COD:H_2O_2=6:1 and H_2O_2: Fe^{+2} molar deliberation at 15:1, 20:1, 25:1 & 30:1 by means of Solar Radiations are described in the Figure 4.

Table 4: Utmost COD elimination at COD: H_2O_2 deliberation ratio and H_2O_2: Fe^{+2}molar ratio with respective reaction time (With Solar Radiation)

Sr. No.	COD: H_2O_2 attention ratio	H_2O_2:Fe^{+2}	Utmost COD Removal with UV Light (%)	Reaction time at which highest Removal is achieved. (min.)
1	2:1	15:1	8	120
2		20:1	20	150
3		25:1	23	120
4		30:1	55	120
5	4:1	20:1	40	150
6		25:1	41	150
7		30:1	30	150
8	6:1	15:1	79	150
9		20:1	30	90
10		25:1	42	150
11		30:1	29	120

3.3 Assessment of efficiency of COD exclusion using UV Light & Solar Radiations

Table 5 describes the data of utmost COD deletion with UV Light and Solar radiations at respective reaction time. Utmost decrease was obtained at COD: H2O2=6:1 in equally the cases so the data of diverse H_2O_2: Fe^{+2} molar concentrations are mention in the table 5. The effect indicates that utmost consequence is achieved in fewer time in case of UV Light than that of Solar Radiation. The average reaction time for utmost removal of COD is 90 minutes in Photo Fenton process with UV Light whereas 150 minutes in Photo Fenton process with solar radiation. Efficiency of COD Removal with UV Light and Solar Radiation at respective H_2O_2: Fe^{+2} molar concentrations are shown in Figure 5.

Table 5: Assessment of competence of COD elimination using UV Light & Solar Radiations with reaction time.

Sr. No.	H_2O_2: Fe^{+2}	Highest COD elimination with UV light (%)	Reaction time at which utmost deduction is achieved. (min.)	Utmost COD Removal with Solar radiation (%)	Reaction time at which highest deduction is obtained. (min.)
1	15:1	37	120	80	150
2	20:1	74	90	31	90
3	25:1	24	90	43	150
4	30:1	31	90	30	120

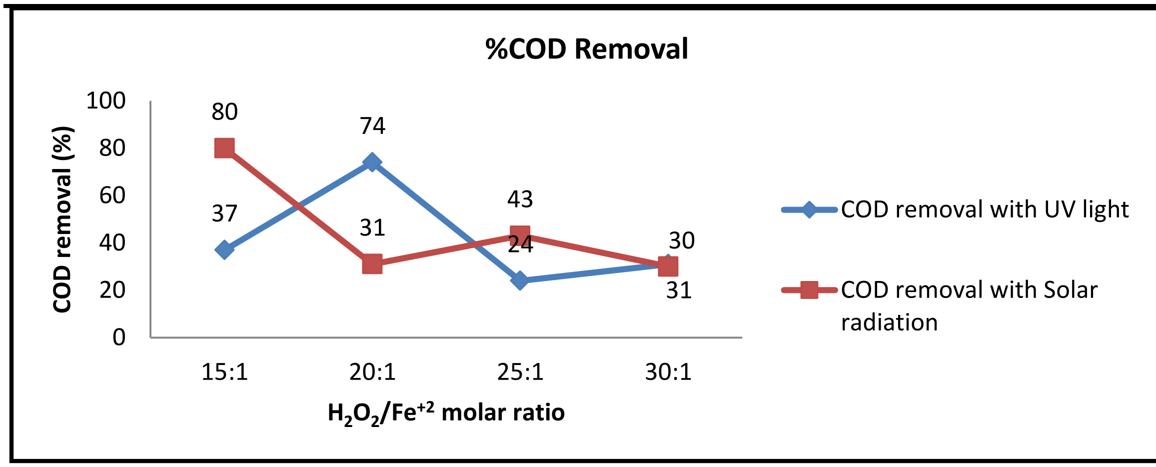

Figure 5: effectiveness of COD elimination at COD: H_2O_2=6:1 at pH=3, with UV Light & Solar Radiation

