Impact of Nanotechnology on Environment

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Abstract—*Besides having various impact in different fields such as military, agriculture, medicine, etc., nanotechnology has a vast impact on our environment as well. In other sense, nanotechnology or nanomaterial are responsible for influencing environmental matters in a very significant way. Utilization of nanomaterial or nanoformulated products by different industries might be responsible for affecting the ecosystem in a positive way or vice versa.*

Although application of nanotechnology has changed our life style even then it is also contributing to environmental pollution. Nanotechnology has both positive and negative impact on environment. Positive impact of Nanotechnology involves increase in the strengths of many materials and devices, efficacy enhancement of monitoring devices, environmental pollution remediation as well as renewable energy production. Negative impacts of nanotechnology on environment include the increased toxicological pollution which may be due to uncertain shape, size, and chemical compositions of some of the nanomaterials. Apart from this, it is difficult to understand nanomaterials utilization risks and resulting damage cost. Hence, it is required to conduct a risk assessment as well as nanotechnology products life cycle analysis at all stages of products which enable us to understand the hazards of nanoproducts. In the present scenario nanobased products have been manufactured by the industries in a large quantity and industrial pollution has become a major concern of environment. Hence, there is a need to develop certain techniques and methods to prevent environmental pollution due to nanomaterials.

Keywords*: Nanotechnology, Environmental Pollution, Nanomaterials, Nanoformulated Products, Renewable Energy*

1. INTRODUCTION

Nanotechnology including nanomaterials and nanoformulated products possess a beneficial role in the field of medicine and the environment as well as can adversely affect the environment involving human body and natural ecosystem. Role of nanotechnology involves the extension from medical, ethical, mental, legal and environmental applications to the engineering, biology, chemistry, computing, materials science, military applications, and communications fields.

Advances in nanotechnology enable to provide highly sensitive air and water quality monitoring detection systems which can measure multiple parameters at the same time and possess real time response capability. Pollution due to industrial emissions can be prevented by metal oxide nanocrystals which are being developed now a day on priority basis. Although nanotechnology provides solutions for several environmental problems even then not much knowledge is there about the adverse effects of nanomaterials on environment (Fig. 1). Advancement in nanotechnology practices provide highly sensitive air and water quality monitoring systems which multiple parameters at the same time. Pollution due to industrial emissions can be prevented by metal oxide nanocrystals. It has been proved that nanotechnology might provide solutions for different problems of environment but a little knowledge is there regarding the toxicological and other adverse effects of nanoparticles on environment [1]. Resource saving by using high strength and lightweight materials can be also assisted through nanotechnology. Besides this, performance of lithium ion batteries can be improved by using nanostructured materials and in advanced photovoltaic cells nanoporous silicon and titanium dioxide can be used for better results. Detailed sorting of nanoparticles existing in the environment has been done by Bhatt and Tripathi (Fig. 1) [2].

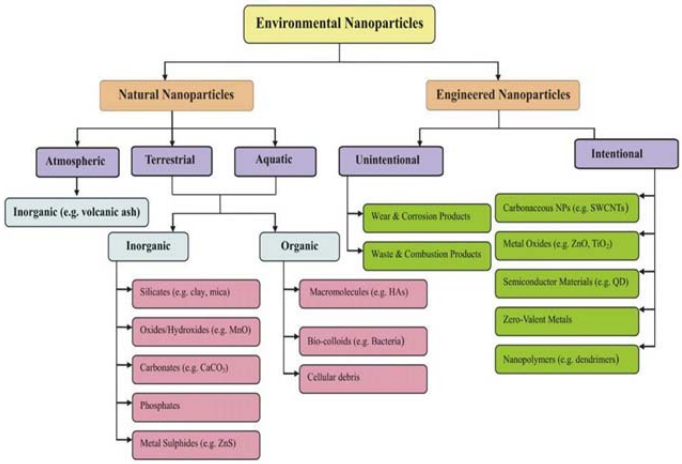

Fig. 1: A detailed sorting of nanoparticles existing in the environment (Bhatt and Tripathi, 2011)

Environmental impact of nanotechnology

Today, one of the most important and emerging technology is nanotechnology which involves wide range of technologies leading to the development of innovative and novel methods

for formulation of new products and also involved in reformulation of improved materials and chemicals which consume less amount of energy and materials as well as act as the source of environmental remediation in a more sustainable way and reduced environmental harm. Applications of nanotechnology with special reference to the environment address the various solutions developed to overcome the already exist environmental problems and any possible risks caused by Nano formulated products. The application also includes the development of preventive measures for future problems of environment resulted from the regular use of nanotechnology.

Impact of Nanotechnology on environmental impact can be divided into two aspects:

1. Positive Aspect: Nanotechnology application practices and innovations which lead to environment improvement
2. Negative Aspect: Pollution which is caused by the release of Nano technological materials in the environment.

Positive Effects of Nanotechnology on Environment

Nanotechnology is considered as the technology which possesses enormous potential of offering societal, economic and environment benefits for different problems. Nanotechnology is also helpful in reducing human interference on environment.

