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Nano Technology in Waste Water Treatment

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Abstract: - **One of the most interesting things about nanotechnology is that the properties of many materials change when the size scale of their dimensions approaches nanometres. Materials scientists work to understand those property changes and utilize them in the processing and manufacture of materials at the nanoscale. Nanotechnology might be able to increase the retrieve of waste water, but the most promising application of nanotechnology is the reduction of cost for recycling plant. Nanotechnology in Wastewater treatment in turn reuse, save water, avoid water scarcity and pollution causes due to storage of water in open places. This paper provides an overview of Nanotechnology in the wastewater treatment and effective usage of the same. The potential implications that these technologies would have on our society are also discussed. Most of the engineering and science, the major research process is carried out with nanotechnology. Nanoscience and engineering are at the heart of it across all disciplines. For those who are passionate about nanotechnology, Material science and engineering is a place for the most research, coursework, and experience in nanotechnology.**

WHAT ARE NANOMATERIALS:

"Nano" is derived from the Greek word for dwarf. A nanometer is one billionth of a meter (10-9) and might be represented by the length of ten hydrogen atoms lined up in a row. Nanotechnology is the general term for designing and making anything whose use depends on specific structure at the nanoscale – generally taken as being 100 nanometres (100 millionths of a millimetre or 100 billionths of a metre) or less. It includes devices or systems made by manipulating individual atoms or molecules, as well as materials which contain very small structures.

They may be in the form of particles, tubes, rods or fibres. The nanomaterials that have the same composition as known materials in bulk form may have different physico-chemical properties than the same materials in bulk form, and may behave differently if they enter the body. They may thus pose different potential hazards. . They exhibit very interesting mechanical, magnetic, optical, chemical and other properties.

WASTE WATER AND NEED FOR WATER TREATMENT:

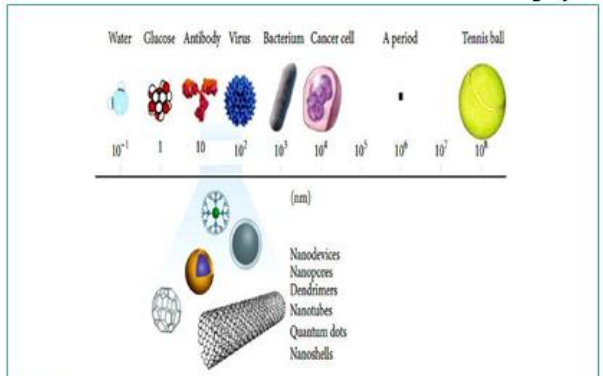
Water is a mythical substance whose material existence is secondary compared to the symbolic value as it is manifested in our mind as the symbol of life. Sustainable supplies of clean water are vital to the world's health, environment and economy.

