Characterization and Treatment of Textile Effluent By Photocatalytic Method

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Abstract- Textile industry is one of the important industries in the world that provide large employment with less required special skills and play a major role in the economy of many countries. The textile industry uses various chemicals and large amount of water during the production process. The waste water produced from this textile industries contains large amount of dyes, which are capable of harming the environment and human health. oxidation of organic and inorganic pollutantsby photochemical method is rapidly becoming an attractive technique for purify the water and wastewater treatment. A photo reactor setup consist of UV lamp and compressor. We take 250 ml of raw sample has to been treated and then add various dosage of Tio2. This sample is treated for 2 hours under UV lamp in the photo reactor. The results indicate that the photocatalytic decolouration process can efficiently treat textile effluent and reduce the levels of COD, Calcium Hardness, pH, Turbidity, Alkalinity, Total solids, Total dissolved solids and Total suspended solids. But this method is not favourable for BOD.

Index Terms- Titanium dioxide, Photo catalysis, UV light and Wastewater treatment.

I. INTRODUCTION

The textile industry is the important for the massive raw material and textiles manufacturing base. Three different types of fibres used in the manufacture of various textile products and various types of dyes are used. The textile industry utilizes various chemicals and large amount of water during the production process. The wastewater produced during this process contains large amount of dyes and chemicals containing trace metals such as Cr, As, Cu, and Zn which are capable of harming the environment and human health. The textile wastewater can cause typhoid, diarrhea, cancer, liver damage, kidney damage, gastroenteritis, cholera, haemorrhage, ulceration of skin, nausea, skin irritation dermatitis. The whole treatment process involves three steps: The primary treatment involves removal of suspended solids most of the oil and grease and gritty material. The secondary treatment is carried out using micro organism under aerobic or anaerobic conditions and involves the reduction of BOD, phenol and remaining oil in the water and control of colour. The tertiary treatment involves the use of electro dialysis, reverse osmosis, adsorption and ion exchange to remove the final contaminates in the wastewater. The selection of purification method depends on the characterization of parameters and types of wastewater. In our project we choose photocatalytic method because it is very economical, requires minimum care, low cleaning cost, non-toxic, eco-friendly etc. photocatalysis is defined as “acceleration by the presence of as catalyst”. A catalyst does not have the property to change in itself or being consumed in the chemical reaction. This definition includes photosensitization, a process by which a photochemical alteration occurs in one molecular entity as a result of initial absorption of radiation by another molecular entity called the photosensitized. There are two types of photo catalyst such as homogeneous and heterogeneous. Heterogeneous photo catalysis employing metal oxides such as TiO_2, ZnO, SnO_2, and CeO_2 has proved its efficiency in degrading a wide range of distinct pollution into biodegradable compounds and eventually mineralizing them to harmless carbon dioxide and water. In our project we choose titanium dioxide. Titanium dioxide photo catalyst was considered as one of the most important practical catalyst due to its optical and electronic properties, low cost, high level of photo catalytic activity, chemical stability and non toxicity. Furthermore it is abundant and thus inexpensive.

II. EXPERIMENTAL

2. 2.1Materials

For the present study, effluent samples were collected from a textile industry at Erode district in Tamilnadu. The effluent samples were collected from the all stages of dying processing such as spinning, weaving, knitting, dyeing, printing etc. The effluent was collected in polythene containers of five litres capacity and were brought to the laboratory with due care and was stored at room temperature. Chemicals used for the analysis of spent liquor were analytical grade reagents. The physical and chemical characteristics of textile wastewater effluents parameters such as pH, Total solids (TS), Alkalinity, COD, BOD, Total Dissolved solids (TDS), Total Suspended Solids (TSS), Calcium, Total hardness were analysed as per standard procedures.

