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Removal of COD, conductivity, chloride and total dissolved solids from textile wastewater using TiO2/UV system

Basavaraj S Karadagi

Assistant Professor Department of Civil Engineering, Sreenidhi Institute of Science and Technology
Yamnampet, Gatkesar Hyderabad-501301

Abstract — ***For the economic development of the country industries play very important role. Volume of wastewater is increasing due to increase in urbanization and industrialization. Some of the industries causative to major water pollution are textile mills, electroplating, paper and pulp industry and sugar mills etc., The major contaminants generated from these industries are alkanes, halo alkanes, aromatic dyes, polymers, surfactants etc.,. So it is necessary to treat wastewater as it contains toxic compounds. Chemical oxygen demand, color, total dissolved solids, suspended solids, acidity and other non biodegradable substances which are the major pollutants from textile wastewater. So it is necessary to treat textile wastewater before disposal to any streams. Some of the conventional treatment methods used are coagulation/flocculation, membrane separation, adsorption etc. In the present study textile effluent was collected from textile mill at banahatti, rabkavi talluk bagalkot (dist) and its initial characterization was done by measuring pH, Electrical Conductivity, Total solids, TSS (Total Dissolved solids), TDS (Total Dissolved solids), Chloride, COD (Chemical Oxygen Demand) and Color etc. Oxidation process of COD, conductivity, TDS, Turbidity and chloride removal has been investigated in this work with respect to the effect of pH, adsorbent dosage, contact time and UV light absorbance (oxidation process).Advanced Oxidation Processes (AOP´s) using TiO_2/UV could be a good option to treat and eliminate textile dyes. Advanced Oxidation Process are the one that offers a highly reactive, non-specific oxidant namely hydroxyl radicals (OH), capable of destroying wide range of organic pollutants wastewater. After treating the textile wastewater with TiO_2/UV in oxidation process removal efficiencies of COD, TDS, Conductivity, and chloride are 92.93%, 89.49%, 90.33% and 86.67% respectively.***

Keywords- Wastewater, COD, TiO_2/UV, TDS, etc.

I. INTRODUCTION

Mainly Textile is the largest and oldest industry present in worldwide. It also provides a major role for job in poor countries. In recent years a substantial amount of interest for decolourization and dye removal of textile wastewater. As textile wastewater consume large amount of water and produce larger amount of wastewater containing higher colour, COD and toxic substances. The treated sample con be reused in the same industry or else used for the other purposes such as agricultural or domestic purpose etc. This means we can save huge amount of water particularly in the countries distress from water shortage.

Various treatment methods are there in textile wastewater treatment such as adsorption, electro coagulation, filtration, membrane filtration and oxidation processes etc.

Oxidation process is a very good process mainly used in the treating textile wastewater and removal of dyes it produces hydroxyl radicals which forms ionic exchange in treating textile effluent. It also similar to adsorption process such as it can be determined with respect to the effect of pH, contact time, dosage, agitation speed and initial concentration. Oxidation process hold good in acidic condition i.e. it can remove major amount of pollutants during acidic condition

Advanced oxidation processes are considered to be a low or non waste generation tools which destroy complex formed structures using shorter life span chemicals with having higher oxidizing power. Hydroxyl radicals (OH^o) are major oxidizing power for AOPs. OH^o radicals may be generated by using chemical, mechanical and electrical or radiation energy source. That is why the AOPs are considered and classified under photochemical, chemical, photo catalytic, catalytic, electrical and mechanical processes.

Treatment using TiO_2/UV: Mainly TiO_2 has three crystalline forms rutile, anatase, and brookite. Most of the studies indicate that the anatase form provides the highest hydroxyl radicals formation rates. The photo-catalytic titanium dioxide (TiO_2) is of wide band gap semiconductor (3.2 eV) and is successfully used as a photo-catalyst for the treatment of organic pollutants. Briefly, for TiO_2, the photon energy required to overcome the band gap energy and excite an electron from the valence band to the conduction band can be provided by light of a wavelength shorter than 387.5 nm. A simplified reaction mechanism of TiO_2/UV process is given in following equations. [1]

$TiO_2 + hv \rightarrow$ e-CB + h+VB --------------- (1)

H_2O + h+VB$\rightarrow OH^- + H^+$----------------- (2)

O_2 + e-CB$\rightarrow O_2$. --------------------------- (3)

$O_2^- + H_2O \rightarrow OH^- + OH^- + O_2 + HO_2$----- (4)

II. EXPERIMENTAL DETAILS

Materials used: The chemicals used during the course of study were NaOH (0.1N) and HCL (0.1N) for the control of pH, **Photo-Reactor:** Experimental box made up of plywood of dimensions **0.68X0.68X0.78 m** with a magnetic stirrer attached at the top with a speed of 40 rpm and UV bulbs are arranged at the centre with space left for glass jar in which solution is to be treated. UV lamps used are 11W of 12 bulbs. As shown in Fig. below.

