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Improvement in the Quality of Bromophenol Blue Containing Polluted Water after Photocatalytic Treatment

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ABSTRACT

The photocatalytic bleaching of bromophenol blue was carried out in the presence of semiconductor ZnO and the progress of the reaction was observed physically, chemically and spectrophotometrically. Zinc oxide appears to be a suitable alternative for water treatment. A detailed investigation of improving the quality of dye contaminated water after photocatalytic degradation has been studied. Photocatalytic degradation is mainly affect the parameters like COD, BOD, nitrate, sulphate and hardness.

Photocatalytic treatment significantly reduces COD and increases the biodegradability The result showed complete colour removal, approx 50% COD reduction, 19.2 % nitrate reduction, pH, hardness, magnesium reduction along with enhancement in conductivity and in the biodegradability of the polluted water (dye containing) which shows the mineralization of the water

Key words: Bromophenol blue, photocatalytic tretment, quality parameter and ZnO**.**

INTRODUCTION

Dyes are extensively used in the textile industry. They are the copious source of coloured organics emanating as a waste from the textile dyeing process. Dye and dye intermediates with high degree of aromaticity and low-biodegradability are introduced into the aquatic system results in the increase of the environmental risk. Conventional methods such as biological, physical and chemical processes are having several drawbacks and they are not effective for complete degradation of recalcitrant organic Compounds[1].

Each method has its own advantages and disadvantages. For example, the use of charcoal is technically easy but has a high waste disposal cost. While in filtration, low-molar-mass dyes can pass through the filter system. Coagulation, using alum, ferric salts or lime is a low cost process. However, the disposal of toxic sludge is a severe drawback in all the above methods. Lastly, the ozone treatment does not require disposal but suffers from high cost[2].

Photocatalysis has been proved an emerging technology for the treatment of waste water because of its high efficiency and relatively simple system. This process successfully used to oxidize many organic pollutants[3-10] and particularly to decolorize and mineralize dyes.[11-16] Photocatalytic degradation of brilliant green over semiconductor ZnO powder suspended in aqueous solution has been reported by Ameta *et al.*[17]

The focus of the present work is to decolorize and mineralize the bromophenol blue dyes with ZnO in the presence of sunlight. Evaluation of quality improvement of waste water was done on the basis of certain parameters like pH, BOD, COD, DO, conductivity, TDS, alkalinity, hardness, calcium, magnesium, chloride, fluoride, sulfate, nitrate and turbidity of pond water, polluted water (by the presence of bromophenol blue) and treated water (photocatalytically).

The water was collected from the Sujan Ganga of Bharatpur District in Rajasthan.

MATERIAL AND METHODS

Bromophenol blue(CDH), ZnO (Merck), EDTA, murexide indicator, potassium chromate indicator, silver nitrate, phenol disulfonic acid, zirconyl- acid reagent and SPADNS solution. Systronics spectrophotometer 104, Systronics water analyser 371, Digital pH meter Systronics Model 106 and Solarimeter CEL Model 211.

Method

Bromophenol blue and ZnO were used in the present investigations. Water samples were collected from Sujan Ganga of Bharatpur District. All considered parameters of the water sample were analysed. The dye solution of bromophenol blue (1.0×10^{-5}M) was prepared in the same pond water and analysed again for these parameters. For the catalytic degradation 500 ml of bromophenol blue (1.0×10^{-5}M) was exposed to sunlight with 3gm of ZnO for 4hours. Sunlight was used for photocatalytic reactions, its intensity was measured by solari meter. After four hours ZnO was separated using A G-3 sintered glass crucible and remaining solution was considered as treated water. Again all the quality parameters of treated water were determined

RESULTS

The photocatalytic treatment of bromophenol blue was carried out in sunlight in the presence of sunlight, ZnO was found effective on parameters like pH, alkalinity, hardness, calcium, magnesium, sulphate and nitrate; however others parameter remained almost unaffected.

Table 1: Results of Photocatalytic Treatment

S.No.	Parameters	Pond Water	Polluted Water	Treated Water
1.	pH	8.13	8.15	8.5
2.	Alkalinity mg/L	430	370	200
3.	Hardness mg/L	1030	910	770
4.	Calcium mg/L	290	290	230
5.	Magnesium mg/L	740	620	590
6.	Chloride mg/L	1100	1100	1100
7.	Fluoride mg/L	.8	.8	.8
8.	Sulfate mg/L	660	666	810
10.	Nitrate (as NO_3) mg/L	625	625	505
11.	DO ppm	2.7	2.7	2.4
12.	BOD ppm	3.25	1.5	1.65
13.	COD mg/L	16	16	8.04
14.	Cond. µmhos/cm	4.0×10^3	3.9×10^3	4.1×10^3
15.	TDS mg/L	2660	2600	2720
16.	Turbidity NTU	1	6	7

Effect on pH

Change in the pH of polluted water depends on the nature of dye. Bromophenol blue dye is basic in nature and hence; it increases the pH of polluted water from 8.13 to8.15. For the treatment the pH of bromophenol blue was set at 9 and kept it for photo oxidation. After treatment pH was noted to be 8.5

Effect on alkalinity

Alkalinity is normally due to the presence of carbonates, bicarbonates and hydroxides of calcium and magnesium. These calcium and magnesium ions precipitate certain dyestuffs, it decreases the alkality of polluted water from 430 to 370 mg/L. After photocatalytic treatment alkalinity was found to be 200 mg/L.

Effect on hardness

Like alkalinity the hardness was also found to be slightly low in polluted water as calcium and magnesium are principal cations responsible for hardness. In polluted water hardness was reduced from 1030 to 910 mg/L and after treatment hardness noted to be 770 mg/L.