2.2 Photocatalytic Mechanism

When photocatalyst titanium dioxide (TiO_2) absorbs Ultraviolet (UV) radiation from sunlight or illuminated light source (fluorescent lamps), it will produce pairs of electrons and holes. The electron of the valence band of titanium dioxide becomes excited when illuminated by light. The excess energy of this excited electron promoted the electron to the conduction band of titanium dioxide therefore creating the negative-electron (e-) and positive-hole (h+) pair. This stage is referred as the semiconductor's ' photo-excitation ' state. The energy difference between the valence band and the conduction band is known as the ' Band Gap '. Wavelength of the light necessary for photo-excitation is:

1240 (Planck's constant, *h)*/3.2ev (band gap energy) = 388 nm

Figure 2.2 Photocatalytic mechanism

2.3 Design of Photoreactor

The photo-catalytic reactor was designed by a hexagonal shape which has six phases, which is made up of wooden box. The designed photo-catalytic reactor were consists of three lamp at the top of the reactor at 8 watts. It has a magnetic stirrer with a magnetic bar to avoid the settlements of the particles in the beaker. The reactor performance will be evaluated on the basis on percentage of conversion. The reactor was operated for three hours. Photochemical oxidation of organic and inorganic pollutants is rapidly becoming an attractive technique for water purification and wastewater treatment. Since artificial sources of light require much energy delivery and more efficient. This method is recommended for toxicity contaminants in a specific concentration range below the recommended levels for recovery and above the levels for conventional biological treatment. Selection of a light source and an oxidation system and determination of key-parameters play an important role in the treatment efficiency. Sufficient UV penetration into the radiated liquid is of crucial importance; especially for an non transparent environment the UV radiation is only available very close to the UV lamp surface. High mass transfer rates for efficient interaction between the pollutant and the photocatalyst and for high oxygen uptake at the gas-liquid interface is another requirement for practical applications. In this regard, reactor design for efficient wastewater treatment has been a challenging problem. Many types of photo reactors have already been studied, implemented, reported and patented. This project presents a revision of some conventional and novel photo reactors equipped with UV lamps or working under solar radiation for wastewater treatment in laboratory and industrial scales.

Figure 2.3 Photoreactor setup

III. RESULTS AND DISCUSSION

The Textile industry is one of the most important Source of water pollution. The type of this textile waste water has to be characterized for higher values of COD, Colour, Calcium Hardness, Turbidity, pH, Alkalinity, Total Solids, Total Dissolved Solids, Total Suspended Solids and BOD. However there was observed a significant decline in the values of the physiochemical parameters. Apparently, the effluent sample collected during textile process and washing operation were blue in colour and giving pungent smell. It is desirable to find out an optimum catalyst loading for efficient reduction. A series of experiments was carried out by varying the amount of catalyst Titanium dioxide (TiO_2) from 2g to 10g per 250 ml of sample and ultra violet (UV) irradiation time of 2 hrs.

3.1 COD

Table 3.1 COD calculation

Dosage of TiO_2 in (g)	COD in mg/l	Efficiency (%)
2	300	75
4	250	80
6	200	82
8	150	87
10	100	91

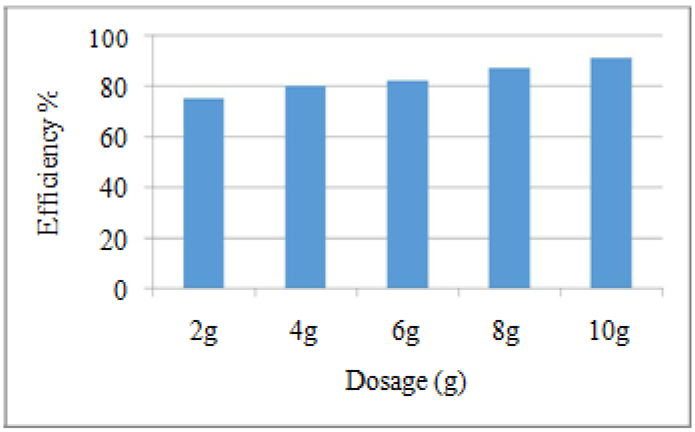

Figure 3.1 COD Chart

As seen from the above chart, the percentage (%) reduction in COD is almost increased at every dosage 2g, 4g, 6g, 8g and 10g of TiO_2 Catalyst. Results show that 91% of COD can be reduced in 10 g of TiO_2.