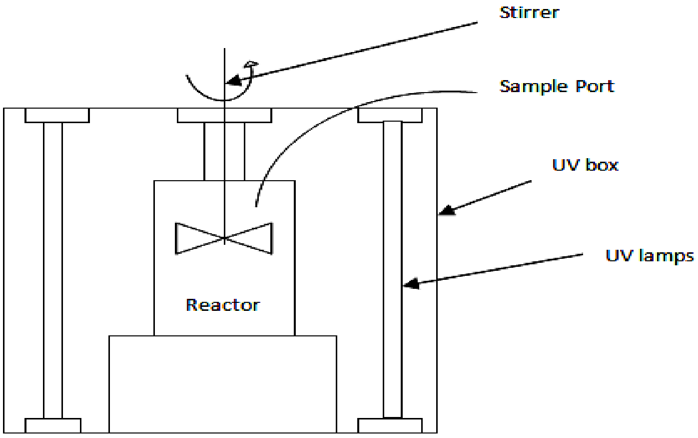

Fig.1. Cross sectional view of Experimental box

Fig.2. Inside view of Experimental box

Fig.3. Outer view of Experimental box

Textile wastewater: Textile wastewater was collected from Prithvi Textiles Banahatti, Bagalkot district.
Initial wastewater characterization was done by laboratory calibration.

Characteristics	Units	Value
Colour		Dark green
pH		9.8
Chemical oxygen demand (COD)	mg/L	2263
Total suspended solids (TSS)	mg/L	1064
Total Dissolved solids (TDS)	mg/L	3085
Total Solids (TS)	mg/L	4160
Chloride	mg/L	875
Conductivity	ms/cm	5.14
Turbidity	NTU	9

III. EXPERIMENTAL PROCEDURE

A) Treatment using oxidation process with TiO_2/UV: The experiment was performed in a bench-scale annular reactor. At 120W low-pressure UV lamp, with light intensity at 253.7 nm surrounded by a quartz protective sleeve, is used as the light source. The reaction volume was 500 mL with an initial concentration of wastewater sample with the maintenance of reaction temperature at 20°C; with adjusting the initial pH. Samples were drawn from the reactor immediately.

B) Effect of pH: The pH of the solution is an important parameter for oxidation process, which controls the production rate of hydroxyl radical and the concentration of TiO_2. It is also an important operational variable in actual wastewater treatment. Initially a series of experiments were conducted at different pH value of 1.0, 2.0, 3.0, 4.0, 5.0, and with addition of 0.1 gm of TiO_2 dose. With addition of TiO_2 dose highest decolourization will be observed at pH 3. Then the sample will be taken out by centrifuging so that TiO_2 will settle at the bottom sample will be taken out by using syringe the residue is used for the determination of COD, Turbidity, TDS, Chloride and Conductivity.

C) Effect of TiO_2 dose: Titanium dioxide plays an important role as an oxidizing agent. The selection of an optimal Titanium dioxide concentration is important aspect from a practical point of view due to its high cost. The objective is to select the best operational dosage of TiO_2 in oxidation process. Dose of Titanium dioxide will be raised from 0.1 to 0.6 mg/l. At pH 3 and reaction time of 30 minutes. The result indicates that removal efficiency with increase in Titanium dioxide dose from 0.1 to 0.6 mg/L after 30 min of reaction time. then the sample will be taken out by centrifuging so that TiO_2 will settle at the bottom sample will be taken out by using syringe the residue is used for the determination of COD, Turbidity, Chloride, TDS and Conductivity.

