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Removal of Reactive Blue 221 Dye from Textile Waste Water **by Using** Zinc Peroxide **Nanoparticles**

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Abstract:

Zinc peroxide nanoparticles were synthesized by using ultrasound sonication process. Zinc peroxide nanoparticles was Characterized by X-ray diffraction, transmission electron microscope. Zinc peroxide nanopaticle are used as a catalyst for removal of a Reactive blue 221 dye. Maximum degradation efficiency of Reactive blue 221 dye was 85.52 % achieved by zinc peroxide with PEG as a catalyst and 81.69 % achieved by zinc peroxide without PEG as a catalyst at 120 min of photo catalytic reaction. The excellent degradation efficiency of Reactive blue 221 dye was achieved at the optimum operational conditions: initial concentration of dye 10 mg/lit, catalyst dosage of 200 mg, pH of solution will be in between 6.5 and temperature 35^{o}C.

Keywords: Zinc peroxide, PEG, Reactive blue dye, Textile waste water, Decolorization.

Introduction:

Dye is one of the environmental pollutant that enters through different sources such as textile, cosmetics, paper and pulp, leather, food industries and printing [1,2]. Problems such as toxicity reduce light dispersion in water and it affect the health of aquatic organisms [4]

Organic dyes and organic pollutants enter from textile waste water are harmful to health of all living organism and it adverse affects on surrounding atmosphere [5,6]. This waste water move to the surface water and ground water through different many sources and it also infect the drinking water. These organic, inorganic waste and heavy metals are harmful to health, environment, and economics so we are trying to remove this by using zinc peroxide as a nano catalyst. This is one of the efficient method for removal of organic pollutants from water to protect health of aquatic life.

There are many number of synthesis process available for the nano particle of zinc peroxide, such as organ metallic precursor method, sol-gel synthesis, polyol synthesis, autoclaves, hydrothermal method, laser ablation and oxidation–hydrolysis–precipitation procedure. Now, in between all the technique oxidation–hydrolysis–precipitation procedure has advantages over all these method because stabilized nanoparticles of zinc peroxide were formed by simple technique [8]. Removal of toxic and harmful Dye from waste water of different industries reduced the impurities from the water.

Reactive dyes are typically azo based dyes and these are combined with different types of groups. They have brilliant in colour, simple application techniques and it require very low energy [9]. Reactive dyes widely used in textile industry. The reactive blue 221dye may be produce harmful by products after any simple decolorization process. Just like Physical, Chemical and biological treatment. Dyes remove from the water by many methods just like conventional treatments, adsorption and coagulation but these methods are not very effective [10]. So here we are using advanced oxidation processes (AOPs), because it is very effective in removing environmental pollutants [11, 12]. In this research study the methods of synthesis, characterization and application over textile waste water will be discussed.

Experimental:

Materials:

Zinc acetate dehydrate A.R. grade procured from the High purity laboratory chemicals private limited, Mumbai-400002; 50% hydrogen peroxide ; Polyethylene glycol 200 ; and sodium hydroxide was brought from Sigma Life Science. Reactive blue 221 dye was brought from merck specialities private limited Mumbai.

Preparation of ZnO_2 nanoparticle solution:

Zinc peroxide nanoparticles were synthesized by dissolving 3 gm of Zinc acetate dehydrates in 30 mL of deionized water.Then after that add 120 ml of Polyethylene glycol 200 and 9 ml of hydrogen peroxide (50%) slowly. The procedure carried out at room temperature and after the continuous stirring of two hours a clear and colorless solution is converted into yellow colour [8]. In this process ultrasound sonication stirring process used because it gives maximum yield as compared to other stirring process

Preparation of ZnO_2 nanoparticle powder:

After stirring of 120 minutes, add sodium hydroxide solution of 3N was added to form a white color precipitate. Then stop adding the sodium hydroxide when pH of solution was achieved11.5.

The white precipitate was separated by using centrifugation process. from the solution. Then mixture was washed at least six times sodium hydroxide solution. Then Wash the solution mixture by distilled water upto the pH of the residue water 8.4 achieved. The white colored rsidue was dried for two hours at 80°C in an oven [8].