3.2 CALCIUM HARDNESS

Table 3.2 Calcium Hardness calculation

Dosage of TiO_2 in (g)	Hardness (mg/l)	Efficiency (%)
2	100.2	65.44
4	92.18	68.21
6	80.16	72.35
8	76.15	73.74
10	60.12	79.26

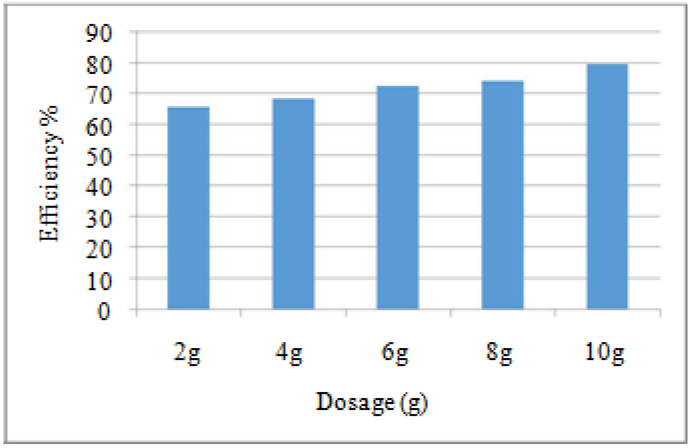

Figure 3.2 Calcium Hardness chart

After the completion of Calcium Hardness test, the percentage (%) reduction in Calcium Hardness is almost increased at every dosage 2g, 4g, 6g, 8g and 10g of TiO_2 Catalyst. Results show that 79.26% of calcium hardness can be reduced in 10 g of TiO_2.

3.3 TURBIDITY

Table 3.3 Turbidity calculation

Dosage of TiO_2 in (g)	Turbidity (NTU)	Efficiency (%)
2	32	27
4	25	43
6	15	65
8	12	72
10	9	79

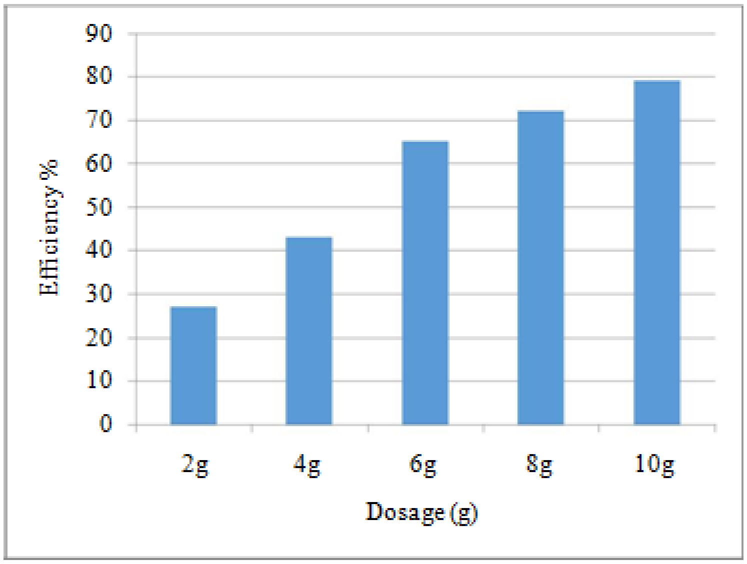

Figure 3.3 Turbidity chart

The percentage (%) reduction in Turbidity is almost increased at every dosage 2g, 4g, 6g, 8g and 10g of TiO_2 Catalyst. Results show that 79% of turbidity can be reduced in 10 g of TiO_2.

