# Environmental Application of Nanotechnology

Ms. Urmil
Civil Engineering Department
BRCM CET, Bahal, Bhiwani,
Haryana

***Abstract-*** **This paper addresses Nanotechnology can deal with environmental application such as contaminated water and air treatment, self-cleaning materials, energy applications, novel functionalized adsorbents for environmental, industrial applications and nonmaterial's for sustainable energy production. Nanotechnology can add significant improvement by providing their role in monitoring, pollution prevention and remediation methods. This paper aims at determining well-researched ways in which this new technology can benefit the environment through an extensive literature review. Outcome of the review show that nanotechnology, when used properly, has tremendous potential benefits to the environment in many ways. As an illustration on the environmental front, nanotechnology is found nonmaterial use for soil and ground water remediation with help of nanoparticles. Environmental applications of nanotechnology address the development of solutions to the existing environmental problems, preventive measures for future problems resulting from the interactions of energy and materials with the environment, and any possible risks that may be posed by nanotechnology itself.**

***Keywords— Dynamic load, finite element, isotropic load, dynamic load***

## I. INTRODUCTION

Nanotechnology is a multidisciplinary science and technology that requires immediate attention from diverse conventional fields of knowledge. Despite its fantastic sounding name, nanotechnology is actually very practical for developing countries. The word 'nano' meaning 'dwarf' in the Greek language refers to dimensions of the order of magnitude $10^{-9}$. There are many different definitions of nanotechnology [1]. Most of them are technical, and usually related to the fabrication of structures less than 100 nm (about 100 times a millionth of a millimetre) in sizes.

Nanotechnology is a field of applied science, focused on the design, synthesis, characterization and application of materials and devices on the nanoscale. This branch of knowledge is a sub-classification of technology in colloidal science, biology, physics, chemistry and other scientific fields and involves the study of phenomena and manipulation of materials in the nanoscale [2-4].

Nanotechnologies are both praised for offering potential environmental benefits and scorned for creating new environmental risks. In this paper, give an overview of the existing and emerging environmental issues relating to nanotechnologies by highlighting general problems and spotlighting three specific cases (nanosilver, carbon nanotubes, and nanoparticles used in environmental remediation). Nanotechnology can contribute solving the environmental problems of a rapidly increasing world population and the growing demands it places on the world's natural resources. Nanotechnology offers solutions to problems of resource usage, energy consumption, and waste generation. Fewer materials will be required for product fabrication; better reuse of waste materials will be possible; and there will be new and renewable energy sources. Environmental improvements will be enabled by smart devices for environmental monitoring, pollution detection and control, and purification and remediation of polluted water, contaminated air and soil (Fig.1).

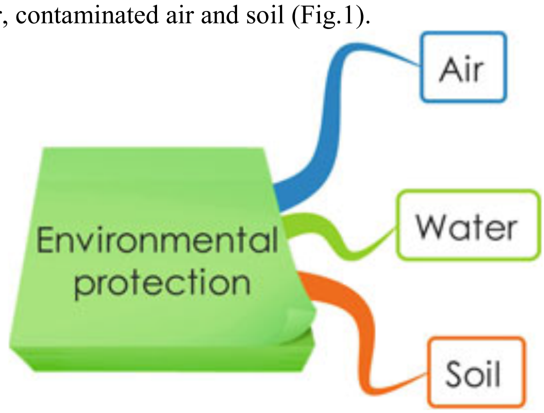


Fig.1 Environmental protections address three main areas: air, water, and soil. Human activities can have an adverse impact on each of them.

The ability to detect the presence of pathogens or toxic agents in air, water, and soil is of great importance for human health and the protection of the environment. Nanotechnology offers the potential for extremely sensitive and fast measurement with sensor equipment which is less bulky, simply to operate, and of low cost.