India is a vast country having diversified geological, climatological and topographic set-up, giving rise to divergent groundwater situations in different parts of the country. Unsustainable uses of resources and indiscriminate applications of pesticides, fertilizers, industrial pollutants are continuously disturbing the status of purity of groundwater. Waste water, is any water that has been adversely affected in quality by anthropogenic influence. Wastewater can originate from a combination of domestic, industrial, commercial or agricultural activities, surface runoff or storm water, and from a sewer in flow or infiltration. Shallow aquifers generally suffer from Agrochemicals, domestic and industrial waste pollution. Major water pollutants include microbes (like intestinal pathogens and viruses), nutrients (like phosphates and nitrates), heavy metals and metalloids (like arsenic, lead, mercury), organic chemicals (like DDT, lubricants, industrial solvents), oil, sediments and heat. Virtually all industrial and goods-producing activities generate pollutants as unwanted by-products. .In general, the organic composition of wastewater is estimated to consist of proteins (50%), carbohydrates (40%), fats and oils (10%), and trace amounts (e.g. µg/L or less) of priority pollutants, surfactants, and emerging contaminants. On the other hand, wastewater often contains 105-108 colony forming unit (CFU)/mL of coliform organisms, 103-104 CFU/mL fecal streptococci, 101-103. Heavy metals can contaminate the aquifer and subsequently can bioaccumulate in the tissues of humans and other organisms. For example, more than 100 million people are living in the arsenic affected districts of India and Bangladesh. 9 districts out of 19 in West Bengal, 78 blocks and around 3150 villages are affected with arsenic-contaminated groundwater. Pollutants can take years to reach the aquifers, but, once it reaches the water source, it is very difficult and costly to remove the pollutants. More than 80% of sewage in developing countries is discharged without proper treatment which can pollute the river systems, lakes and coastal water bodies. Major problem in the world especially India is water polllution which takes the lives of millions of people every year.Its been reported that about 1.2 trillion gallons of untreated sewage,storm water and industrial waste are discharge into US waters annually.About 40% of America‘s rivers and 46% of America‘s lakes are too polluted for aquatic life.According to the report given by United Nations released on March 22,2010 on World Water Day says that water pollution kills more people than all other forms of violence including Wars.90 % of waste water discharged daily in developing countries contributes to the deaths of some 2.2 million people a year from diarrheal diseases.Atleast 1.8 million children younger than 5 die every year due to water-related diseases.Newdelhi‘s body of water is little more than a flowing garbage dump,with fully 57% of city‘s waste finding its way to the Yamuna.River Cooum,which is quite considered pure in 19th century is slowly dying due to unchecked pollution like the River Ganga. In countries like India, 80% of the diseases are waterborne specially drinking water. Any water intended for drinking should contain fecal and total coli form counts of zero, in any 100 mL sample as recommended by the World Health Organization (WHO) . Today a number of techniques are used for treatment of water i.e. chemical and physical processes such as treatment of chlorine and its derivatives, ultraviolet light, boiling, low frequency ultrasonic irradiation, distillation, reverse osmosis, water sediment filters, etc The major aim of wastewater treatment is to remove as much of the suspended solids as possible before the remaining water, called effluent, is discharged back to the environment. As solid material decays, it uses up oxygen, which is needed by the plants and animals living in the water."Primary treatment" removes about 60 percent of suspended solids from wastewater. This treatment also involves aerating (stirring up) the wastewater, to put oxygen back in. Secondary treatment removes more than 90 percent of suspended solids.

ROLE OF NANO-MATERIALS IN WASTE WATER TREATMENT

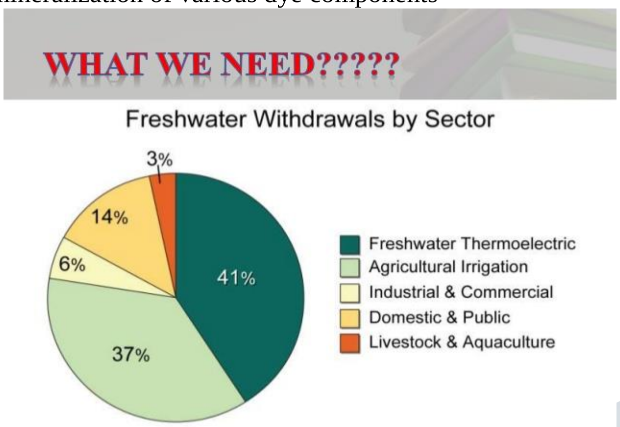
I. INTRODUCTION

Water is the most vital substance in our life. Approximately, onesixth of the world’s population suffers from access to clean drinking water. The world is facing formidable challenges in meeting rising demands of clean water as the available supplies of freshwater are depleting due to (i) extended droughts, (ii) population growth, (iii) more stringent health based regulations and (iv) competing demands from a variety of users. Therefore, an urgent stride is required to develop an innovative technology to provide clean and affordable water to meet human needs. Clean potable water is essential to maintain healthy life. In countries like India, 80% of the diseases are waterborne specially drinking water. Any water intended for drinking should contain fecal and total coli form counts of zero, in any 100 mL sample as recommended by the World Health Organization (WHO). Today a number of techniques are used for treatment of water i.e. chemical and physical