D) Effect of contact Time: Contact time plays an important role in treating textile wastewater in presence of TiO_2 with UV light contact time changes from 30, 60, 90, 120, 150 and 180 minutes at pH 3 and TiO_2 dosage at 0.5 gm/L was kept constant with respect to change in time after every 30 minutes interval sample will be taken out then the sample will be taken out by centrifuging so that TiO_2 will settle at the bottom and sample will be taken out by using syringe the residue is used for the determination of chloride, COD, Turbidity, TDS and Conductivity.

E) Effect of UV light absorbance: UV light intensity plays an important role in treating the wastewater by varying light intensity from 10W to 150W with constant time of 120 minutes and pH 3 and TiO_2 dosage of 0.5 mg/L for every change in the light intensity the sample will be taken out and used for the determination of COD, Turbidity, Chloride, TDS and Conductivity.

IV. RESULTS AND DISCUSSION

Effect of pH

pH	COD(mg/L)	Conductivity(ms/cm)	TDS(mg/L)	Chloride(mg/L)
1	1360	4.11	2466	311
2	1320	4.1	2460	279
3	1120	4.08	2448	269
4	1120	4.08	2448	269
5	1120	4.12	2472	269

Table 4.5 Final parameters after effect of pH

From the above results of COD, TDS, Turbidity, chloride and conductivity maximum reduction occurred at optimum pH 3 hence the effect of contact time and adsorbent dosage will be done at constant pH 3 at 120W of UV Light.

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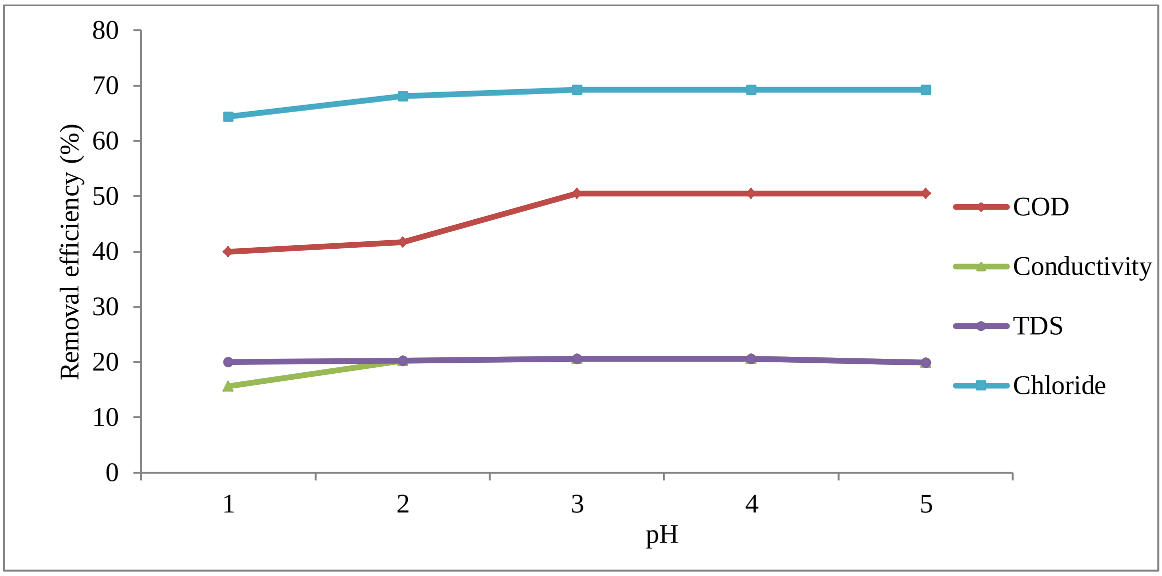

Fig. 4.4 pH vs. Removal efficiency

Effect of TiO_2 dosage

TiO_2 dosage (g)	COD(mg/L)	Conductivity(ms/cm)	TDS(mg/L)	Chloride(mg/L)
0.1	1120	4.08	2448	269
0.2	1240	3.95	2370	265
0.3	920	3.04	1824	268
0.4	800	3.04	1824	254
0.5	680	2.94	1764	247
0.6	680	2.94	1764	247

Table 4.6 Final parameters after effect of TiO_2 dosage

From the above results of COD, TDS, chloride and conductivity maximum reduction occurred at TiO_2 dosage of 0.5 mg/L hence effect of contact time will be done at constant pH 3 and dosage of 0.5 mg/L at 120W of UV Light.

