Short Communication (NS-2)

EFFECT OF PHOTOCATALYTIC TREATMENT ON QUALITY PARAMETERS OF RHODAMINE B.

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ABSTRACT

The photocatalytic degradation of rhodamine B was studied using ZnO as semiconductor in the presence of sunlight. Zinc oxide appears to be a suitable alternative for water treatment. A comparison of quality parameters of canal water, polluted water (dye containing) and treated water has been done. Parameters like pH, BOD, COD, DO, conductivity, TDS, alkalinity, hardness, calcium, magnesium, chloride, fluoride, sulfate and nitrate were determined. After photocatalytic treatment, the results showed complete colour removal, approx 50% COD reduction, 26% nitrate reduction, pH, hardness, magnesium reduction along with enhancement in conductivity and in the biodegradability of the polluted water (dye containing) from 2.33 to 2.6 which shows the mineralization of the water.

Key Words: Rhodamine B, Zinc oxide, Quality parameters, Photocatalytic treatment, Polluted water

INTRODUCTION

Increasingly stringent effluent discharge limitations have been put into effect1. The textile industries generally face difficulties in meeting wastewater discharge limits, particularly with regard to dissolved solids, ionic salts, pH, COD, colour, and sometimes, heavy metals2-4.

Dye and dye intermediates with high degree of aromaticity and low-biodegradability are introduced into the aquatic system resulting in to an increase of the environmental risk. Conventional methods such as biological, physical and chemical processes are having several drawbacks and are not effective for complete degradation of recalcitrant organic compounds5.

Currently, research interests have been focused on the techniques for the treatment of polluted environment that are low cost and eco friendly in nature. In this regard photocatalytic treatment has attracted a great attention, because this kind of reaction needs only light, catalyst and air. Secondly, the processing cost is also lower, and hence, it is becoming a kind of new promising method for the liquid waste processing5-7. Semiconductors are being used to degrade organic pollutants in water to less harmful inorganic material.8 Use of semiconductors in photocatalytic bleaching of some dyes (malachite green, crystal violet and methylene blue) has been reported by Ameta et al9 Decolorization of effluent from textile dyeing and finishing industry has been regarded important because of aesthetic and environmental concerns10.

The focus of the present work is to analyze the changes occurring in quality parameters of water after photocatalytic treatment of polluted water (containing dye). 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 canal water, polluted water (by the presence of rhodamine B) and treated water (photocatalytically).
The water was collected from the Sujan Ganga of Bharatpur District in Rajasthan.

**AIMS AND OBJECTIVES**

Main objective is to compare the quality parameters of water, polluted water (containing dye) and treated water on the basis of certain parameters like pH, BOD, COD, DO, conductivity, TDS, alkalinity, hardness, calcium, magnesium, chloride, fluoride, sulfate and nitrate.

**MATERIAL AND METHODS**

**Reagents**

Rhodamine B (S. D. Fine Chem.), ZnO (Merck), EDTA (S. D. Fine Chem.), murexide indicator (Merck), potassium chromate indicator, silver nitrate (Merck), phenol disulfonic acid, zirconyl-acid reagent and SPADNS solution (BDH Chem.).

**Apparatus**

Systronics spectrophotometer 104, Systronics water analyser 371, Digital pH meter Systronics Model 106 and solarimeter cell Model 211.

**Methods**

Rhodamine B and ZnO were used in the present investigations. Water samples were collected from Sujan Ganga of Bharatpur District. All considered parameters were analyzed. The dye solution of Rhodamine B \( (4.0 \times 10^{-5} \text{M}) \) was prepared in the same canal water and analyzed again for these parameters. For the photocatalytic degradation 500 ml of Rhodamine B \( (4.0 \times 10^{-5} \text{M}) \) was exposed to sunlight with 3gm of ZnO for 5 hours. Sunlight was used for photocatalytic reactions, its intensity was measured by solari meter. After five 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 AND DISCUSSION**

The photocatalytic treatment of Rhodamine B was carried out in sunlight. In the presence of sunlight, ZnO was found effective on parameters like pH, alkalinity, hardness, magnesium, and nitrate; however others parameter remained almost unaffected. (Table 1)