FiguA size comparison of nanoparticle

processes such as treatment of chlorine and its derivatives, ultraviolet light, boiling, low frequency ultrasonic IR radiation, distillation, reverse osmosis, water sediment filters (fiber and ceramic), activated carbon treatment etc. Over the last few decades, nanotechnology is emerging as a rapidly growing sector of a knowledge-based economy due to unique physiochemical properties of nanomaterial. This technology gained a tremendous impetus due to its capability of reformulating the particle of metals into new nanosized form. ‘Nano’ is derived from the Greek word for ‘dwarf’. A nanometer is one billionth of meter (10-9) and might be represented by the length of ten hydrogen atoms lined up in a row. The high surface area to mass ratios of nanoparticles can greatly enhance the adsorption capacities of sorbent materials. Nanotechnology is a deliberate manipulation of matter at size scales of less than 100 nm (Figure 1) in at least one dimension meaning at the level of atoms and molecules as compared with other disciplines such as chemistry, engineering, and materials science. In addition to having high specific surface areas, nanoparticles also have unique adsorption properties due to different distributions of reactive surface sites and disordered surface regions. Their extremely small feature size is of the same scale as the critical size for physical phenomena for example, the radius of the tip of a crack in a material may be in the range 1-100nm. The way a crack grows in a larger-scale, bulk material is likely to be different from crack propagation in a nanomaterial where crack and particle size are comparable such as Choi et al. describes the application of novel chemistry methods for the fabrication of robust nanostructured titanium oxide (TiO2) photo catalysts. Such materials can be applied in the development of efficient photocatalytic systems with unique characteristics of high surface area (147 m2 /g) and porosity (46%), narrow pore size distribution ranging from 2 to 8 nm, homogeneity without cracks and pinholes, active anatase crystal phase, and small crystallite size (9nm) for the treatment of water. These TiO2 photo catalysts were highly efficient for treatment of dye industry effluent with complete mineralization of various dye components



MECHANISM OF NANOMATERIAL TO REMOVE THE POLLUTANT FROM WASTE WATER

The several advances were made in the study of nano-scale structures. The term nano-technology was described by Taniguchi (1974) as “Nano-technology mainly consists of the processing of, separation, consolidation, and deformation of materials by one atom or one molecule”. The tools and the methods for nanotechnology involve imaging, measuring, modeling, and manipulating matter at the nanoscale. Development of particles at the nanoscale level contributed extensively to the production, modification and shaping of structures that were used in different industrial, health and environmental applications. Contamination of water with toxic metal ions [Hg(II), Pb(II), Cr(III), Cr(VI), Ni(II), Co(II), Cu(II), Cd(II), Ag(I), As(V) and As(III)] is becoming a severe environmental and public health problem . To achieve environmental detoxification, various techniques like adsorption, precipitation, ion exchange, reverse osmosis, electrochemical treatments, membrane filtration, evaporation, flotation, oxidation and biosorption processes are extensively used. Nanostructured materials such as magnetic nanoparticle, carbon nanotubes, silverimpregnated cyclodextrin nano-composites, nano structured iron zeolite, carbon-iron nanoparticles, photocatalytic titania nanoparticles, nanofiltration membranes and functionalized silica nanoparticles can be employed in water treatment to remove heavy metals, sediments, chemical effluents, charged particles, bacteria and other pathogens. Nanoparticles, like nanosized zero valent ions when used as adsorbents, helps in pollutant removal/ separation from water as well as catalyze the chemical or photochemical oxidation process for effective destruction of persistent contaminants.