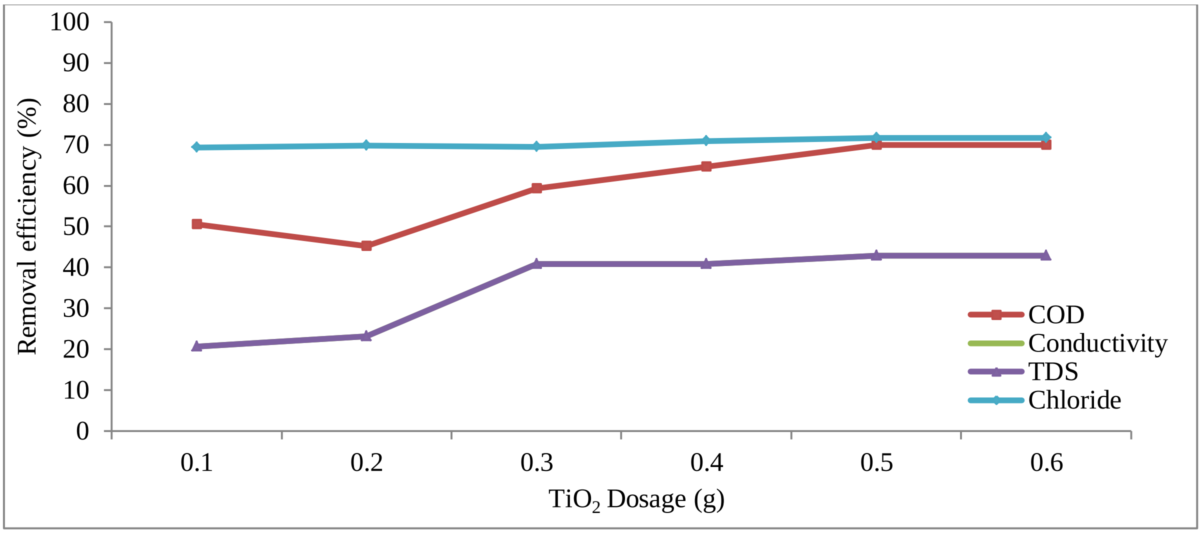

Fig. 4.5 TiO_2 Dosage vs. Removal efficiency

Effect of contact time

Contact time (minutes)	COD(mg/L)	Conductivity(ms/cm)	TDS(mg/L)	Chloride(mg/L)
30	680	1.51	1057	169
60	520	0.92	644	163
90	360	0.61	427	124
120	160	0.54	378	117
150	160	0.55	385	117

Table 4.7 Final parameters after effect of contact time

From the above results of COD, TDS, chloride and conductivity maximum reduction occurred at contact time of 120 minutes hence effect of UV light absorbance will be done at constant pH 3, dosage of 0.5 mg/L and 120 minutes contact time.