As summarized in Fig.2, nanotechnology has applications in three time ranges:

• By helping to clean up damage done in the past where environmental concerns were not as high as today;
• By reducing the present human impact on the environment;
• By preventing or reducing future environmental impacts and reducing raw materials use.

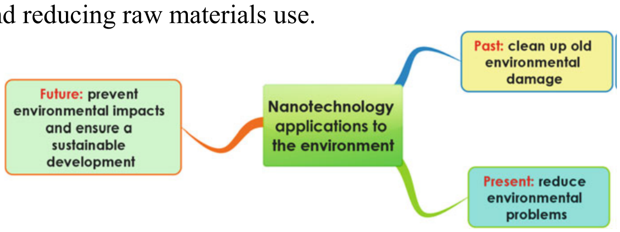


Fig. 2. Schematic representation of the benefits of nanotechnology for the environment

In this paper, address some of the advances method and their role which are being applied to provide more sensitive detection techniques for air and water quality monitoring.

## II. METHODOLOGY

The literature review was done for the purpose of determining research studies that directly discussed benefits of using or possible future uses of nanotechnology in environment fields. The scientific databases on the World Wide Web searched. This paper addresses environmental application of nanmaterial in ground water and air remediation. It describes the main type of nanomaterial, contaminates that can be treated using nanomaterial.

## III. WATER POLLUTION REMEDIATION TECHNIQUES

With respect to remediation of environmental contaminants, the range of nanotechnology applications mirrors the spectrum of "non-nano" strategies for contaminant remediation [5]. Two of the major distinctions that define types of conventional remediation technologies also apply to nanotechnologies for remediation: adsorptive versus reactive and in situ versus ex situ. Absorptive remediation technologies remove contaminants (especially metals) by sequestration, whereas reactive technologies affect degradation of contaminants. In situ technologies involve treatment of contaminants in place, whereas ex situ refers to treatment after removing the contaminated material to a more convenient location (e.g. pumping contaminated groundwater to the surface and treatment in aboveground reactors) [6].
Nanotechnology can develop techniques that will allow for more specific and cost effective remediation tools. Currently many of the methods employed to remove toxic contaminants involve laborious, time consuming and expensive techniques. A pre treatment process and removal of the contaminated area is often required, with a consequent disturbance of the ecosystem. Nanotechnology allows developing technologies that can perform in situ remediation and reach inaccessible area such as crevices and aquifers, thus eliminating the necessity for costly 'pump- and – heat' operations. In addition thanks to its ability to manipulate matter at a molecule level, nanoscience can be used to develop remediation tools that are specific for a certain pollutant (e.g., metal), therefore affinity and selectivity, as well as improving the sensitivity of the technique.

### *A. Ex-Situ Nanotechnology*

Conventional methods include primarily pump and treat operations. This method involves extraction of groundwater through wells and trenches and treating groundwater by above-ground (ex situ) processes such as air stripping, carbon adsorption, biological reactors or chemical precipitation [7]. But unfortunately, most of these methods produce highly contaminated waste which then has to be disposed off, resulting in high operation time [8]. Nanotechnologies that affect remediation by contaminant degradation – rather than adsorption – are particularly attractive for organic contaminants. A well-established approach for remediation of organic contaminants is photo-oxidation catalyzed by metal oxide nanoparticle such as $TiO_2$, and the potential benefits of quantum-sized (< ~10 nm) photocatalysts have long been recognized for contaminant degradation applications. Another method is based on injection of Fe0 nanoparticles into the groundwater through application wells. This technology is environmentally friendly and cost-effective compared to methods like pump & treat or gas extraction (venting) [9].

