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Nanotechnology for waste water treatment

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Abstract

Sufficient and adequate supply of clean, safe and potable water on a regular basis, are among the foremost issues faced by the people now a days. To accomplish this objective wastewater should be treated so that it can be reused and also the environment should be saved by the harmful effects of the untreated wastewater. Here we will study the use of nanotechnology that can help in wastewater treatment. As we all know traditional wastewater treatment technologies continue to be ineffective for providing ample safe water due to increasing demand of water along with severe health guidelines and emerging contaminants. The development of cost-effective and steady materials and methods for providing the drinkable water in sufficient amounts is the need of the present world. Nanotechnology- based multifunctional and highly efficient processes are providing affordable solutions to wastewater treatments that do not require large infrastructures or centralized systems. The aim of the present study is to review the possible applications of the nanotechnology for the removal of pollutants from wastewater.

Keywords: Nanotechnology, Wastewater Treatment, Contaminants, Pollutants, Environment, Nanoparticles, Dendrites, Zeolites.

1. Introduction

Water has a wide spread impact on all aspects of human life including but not limited tohealth, food, energy, and economy. Along with environmental, economic, and social effects of poor water supply and sanitation [1], the supply of fresh water is indispensable for the safety of children and the poor. It is estimated that billions of people in the world not have access to clean water and within couple of decades the current water supply and resources will decrease to one-third. There is very narrow chance of an increase in the supply of fresh water due to challenging demands of ever increasing populations all over the world; also, water-related problems are anticipated to increase further due to severe climate changes and due to population growth over the next decades [2]. A major problem in developing as well as developed countries is drinking water that is contaminated with bacteria and various other types of viruses, which are the main reasons of water-borne diseases. Also the severe change in climatic conditions, Ever-increasing pollution, clean water will become even scarer, particularly in developing countries. Additionally, in these countries, available water is unsafe to drink.

Wastewater is the water containing superfluous substances that adversely affect its quality and thus making it not suitable for use. Wastewater is generated from various sources like as in residential are as, commercial areas, industrial properties, agriculture lands etc. Composition of wastewater differs extensively and it is majorly dependent on the source from which it is generated. Common constituents of wastewater are inorganic substances like solutes, heavy metals, metal ions, ammonia along with gases, complex organic compounds such as excreta, plants material, food, protein, natural organic matter, nitrate, and other pollutants present in surface water, ground water, and/or industrial water. When left untreated these constituents may pose threat to living beings and the environment, which makes it crucial to treat wastewater before disposal. Various physical, chemical and biological treatment processes are used for waste water treatment.

The traditional materials and treatment technologies like activated carbon, oxidation, reverse osmosis (RO) membranes and activated sludge are not efficient to care for complex and intricate polluted water consisting of pharmaceuticals, surfactants, various industrial additives, and abundant chemicals professed. The traditional and decade old water treatment processes are not able to address adequately the removal of toxic chemicals, organic materials and microorganisms present in rawwater.

Currently, nanotechnology has been extensively studied by researchers as it offers potential advantages like low cost, reuse and highly efficient in removing and recovering the pollutants. Various Nanomaterials like carbon nanotubes (CNTs), nanomembranes, zeolites and dendrimers etc. are helping in the development of more proficient treatment processes among the advanced water systems [3]. There are many aspects of nanotechnology that can be used to address the multiple problems of water quality in order to ensure the environmental stability. Nanotechnology-based multifunctional and highly efficient processes are providing affordable solutions to wastewater treatments that do not require large infrastructures or

centralizedsystems.

2. What is Nanotechnology?

Nanotechnology is among the most revolutionary technologies in the world. The term nanotechnology describes a range of technologies performed on a nanometer scale with widespread applications as an enabling technology in various industries. Nanotechnology is the creation of materials, devices, and systems using individual atoms and molecules. Nanotechnology uses particles that are 1/80,000 the diameter of a human hair. At such a small scale, new physical, chemical, and biological properties becomeevident.

It is a multidisciplinary science that looks at how we can manipulate matter at the molecular and atomic level. To do this, we must workon the nanoscale, a scale so small that we can't see it with a light microscope. In fact, one nanometer is just one-billionth of a meter in size. Atoms are smaller still. It's difficult to quantify an atom's size - they don't tend to hold a particular shape. But in general, a typical atom is about one-tenth of a nanometer indiameter.

