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NANO MATERIALS FOR WATER AND WASTE WATER TREATMENT: AN OVERVIEW

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ABSTRACT

Availability and accessibility to clean and fresh water for human being is now a days most important issue worldwide and lots of people are working to solve this problem. Nano technology is the emerging field to the features and properties of various nano materials. Nano materials provides the mechanism of removal of contaminants offering cost effective treatment methods with high capabilities. To achieve the goal of adequate supply of the water, the waste water must be treated so that it can be reused for its optimum utilization. This work is focused on the different types of nano materials used by nano technology that can help in wastewater treatment and remediation. This technology has lots of advantages over conventional methods of the waste water treatment.

KEYWORDS: Nanomaterial, Nanotechnology, Waste Water, Treatment

INTRODUCTION

Water is one of the most vital elements required for the existence of life on earth. Humans, like other living organ-isms, also entirely dependent on water for their everyday life. Water sources are shrinking day by day due to their over-exploitation. Growing water contaminations poses a major threat to all living beings and earth (Gupta et al., 2015). The hazardous and toxic chemicalsor biological waste from manufacturing industries, residential areas or from the other sources (Madhushikaet al., 2019; Mostafizet al., 2020) are found to be the chief sources for the cause and spread of diseases when they contaminate water bodies. They cause health issues to humans or other organ-isms and damage the earth's ecosystem with long-term effects(Daset al., 2012; Rehmanet al., 2018; Su et al., 2020; Hanifet al., 2020). Its consequencesare awful and everlasting. Current wastewater management systems have largely been well studied but still have lots of disadvantages (Crini and Lichtfouse, 2019). This review explores the techniques in the nano particle-based wastewater management system and tries to identify some of the new advances, perspectives, merits and demerits of this key emergin

Water is the most important element required for the existence of life of human being and all other species on the earth. Water resources are becoming short day by day due to it's over exploitation and misuse. Increasing water impurities and contaminations poses major threats of the living beings on the earth. There are many toxic and hazardous chemicals along with the biological waster form various industries, residential areas which are the cause of dangerous diseases. This contaminated

water is reason behind the degraded health of human and other organisms which lead to damaged ecosystem as a long term effect. Currently the waste water treatment technologies and techniques are the demand of the time so as to overcome the water shortage in the future. Already a large number of physics, chemical and biological treatment processes are being used for water treatment. Nanotech logy has given boost to the research of waste water treatment due to its advantages such as reusing capability, low cost process and highly efficient methods in removal of pollutants. In this technology nanoparticles are used to treat and clean the water, Nanoparticles have distinguished physical, chemical and biological properties depending on size of the particle, surface area , charge, shape and solubility (J. Lelieveld, 2001). Improving waste water management using nanoparticles is one of the major focuses of nanotechnology. An overview of waste water treatment and various nanoparticles used for this treatment is presented in this paper.

Nanotechnology: The word Nanotechnology is divided into two separate terminology: Nano and Technology. Nano here is referred to Greek prefix named 'Dwarf' which means something very small and represents one thousand millionth of a meter (10^{-9} m) and Technology is something related with the practical applications of the small particles or things. Nanotechnology is the only science which has potential and caliber to impact all devices available now and in future too. All industries are dependent on the materials and various devices made by atom and molecules which may be improved by the applications of nanotechnology (Bhargava and Sachdeva). Now a days Nanotechnology is playing an important role in purification and treatment of water. Here Nano membranes are used to purify physical, biological and chemical impurities. There are distinguish techniques in nanotechnology which uses different Nano particles for getting safe drinking water with a high level of effectiveness.

