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Enhancing Environment by Nanotechnology

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ABSTRACT: The ecosystem is being poisoned by growing industrialization and urbanisation. Conventional methods are costly and not effective, like filtration, centrifugation and biological treatment. Therefore, innovative and appropriate strategies for environmental monitoring and treatment need to be established. The approach to the above problems is nanotechnology. For waste water treatment, nanoparticles, nanomembranes, nanofilters, and nanocatalysts have been developed. Nanotechnology has the power to manipulate nanoscale matter and thus produces certain materials with unique properties and functions. These have smaller sizes (1-100 nm) and a higher ratio of volume to surface area. The dangerous contaminants could be degraded to the less hazardous component utilizing nanotechnology and the volume of contaminants can also be decreased by reducing the amount of content used in the processing processes. Because of these characteristics, they have more reaction surface, resulting in improved performance and selectivity. With certain challenges resolved, nanotechnology will fix all environmental concerns.

KEYWORDS: Contaminants, Detection, Environment, Nanotechnology, Nanoparticles,Material, Technology.

INTRODUCTION

The amount of contamination in the atmosphere is also rising with the rise in industrial development. Heavy metals (cadmium, copper, arsenic, mercury and lead), sulphur dioxide, carbon monoxide, nitrogen oxide, chlorofluorocarbons (CFCs), dioxins, volatile organic carbons (VOCs) etc. are used to pollute the atmosphere. In the world, the levels of nitrogen and sulphur oxide have risen because of too much combustion of coal, gasoline, and gas, contributing to acid rain. Water pollution is caused by many factors, involving herbicide runoff, chemicals, oil leaks in water bodies, as well as the leakage of by-products from industrial applications and the production and burning of fossil fuels[1].

In water, air and dirt, the toxins are mainly contained. Contaminant toxicity is described as the level of toxicity and measured in ppm (parts per million) or ppb (parts per billion). The toxicity level of water for mercury is 0.002 ppm and that in soil for arsenic is 10 ppm. Contaminants are found both in mixtures and in extremely limited quantities in the atmosphere. Therefore, certain methodology which might identify the pollutants existing even at small concentrations must be created. Nanotechnology represents the solution to this troubling question. "Nano" is originated from a term that means dwarf in Greek.A nanometer is a billionth of a metre (10-9) measured by the length of 10 "H" atoms lined up in a row. Of course, a billion years ago, nanotechnology originated from the stage where molecules started to assemble themselves in the shape of a complex structure. The scanning tunnelling microscope (STM), atomic force microscope (AFM), molecular beam epitaxy (MBE) and scanning probe microscopes are various instruments for testing nanotechnology (SPMs). Nanotechnology has the power to manipulate nanoscale matter and thus produces certain materials with unique properties and functions[2].

The advanced manufacturing that uses materials with dimensions between 1 and 100 nm is nanotechnology, which makes devices using these nanomaterials. In developing sensitive, precise and miniature devices (nanosensors) for measuring emission levels in the atmosphere,

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the small size and greater surface area to volume ratio of nanoparticles support. In addition, the hazardous contaminants could be degraded to a less dangerous form using nanotechnology and the volume of pollutants could also be minimised by minimising the amount of material used in the processing processes. Therefore, not just in the identification of toxins, but also in their handling, nanotechnology aids[3].

By implementing manufacturing processes and material science, nanotechnology assists in reducing the production of contaminants. Therefore, it has three main environmental applications:

• Identification of emissions (sensing and detection)

• Emission reduction

•Purification of contamination and remediation

DISCUSSION

Detection of Contaminants Using Nanotechnology

For the effective handling of contaminants, it is very critical to improve methods of detection that will assist in rapid and effective identification. The sensors should be mobile and compact so that identification can be carried over wide areas of the ground. Sensor is a system that, upon contact with the compound (biological or chemical) to be detected, generates a digital electronic signal. Contaminants in biological samples, soil, water, air, chemical compounds and agricultural goods can be detected at low ppm and ppb levels using traditional sensors. Using nanoparticles for sensor growth, these identification standards could be increased.Using nanoparticles, the sensors produced are highly selective and precise. Also at very low concentrations, they help to detect heavy metals, microbial pathogens, organic compounds, etc. The reactivity increases, and hence its sensitivity, with the increased surface area to volume ratio. In comparison, the small size also increases the amount of receptive sensor sites that help detect several compounds (multiplex sensors).

