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A REVIEW PAPER ON ADSORPTION OF DYES FROM WASTEWATER USING ZnO NANO PARTICLES.

Aditi Gulabbhai Patel[1], Prof. (Dr.) Reshma L Patel[2], Prof. Jignesh I Brahmbhatt[3]

[1]M. Tech Environmental Engineering Student, [2]Associate Professor, [3]Assistant Professor

[1,2,3]Department of Civil Engineering

[1,2,3]BVM Engineering College, Anand, Gujarat, India.

Abstract : Water is an essential commodity in everyday life for every form of life. Though the water is the most abundant substance found in earth, still the usable/potable water resources are shrinking every passing day. One of the problems due to which the water gets contaminated is presence of dyes. This following review paper focuses on using an advanced technique involving adsorption of dye particles using ZnO nano particles. The ZnO nano particles are synthesized in the lab using simple precipitation method. The dyes are characterized by UV-Vis spectrophotometer and the ZnO nano particles characterized for its structural morphology using X-ray diffraction (XRD), scanning electron microscopy (SEM), Fourier trans-form IR (FTIR) analysis. The size of the nano particles is found out and the application of these NPs are tested at various concentrations of dyes at various pH. The adsorption mechanism is studied in line with Langmuir model using diverse literature available. The treated water possesses characteristics within the safe disposable limits and can be either disposed to any stream of water or used for any raw water intake.

Index Terms **- Wastewater treatment, adsorption, dye removal.**

1. Introduction

Water plays a crucial role in every form of life. There are multitude of problems that can occur without water and hence mankind's lives can get extinct. Various problems prevail, several new occur and solutions should be implemented in order to protect water supplies and to treat water used in residential areas, municipal sewerage, industries etc. Among solutions, wastewater treatment is sounded economical and convenient way to overcome water scarcity. Physical, chemical, biological, and mixed treatment systems provide ample opportunity to use water over and over again. However, nano technology can treat wastewater and reach much more quality and overcome their drawbacks. There are many techniques involving point of care treatment, nano technology, oxidation/reduction processes and many more. Use of nanoparticles of metal oxides is a proven method and huge research has been done in this area.

Many industries like, textile, paper, plastic manufacturing use dyes which can also be found in their effluent in considerable concentrations (Ahmed Samer Elfeky, 2019). Such wastewater when discharged in water streams creates bad aesthetics, fouling, blocks sunlight and obstructs oxygen exchange into the water body (Gayathri. S, 2019). Dyes are mostly aromatic compounds which are prone to natural degradation and hence a biological treatment for them is quite difficult (F. Hai, 2007). Many treatment methods based on adsorption, activated carbon, zeolite, micro and ultrafiltration have been researched to eliminate the presence of dyes in wastewater but there persists one or another problem in these treatment technologies. There are different methods available for the removal of coloured contaminants like methyl blue, methyl orange, crystal violet, crystal red etc from wastewater but adsorption has received considerable attention for colour removal from wastewaters as it offers the most economical and effective treatment methods (Mohammad Abul Hossain, 2018). The use of nano particles of metal oxides such as ZnO, TiO_2 have gained quite an attention and have been widely used as a direct treatment as well as catalysers in advanced oxidation processes (Gaurav K. Upadhyaya, 2018). ZnO nanoparticles are accepted for decolourization of the coloured effluent. The size and shape of the nanoparticles play an important role in the decolourization and can be controlled by various physical and chemical routes (Kane, 2016).

2. Preparation of ZnO Nano Particles

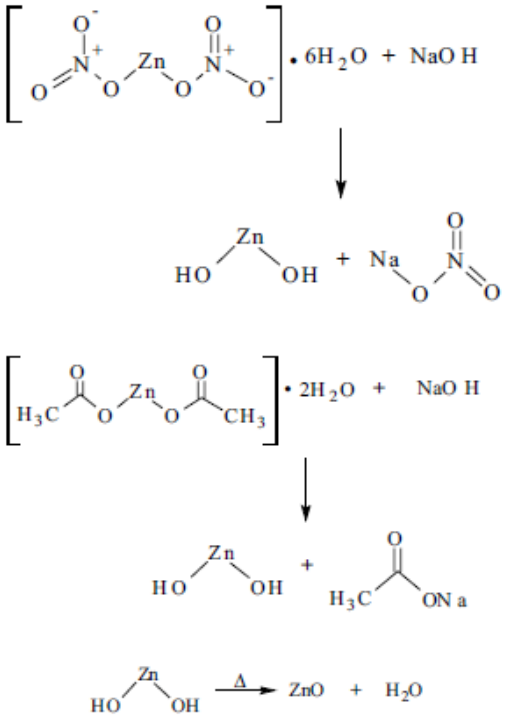
(Gayathri. S, 2019) prepared the ZnO nano particles by following method. Zinc acetate of 2.1 g dissolved in double distilled water of 200 ml. After 10 minutes of stirring about 1.5 g of tri-sodium citrate mixed in 10 ml water and 4.2 ml of 25 % ammonia solution were added. Next, 2M NaOH solution of 20 ml added drop wise with vigorous stirring. Temperature of contents raised to 800 C and kept at this temperature for 6 hours. Then contents centrifuged and precipitate washed five times in distilled water and dried at 600 C and thoroughly ground of the solutions Sodium Hydroxide (NaOH) and Hydrochloric acid (HCL) of 2N solution were added.