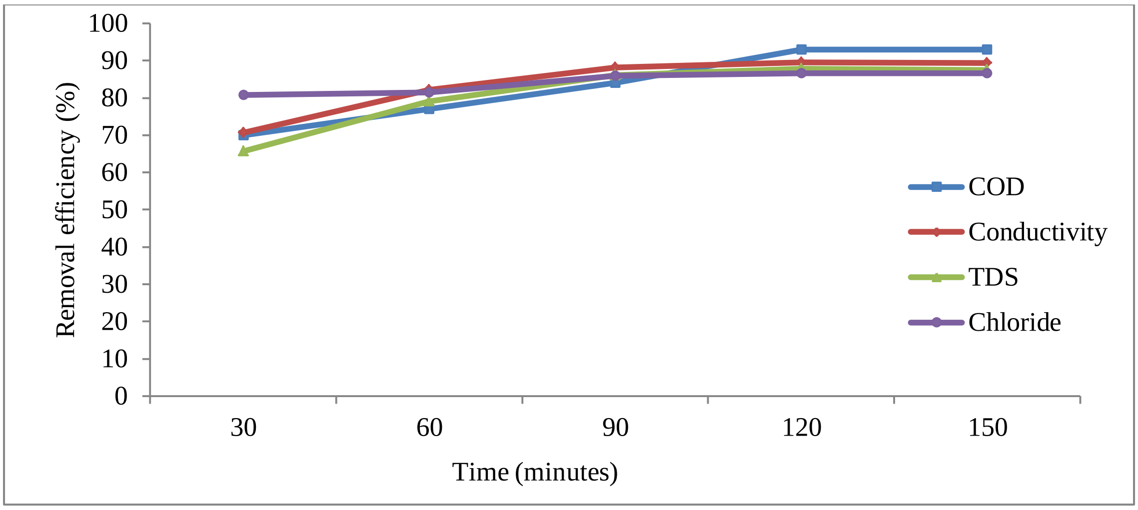

Fig. 4.6 Contact time vs. Removal efficiency

Effect of UV light absorbance

UV light intensity (watts)	COD(mg/L)	Conductivity(ms/cm)	TDS(mg/L)	Chloride(mg/L)
30	520	1.51	1057	244
60	280	1.14	826	230
90	200	0.57	825	220
120	160	0.54	378	117
150	160	0.54	385	117

Table 4.8 Final parameters after effect of UV light intensity

From the above results of COD, TDS, chloride and conductivity maximum reduction occurred at pH 3, TiO_2 dosage of 0.5 mg/L, contact time 120 minutes and UV Light absorbance of 120W. Hence optimum reduction of COD, TDS, Conductivity and Chloride occurred at 3 pH, 0.5 gm TiO_2 at 120 minutes in the presence of 120W of UV light.

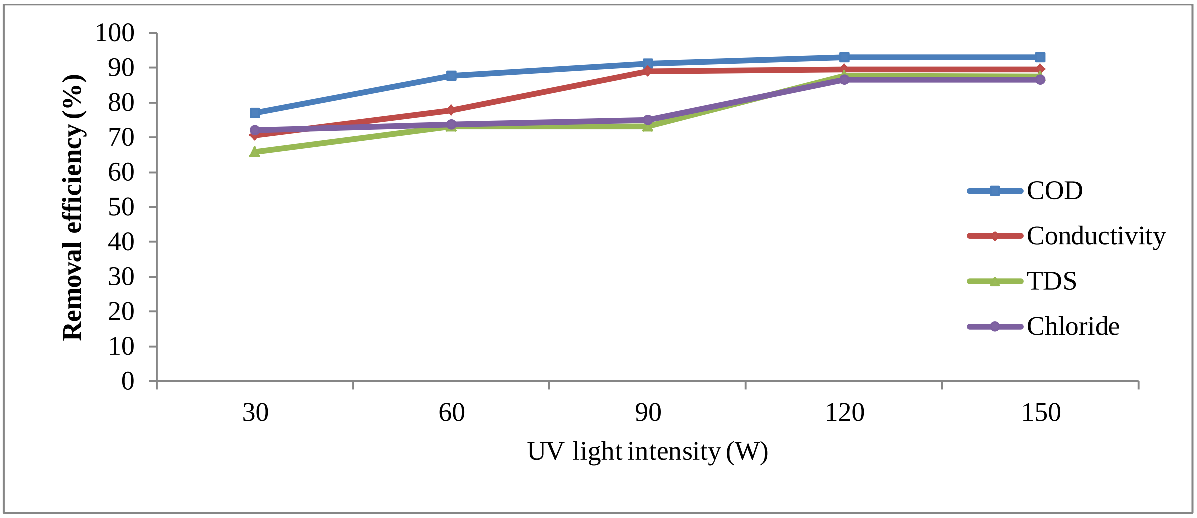

Fig. 4.7 UV light intensity vs. Removal efficiency

After all the above results TiO_2 in presence of UV light gives best result in treating Textile wastewater which may produces Hazardous content to the environment. In presence of TiO_2 Maximum reduction of all the parameters such as COD, TDS, Turbidity, Conductivity and other parameters which may results in nearly 90% reduction.

V. CONCLUSION

After treating the textile wastewater with TiO_2/UV in oxidation method removal efficiencies of COD, TDS, Conductivity, and chloride are 92.93%, 89.49%, 90.33% and 86.67% respectively at a pH of 3 TiO_2 dosage of 0.5 mg/L with 120 mins contact time in the presence of 120W ultraviolet rays. As the textile wastewater is having larger amount of organic and inorganic substances and also from the above results of removal efficiencies of considered parameters Titanium dioxide holds good as an oxidizing agent in the presence of ultraviolet rays.

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