Removal of Reactive blue 221 dye:

A stock solution was made by dilluting a 1gm of reactive blue 221 dye in 1 litre of distilled water. Experiments were carried out to study the effect of various parameters such as the dye concentration, pH, catalyst dosage, temperature and contact time. For this experimental procedure dye concentration (1 to 15 mg/lit), Catalyst dosage (100 - 1000 mg/100 ml), pH (1 to 12), contact time of (10 to 180 min) ,temperature(27-55^{o}C) were considered .For every experimental batch , 100 ml of dye solutions with varying concentration and at a different pH and different amount of the catalyst were taken in a 500 ml beaker. The samples were stirred by using magnetic stirrer in presence of UV lamp. To separate the catalyst from the solutions, samples were centrifuged by using centrifugation process and then samples were measured by UV spectrophotometer. Dye concentration in solutions measured by UV-Visible spectrophotometer at λmax = 592 nm for reactive blue 221 dye. The % removal efficiency of dye was calculated using the following equation:

$$\% \text{ Removal} = \frac{(C_0 - C_t)}{C_0} \times 100$$

Where C_0 and C_t (mg/lit) are the initial dye concentration and concentration after time (t), respectively [13].

Characterisation:

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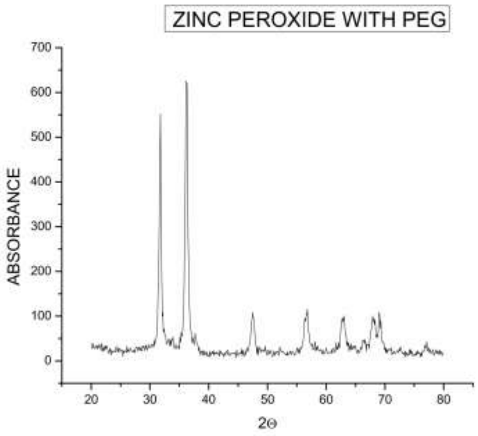
X-ray diffraction analysis:

Figure 1a and 1b shows XRD diffraction pattern of Zinc peroxide nanoparticles. Figure 1 shows the crystal structure and phase purity of the ZnO_2. The peaks are indexed as 31.8º (552), 36.2º (626), 47.5º (88), 56.7º (233), 62.8º (126), 66.06º (123), 68º (119) and 69 (109) respectively. From this it is proved that pure nanoparticles of zinc peroxide were synthesized[14].



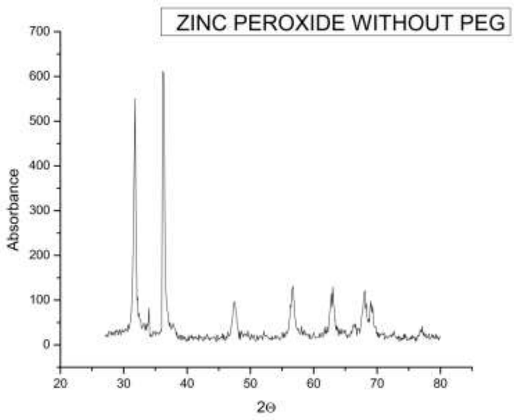
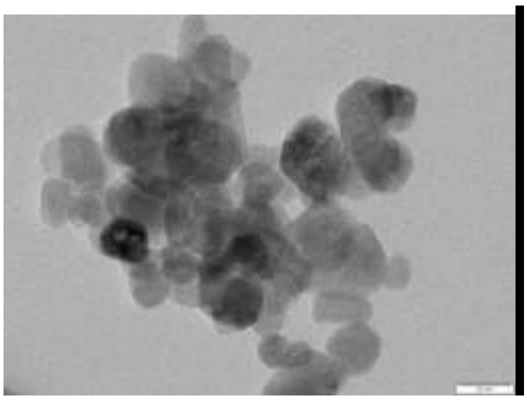


Figure 1 (a): XRD patterns of zinc peroxide with PEG nanoparticle

Figure 1 (b): XRD patterns of zinc peroxide without PEG nanoparticle

Transmission Electron Microscopy:



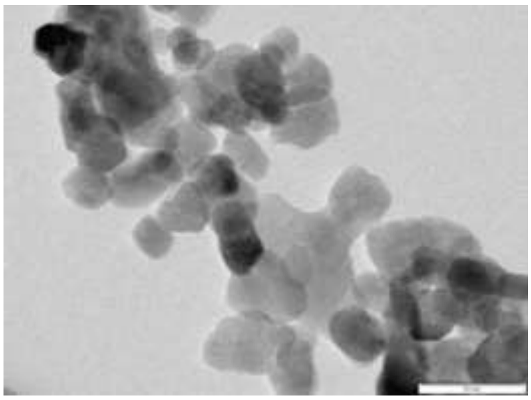


Figure 2 (a): TEM of ZnO_2 without PEG

Figure 2 (b): TEM of ZnO_2 with PEG

Figure 2 (a & b) show the TEM images of nano size zinc peroxide. TEM analysis was done using TEM CM 200 of the PHILIPS Company at IIT, Powai. The microstructure and morphology of the zinc peroxide nanoparticles was examined by using TEM analysis.