For pollution management, nanosensors have been produced in the form of nanowires and nanotubes. In order to detect NH3 and NO2, single-walled carbon nanotubes (SWCNTs) have been used to provide a quicker response relative to solid-state sensors (Kong et al. 2000). In addition, the SWCNTs can be run at ambient temperature, while at 200-600 C, solid-state sensors are controlled. This improved reactivity is based on the assumption that the gaseous atoms bind directly to the SWCNTs, resulting in the electrically produced signal being increased or decreased. For the identification of glucose in liquids, calcium, antibodies and proteins, boron-doped silicon nanowires have been used in addition to SWCNTs.For the identification of pathogens and biological and chemical elements in water, air, and food, real-time sensing using nanowires is used[4].

Treating Pollutants Using Nanotechnology

It is a matter of considerable concern to contaminate sites in the area of industrial plants like old mines, reservoirs, ponds, underwater storage leakages and landfills. Chemical materials like creosote, chlorinated solvents, benzene, etc., and heavy metals like arsenic, lead, mercury, and cadmium may be pollutants throughout these regions. The traditional waste disposal systems used are costly, time-consuming, and laborious. Consequently, to establish

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cost-effective and precise approaches, nanotechnology can be used. Pretreatment and disposal of the polluted site, i.e. the pump and treatment process, are used in treatment technologies.

This approach infuriates the environment when pollutants are collected from the site and transferred for disposal purposes to a nearby site. Using nanotechnology, this issue may also be addressed as it will assist in designing in situ treatment systems that are precise and effective for a particular pollutant. Nanocomposites produced from surface-functionalized Nanoparticles, CNT (carbon nanotubes), and PAN (carbon nanotubes) also can extract organic dyes (indigo carmine and methylene blue) from waste water (polyacrylonitrile)[5].

Iron Nanoparticles

Utilizing iron nanoparticles (Fe0) for the mitigation of soil and groundwater is the most accurate option of environmental treatment utilizing nanotechnology. Iron is the non-toxic compound found in dirt, rocks and water, and is thus used by many factories to handle their fresh industrial waste as 'iron powders'. This iron powder cannot, however, be used to handle waste that has already been poured into the soil or water. Furthermore, the iron powder reduction is partial, i.e. TCE (trichloroethylene) and PCE (perchloroethylene) are partly decreased to DCE (dichloroethylene).Partial reduction products are much more toxic than those of the parent compounds. Moreover, owing to the development of passivation deposits on their surfaces, the iron powders can be used only for a short amount of time. The process has since moved from iron powder to iron nanoparticles. In contrast to iron powders, the nanoparticles (1-100 nm) are 10-1000 times more effective. With groundwater, they are quickly transported since they have small scale and greater surface area. In comparison, nanoparticles have the advantage that they do not change with a change in the abundance of nutrients, pH or soil temperature. They then remain in suspension, establishing a region of in situ therapy[6].

Titanium and Zinc Nanoparticles

The semiconductors are ZnO and TiO2 and are commonly used since they are inexpensive and readily available for remediation purposes. As they are used in the nanosize form, as the surface area for the contact is greater, the effects of the cleanup are much more efficient. Construction of solar photocatalysis remediation systems is the primary aim of the use of ZnO and TiO2 nanoparticles. Pollutants like chlorinated benzene are transformed by solar rays into benign materials.A number of toxic compounds can degrade these semiconductors, but their performance also needs to be improved as they consume only ultraviolet (UV) radiation, that is only 5% of the overall solar spectrum. This may be solved through using inorganic or organic dyes to coat the nanoparticles that transfer the absorbance from the UV region to the visible region.

Magnetic Nanoparticles

The magnetic nanoparticles are rust nanoparticles that help to purify water by extracting arsenic with a magnetic effect. Rust nanoparticles have a greater surface area and a diameter of 10 nm and act as small magnets. This causes arsenic to be bound to the nanoparticles, which can then be separated using magnets. The water is then treated and becomes arsenic-free[7].