DIFFERENT NANOMATERIALS USED FOR WATER AND WASTE WATER TREATMENT

In terms of water and waste treatment, various nanomaterials are used to remove impurities, pollutants, heavy metals etc. These impurities poses a serious problem in environment as all these impurities are toxic for living organisms and also to human beings. Along with this these impurities are not biodegradable. There are different methods such as Adsorption, photo catalysts, electrochemical oxidation Nanofilteration, Nano membranes which uses various nanoparticles such as TiO_2, Silver nanoparticle, Iron Nanoparticles, ceramic membranes, ZnO, nanowire membrane etc. to resolve the problems (Mueller:2009, Mamadou: 2005, Haijiao Lu). Following are different types of materials used for the water and waste water treatment and its purification.

Silver Nanoparticles: Silver Nanoparticles (Ag NPs) are highly toxic to microorganisms and hence give strong antibacterial effects against huge range of micro organisms, virus, fungi and bacteria (B. Borrego: 2016, Krishnaraj: 2012 and Kalhapure: 2015). Silver nanoparticles are being used for disinfection of water. Although using Ag NPS for the water treatment is always a matter of debate amongst researchers and many theories have been presented by the research on the use of Ag NPs for purification of water. Silver nanoparticles are capable of adhering to the bacterial cell wall and penetrate into it, leading to the structural changes to the cell membranes which cause an increase in the permeability of the cell membrane (Sondi, 2004). Ag NPs have ability to kill the bacteria by damaging the cell membrane which causes death of cell. With the development of Nanotechnology, Ag NPs are

successfully applied for the treatment of water and waste water. Silver nanoparticles are attached to the filter materials or blotting paper to remove the disinfection due to the high antibacterial properties (Quang, 2013).

Iron Nanoparticles: Various nanoparticles such as Fe, Ni, Al and Zn have been used in pollutant water treatment at a large scale in past few years. Due to extremely high reductive ability of Al nanoparticles, they become thermodynamically unstable in presence of water which forms oxides or hydroxides on the surface, which completely transfer electrons from metal surface to the contaminants (Rivero-Huguet, 2009). If one compares Fe and Ni,Ni has negative standard reduction potential which indicates its lower reducing ability. Compare to Ni, Fe and Zn nanoparticles act as good reducing agents. Fe nanoparticles have significant advantages over Zn for the water pollution treatment applications which includes adsorption properties, oxidation and precipitation and low cost. Thus iron nanoparticles have been most widely studied zero valent nanoparticles.

Metal Oxide Nanoparticles: Metal oxide nanoparticles are buildup of purely metal precursors. There are many metal oxide nanoparticles such as TiO_2, ZnO, Zirconium Oxide, Magnesium oxide,Iron oxide and aluminum oxidewhich play significant role in the different fields of physics, material science, and chemistry. These metal oxide nanoparticles adopt a vast number of structuralgeometries with an electronic structure that can exhibit insulator,semiconductor, or metallic characteristics. Common applications that metal oxide nanoparticles are gas sensors, ceramics, semiconductor, absorbents, microbial applications, superconductor, and many more. For antibacterial activities and the removal of dye from the waste water, metal oxide nanoparticles are selected based on their size, morphology and aggregation. In adsorption mechanism, the objective is observe the effect of pH, initial contact time, removal efficiency and on the mechanism how pollutants react with adsorbent surface. Other category of nanoparticles cover alkali and noble metal nanoparticles such as Ag, Au, Cu having wide absorption band in the visible electromagnetic spectrum zone. Au nanoparticles are generally used for Scanning Electron Microscopic analysis. These nanoparticles are effective for removal of impurities, pollutants and bacteria from the water and waste water.

CONCLUSION

Here in this paper a brief overview of the mostly used nanoparticles, zerovalent metal nanoparticles such as Ag, Au and Zn, metal oxide nanoparticles such as ZnO, TiO2, Iron oxide, Aluminum oxide and Magnesium oxide were highlighted. It has been notified that in the present scenario when lots of efforts are being done by the research to purify the water nanoparticles are the extremely effective in the water and waste water treatment. However there are many challenges which are still to be sorted out as only few nanoparticles are being used commercially due to the growing concern of the toxicity and effect on human health. Still it is hard to compare the performance evaluation of the nanoparticles to use them for the water and waste water treatment.

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