Type of Nanoparticle	Type of pollutants removed
Nano Scale metal Oxide	Heavy metals Radionucleides
Nano catalyst	PCB, Azodyes,Pesticides etc
Carbon nano tubes	Organic Contaminant
Bioactive nanoparticle	Removal of Bacteria, fungi
Biomimetic membranes	Removing Salts
Nano Structured catalytic	Decomposition of organic pollutant inactivation of micro organisms

Table1: Nanotechnology in waste water treatment

Scientists classified nanoscale materials that are being evaluated as functional materials for water purification into four classes namely, dendrimers, metal-containing nanoparticles, zeolites and carbonaceous nanomaterials. Above mentioned nanomaterials can be efficiently used in wastewat treatment and purification utilizing the unique features of nanotechnology. Nanotechnology has been considered effective in solving water problems related to quality and quantity. Nanomaterials like carbon nanotubes (CNTs) and dendrimers are contributing to the development of more efficient treatment processes among the advanced water systems due their exceptional adsorption properties. There are many aspects of nanotechnology to address the multiple problems of water quality in order to ensure the environmental stability. The most promising materials and applications are highlighted in Table 1. Opportunities and challenges of using nanomaterials in the purification of surface water, groundwater and industrial wastewater streams is a matter of continuing concern. Apart from the conventional utilization pattern of the nano particles like, killing harmful organisms, repairing body tissue, and curing diseases; nanotechnology in future can be exploited in large scale water treatment plants being a cost effective and labor intensive process and a promising alternative to conventional water treatment practices. In short, the development of different nanomaterials like nanosorbents, nanocatalysts, zeolites, dendrimers, and nanostructured catalytic membranes have made it possible to disinfect disease causing microbes, removing toxic metals and organic and inorganic solutes from water/wastewater.

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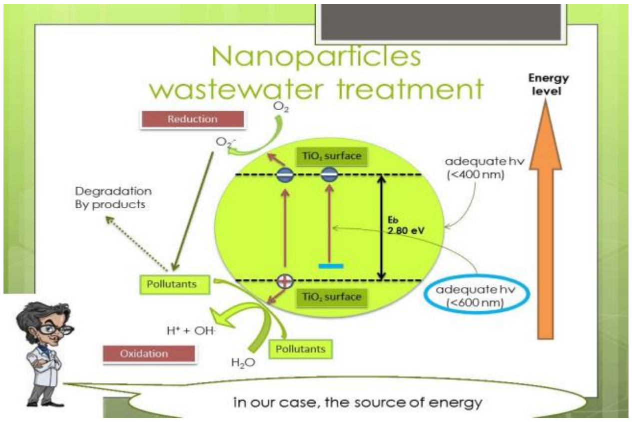
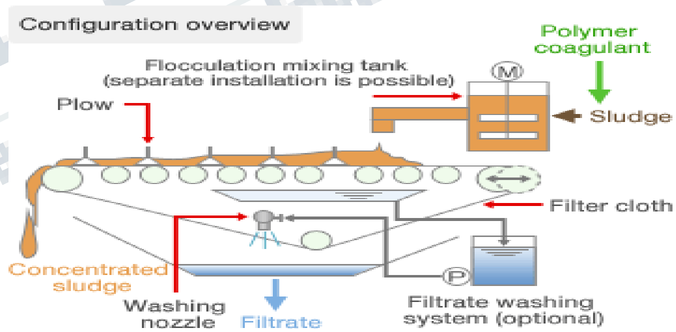
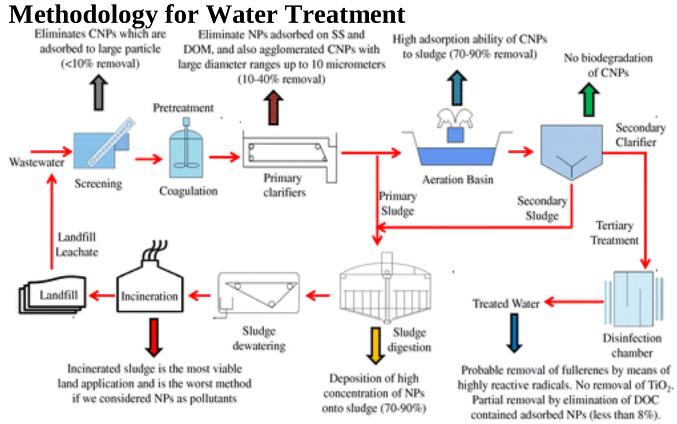


