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Research Article

A Speculative Analysis of the Wastewater Generated by the Pulp and Paper Industry Using the Solar Photo Fenton Process

Elang

Research Analyst, Federal University of Paraná.

I N F O

E-mail Id:
elangovan@nie.gov.in

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A B S T R A C T

Due to the limited availability of water, improvements are going to be made to the quality of the wastewater that is flushed into the ground. As of right now, the Paper and Pulp manufacturing sector is now ranked fourth for its water usage, it is also most likely the largest producer of wastewater. The Paper and Pulp Manufacturing Industry Due to the proximity of dangerous compounds, wastewater is regarded as a natural hazard of an extreme level when it is either not treated at all or treated to an extraordinary degree before being released into waterways that can take it. "Effluent solids, sediments, absorbable organic halides (AOX), chlorinated organic compounds, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), contaminants, thermal loads, microorganisms such as coliform groups, toxic chemicals" are all examples of the types of contaminants that are inherently present in wastewater from the paper and pulp industry. Conventional methods for taking with wastewater from the paper and pulp industry include the use of physical, chemical, or even natural processes, in some cases, a combination of a few or all of these techniques is used. The methods that are currently used to treat wastewater are thought to be inadequate in terms of completely removing contaminants, especially organic debris. As a result of the fact that these organic compounds, in many cases, are resistant to the treatment approaches that are typically used, there is a want for contemporary engineering sciences. This article details the impact that the solar photo-Fenton process has had on the wastewater produced by the pulp and paper industry. In addition, an examination is being carried out to determine the colour and chemical oxygen efficiency (COD) removal efficiencies. The experiment is carried out in a lab-scale solar photo-Fenton reactor with a capacity of 1 litre, which is exposed to sunlight and has a reaction time of either 180 or 120 minutes. In the solar photo-Fenton procedure, the optimum dosage of 50:1 ratio of Fe^{2+}+H_2O_2 is obtained after 75 minutes of reaction time. This analysis is being suggested as a solution to the problems that arise while eliminating a diverse variety of contaminants and as a means of making more effective use of available financial resources.

Keywords: Biological Oxygen Demand (BOD, Contaminants, Thermal Loads, Microorganisms Such As Coliform Groups, Toxic Chemicals

Introduction

Paper is a relatively new substance that dates back around two thousand years. It is made by drying sheets of cellulose pulp that have been pressed together with wet fibers of cellulose pulp sourced from wood, rags, or grasses and then pressing them together again. It is a versatile substance that may be used for a variety of purposes, such as writing, printing, packing, cleaning, as well as for a number of operations used in industry and construction. More than 450 million tons of papers are produced annually by the world paper industry in order to satisfy the demand for paper on a daily basis. It is anticipated that by the end of the year 2020, the demand for paper usage would have reached a level of 500 million tons per year. India is the 20^{th} most productive nation in the world in terms of paper production. The paper and pulp industry is now ranked fourth for its overall water usage. To make tonnes of paper, current mills need anything from 15 to 50 cubic metres of water to run their machines. The paper and pulp industry in India is responsible for the yearly emission of around 700 million m^3 of wastewater in addition to the use of approximately 900 million m^3 of water. The amount of water used in the paper and pulp industry is variable depending on the grade and kind of paper that is to be created. In terms of the total amount of wastewater produced by industrial processes around the globe, the paper and pulp industry is responsible for producing 42 percent of that total. Nearly two percent of global commerce and three and a half percent of the world's total industrial pollution are caused by industries related to paper.

The washing of wooden chips, baggase, rice or wheat before pulping, chemically cooked pulp, pulp during bleaching, pulp from pulp cleaning equipment are the primary contributors to the wastewater that is produced by the paper and pulp industry. Other contributors include chemical processing of pulp and pulp during bleaching. The primary components of wastewater are bark particles, fibre pigments, dirt, dissolved colloidal organics such as hemicellulose, sugars, lignin compounds, alcohols, turpentine, sizing agents, adhesives such as starch and sulphates, etc.

Colour bodies primarily composed of lignin compounds and dyes, suspended solids such as fibre pigments, bark particles, dirt. Dissolved inorganics such as NaoH, Na_2so_4, bleach chemicals, heat loads, microorganisms such as the coliform group, certain hazardous compounds are also factors to consider. Primary, secondary, tertiary treatments are carried out in the paper and pulp industry to remove solids, particulate matter, biodegradable organic matter, also the microorganisms that are present in it. Both physicochemical and biological treatment methods are considered to be the industry standard in the paper and pulp industry when it comes to wastewater treatment.