### *B. In Situ Nanotechnology*

A common type of *in situ* or below-ground remediation method used for cleaning up contaminated groundwater is the permeable reactive barrier (PRB). PRBs are treatment zones composed of materials that degrade or immobilize contaminants as the groundwater passes through the barrier. They can be installed as permanent, semi- permanent or replaceable barriers within the flow path of a contaminant plume. The material chosen for the barrier is based on the contaminant(s) of concern [7]. One drawback of PRBs is that they can only remediate contaminant plumes that pass through them; they do not address dense non aqueous-phase liquids NAPLs (DNAPLs) or contaminated groundwater that is beyond the barrier. Although a variety of types of nanoparticle might be applicable to in situ remediation (e.g. nonionic amphiphilic polyurethane or alumina-supported noble metals by far the greatest interest is currently in nanoparticles that contain nZVI. [10].

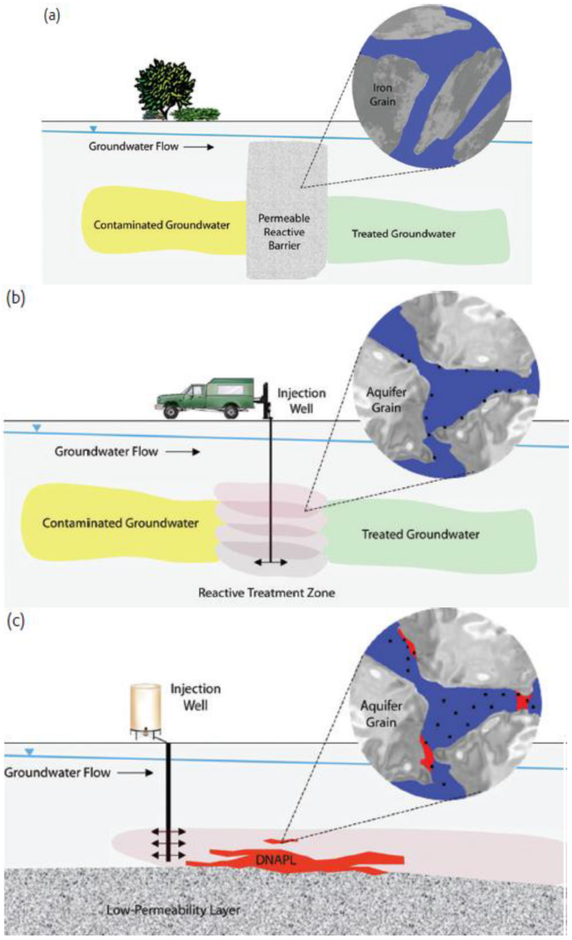

Fig.3 Three approaches to application of Fe particles for groundwater remediation: (a) a conventional "permeable reactive barrier" made with millimeter-sized construction-grade granular Fe; (b) a "reactive treatment zone" formed by sequential injection of nanosized Fe to form overlapping zones of particles adsorbed to the grains of native aquifer material; and (c) treatment of nonaqueous phase liquid contamination by injection of mobile nanoparticles. In (b) and (c), nanoparticles are represented by black dots and zones that are affected by nanoparticles are represented as pink plumes [9].

For in situ treatment, it is necessary to create either an in situ reactive zone with relatively immobile nanoparticles or a reactive nanoparticle plume that migrates to contaminated zones. For applications in topsoil, nanoparticles can be worked into the surface of the contaminated soil using conventional agricultural practices. These different approaches are shown in Fig. 3.

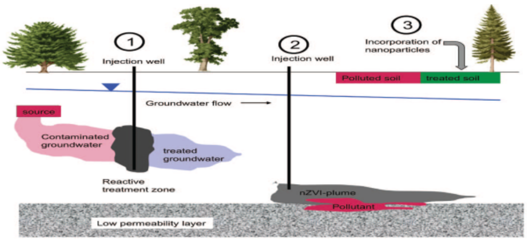


Fig 4. In situ technologies used to treat polluted groundwater and soils: (1) injection of nZVI to form a reactive barrier; (2) injection of mobile nZVI to form an nZVI plume; (3) incorporation of NP into topsoil to adsorb or degrade pollutants.