(Kondawary, 2018) prepared the metal oxides and their nano particles by a sol-gel method. ZnO nano structures were made by typical polymerization of aniline. In a typical process, 0.905 gm ZnO was dispersed by ultrasonic in 50 mL aqueous solution of 0.2 mol aniline monomer. 0.2 mol ammonium persulphate as oxidant was added

dropwise to the mixture of ZnO for six hours. The mixture was filtered and filtrate was dried in the oven. It was the ZnO which was ground to obtain the nano particles of desired size.

(Qingyong Tian, 2005) synthesized MoS_2/ZnO Heterostructure Photocatalyst by dispersing MoS_2 nano particles in a flask of water. 12.5 ml of Zn(CH3COO)2 solution with different concentrations were added into the mixture and raised to 40 °C. 4 ml of ammonia (5% wt) was added slowly into the above mixture. After 1 h, the mixture was centrifuged at 5000 rpm.

(S. Mustapha, 2020) described sol-gel method to synthesize ZnO nano particles. The chemical reactions of which can be understood by the following flow.



3. Characterization of ZnO Nano Particles.

ZnO nanoparticles are characterized based on the purpose for which they are produced. The most adopted techniques for their characterisation are electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Brunauer–Emmett–Teller (BET), X-ray photoelectron spectroscopy (XPS), dynamic light scattering (DLS), photoluminescence (PL), and ultraviolet–visible (UV–Vis).

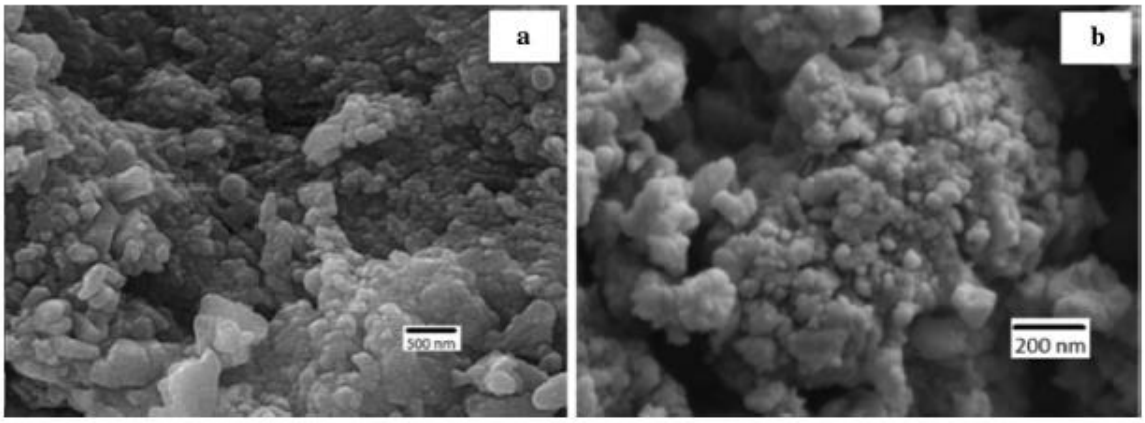


Fig 1. SEM image of prepared ZnO nanoparticles **a** as-synthesized **b** calcined at 500 °C for 3 h (Farahmandjou, 2015)

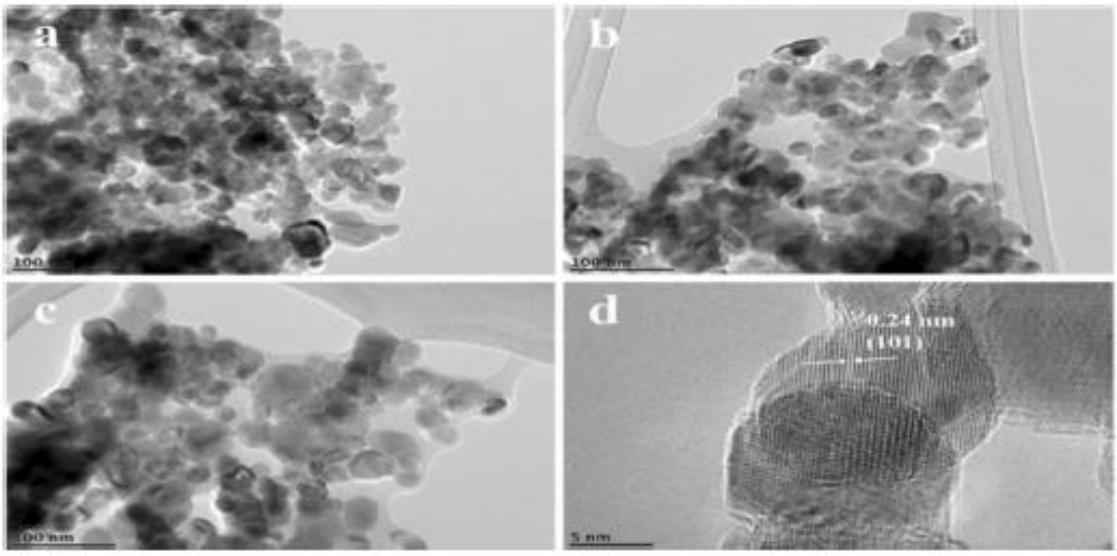


Fig 2: TEM images of ZnO Nano particles (Kamali, 2017)

4. Removal of Dyes Using ZnO Nano Particles

There is vast literature available showing effective removal of dyes using ZnO nano particles. Some of the best curated studies can be tracked as under.