The physicochemical method, which comprises membrane filtration, sedimentation, coagulation, precipitation, as well as adsorption, chemical oxidation, adsorption. The highest negative effects on the environment caused by this method are the mass production of metal hydroxide, the release of a significant amount of greenhouse volumes, the difficulties associated with waste disposal. The biological method might take either an aerobic or anaerobic approach, depending on the situation. For COD elimination using an aerobic approach, a high amount of energy is typically required, ranging from 880 to 1000 kilowatt hours per ton. An anaerobic approach cannot function unless the temperature is sufficiently high, meaning it must be more than 300 degrees Celsius. The most major downsides of this method include the fact that the biogas that is generated as a byproduct of the process cannot easily be stored and must be treated since it contains impurities such as H_2s.

Mills are being pushed to employ unconventional and technologically advanced treatment systems in order to minimise the amount of refractory organic compounds in their waste in order to remain in compliance with the increasingly stringent discharge limitations. As a result, treatment with some kind of advanced oxidation process, often known as AOPs, is required. As a result, the objective of this research is to evaluate the effectiveness and viability of the solar photo fen ton method for the preliminary treatment of wastewater from the pulp and paper industry.

Collection of Sample

The waste water from the pulp and paper mill in Erode was collected and stored at a temperature of 4 degrees Celsius. Initial features of pulp wastewater are observed and reported in Table 1, at the beginning of the process.

Table 1.Initial Traits of Untreated Waste Water

S.No	Parameters	Units	Value
1.	pH		8.4
2.	Total Dissolved solids (TDS)	mg/L	4900
3.	Total Suspended solids (TSS)	mg/L	1350
4.	Total Chemical Oxygen demand (TCOD)	mg/t	3050
5.	Soluble Chemical Oxygen demand (SCOD)	ms/L	2200
6.	Total Solids (TS)	mg/L	1600
7.	Chlorides	mg/L	79.2
8.	Alkalinity	mg/t	449.26
9.	BOD5	mg/t	65.19

Solar Photo Fenton Treatment

Solar photo In a glass tray reactor of 21.5 cm x 21.5 cm x 15 cm, a Fenton treatment was carried out using 500 millilitres

of discarded water. In a tray reactor with a working capacity of 1 litre, the photo-Fenton reactions were taken out and recorded. During the months of March through May, the whole system was put under intense solar radiation exposure from 11:00 AM to 3:00 PM. It was read at the beginning of the experiment when the system was in risk of being exposed to the sun. In order to conduct an analysis of COD, a sample was taken from the reactor at regular intervals of ten minutes. The colour was evaluated using an absorbance scale that went up to 475 nm. In order to prevent the production of floc, an overhead stirrer is used.

Result and Discussion

Effect of Dosage of Concentration $fe^{2+}+ H_2O_2$ on COD Removal

It is evident from the data shown in figure 1 that increasing the concentration of $Fe^{2+}+ H_2O_2$ results in increased COD and colour removal. There is very little difference in COD removal efficiency across ratios of 5:1, 10:1, 20:1, 30:1, 40:1, 50:1, 60:1. At duration of 75 minutes, a dosage of a 50:1 ratio of $Fe^{2+}+ H_2O_2$ was determined to be optimal. The rate of degradation slowed down when there was an increase in the concentration of $Fe^{2+}+ H_2O_2$. As a result, taking a significant amount of H_2O_2 dosage with the hope of increasing degradation was not worth.

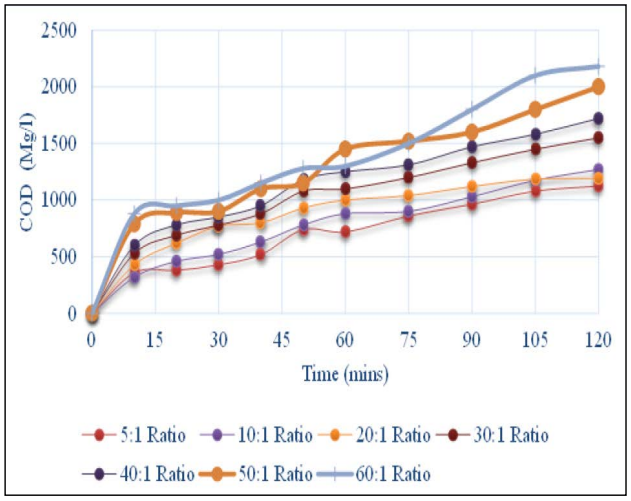

Figure 1.Analysis of the Relationship Between COD Removal B on Dosage and Concentration of $Fe^{2+}+ H_2O_2$

Effect on the Removal Efficiency of Varying the Dosage and Concentration of $Fe^{2+}+ H_2O_2$

An increase from 40 percent to 60 percent in COD reduction is achieved. Up to 75 minutes into the reaction, a linear increase in COD reduction may be observed; beyond that time, the rise nearly increases off. As can be shown in figure 2, a dosage with a 50:1 ratio and an irradiation time of 75 minutes has a significant impact on the reduction of COD that is noted.