TEM observations of the Zinc peroxide with PEG and zinc peroxide without PEG, examine a dissimilarity between the agglomeration shape as shown in figure 2a Zinc peroxide without PEG formed intense agglomerates, whereas in figure 2b. Zinc peroxide with PEG created slighter size agglomerates.

Results and Discussion:

Effect of dosage and time:

Effect of contact time on % removal of Reactive blue 221 dye (5 mg/litre) at different dosage of zinc peroxide nanoparticles as shown in figure.3 and 4. The figure 4 proves that as the catalyst dosage of zinc peroxide nanoparticles with PEG and zinc peroxide without PEG increased from 100 to 1000 mg , maximum % decolourization of reactive blue 221 dye was achieved at 200 mg and at time 120 min as shown in figure 3.[15]

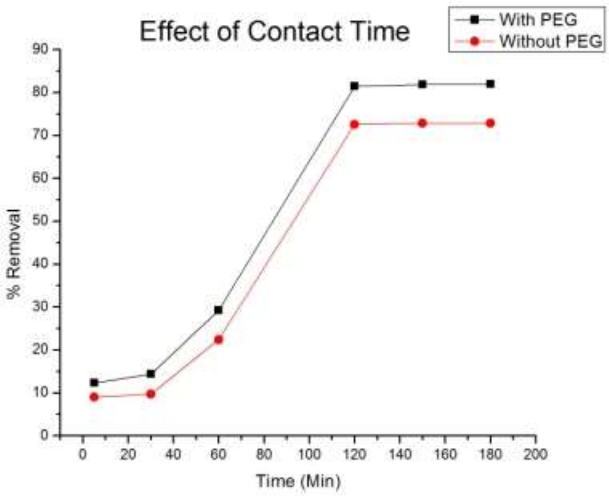


Figure 3: Effect of contact time on removal of RB 221 dye (Dye concentration= 5 mg/lit, Temperature- 30^{o}C, pH-6.5, Catalyst dose-200mg)

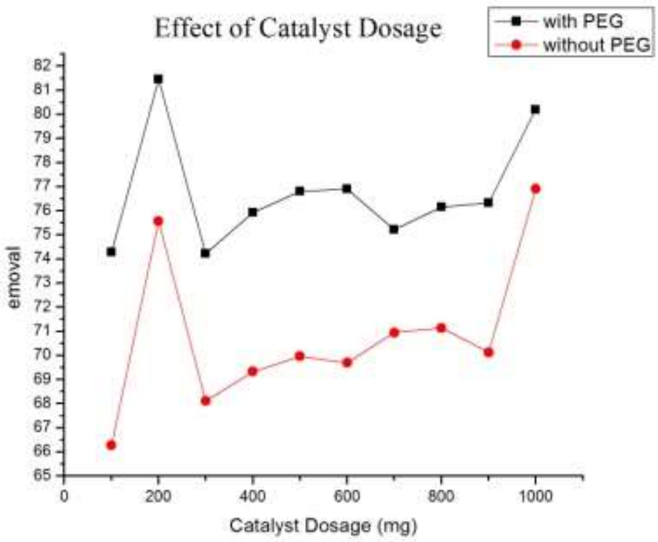


Figure 4: Effect of catalyst dosage on removal of RB 221 dye (Dye concentration-5 mg/lit, Temperature-30^{o}C, pH-6.5, Time- 120 min)

Effect of Reactive blue 221 dye concentration:

The effect of Reactive blue 221 dye concentration was studied by varying concentration from 1 to 15 mg/Lit. The dye decolourization study was performed using 200 mg/100ml nanoparticle for 120 min and pH of solution was 6. The absorbance of the dye solution has remained constant after 10 mg/litre at wavelength (592 nm) disappearing completely. The maximum % decolourization was observed at 10 mg/L for ZnO_2 with PEG and ZnO_2 without PEG. (for 120 min) as shown in figure 5.

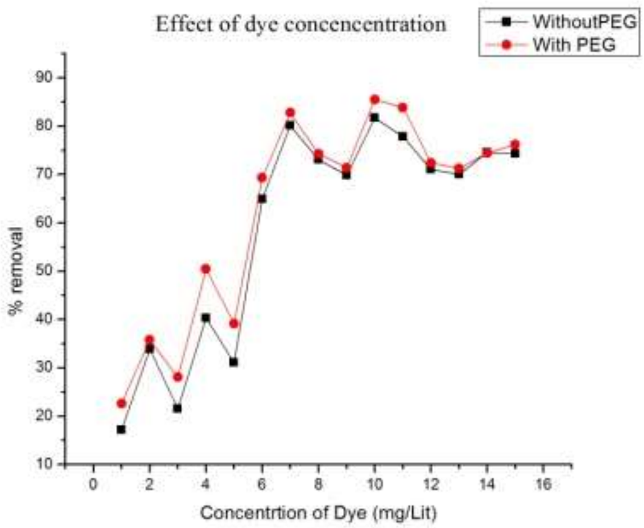


Figure 5: Effect of initial dye concentration on removal of RB 221 dye (Temperature-30^{o}C, pH-6.5, Catalyst dose-200mg, Time- 120 min)