Environmental benefits due to nanotechnology use include the following points:

- Use of nanotechnology in industry leads to highly efficient and clean industrial processes which ultimately reduce the pollution.
- Using nanotechnology practices pollution can be detected easily as well as water, soil and air quality improves which lead to the pollution level towards the lower side [3].
- Reduce the amount of waste. Hence, will lead to high precision manufacturing
- Nanotechnology is helpful in the removal of greenhouse gases and various other pollutants from the atmosphere
- Need for large industrial plants has been decreased
- Helpful in environmental damage remediation

Liou *et al*. (2005) used uncatalyzed and catalyzed nanoscale Fe^0 systems for the denitrification of unbuffered nitrate solutions at initial neutral pH.. Results suggested that as compared to microscale Fe^0 (<100 mesh), the efficiency and rate of nitrate removal using uncatalyzed and catalyzed nano-Fe^0 were highly promoted. The maximum elevated rate was obtained using copper-catalyzed nano-Fe^0 (nano-Cu/Fe) (Fig. 2) [4].

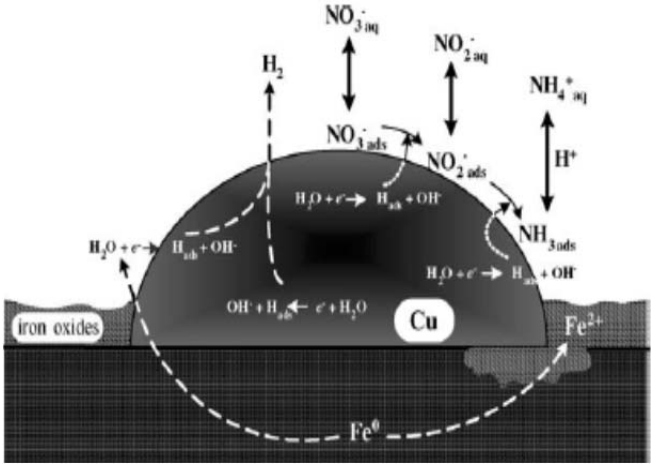

Fig. 2: Proposed scheme of the nitrate reduction reaction at Cu/Fe system (Liou *et al*., 2005)

Negative Effects of Nanotechnology on Environment

Knowledge and awareness regarding nanotechnology associated environmental effects and risks are incomplete and variable. Negative effects of nanotechnology to environment are as follows:

- Distribution of nanosubstances which are toxic and persistent are responsible to originate harm to the environment
- Recycling and recovery rate of environment is low
- Implications of environment to other life cycle stages is not clear
- Trained engineers and workers rate is lacking

In the present scenario different aspects of nanotechnology are developing in which impact on environment is also need to be considered. Nanotechnology and Nanoscience possess a significant potential for developing and improving environmental protection related technologies continuously. The present paper has given additional clue to this issue and tried to address all the potential environmental impacts of nanotechnology. Having high surface areas than the bulk materials made nanoparticles responsible to cause more damage to environment and human body. Therefore, risk due to nanoparticles on society has become a major concern globally. Nanoparticles are very much useful in monitoring air pollution as well as they are helpful in reducing consumption and remediation of material. For a quick review, the summary of practical aspects of nanotechnology applications for efficient removal of pollutants in the environment is briefly described by Mansoori *et al*. (2008) and presented in (Table 1) [5].

Table 1: Summary of Environmental Treatments Using Nanoparticles (Mansoori *et al*., 2008)

Type of nanoparticle	Type of treatment	Removal target	Advantage	Disadvantage
Nanoparticles based TiO2	Photocatalyst oxidation	Organic pollutants	Non toxicity, Water insolubility under most conditions, photo-stability	High operation cost, Hard to recovery, sludge generation
Nanoparticles based iron	Reduction, adsorption	Heavy metals, anions, organic pollutants (dechlorination)	In situ remediation, soil & water treatment, Low cost, safe to handle	Hard to recovery, sludge generation, cost for sludge disposal, Health risk
Nanoparticles based Bimetallic	Reduction, adsorption	Dechlorination, denitrification	Higher reactivity than the iron nanoparticle	Hard to recovery, sludge generation,
Nanoclay	Adsorption	Heavy metals, organic pollutants	Low cost, Unique structures, Long-term stability, reuse, High sorption capacity, Easy recovery, large surface and pore volume	sludge generation
Nanotube & fullerene	Adsorption	Heavy metals, anions, organic pollutants	Treatment of pollution from air & water, exceptional mechanical properties, unique electrical properties, Highly chemical stability	High capital cost, low adsorption capacity, Hard to recovery, sludge generation, Health risk
Nanofiltration & nanosieve membranes	Nanofiltration	Organic and inorganic compound	Low pressure than RO	Costly, prone to membrane fouling

From the present study it has been concluded that field of applied science which focused on the synthesis, characterization and application of materials measured in nanometers, is known as nanotechnology. The technology involves the study of phenomena and manipulation of materials in the nanoscale [6].

In nanoscale materials there is a significant feature of having high surface area to volume ratio which opens new prospects in surface-based sciences [7].

Nanotechnology is an emerging and exciting field of technology which possess significant impacts on environment. Research is needed using nanoscale science and technology to identify chances and uses to environmental problems, and to evaluate the potential environmental impacts of nanotechnology. Also, techniques are needed to deal new capabilities for preventing or treating highly toxic or persistent pollutants, which would result in the more effective monitoring of pollutants or their impact in the ways not currently possible.

In the present paper, review has been done on the positive as well as negative effects of nanoparticles on environment due to their inappropriate use and development of new methods to overcome the problems occurred from them.

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