wjert, 2024, Vol. 10 Issue 2, 138-142. Review Article ISSN 2454-695X

World Journal of Engineering Research and Technology
WJERT
www.wjert.org

SJIF Impact Factor: 5.924

USE OF NANOPARTICLES IN WASTE WATER TREATMENT: A REVIEW

Dr. Richa Sharma*

Associate Professor, S. S. Jain Subodh P. G. (Auto.) College, Rambagh Circle, Jaipur.

Article Received on 21/12/2023 **Article Revised on 11/01/2024** **Article Accepted on 31/01/2024**

***Corresponding Author**
Dr. Richa Sharma
Associate Professor, S. S. Jain Subodh P. G. (Auto.) College, Rambagh Circle, Jaipur.

ABSTRACT

The scarcity of water throughout the world has led to the recent research for water security and safety. The water resources are mainly polluted due to the discharge of the industrial effluents, thus making it unusable for further use without treatment. The use of polluted water may pose severe threat to the health and environmental hazards urging for the suitable technology to treat such waste water. The technologies available for the treatment of dye effluent in the water is time consuming, cost-intensive and less effective. Thus, nano particles due to their chemical reactivity and excellent surface properties have emerged as a better alternative for the dye removal. This paper reviews the potential of nanoparticles in dye effluent treatment. Though studies have revealed that the treatment of waste water with silver nanoparticles leaves traces of toxicity into water after treatment. The further research on mitigation of toxicity induced due to the use silver nanoparticles will decide the fate of use of silver nanoparticles for dye treatment.

KEYWORDS: Dye; Adsorbent; Ozonisation; Aerobic degradation, Anaerobic degradation.

INTRODUCTION

The growth of industrialization has caused major threat in terms of water pollution. Besides this, the scarcity of water makes the problem grave. Dyes are being used by several industries as a colorant including textile, pharmaceutical, food, plastic, Cosmetics, pint, photographic and paper.[1] The dye effluent from the industries is the major source of contamination which includes both organic and inorganic dyes. Based on the structural forms the dyes can be

classified into acidic, basic, azo, disperse, reactive, diazo, anthraquinone based and metal-complex. The treatment of the effluent before discharging the same into the water bodies helps in reducing the further contamination of the water resources. There are different methods of treatment available for the removal of dyes from the effluent. However, each method has its pros, cons and efficiency. Based on the principle, the treatment methods can be categorized into physical, chemical and biological treatment. It is seen that the majority of the dyes being used are xenobiotics in nature, which resist conventional removal procedures. In past decade, the use of nanoparticles for the treatment dye in the effluent has gained importance due to its large surface area, high adsorption properties, less resistance to diffusion and show faster rates of equilibrium.[2] More specifically, the role of silver nanoparticles in dye removal has been main focus point of the researchers in the field all over the world. In addition to the above characteristics, the Silver nanoparticles also have antibacterial and antimicrobial properties which further enables their suitability for the treatment of waste water.[3]

Treatment Technology

The various treatment methods available for removal of dyes from the waste water is classified into Physical, Chemical and Biological treatment.

Physical Treatment: Physical treatment of the waste water includes adsorption, Ion exchange, Filtration and Coagulation/flocculation.

Adsorption: Adsorption is used as one of the treatment procedures for the removal of dissolved organic pollutants like dyes from industrial waste water. Adsorption is defined as concentration of materials on the surface of solid bodies. Adsorption is a surface phenomenon which deals primarily with the utilization of surface forces. When a solution having absorbable solute, also called as adsorbate, comes into contact with a solid, called as adsorbent, with highly porous surface structure liquid-solid intermolecular forces of attraction causes the solute to be concentrated at the solid surface. Adsorption is one of the unit operations in the chemical engineering processes used for the separation of industrial wastewater pollutants. Adsorbents are mainly derived from sources such as zeolites, charcoal, clays, ores, and other waste resources.[4]

Chemical Treatment: Ozonisation, Photocatalytic methods and Fenton reagent Technique.

Photocatalytic methods: Photocatalysis is a leading mechanism in dye treatment of dye effluent wherein the electrons excited from the valence band to conduction band upon irradiation, result in electron-hole pair generation.[5] The hydroxyl radical generated acts as a potent oxidizing agent and completely degrades the dye to nonhazardous products (CO2, H2O, etc). Heterogeneous photocatalysis has proved to be as an efficient tool in degradation of both atmospheric and aquatic organic contaminants. It uses the sunlight in the presence of a semiconductor photocatalyst to accelerate the remediation of environmental contaminants and destruction of highly toxic molecules. The type of the radiation used depends on the type of catalyst. Visible light can also be used for the excitation purpose but due to unavailability of proper catalyst and other contributing factor, it has been considered as less effective source for irradiation.

Biological Treatment: Aerobic degradation and Anaerobic degradation.

