Nanotechnology for Sustainable Wastewater Treatment

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Abstract

Nanotechnology, the engineering and art of manipulating matter at the Nano scale (1-100 nm) are increasingly evident in all areas of science and technology, including the field of environmental studies and treatment of surface water, groundwater and wastewater contaminated by toxic metal ions, organic and inorganic solutes and microorganisms. Due to their unique activity toward recalcitrant contaminants many nanomaterial's are under active research and development in the treatment of wastewater.

This paper brings together a technical set of information that demonstrates the range of complex issues that need to be considered and addressed in applying these technologies (Nano scale zero Valente iron, nanocrystalling zeolites, bimetallic particles, nanoscale Semiconductor photo catalysts, ferritin, self assembled monolayers on mesoporous silica, dendrimers, polymeric nanoparticles, tunable biopolymers, single-enzyme nanoparticles), including how these individual nanotechnologies might eventually be implemented for improving basic sanitation and access to clean water.

Keywords: Nanotechnology, Wastewater Treatment, Nanoscale Zero Valent Iron, Nanocrystalling Zeolites, Sustainable.

1. INTRODUCTION

A significant number of technologies today already fit the definition for "nano" as defined by the NNI. Nanotechnology has contributed to the development of materials used in electronic, magnetic and optoelectronic, biomedical, pharmaceutical, cosmetic, energy, catalytic, and materials applications. In the manufacturing community, initially, the most profitable avenues for nanoscale particles and materials have been in the areas of sunscreen, magnetic recording tape, automotive catalyst supports, biolabeling, chemical-mechanical polishing, electroconductive coatings, and optical fibers [1].

In a recent review, Masciangioli et al. divided the potential impact areas for nanotechnology into three categories: treatment and remediation, sensing and detection, and pollution prevention. Of the three environmental categories, treatment and remediation have felt the earliest impacts of the nanotechnology revolution. A variety of nanomaterials are in various stages of research and development, each possessing unique functionalities for treatment. Some nanoparticles destroy contaminants, for instance, while others sequester them [2]. The specific nanotechnologies discussed hereafter solely focus on site remediation and some wastewater treatment.

Given the importance of clean wastewater to people in developed and developing countries, numerous organizations are considering the potential application of nanoscience to solve technical challenges associated with the removal of wastewater contaminants.Technology developers and others claim that these technologies offer more effective, efficient, durable, and affordable approaches to removing specific types of pollutants from wastewater. A range of wastewater treatment devices that incorporate nanotechnology are already on the market and others are in advanced stages of development [3].

This paper shows that nanotechnology research is being conducted in a broad spectrum of areas relevant to wastewater treatment. However, the maturity of research and development efforts is uneven across these areas, with nanofiltration currently appearing most mature. Interest in the application of nanotechnology for weastewater treatment appears to be driven by several factors including, but not limited to, reduced costs, improved ability to selectively remove contaminants, durability, and size of the device. While the current

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