When modified at nanoscale, matter can exhibit certain extraordinary and useful properties, which are not observed before. Research in nanotechnology promises breakthroughs in areas such as medicine, data storage, food industry, molecular biotechnology, computing, defence, robotics, textiles, environment and sanitation[4]. Another exciting and promising application of nanotechnology in water purification seems to be in desalination of water[5].

Despite its lucrative applications in various fields, certain environmental and ethical concerns cloud the celebration of nanotechnology as the next technological boom.

3. Nanotechnology in Waste WaterTreatment

Nanotechnology is revolutionizing many fields of applications, and has great potential to change the traditional water supply and wastewater treatment paradigm. The unique properties of many nanomaterials can enable novel technologies for contaminant removal, microbial control, sensing and monitoring, and resource recovery. The super high surface area, high reactivity, and catalytic properties of nanomaterials are expected to greatly enhance the kinetics and efficiency of various chemical and physicochemical processes used in water and wastewater treatment, and therefore reduces system size as well as chemical and energy consumption. These unique features have the potential to enable the paradigm shift towards distributed wastewater treatment and water supply, a much needed change in large metropolitan areas facing challenges of rapid population growth and aginginfrastructure.

Four classes of nanoscale materials that are being evaluated as functional materials for water purification:

(1) Dendrimers
(2) metal-containingnanoparticles,
(3) Zeolitesand
(4) Carbonaceousnanomaterials.

These have a broad range of physicochemical properties that make them particular attractive as separation and reactive media for water purification. Characterization of the interactions of the nanoparticles with the bacterial contaminant by Atomic Force Microscopy (AFM), Transmission Electron Microscopy (TEM) and laser confocal microscopy show considerable changes in the integrity of the cell membranes, resulting in the death of the bacteria in most cases [7]. Research is underway to use advance nanotechnology in water purification for safe drinking. Nanotechnology, the deliberate manipulation of matter at size scales of less than 100 nm, holds the promise of creating new materials and devices which take advantage of unique phenomena realized at those length scales, because of their high reactivity due to the large surface to volume ratio [8].

Nanoparticles are expected to play a crucial role in water purification
[9].

The principal way nanotechnologies might help in removing water problems is by solving the technical challenges that removing water contaminants including bacteria, viruses, toxic metals, pesticides and salts [6]. The application of nanotechnology for the removal of toxic pollutants such as the pharmaceutical and personal care products, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, phthalates, furans and dioxins, agrochemicals and pesticides, volatile organic compounds, viruses and bacteria, dyes, inorganic pollutants, etc. has been widely reported by several investigators in the field of nanotechnology [11]. Numerous scientists' claims that nanotechnologies offer more affordable, effective, efficient and durable ways of achieving specific nanoparticles for water treatment will allow manufacturer to prepare less toxic particles using classical methods. Interestingly, results have shown that environmental nanotechnology could be effectively utilized for the removal of organic and inorganic contaminants from sewage, municipal, industrial and process wastewater. On the other hand, like any new family of materials, the potential impact of nanomaterials on human health and the environment is unclear. The environmental fate and toxicity of a

material are critical issues in materials selection and design for water purification. No doubt that nanotechnology is better than other technique used in water treatment but today the knowledge about the environmental fate, transport and toxicity of nanomaterials [10] is still in infancy.

4. Conclusion

Commercialization, Industrialization and ever increasing population are among the main reasons for increase in amount of wastewater. These are also the areas that require regular supply of clean water and ever increasing demand. Several methods are being used to ensure a continued supply of water for the indispensable purposes. In the area of water purification, nanotechnology provides for the possibility of a proficient removal of pollutants, viruses and microorganisms etc. Nanotechnology is also being considered as a method to provide an economical, convenient and ecofriendly way of wastewater treatment. Diverse types of nanoparticles have proven effective in detection, removal and annihilation of various contaminants. Various Nanotechnology applications for sustainable water supplies are water filtration, water treatment, desalination, and using such techniques as sensors, nanoparticles, and catalysts. Nanotechnology is a promising and fresh technology, for the treatment of wastewaters which is vital for the existence of human beings. The limitation to the use of nanotechnology in wastewater treatment is that the Nanoparticles might be difficult to separate from the treated solution, which may results to loss of the Nanoparticles. Nevertheless, this problem could be reduced by immobilization of the Nanoparticles on appropriate substrate. The toxicity and environmental impact of Nanoparticles are also currently been investigated to understand their impact on human health and the environment

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