3.4 pH

Table 3.4 pH value

Dosage of TiO_2 in (g)	pH value
2	8.6
4	8.5
6	8.4
8	8.4
10	8.3

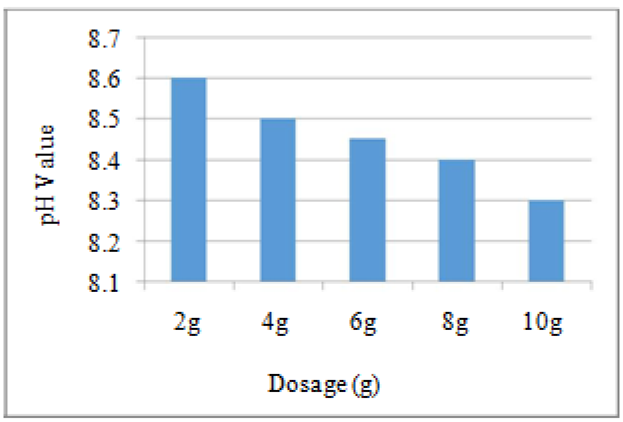

Figure 3.4 pH chart

pH value is decreases at every dosage 2g, 4g, 6g, 8g and 10g of TiO_2 Catalyst. Results show that 8.3 pH value is reduced in 10 g of TiO_2.

3.5 ALKALINITY

Table 3.5 Alkalinity calculation

Dosage of TiO_2 in (g)	Alkalinity (mg/l)	Efficiency (%)
2	300	33
4	270	40
6	220	51
8	190	57
10	150	66

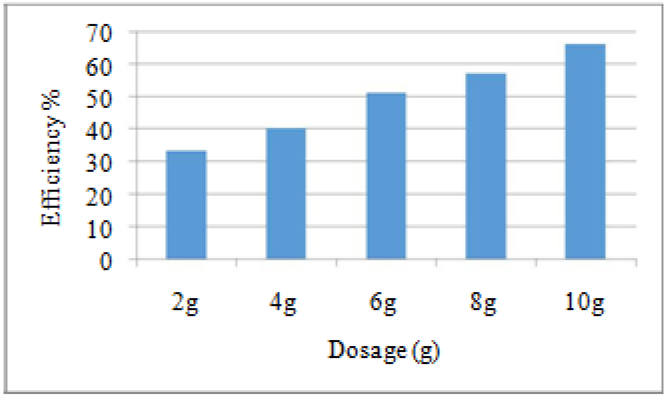

Figure 3.5 Alkalinity chart

As seen from the above chart, the percentage (%) reduction in Alkalinity is almost increased with dosage 2g, 4g, 6g, 8g and 10g of TiO_2 Catalyst. Results show that 66% of alkalinity can be reduced in 10 g of TiO_2.

3.6 TOTAL SOLIDS

Table 3.6 Total Solids calculation

Dosage of TiO_2 in (g)	Total solids (g)	Total dissolved solids (g)	Total suspended solids (g)	Efficiency (%)
2	23.6	21.3	2.3	43
4	23	20.8	2.2	56
6	21.7	20	1.7	59
8	21.1	20.1	1	62
10	21	20.5	0.5	69

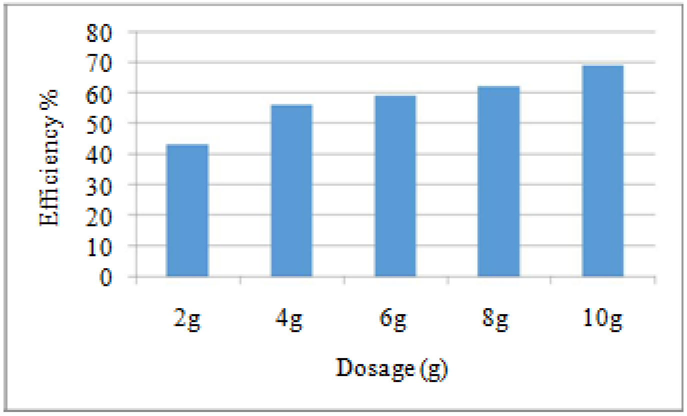

Figure 3.6 Total solids chart

The above chart represents the percentage (%) reduction in Total suspended solids is almost increased at various dosage 2g, 4g, 6g, 8g and 10g of TiO_2 Catalyst. Results show that 69% of Total suspended solids can be reduced in 10 g of TiO_2.