I. CONCLUSION

In polluting water stream textile waste water has been playing a major role. Hence to reduce pollution need of a proper method treatment is very use full. For advance oxidation process bio degradability was 0.1 which makes it suitable for AOP. Therefore treatability of effluent done with AOP as non biodegradability nature of effluent. It is stated that there is no need of any pre treatment needed to the effluent before giving Photo Fenton treatment. H_2O_2 is in a different way linked in glow of the fact that it has no vaporous discharge or chemical residues as originate with further chemical oxidants. The COD: H_2O_2 molar ratio used in the study were 2:1, 4:1 and 6:1 from which utmost removal was obtained at 6:1.The Photo Fenton's treatment with both the light sources can achieve up to 70% removal of COD at H_2O_2:Fe^{+2} molar concentration of 20:1 (for UV Light) and 15:1(for Solar Radiation).The Photo Fenton process with Solar Radiation can be used to reap out the utmost benefits. This technique can establish as a low cost high efficiency management process.

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II. REFERENCES

[1] Advanced Oxidation Processes (AOP) For Water and Wastewater Treatment Contents', *Ultrasound*

[2] Barbusiński, K., 'The Modified Fenton Process for Decolorization of Dye Wastewater', *Polish Journal of Environmental Studies*, 14 (2005), 281–85 <https://doi.org/10.1021/ar50088a003>

[3] Brillas, Enric, 'A Review on the Degradation of Organic Pollutants in Waters by UV Photoelectro-Fenton and Solar Photoelectro-Fenton', *Journal of the Brazilian Chemical Society*, 25 (2014), 393–417 <https://doi.org/10.5935/0103-5053.20130257>

[4] Chun, Hu, Wang Yizhong, and Tang Hongxiao, 'Destruction of Phenol Aqueous Solution by Photocatalysis or Direct Photolysis', *Chemosphere*, 41 (2000), 1205–9 https://doi.org/10.1016/S0045-6535(99)00539-1

[5] Dehghani, Mansooreh, Esmaeel Shahsavani, Mahdi Farzadkia, and Mohammad Samaei, 'Optimizing Photo-Fenton like Process for the Removal of Diesel Fuel from the Aqueous Phase', *Journal of Environmental Health Science and Engineering*, 12 (2014), 87 <https://doi.org/10.1186/2052-336X-12-87>

[6] Ebrahiem, Ebrahiem E., Mohammednoor N. Al-Maghrabi, and Ahmed R. Mobarki, 'Removal of Organic Pollutants from Industrial Wastewater by Applying Photo-Fenton Oxidation Technology', *Arabian Journal of Chemistry*, 10 (2017), S1674– 79 <https://doi.org/10.1016/j.arabjc.2013.06.012>

[7] Esplugas, Santiago, Jaime Gimenez, Sandra Contreras, Esther Pascual, and Miguel Rodriguez, 'Comparison of Different Advanced Oxidation Processes for Phenol Degradation', *Water Research*, 36 (2002), 1034–42 <https://doi.org/10.1016/S0043-1354(01)00301-3>

[8] Ganesan, R, and K Thanasekaran, 'Decolourisation of Textile Dyeing Wastewater by Modified Solar Photo-Fenton Oxidation', *Int. J. Environ. Sci.*, 1 (2011), 1168–76 https://doi.org/10.6088/ijes.00106020011

[9] Kehinde, FagbenroOluwakemi, and Hamidi Abdul Aziz, 'Textile Waste Water and the Advanced Oxidative Treatment Process, an Overview', *International Journal of Innovative Research in Science, Engineering and Technology*, 3 (2014), 15310–17 <https://doi.org/10.15680/IJIRSET.2014.0308034>

[10] Kos, Lech, Karina Michalska, and Jan Perkowski, 'Textile Wastewater Treatment by the Fenton Method', *Fibres and Textiles in Eastern Europe*, 81 (2010), 105–9

[11] Lodha, Bharat, and Sanjeev Chaudhari, 'Optimization of Fenton-Biological Treatment Scheme for the Treatment of Aqueous Dye Solutions', *Journal of Hazardous Materials*, 148 (2007), 459–66 <https://doi.org/10.1016/j.jhazmat.2007.02.061>