Ferritin Nanoparticles

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Ferritin is a 24-polypeptide cage-like iron-containing protein that regulates the shape and action of mineralized structures and stores iron in animals and plants as well. Under the impact of solar rays and visible light, ferritin remediates chlorocarbon and radioactive metals. The stability and nonreactivity of ferritin under photoreductive conditions has been shown to be beneficial over other ferrous catalysts. An significant application of ferritin is that Cr(VI), which is a carcinogenic pollutant, is modified to Cr(III), that is less toxic and water-insoluble.Using hybrids produced by Pd in nanometallic form and ferrtin isolated from Pyrococcusfuriosus, alcohols found in the sample could be oxidised.

Polymeric Nanoparticles

In the disinfection of wastewaters, polymeric nanoparticles were used. These act as amphiphilic compounds, all of which are hydrophobic and hydrophilic. A polymer cell with a diameter of many nanometers is developed with a hydrophilic part within and surrounded by a hydrophobic part when water is available. Cross-linking is performed before aggregation, in order to stabilise these nanoparticles. As a remediation agent, amphiphilic polyurethane (APU) nanoparticles are used.Traces of TNT (trinitrotoluene) were found to use a poly(styrene-co-acrylic acid) PSA/SiO2/Fe3O4/AuNPs/lignin (L-MMS)-modified GCE (L-MMS) electrochemical sensor (glassy carbon electrode). Due to the presence of Fe3O4/AuNPs and lignin film, TNT was pre-concentrated on the electrode surface, resulting in a fast dynamic response (3 sec). The electrode serves the benefit of being repeatedly used for five cycles of adsorption/desorption.

Dendrimers

Dendrimers used for the removal of metal pollutants have nanoscale dimensions, regulated structure, and strongly branched polymers. As the cages are formed to capture the zero-valent metals and metal ions, they can attach to the suitable surface and are soluble in nature. Research is ongoing to be using dendrimers as nano-chelating agents in ultrafiltration systems[8].

Nanocatalysts

The material that improves a reaction's speed without used in the reaction is known the catalyst. A catalyst's reactivity depends on the active site at which the reaction happens. If the size of the compound declines to the nano level, the region of the reaction surface increases, which enhances its effectiveness. For the production of sulphur free fuels, nanocatalysts are used. Sulfur persists in the fuel and creates sulfuric acid following burning during the refinement processes of fuels. This could be minimised by nanocatalysts processing the fuels with (nano-sized cerium oxide).In the existence of silver and gold nanoparticles synthesised utilizing PunicaGranatum juice, organic dyes like anionic monoazo dye, cationic phenothiazine dye and cationic fluorescent dye may be deteriorated effectively[9].

Problems to Be Solved

With advances in technology, a range of sensors for continuous environmental monitoring have been established. Since the past, microorganisms were used for the production of sensors for environmental control, but their genomic research has recently become known for better comprehension. In order to build effective sensors for environmental control and treatment, microbes should be examined and classified at their genetic stages. Only with the aid of recent developments in nanotechnology would this be feasible. In comparison, there is

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no understanding of the nanoparticles' existence, mechanism of conversion and chemical composition. Furthermore, the nanoparticles in dust, air and water are difficult to classify. The traditional methods used to identify nanoparticles for data collection are non-quantitative, sluggish and not reliable. The detection methods can also be enhanced so that the nanoparticles can be quickly and accurately identified. Therefore, for the efficient diagnoses and management of environmental pollutants, the refining of freshly used nanotechniques is essential.

CONCLUSION

With globalisation, the amount of pollution is rising at alarming rates. For the measurement and management of emission levels, a variety of methods such as filtration, centrifugation, and chromatography have been used, however these technologies have several loop holes. These holes can be solved by nanotechnology and new and powerful ways of diagnosing and treating emission levels can be created. The benefits of nanotechnology for environmental healing are nanoparticles, nanocatalysts and nanocomposites. Different nanoparticles, such as iron, magnetic, TiO_2, ZnO, ferritin, and polymeric and bioactive nanoparticles, have rapid reaction and also lead to pollutant eradication.To obtain the best outcomes from nanotechnology in the field, some of the differences, including the research and use of microbes at genetic levels for the mitigation of environmental materials, need to be resolved.

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