**Effect on pH**

<table>
<thead>
<tr>
<th>S/N</th>
<th>Parameters</th>
<th>Canal water</th>
<th>Rhodamine B. polluted</th>
<th>Rhodamine B. treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>pH</td>
<td>9.57</td>
<td>9.72</td>
<td>8.78</td>
</tr>
<tr>
<td>2.</td>
<td>Alkalinity mg/l</td>
<td>240</td>
<td>240</td>
<td>200</td>
</tr>
<tr>
<td>3.</td>
<td>Hardness mg/l</td>
<td>980</td>
<td>920</td>
<td>840</td>
</tr>
<tr>
<td>4.</td>
<td>Calcium mg/l</td>
<td>340</td>
<td>340</td>
<td>338</td>
</tr>
<tr>
<td>5.</td>
<td>Magnesium mg/l</td>
<td>640</td>
<td>580</td>
<td>502</td>
</tr>
<tr>
<td>6.</td>
<td>Chloride mg/l</td>
<td>1100</td>
<td>1100</td>
<td>1100</td>
</tr>
<tr>
<td>7.</td>
<td>Fluoride mg/l</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>8.</td>
<td>Sulfate mg/l</td>
<td>700</td>
<td>700</td>
<td>700</td>
</tr>
<tr>
<td>9.</td>
<td>Nitrate mg/l</td>
<td>800</td>
<td>806</td>
<td>593</td>
</tr>
<tr>
<td>10.</td>
<td>DO ppm</td>
<td>3.9</td>
<td>3.9</td>
<td>2.8</td>
</tr>
<tr>
<td>11.</td>
<td>BOD ppm</td>
<td>3</td>
<td>2.33</td>
<td>2.6</td>
</tr>
<tr>
<td>12.</td>
<td>COD mg/l</td>
<td>14</td>
<td>14.02</td>
<td>7.2</td>
</tr>
<tr>
<td>13.</td>
<td>Cond. µmhos/cm</td>
<td>4090</td>
<td>3950</td>
<td>4190</td>
</tr>
<tr>
<td>14.</td>
<td>TDS mg/l</td>
<td>2660</td>
<td>2600</td>
<td>2720</td>
</tr>
<tr>
<td>15.</td>
<td>Turbidity NTU</td>
<td>1</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>
Change in the pH of polluted water depends on the nature of dye. Rhodamine B dye is basic in nature and hence; it increases the pH of polluted water from 9.57 to 9.72. For the treatment the pH of rhodamine B was set at 10 and kept it for photo oxidation. After treatment pH was noted to be 8.78. It is clear that photocatalytic treatment affects the pH and make it more desirable.

**Effect on Alkalinity**

The alkalinity of surface waters is primarily due to carbonate, bicarbonate, and hydroxide contents. Alkalinity was found to same in canal water and treated water. After photocatalytic treatment of this sample alkalinity was found to decrease i.e. from 240 to 200 mg/L.

**Effect on Hardness**

Hardness is defined as the sum of the calcium and magnesium concentrations. Hardness was found to be slightly low in water contaminated by rhodamine b as calcium and magnesium are principal cations responsible for hardness and these ions precipitate certain dyestuffs in polluted water. In polluted water the hardness was reduced from 980 to 920 mg/L and after photocatalytic treatment hardness reduced to 840 mg/L.

**Effect on Magnesium**

Magnesium enters in the drinking system from natural geological sources. In polluted water magnesium ions reacted with dye elements that is why magnesium was found to low in the polluted water. In canal water magnesium was noted 640 mg/L which was further reduced in polluted water and treated water to 580 mg/L and 502 mg/L.

**Effect on BOD**

Biological Oxygen Demand (BOD) is a measure of the oxygen used by microorganisms to decompose this waste. BOD was found to be decreased from 3 to 2.33 ppm in polluted water because dye prevents the biological activity of organisms. BOD of the treated water was noted 2.6 ppm which is higher than polluted water and lower than canal water which shows that photocatalytic treatment increases the biodegradability

**Effect on COD**

The chemical oxygen demand is a measure of the oxidizability of a substance, expressed as the equivalent amount in oxygen of an oxidizing reagent consumed by the substance under fixed laboratory conditions. COD was found constant in canal water and polluted water but after treatment COD was decreased from 14.02 to 7.2mg/L which is a notable change

**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 CO₂ and inorganic ions

**Effect on Nitrate**

Photocatalytic treatment was also found to be affected to reduce the number of nitrates. In treated water nitrate was decreased from 800 to 593 mg/L

**CONCLUSION**

Textile effluents with diverse composition were effectively treated using ZnO in the presence of sunlight. The reduction in COD, alkalinity, hardness, magnesium and nitrate. The results of treated water sample suggest that the dye molecules were mineralized in this process along with colour removal. Conductivity increased due to the formation of ion and TDS and turbidity increased because of Zno, which can be separated to get desired results. 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. Photocatalytic treatment significantly reduces COD and increases the biodegradability. Considerable decrease in COD values and an increase in BOD and conductivity also prove reduction in the toxicity.

Photocatalytic treatment is a eco- friendly method with no side effect. There is no waste generation after treatment and also a low cost treatment. After treatment this water can be used for lower grade work in industries like cleaning, washing or for irrigation.

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REFERENCES