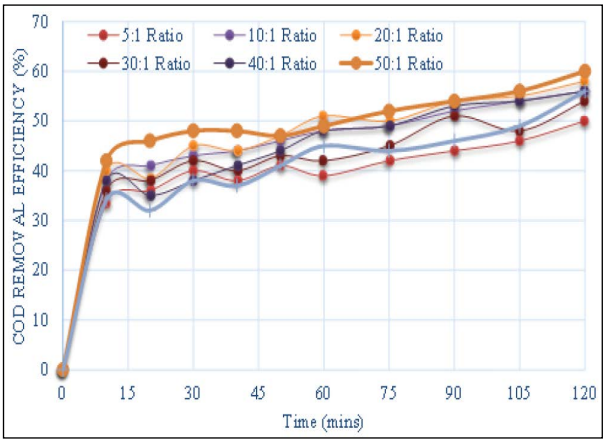

Figure 2.Effect of Dosage of Concentration $Fe^{2+}+ H_2O_2$ on Removal Efficiency

Effect of Biodegradability

There is evidence of biodegradability. According to figure 3, the optimum reaction time is observed to be 75 minutes with a dosage ratio of 50:1.

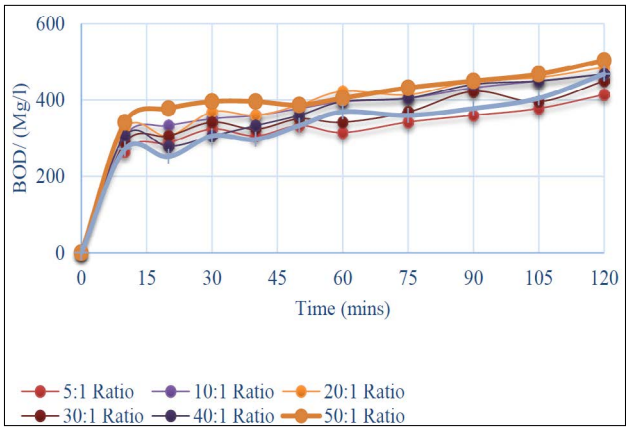

Figure 3.Effect of Biodegradability

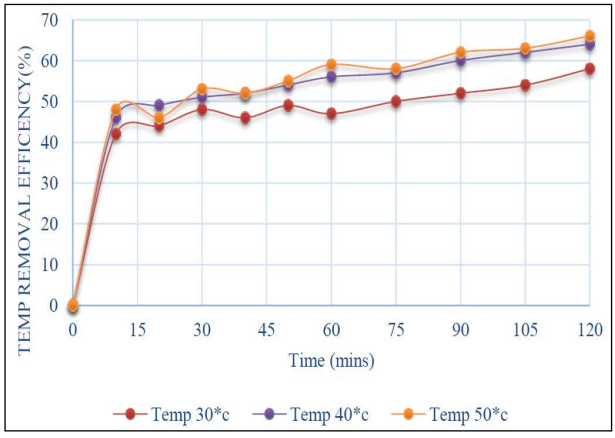

Figure 4.Effect of Temperature

Effect of temperature and cod removal efficiency

The experiment was carried out at three distinct temperatures: 30 degrees temperature, 40 degrees Celsius,

50 degrees Celsius, while the dosage ratio varied. It is evident from figures 4 and 5 that, at its peak performance, the removal efficiency of the system reached 58 percent, while the COD release rose between 40 and 50 degrees Celsius.

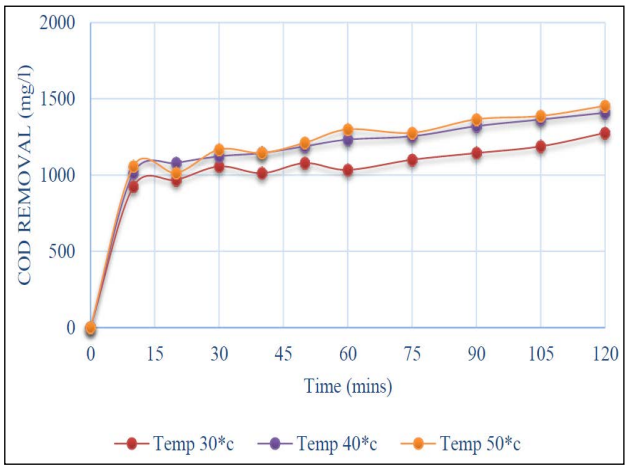

Figure 5.Effect of Temperature on COD Removal Efficiency

Effect of lignin

When there is a greater amount of concentration, the rate of its degradation speeds up. As can be seen in figure 6, the amount of lignin that was successfully extracted from the wastewater was as high as 70 percent.