Biological process for the treatment of effluent containing dye is better alternative compared to the physical and chemical treatment. Out of which the chemical treatment being cost intensive founds low acceptability in large scale treatment of dye waste. On the contrary, biological treatment of the dye waste water being inexpensive, having energy saving feature and environmentally friendly generates by products which are non-toxic. The treatment of dye decolorization is achieved through two main processes of adsorption and degradation. These processes can take place both in aerobic and anaerobic conditions. Though biomass, carbon dioxide and water are the main products during aerobic reaction whereas methane is the main product during the anaerobic condition of treatment. Enzyme-assisted degradation of dye-containing wastewater is also one of the viable biological treatment methods resulting in generation of non-toxic by products.[6]

CONCLUSIONS AND FUTURE PERSPECTIVES

Water being most essential component of life for all forms of living organisms, it is estimated that still nearly 800 million people around the world do not have safe access to potable water. The presence of dye in waste water poses greater environmental concern and threat to the human health. The widespread development of industries has led to the extensive pollution of natural water resources. The treatment of dye containing waste water is a big challenge as no specific treatment methodology exists. The physical and chemical methods of treatment of dye removal though appears to be effective are expensive with high operating cost and produce toxic byproducts. The biological treatment of the dye containing waste water, on the

other hand is cost effective, environmentally safe and widely acceptable. The major disadvantage of biological treatment is the long retention time required for complete decolorization. This review has addressed the various dye removal techniques- Physical, Chemical and biological treatment. Nanoparticles has thus emerged as a better alternative for the treatment of the dye containing waste water due to its unique structural properties. Though Nano materials have shown promising future but more research work is required to be conducted for its widespread acceptability for large scale units.

REFERENCES

1. G.A.R.d.O. Farah Maria Drumond Chequer, Elisa Raquel Anastácio Ferraz, Juliano Carvalho Cardoso, Maria Valnice Boldrin Zanoni, Danielle Palma de Oliveira, Textile dyes: Dyeing process and environmental impact, Eco-Friend. Text. Dyeing Finish, 2012; 26.
2. Ahmad, S.H. Mohd-Setapar, C.S. Chuong, A. Khatoon, W.A. Wani, R. Kumar, M. Rafatullah, Recent advances in new generation dye removal technologies: Novel search for approaches to reprocess wastewater, RSC Adv., 2015; 5(39): 30801–30818.
3. T. Quang Huy, N. Van Quy, L. Anh-Tuan, Silver nanoparticles: Synthesis, properties, toxicology, applications and perspectives, Adv. Nat. Sci. Nanosci. Nanotechnol, 2013; 4(3): 033001.
4. A.C. Jadhav, N.C. Jadhav, Treatment of textile wastewater using adsorption and adsorbents Sustainable Technologies for Textile Wastewater Treatments, Woodhead Publishing, 2021; 235-273.
5. Rauf MA, Ashraf SS. Fundamental principles and application of heterogeneous photocatalytic degradation of dyes in solution. Chem Eng J., 2009; 151: 1–3.
6. V.V. Dawkar, U.U. Jadhav, D.P. Tamboli, S.P. Govindwar, Efficient industrial dye decolorization by Bacillus sp. VUS with its enzyme system Ecotoxicol. Environ. Saf., 2010; 73(7): 1696-1703.
7. S. Samsami, M. Mohamadizaniani, M.H. Sarrafzadeh, E.R. Rene, M. Firoozbahr Recent advances in the treatment of dye-containing wastewater from textile industries: overview and perspectives Process Saf. Environ. Prot., 2020; 143: 138-163.
8. S. Mishra, A. Maiti, Applicability of enzymes produced from different biotic species for biodegradation of textile dyes Clean. Technol. Environ. Policy, 2019; 21(4): 763-781.

9. Tan et al., L. Tan, M. He, L. Song, X. Fu, S. Shi, Aerobic decolorization, degradation and detoxification of azo dyes by a newly isolated salt-tolerant yeast Scheffersomyces spartinae TLHS-SF1 Bioresour. Technol., 2016; 203: 287-294.
10. Tony et al., 2009 B.D. Tony, D. Goyal, S. Khanna Decolorization of textile azo dyes by aerobic bacterial consortium Int. Biodeterior. Biodegrad., 2009; 63(4): 462-469.
11. Tounsadi et al., 2020, H. Tounsadi, Y. Metarfi, M. Taleb, K. El Rhazi, Z. Rais Impact of chemical substances used in textile industry on the employee's health: epidemiological study Ecotoxicol. Environ. Saf., 2020; 197. Article 110594.
12. A.J. Wang, H.C. Wang, H.Y. Cheng, B. Liang, W.Z. Liu, J.L. Han, B. Zhang, S.S. Wang Electrochemistry-stimulated environmental bioremediation: development of applicable modular electrode and system scale-up Environ. Sci. Ecotechnol., 2020; 3. Article 100050.
13. Xiang et al., 2020 H. Xiang, G. Ren, X. Yang, D. Xu, Z. Zhang, X. Wang A low-cost solvent-free method to synthesize α-Fe2O3 nanoparticles with applications to degrade methyl orange in photo-fenton system Ecotoxicol. Environ. Saf., 2020; 200. Article 110744.
14. Yadav et al., 2019, K.K. Yadav, S. Kumar, Q.B. Pham, N. Gupta, S. Rezania, H. Kamyab, S. Yadav, J. Vymazal, V. Kumar, D.Q. Tri, A. Talaiekhozani Fluoride contamination, health problems and remediation methods in Asian groundwater: a comprehensive review Ecotoxicol. Environ. Saf., 2019; 182. Article 109362.
15. Yang et al., Y. Yang, B. Wei, Y. Zhao, J. Wang Construction of an integrated enzyme system consisting azo reductase and glucose 1-dehydrogenase for dye removal Bioresour. Technol., 2013; 130(2013): 517-521.
16. Yu and Wen, 2005 Z. Yu, X. Wen Screening and identification of yeasts for decolorizing synthetic dyes in industrial wastewater Int. Biodeterior. Biodegrad., 2005; 56(2): 109-114.
17. Zhu et al., 2017 X. Zhu, J. Chen, K. Qiu, B. Kuai Phytohormone and light regulation of chlorophyll degradation Front. Plant Sci., 2017; 8: 1911.