(A.V.Kulkarni, 2016) prepared different concentrations of MB dye (50,100,150,200) and treated uing 0.1 g of ZnO NPs by agitating at room temperature for various time intervals (10, 20, 30, 40,….180 minutes). After the completion of treatment, the concentration was analyzed by UV analysis at the standard wavelength. It was found that there is 90% removal of ye achievable at pH 6.5 using 0.1 gm of NPs.

(Kane, 2016) found out that maximum removal of RB21 dye was observed at 120 min using 0.5-1.5g/L of nano particles. Effect of pH and alkali was also studied. The removal of the dye can be clearly visualized using the following picture from the study.

Figure 4: Decolourization progress at different time intervals

(Gayathri. S, 2019) in their study could observe that removal was good at pH 5 and 9 in different conditions. They could remove 99.6% and 98.5 % of reactive black and direct red dyes respectively. The studies were carried out for selected range of variables, conclusions and inferences are drawn considering the best out these variables. However, the refined optimization of variables experimentation is the limitation in present setup.

(Muhammad Nadeem Zafara, 2019) in their research synthesized ZnO NPs by co precipitation and found out that at pH between 5-6, dosage of 0.3 gm, room temperature conditions and 125 rpm, the removal of methyl orange and Amaranth was maximum.

5. Conclusion

ZnO Nano particles can be prepared using a number of methods but co-precipitation methods are preferred. These can be characterized suing SEM, TEM, FTIR, BET. These are cheap and can be reused. Literature suggests that removal of dyes using ZnO nano particles is easy, efficient and time saving. The few challenges associated with this technique are effect of pH and its affinity to cationic and anionic dyes. Overall, it is an established method which can be used as a full-fledged treatment or a polish treatment to save and enhance the quality of water and save the receiving stream from getting polluted.

6. References

[1.] F. Hai, K. Y. (2007). Hybrid Treatment Systems For Dye Wastewater. *Critical Reviews: Environemntal Science And Technology*, 317.

[2.] Farahmandjou, M. (2015). Sol-Gel Synthesis Of Zinc Oxide (Zno) Nanoparticles: Study Of Structural And Optical Properties. *Journal Of Sciences, Islamic Republic Of Iran*.

[3.] Gaurav K. Upadhyaya, J. K. (2018). Synthesis Of Zno:Tio2 Nanocomposites For Photocatalyst Application In Visible Light. *Vacuum*.

[4.] Gayathri. S, M. N. (2019). BATCH STUDIES ON COLOUR REMOVAL POTENTIAL BY ZINC OXIDE. *International Research Journal Of Engineering And Technology (IRJET)*.

[5.] Kamali, A. M. (2017). Effect Of Calcination Temperature On Performance Of Zno Nanoparticles For Dye-Sensitized Solar Cells. *Powder Technology*.

[6.] Kane, R. D. (2016). Colour Removal Using Nanoparticles. *Textiles And Clothing Sustainability - Springer*.

[7.] Kondawary, N. V. (2018). Polyaniline/Zno Nanocomposites For The Removal Of Methyl Orange Dye From Waste Water. *International Journal Of Modern Physics B*.

[8.] Mohammad Abul Hossain, M. M. (2018). Comparative Adsorption Of Methylene Blue On Different Low Cost Adsorbents By Continuous Column Process. *International Letters Of Chemistry, Physics And Astronomy*.

[9.] Muhammad Nadeem Zafara, Q. D. (2019). Effective Adsorptive Removal Of Azo Dyes Over Spherical Zno Nanoparticles. *Journal Of Material Science And Technology*.

[10.] Qingyong Tian, W. W. (2005). Zinc Oxide Coating Effect For The Dye Removal And Photocatalytic Mechanisms Of Flower-Like Mos2 Nanoparticles. *NANO EXPRESS*.

[11.] S. Mustapha, M. M. (2020). Application Of Tio2 And Zno Nanoparticles Immobilized On Clay In Wastewater Treatment: A Review. *Applied Water Science*.

[12.] A.V.Kulkarni, A. (2016). Zno Nanoparticles As Adsorbent For Removal Of Methylene Blue. *Research Journal Of Chemical And Environmental Sciences*.

[13.] Ahmed Samer Elfeky, H. F. (2019). Adsorption Of Dye From Wastewater Onto Zno Nanoparticles-Loaded Zeolite: Kinetic Thermodynamic And Isotherm Studies. *Zeitschrift Für Physikalische Chemie - DE Gruyter*.