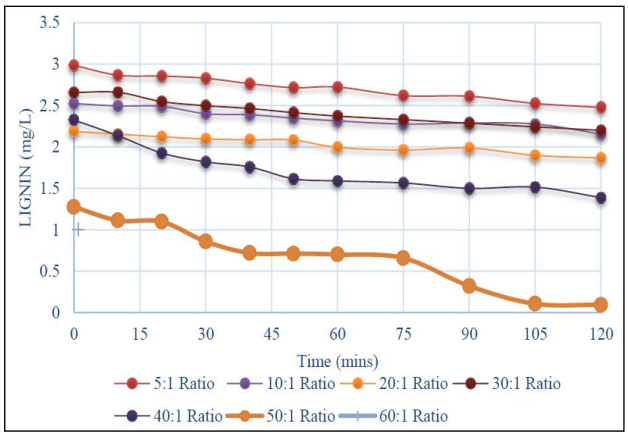

Figure 6.Effect of Lignin

Effect of pH

The experiment was carried out at a variety of pH values ranging from 2 to 6. The ratios 5:1, 10:1, 20:1, 30:1, 40:1, 50:1, 60:1 were used to determine the dosages, the COD release increased along with the amount of Fe^{2+}+ H_2O_2 that was administered. The removal of COD was obtained to be most optimum at a pH of 3, a ratio of 50:1, a reaction time of 75 minutes at 40 degrees Celsius, a temperature of 400. It has been determined, using figures 7 and 8, that the percentage of COD reduction is 51%.

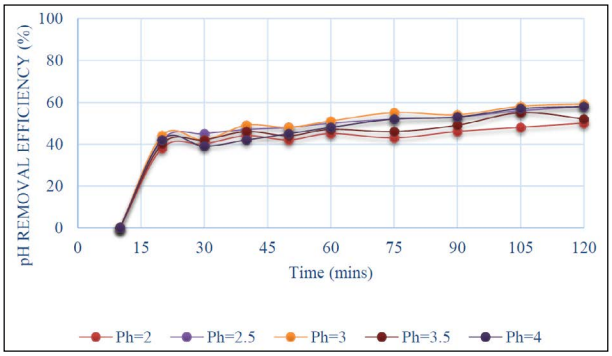

Figure 7.Effect of pH for COD Removal

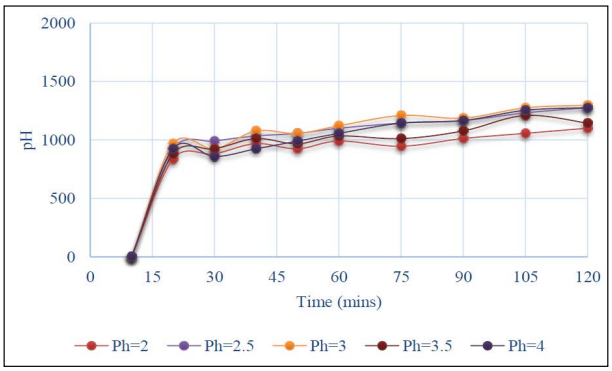

Figure 8.Efficiency of pH

Conclusion

Within the scope of this study, a research into the efficiency of solar photo Fenton treatment is carried out on wastewater derived from the pulp and paper industry. In the solar photo-Fenton procedure, the optimum dosage of 50:1 ratio of Fe^{2+}+ H_2O_2 is obtained after 75 minutes of reaction time. An increase from 40 percent to 60 percent in COD reduction is achieved. Up to 75 minutes into the reaction, a linear increase in COD reduction may be observed; beyond that time, the rise nearly increases off. Therefore, a dosage with a ratio of 50:1 and an irradiation time of 75 minutes is significant for the reduction of COD. In addition, the removal of COD was obtained to be most optimum at a pH of 3, a ratio of 50:1, a reaction time of 75 minutes at 40^0c, a temperature of 40^0c. As much as seventy percent of the lignin originally present in the wastewater is recovered after treatment. In this work, the performance of the solar photo fenton process and the efficient removal of the non-biodegradable chemical are shown. In addition, it is recommended to do this analysis in order to alleviate the difficulties associated with eliminating a diverse range of contaminants and to facilitate more efficient use of economic resources.

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