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Short Communication

Nanotechnology for Water Treatment

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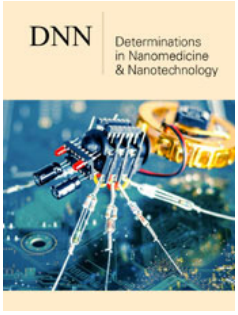
Abstract

Wide range applications of nanotechnology are well known and majorly include medicine, energy, agriculture, and water. Modification of shape, nature, and size is regularly opening unique physicochemical and surface properties that lend themselves to novel uses. Recently the advancement of nano-synthesis and characterization has proved that the major challenges of the global water issue, occurred due to climatic change and population growth can be reduced. Against this condition, the highly advanced nanotechnology provides new prospects in developing technologies for water technology process.

Keywords: Nanotechnology; Nano membranes; Water technology; Nanoparticles; Water treatment



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Introduction

Around 76 million people have no reliable access to clean and safe water. The unsafe water and improper sanitation caused over 68,000 children die each year from Diarrhea in India (as Per Civil Society Report). Drinking water contaminants are mainly categorized under i) physical contaminants those fundamentally affect the physical appearance or other physical properties of water. ii) chemical contaminants comprises nitrogen, salts, pesticides, metals, poisons from microscopic organisms, human or animal drugs. iii) biological contaminants are microorganisms in water such as bacteria, viruses, protozoan, and parasites. iv) there are reports of radiological contaminants mainly including caesium, plutonium, and uranium. Nano technology can address the above challenges by two prominent ways-nano-filtration (NF) and nano-adsorbent [1]. Nanoadsorbent and nano membranes technology as shown in Figure 1 can be useful for the removal of heavy metals and toxic ions with disinfecting microbes.

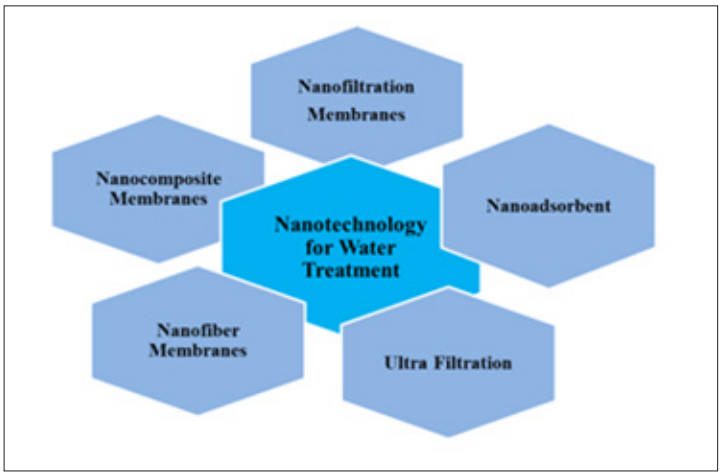

Figure 1: Classification of nanotechnology for water treatment.

Nano adsorbent

Adsorption is considered as an affordable and easy method for water treatment on account of its ease and value adequacy. Adsorbents that are extensively utilized for the removal of contaminants are mainly developed from natural materials and activated carbon. The adsorption process occurred through nanomaterial for water treatment may take place by i) mass exchange of contaminant to the outer surface of the adsorbent, ii) contaminant adsorption onto outside surface of the molecule and iii) intra-molecule dispersion of the

contaminant from external surface and conceivable interchange with elements on pore surface within particles. For efficient adsorption of toxic ions, the adsorbent appears to be depending on features like capability to adsorb from aqueous solution, pH range, adsorbent stability, capacity, rate and cost-effectiveness [2].

The adsorption process characterizes the following steps:

A. Disposal of saturated/spent adsorbent is required

B. Effect of pH and temperature are important

C. Not often requirement of post-treatment

D. Removal efficiency of contaminant varied depending upon the adsorbent

E. Process is economic and easy to operate

Arsenic, Fluoride and Nitrate (AFN) are the most common pollutants in Indian scenario and some adsorbents have shown significant potential to remove AFN. γ-Fe_2O_3 (Maghemite) nanoparticles have been successfully tested for simultaneous removal of AFN where sorption capacity of γ-Fe_2O_3 nanoparticles was found more than 90% for fluoride removal. Activated aluminum oxide (AA) has been effectively applied for AFN removal from water [3-5]. Regular AA adsorbents have undefinable pore structures beside less sorption capability. Another metal oxide like, Al-Fe (hydr) oxides and Mn-Al binary oxide have also been observed for removal of inorganic contaminants from water. Few nano-composites such as deposition of nZVI on CNTs, has good possible for quick and efficient removal of nitrate in water. It is important to note that selection of nano adsorbents depend on better surface area, physical property, chemical property, dissolvability of holding materials, nanoparticles leaching into treated water, separation procedure of nanoadsorbents after water treatment, field relevance, natural effect, cost viability, and hazard evaluation. Recyclability of nano-adsorbent requires more exploratory research.

Nano membranes (NM)

Nanofiltration membranes are basically pressured driven process and are characterized depending upon the charge-based repulsion mechanism permitting the separation of ions. Membranes are mainly applicable to reduce the colour, heavy metal ions, hardness and odour from water. The available sea water can also be converted into potable water (desalination). The NM is also prepared in the form of nanocomposite membranes which can be taken as mew form of filtration materials. This membrane consists of mixed matrix membranes and surface-functionalized membranes. The nanofillers (inorganic) which are having higher surface and providing a better surface to mass ratio were embedded in the polymer [6]. The mechanical strength and thermal stability of the membranes can be increased using metal oxide nanoparticles. Like any alternative membrane processes, the NM is facing membrane fouling problem which is one of the major problems. So, to understand the fouling mechanism and to investigate an acceptable control option is one of the essential elements during the membrane application [7]. In recent years fouling has been controlled by flocculation and magnetic ion exchange methods [8].

Conclusion

Various water treatment technologies are based on the primary, secondary and tertiary process. Each process has its own limitations for meeting the challenges of water treatment. There are serious concerns for balancing durability, demand, energy consumption, and commercial competitiveness. However, nanotechnology-based treatments (Nanoadsorbent and nano membranes) have shown the potential for water treatment but very few have reached to commercial scale. Since low production cost is crucial to ensure their widespread applications it's important to meet the competitiveness through economic efficiency as well as effect on human health.

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