## IV. AIR POLLUTION REMEDIATION TECHNIQUES

Elevated concentrations of air pollutants cause significant damage to human health, vegetation and cultural heritage. Further action is needed to meet this objective. Internationally, steps must be taken to reduce concentrations of particulates and ground-level ozone. At a national level, additional action is required to curb emissions of nitrogen oxides and of particulates from the use of studded tyres. Air pollution can be remediated using nanotechnology in several ways. One is through the use of nano-catalysts with increased surface area for gaseous reactions. Catalysts work by speeding up chemical reactions that transform harmful vapors from cars and industrial plants into harmless gases. Catalysts currently in use include a nanofiber catalyst made of manganese oxide that removes volatile organic compounds from industrial smokestacks [11]. Another approach uses nanostructured membranes that have pores small enough to separate methane or carbon dioxide from exhaust [12].

## V. CONCLUSION

The objective of this review was to evaluate the remediation of groundwater using nanotechnology and nanoparticles to solve environmental issues. *In situ* nanoremediation methods entail the application of reactive nanomaterials for transformation and detoxification of pollutants *in situ*. These nanomaterials have properties that enable both chemical reduction and catalysis to mitigate the pollutants of concern. No groundwater is pumped out for above-ground treatment, and no soil is transported to other places for treatment and disposal. Nanoscale Fe particles are effective for the remediation and transformation of a variety of environmental contaminants. Because of the high cost and lengthy operating periods for pump-and-treat remedies, *in situ* groundwater treatment technologies are increasing. The number of actual applications of nZVI is increasing rapidly. Although the technology is likely a beneficial replacement of current practices for site remediation. Nanotechnology can also be applied to clean the air from toxic gases such as CO and VOCs using CNTs, nanoparticles and other adsorbents. Nanoparticles and nanotubes can also be applied as a sensor for toxic substances, particularly substances that are difficult to detect with conventional technology because they have a very small in size and concentration.

## VI. REFERENCES

[1] Drexler KE, (1995), Introduction to nanotechnology in Prospects of Nanotechnology, Chp 1. Edited by Krummenacker M and Lewis J. John Wiley & Sons, Inc. USA.
[2] G.A. Mansoori, and T.A.F. Soelaiman, J. ASTM International 2, 21 pages (2005).
[3] G.A. Mansoori, United Nations Tech. Monitor, Special Issue, 53 (2002).
[4] http://www.nano.gov/nsetrpts.htm. National Nanotechnology Initiative: The Initiative and ItsImplementation Plan; NSTC/NSET report, Washington D.C., March (2001).
[5] B .Karn, T. Kuiken, and M. Otto. (June 2009) Nanotechnology and in situ Remediation: a review of the benefits and potential risks. Environ Health Perspect. [Online]. 117(12). pp. 1813-1831 Available:http://www.ncbi.nlm.nih.gov/pubmed/20049198
[6] Paul G. Tratnyek and Richard L. Johnson Nanotoday May2006, Number 2
[7] Cost Analyses for Selected Groundwater Cleanup Projects Pump and Treat Systems and Permeable Reactive Barriers. (Februar 2001). Environment Protection Agency (EPA), [Online]. Available: http://www.epa.gov/tio/download/remed/542r00013.pdf
[8] Cleaning Up the Nation's Waste Sites: Markets and Technology Trends. (2004). Environment Protection Agency (EPA). [Online]. Available: http://www.cluin.org/download/market/2004 market.pdf
[9] Xu, Y., and Zhao, D., Ind. Eng. Chem. Res. (2006) 45, 1758
[10] Hoffmann, M. R., et al., Chem. Rev. (1995) 95, 69
[11] Air Pollution and Nanotechnology. Available at http://www.understandingnano.com/air.html (18 December 2008)
[12] J. Zhu, Dr John Zhu, School of Engineering (19 September 2007). Available at http://www.uq.edu.au/research/index.html?page=68941&pid=68941 (15 December 2008)