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# AN ANALYSIS OF ZnO ASSISTED PHOTOCATALYTIC DEGRADATION OF GIEMSA DYE

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## ABSTRACT

Present investigation analyzes various parameters of water after ZnO assisted photocatalytic degradation of Giemsa dye in aqueous suspension. Significant changes were noted in alkalinity, turbidity, hardness, nitrate, calcium ion concentration, chloride ion concentration, magnesium ion concentration, COD, BOD, sulfate ion concentration, temperature and pH. At pH 8.6 various investigated parameters were found within the WHO standards of drinking water. Photocatalytic treatment of waste water needs to be accompanied with secondary treatment to ensure environmental safety.

**Key words**: Biosafty, ZnO, Giemsa dye, Photocataysis.

## INTRODUCTION

Giemsa dye is extensively used to stain DNA molecules as a non-radioactive marker in biotechnology laboratories. Giemsa dye polluted water (after treatment with DNA) is discarded into sink in various biochemical laboratories. Disposal of Giemsa dye into sanitary sewer or sink drain is not permitted over its hazardous concerns. Although it is an effective tool to visualize nucleic acid, but its hazardous properties require safe handling and disposal procedures. It pollutes ground water resources and poses a threat to environment while released from manufacturing units or laboratories. Several attempts have been made to degrade dyes by semiconductors and their conjugated nanoparticles but it is also notable to observe if any change occurred in water quality after photocatalytic treatment. Most of such photocatalytic treatment methodologies deal with semiconductors, their conjugates, initial dye concentration, catalyst doses, reaction temperature and light illumination / exposure time,

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but remain silent over wide varieties of water quality parameters[1-3]. Here an attempt has been made for photocatalytically degrade Giemsa dye by using ZnO semiconductor. Photocatalytic degradation of Giemsa dye was evaluated on the basis of change in optical density at concerned $\lambda_{max}$. Quality of photocatalytically degraded Giemsa dye polluted water was evaluated by analyzing alkalinity, turbidity, hardness, nitrate, calcium ion concentration, magnesium ion concentration, COD, BOD, sulfate ion concentration, temperature and pH. Proposed investigation was carried out to analyze various water quality parameters of ZnO assisted photocatalytic degradation of Giemsa dye. Such studies can be helpful in deciding whether photocatalytic water treatment methodologies may be appropriate upto an extent. These studies will redefine a road map that how such dyes polluted water and their photocatalytically degraded products should be disposed off/ affects environment.

## EXPERIMENTAL

### Chemicals

ZnO nanoparticles were kindly supplied by Chem Life Enterprises. Giemsa dye was purchased from Sigma Aldrich. Sodium fluoride, zirconium reagent, sodium arsenite, sodium azide, sodium iodide, $Na_2S_2O_3$, eriochrome black T indicator and diphenylamine indicator were purchased from Qualigens; murexide indicator, starch indicator, ortho phosphoric acid, ferrous ammonium sulphate, methanol were from Fisher Scientific; EDTA, $K_2Cr_2O_7$, $AgNO_3$, AgCl, $Ag_2SO_4$, $FeCl_3$, $MgSO_4$, HCl, NaOH were from Central Drug House.

### Photocatalysis of Giemsa dye

A 100 mL solution of Giemsa dye (25 ppm) was prepared in tap water at different pH (2, 4, 6, 8, 10, and 12) to screen optimum pH for photocatalysis. Absorbance of these solutions was measured at $\lambda_{max}$ 660.7 nm at 25$^{o}$C by using UV-Vis spectrophotometer (Jasco-630). The solutions were maintained in glass bottles (without lid) under sun light exposure (3000 Lux/h) for 4 h with suspended ZnO nanoparticles (1000 ppm; without stirring) for photocatalytic degradation with control. Control was used to check solar assisted dye degradation for comparative analysis. Photocatalytically treated samples were centrifuged at 4000 g for 5 minutes (REMI cooling centrifuge C 24). The supernatant was analyzed for optical density at $\lambda_{max}$ 660.7 nm at 25$^{o}$C temperature to assess photocatalytic degradation of Giemsa dye at different pH (2, 4, 6, 8, 10, and 12). The pH at which maximum % change in absorbance was noticed after photocatalysis was considered as optimum pH.