[12] Matavos-aramyan, Sina, and Mohsen Moussavi, 'Advances in Fenton and Fenton Based Oxidation Processes for Industrial Effluent Contaminants Control-A Review', *International Journal of Environmental Science & Natural Resources*, 2 (2017), 1–18 <https://doi.org/10.19080/IJESNR.2017.02.555594>

[13] Mazille, F., T. Schoettl, A. Lopez, and C. Pulgarin, 'Physico-Chemical Properties and Photo-Reactivity Relationship for Para-Substituted Phenols in Photo-Assisted Fenton System', *Journal of Photochemistry and Photobiology A: Chemistry*, 210 (2010), 193–99 <https://doi.org/10.1016/j.jphotochem.2009.12.015>

[14] Mehta, Mehali, and Swati Parekh, 'Applicability of Fenton Process for Treatment of Industrial Effluents : A Review', *International Journal of Engineering Research and Application*, 4 (2014), 26–29

[15] Meric, Sureyya, Giusy Lofrano, and Vincenzo Belgiorno, 'Treatment of Reactive Dyes and Textile Finishing Wastewater Using Fenton's Oxidation for Reuse', *International Journal of Environment and Pollution*, 23 (2005), 248–58

[16] Pérez, Montserrat, Francesc Torrades, Xavier Domènech, and José Peral, 'Fenton and Photo-Fenton Oxidation of Textile Effluents', *Water Research*, 36 (2002), 2703–10 <https://doi.org/10.1016/S0043-1354(01)00506-1>

[17] Punzi, Marisa, *Treatment of Textile Wastewater by Combining Biological Processes and Advanced Oxidation*, 2015

[18] Rabelo, M. D., C. R. Bellato, C. M. Silva, R. B. Ruy, C. A. B. da Silva, and W. G. Nunes, 'Application of Photo-Fenton Process for the Treatment of Kraft Pulp Mill Effluent', *Advances in Chemical Engineering and Science*, 4 (2014), 483–90 <https://doi.org/10.4236/aces.2014.44050>

[19] Ramachandran, Ganesan, and Thanasekaran Kumarasamy, 'Degradation of Textile Dyeing Wastewater by a Modified Solar Photo-Fenton Process Using Steel Scrap/H2O2', *Clean - Soil, Air, Water*, 41 (2013), 267–74 <https://doi.org/10.1002/clen.201100462>

[20] Review, A, 'Advanced Oxidation Processes for Treatment of Textile and Dye Wastewater : A Review', 4 (2011), 271–75

[21] Rodrigues, Carmen S D, Luis M. Madeira, and Rui A R Boaventura, 'Optimization and Economic Analysis of Textile Wastewater Treatment by Photo-Fenton Process under Artificial and Simulated Solar Radiation', *Industrial and Engineering Chemistry Research*, 52 (2013), 13313–24 <https://doi.org/10.1021/ie401301h>

[22] Rodríguez, Miguel, 'Fenton and UV-Vis Based Advanced Oxidation Processes in Wastewater Treatment: Degradation, Mineralization and Biodegradability Enhancement', *Department D'Enginyeria Quimica I Metal·lurgia*, 2003, 296 <http://diposit.ub.edu/dspace/handle/2445/35398>

[23] Sahunin, Chantanapha, Jittima Kaewboran, and Mall Hunsom, 'Treatment of Textile Dyeing Wastewater by Photo Oxidation Using UV/H 2O2/Fe2+ Reagents', *ScienceAsia*, 32 (2006), 181–86 <https://doi.org/10.2306/scienceasia1513- 1874.2006.32.181>

[24] Starling, M C, L A S Castro, R B P Marcelino, C C Amorim, Universidade Federal, and De Minas Gerais, 'Textile Wastewater Treatment Ferrioxalate Reuse After Photo- Using Fe (Ii) and', 1–8

[25] Tony, Maha a., and Zeinab Bedri, 'Experimental Design of Photo-Fenton Reactions for the Treatment of Car Wash Wastewater Effluents by Response Surface Methodological Analysis', *Advances in Environmental Chemistry*, 2014 (2014), 1–8 https://doi.org/10.1155/2014/958134

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