Effect of pH:

Effect of pH on dye degradation in the range of 3–12 pH of dye solution were set with a dye concentration of 10 mg/lit and their pH was adjusted. Figure 6.shows decolorization of the dye at different pH values. The maximum % removal with catalyst ZnO_2 with PEG and ZnO_2without PEG was observed at pH 6.

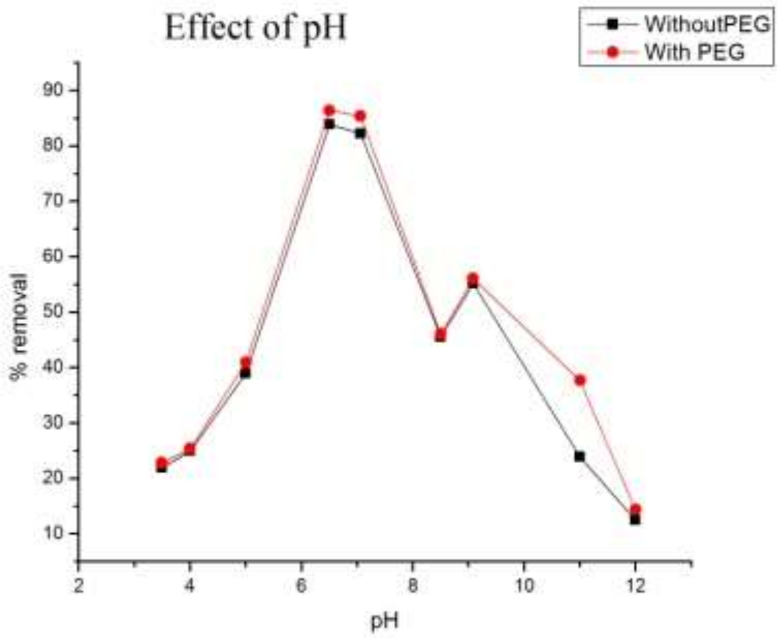


Figure 6: Effect of pH on removal of RB 221 dye (Dye concentration-10 mg/lit, Temperature-30^{o}C, Catalyst dose-200mg, Time- 120 min)

Effect of temperature:

Effect of temperature on the photocatalytic removal of Reactive blue 221 dye was obtained in the range of temperatures 27^{0}C to 55^{0}C. The photocatalytic dye removal were increased with as increase in the reaction temperatureas shown in figure 7.

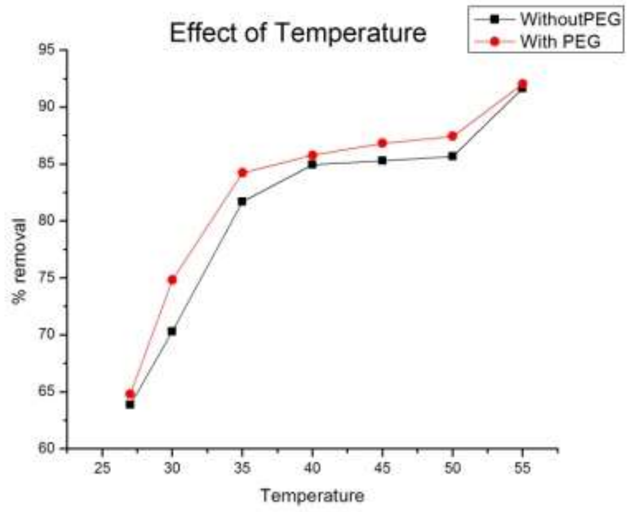


Figure 7: Effect of temperature on removal of RB 221 dye (Dye concentration-10 mg/lit, pH-6.5, Catalyst dose-200mg, Time- 120 min)

Conclusion:

Oxidation, hydrolysis and precipitation method were used for synthesis of Zinc peroxide nanoparticles. Characterizations of nanoparticles were done by different techniques (eg. XRD, TEM, FTIR). The decolourization of Reactive blue 221 dye was done by two catalyst, ZnO_2 with PEG and ZnO_2 without PEG. For the photocatalytic decolourization of dye following optimum conditions are obtained: Amount of catalyst - 200mg, Dye Concentration - 10 mg/lit, pH-6, time - 120 min.

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