### Quantitative analysis of samples

The parameters (alkalinity, turbidity, hardness, nitrate, calcium ion concentration, magnesium ion concentration, chemical oxygen demand (COD), biological oxygen demand (BOD) (BOD incubator: Kumar Systems), dissolved oxygen (DO), sulfate ion concentration) of photocatalytically treated and untreated samples were analyzed at optimum pH. Estimation of nitrate, hardness, alkalinity, magnesium, COD, BOD, DO and sulfate were assessed by standard method of titration[4,5]. The obtained results were compared with international standards for drinking water, World Health Organization (WHO)[6].

## RESULTS AND DISCUSSION

The use of nanocrystalline ZnO in the photocatalytic oxidation of organic molecules represents a promising remediation strategy for wastewater systemsn. $\lambda_{max}$ = 660.7 nm for Giemsa dye was determined by using UV-Vis spectrophotometer (Jasco-630) at 25$^oC$. Among experimented pH (2, 4, 6, 8, 10, 12) maximum photocatalytic degradation (99.88%) of Giemsa dye was observed at pH 8 (Table 1). Photocatalytic efficiency has been determined based up on % decrease in optical density. Various water quality parameters were studied in photocatalyzed dye sample and compared with untreated dye samples (Table 2). A significant change was noticed in each studied parameter. These parameters were compared with World Health Organization standards for drinking water (Table 2)[6]. Only hardness of solution was found higher than WHO standards for drinking water.

**Table 1: ZnO assisted photocatalytic degradation of Giemsa dye at different pH**

| pH | Photocatalytic efficiency % | % Photolytic efficiency in control |
|---|---|---|
| **2** | 99.75 | 6.40 % |
| **4** | 95.01 | 0.96 % |
| **6** | 97.65 | 0.43 % |
| **8** | 99.88 | 9.56 % |
| **10** | 94.94 | 2.47 % |
| **12** | 90.71 | 5.81 % |

**Table 2: Quantitative analysis of water**

| Parameters | Tap water | Untreated water | Treated water | WHO Standard |
|---|---|---|---|---|
| Alkalinity | 45 ppm | 283 ppm | 116.6 ppm | 200 ppm |
| BOD | 1.3 ppm | 4.5 ppm | 2 ppm | 6 ppm |
| $Ca^{2+}$ | 13 ppm | 24.0 ppm | 18.7 ppm | 75 ppm |
| $Cl^-$ | 124.3 ppm | 213 ppm | 142 ppm | 200 ppm |
| COD | 2.1 ppm | 20 ppm | 5.3 ppm | 10 ppm |
| DO | 8.3 ppm | 11.4 ppm | 10.3 ppm | Not reported |
| Fluoride | 0.34 ppm | 0.36 | 0.35 | Not reported |
| Hardness | 72.6 ppm | 380 ppm | 293.3 ppm | 100 ppm |
| $Mg^{2+}$ | 1.68 ppm | 4.90 ppm | 1.82 ppm | 30 ppm |
| $NO_3^-$ | 0.7 ppm | 2.38 ppm | 1.56 ppm | 50-100 ppm |
| $SO_4^{2-}$ | 21.34 ppm | 36.33 ppm | 24.84 ppm | 200 ppm |
| TDS | 30 ppm | 100 ppm | 70 ppm | 500 ppm |
| pH | 8.5 | 8 | 8.6 | 6.5-8.5 |
| Temperature ($^o$C) | 34.5 | 34.7 | 35.8 | Not reported |
| Turbidity NTU | 4 | 4 | 6 | Not reported |

## CONCLUSION

Investigation reflects that ZnO nanoparticles may be used for degradation of Giemsa dye in research laboratories, which pose a continual threat to environment but still it needs secondary treatment to evaluate xenotoxicity before it is disposed into environment.

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