Effect on calcium

After photocatalytic treatment value of calcium fall from 290 to 230 mg/L while no change were found in pond water and polluted water.

Effect on magnesium

In pond water magnesium was noted 740 mg/l which was reduced in polluted water and treated water till 620 mg/L and 590 mg/L.

Effect on BOD

BOD was found to be decreased from 3.25 to 1.5 ppm in polluted water because dye prevents the biological activity of organisms. BOD of the treated water was noted 1.65 ppm which is higher than polluted water and lower than pond water which is a good sign

Effect on COD

COD was found constant in pond water and polluted water but after treatment COD was decreased from 16 to 8.04mg/L which is a significant change.

Effect on sulfate

After photocatalytic treatment sulfate formation found in the bromophenol blue. Sulphate was increased from 666 to 810 mg/L which shows the mineralization of polluted water

Effect on nitrate

Photocatalytic treatment was also found to be affected to reduce the number of nitrates. In treated water nitrate was decreased from 625 to 505 mg/L.

Effect on TDS and conductivity

TDS and conductivity were found to be increased in treated water. Slight decrease in pH and increase in conductivity also confirms the mineralization of dye into CO_2 and inorganic ions[18].

DISCUSSIONS

Textile effluent with diverse composition was effectively treated using ZnO in the presence of sunlight . The reduction in COD, Alkalinity, Hardness, Magnesium, Nitrate of the water sample suggests that the dye molecules were completely mineralized along with colour removal. It can be concluded that the ZnO assisted photocatalytic degradation of textile dyes and textile effluent may be a versatile, economic, environmentally benign and efficient method of treatment.[19]

Photocatalytic treatment significantly reduces COD and increases the biodegradability. Considerable decrease in COD values and an increase in BOD values that proves the reduction in the toxicity.[20]

After potocatalytic treatment, the quality of wastewater improves and the treated water can be reused in many ways like production areas of the factory like cleaning and washing and also can use for the irrigation. Photocatalytic treatment will provide us with a more effective method for recycling textile dye house wastewater.

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REFERENCES

1. Houas A., Lachheb H., Ksibi M., Elaloui E., Guillard C. and Herrmann J.M., *Appl. Catal. B, Enviro*., **31**: 145-157 (2001).
2. Byrappa K., Subramani A.K., Ananda S., Lokanatha Rai K.M., Dinesh R. and Yoshimura S., *Bull. Mater. Sci*., **29**(5): 433-438 (2006).
3. Schiavello M., Photocatalysis and Environment.Trends and Applications, Vol. C237, Dordrecht, Netherlands, (1988).
4. Serpone N. and Pelizzetti E., Photocatalysis-Fundamentals and Applications, Wiley-Interscience, New York, (1989).
5. Herrmann J. M., Catal. Today, 53, 115 (1999).
6. Al-Ekabi H. A. and Ollis D. F., Photocatalytic Purification and Treatment of Water and Air, Elsevier Science Pub. B. V., Amsterdam, (1993).
7. Bahnemann D. W., Cunningham J., Fox M. A., Pelizzetti E., Pichat P. and Serpone N., Aquatic Surface Photochemistry (Zeep R. G., Helz G. R. and Crosby D. G., eds.), F. L. Lewis Publishers, Boca Raton, 261 (1994).
8. Legrini O., Oliveros E. and Braun A. M., *Chem. Rev*., **93,** 671-698 (1993).
9. Herrmann J.M., Water Treatment by Heterogeneous Photocatalysis in Environmental Catalysis (Jansen F. and Santen R. A. van., eds.), Imperial College Press, Catalytic Science Series, London, **9**: 171 (1999).
10. Blake D. M., Bibliography of Work on the Photocatalytic Removal of Hazardous Compounds from Water and Air. NREL/TP-430-22197, National Renewable Energy Laboratory, Golden Co. United States (1997).
11. Houas A., Lachheb H., Ksibi M., Elaloui E., Guillard C. and Herrmann J. M., *Appl. Catal. B: Enviro,* **31**: 145 (2001).
12. Vautier M., Guillard C. and Herrmann J. M., *J. Catal*., **201**: 46-59 (2001).
13. Lachheb H., Puzenat E., Houas A., Ksibi M., Elaloui E., Guillard C. and Herrmann J. M., *Appl. Catal. B: Enviro*., **39:** 75-90 (2002).
14. Puzenat E., Lachheb H., Karkmaz M., Houas A., Guillard C. and Herrmann J. M., *Int. J. Photo-Energy*, **5:** 51 (2003).
15. Guillard C., Disdier J., Monnet C., Dussaud J., Malato S., Blanco J., Maldonado M. I. and Herrmann J. M., *Appl. Catal. B: Enviro*., **46**: 319-332 (2003).
16. Karkmaz M., Puzenat E., Guillard C. and Herrmann J. M., *Appl. Cat. B: Enviro*., **51**: 183-194 (2004).
17. Ameta R., Vardia J., Bhat C. V. and Ameta S. C., Sam. *J. Chem*., **1**: 29 (1997).
18. Pare Brijesh, Singh Pradeep and Jonnalgadda S. B., *Indian J. of Chem.,* **48**A: 1364-1369 (2009).
19. Byrappa K., Subramani A. K., Ananda S., Lokanatha Rai K. M., Dinesh R. and Yoshimura M. *Bull. Mater. Sci.,* **29**(5): 433-438 (2006).
20. Noorjahan M., Pratap Reddy M., Durga Kumari V., Lavedrine B., Boule P. and Subrahmanyam M., *J. of Photochem . Photobiol A: Chemistry*, **156**: 179-187 (2003).