3.7 FINAL RESULTS

Table 3.7 Final results in Efficiency

Dosage of TiO_2 in (g)	COD (%)	Calcium Hardness (%)	Turbidity (%)	Alkalinity (%)	Total Solids (%)	pH Values	BOD (%)
2g	75	65.44	27	33	43	8.6	53
4g	80	68.21	43	40	56	8.5	47
6g	82	72.35	65	51	59	8.4	42
8g	87	73.74	72	57	62	8.4	37
10g	91	79.26	79	66	69	8.3	32

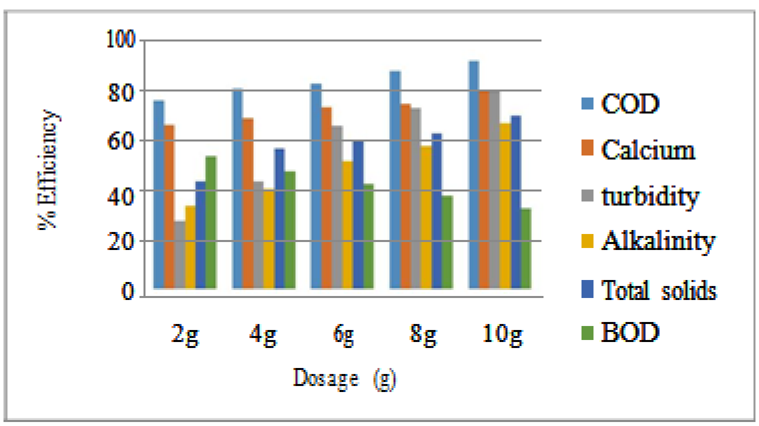

Figure 3.8 Final results

This graph shows the final efficiency of COD, Total solids, Alkalinity, Turbidity, Calcium and BOD. The removal of COD, Total solids, Alkalinity, Turbidity and Calcium increases based on the various dosage of TiO_2. Adding various dosage of TiO_2 is directly proportional to reduction efficiency. This method is not suitable for BOD.

IV. CONCLUSION

The textile industry consists of a series of processes which lead to discharge of harmful pollutants into the effluent stream. These pollutants if released unchecked and untreated can cause adverse effects to the environment and aquatic life. Hence, the effluents from textile industries need to be properly treated and discharged. The textile industry utilizes various chemicals and large amount of water during the production process. The waste water produced during this process contains large amount of dyes and chemicals containing which are capable of harming the environment and human health. The textile waste water can cause hemorrhage, ulceration of skin, nausea, skin irritation and dermatitis. The chemicals present in the water block the sunlight and increase the biological oxygen demand thereby inhibiting photosynthesis and reoxygenation process.

The effluents treated with advanced oxidation process were found to reduce high value of pH (7.2), COD (1200 mg/l) 91% reduction in 10g of TiO_2, Calcium hardness (290 mg/l) 79.26% reduction in 10g of TiO_2, Alkalinity(450 mg/l) 66% reduction in 10g of TiO_2, TSS(1.3 g), TDS (22.3 g), TS (21g) 69% reduction in 10g of TiO_2, Turbidity(44NTU) 79% reduction in 10g of TiO_2, BOD (121.82 mg/l) 53% reduction in 2g of TiO_2 and Colour intensity(Dark yellow). Photocatalytic activity of TiO_2 was studied on different commercial dye and organic pollutants. Further studies were carried out using various concentration of TiO_2 and it was found that 2g, 4g, 6g, 8g and 10g of TiO_2 in 250 ml effluent sample and 2 hours was most effective for photoreduction. The developed method shows that TiO_2 have great potential in reduction of organic pollutants in effluents and was applied commercially in treatment of textile effluent. The decline in physiochemical parameter values shows the effect of decolourization ability of TiO_2.

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