Strategies for Synthesis of Nanoparticles

Nano-sized materials spontaneously synthesized in nature being highly unstable, its synthesis processes are crucial to choose for practical applications. Numerous techniques are used to fabricate different nanomaterial. Nanoparticles can be produced from larger structures (top down) by use of ultrafine grinders, lasers and vaporization followed by cooling. For complex particles, nanotechnologists generally prefer to synthesize nanostructures by a bottom-up approach by arranging molecules to form complex structures with new and useful properties. 'Layer by layer' deposition is a technique where the platforms for bilayer membranes that can be used for protein analysis can be fabricated by layering of sodium silicate and poly (allylamine hydrochloride) on gold followed by calcinations in a furnace. Lipid bilayers can fuse to the silicate layer and be used to detect specific proteins. Rivero et al. have reported synthesis of silver nanoparticles (AgNPs) with different shape, aggregation state and color (violet, green, orange) successful incorporation into polyelectrolyte multilayer thin films using the layer-by-layer (LbL) assembly. Zhao et al. fabricated multilayer films containing silver nanoparticles and polycation poly (dialyldimethylammonium chloride) (PDDA) following similar techniques. During synthesis of biocompatible fibers, nanoparticle play crucial role in providing temporal stability. During that particular synthesis process (hydroxyapatite-aspartic acid/glutamic acid), crystallization is one the effective strategies. Gold nanorods and nanoparticles with other shapes were produced by incubation of dead oat stalks with an acidic aqueous solution of gold ions (Au III). Some living plants are also known to take up and sequester heavy metals (to prevent being poisoned by these metals) and these plants and its leaf and seed extract may also be useful in producing nanoparticles of metals also, which are all biomass reduction process of nanoparticle synthesis and micro-living cells have been harnessed to produce nanoparticles also known as microbial synthesis, for example, silver nanoparticles produced extracellularly by the fungus Aspergillus fumigatus. Gold and silver nanoparticles can also be produced by other fungi and a number of bacterial species Major nanoparticle synthesis techniques belongs to two broad areas namely, gas phase synthesis and sol-gel processing. Nanoparticles with diameters ranging from 1 to 10 nm with consistent crystal structure, surface derivatization and a high degree of monodispersity have been processed by both gas-phase and sol-gel techniques. Initial development of new crystalline materials was based on nanoparticles generated by evaporation and condensation (nucleation and growth) in a sub-atmospheric inert-gas environment. Various aerosol processing techniques have been reported to improve the production yield of nanoparticles. In self assembly technique, manipulation of physical and chemical conditions such as pH, temperature and solute concentrations can induce self assembly of molecules to form fibrous nanostructures. 'Polymerosomes' are special type of nanomaterials having immense potential in waste water treatment. Polymerosomes are synthetic vesicles which are self assembles tiny hollow spheres composed of block copolymeric amphiphiles, synthesized by self assembly technique. The presence of both hydrophilic and hydrophobic groups in polymerosomes creates layers along with an aqueous core in the copolymers which help in retaining variety of guest molecules at different pH values. Hence, these hyper branched nano-sized copolymers are good promising tools for removal of organic wastes from water bodies.



Methodology for Water Treatment



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This section describes most promising technologies of waste water treatment involving nanomaterials as key component. Adsorption is one of the most well practiced techniques for water treatment. Use of nanomaterials as adsorbent in treatment of waste water is applicable in various forms like catalytic, absorptive, catalytic membrane, bioactive nanoparticles, biomemetic membrane, polymeric and nano composite membrane, thin film composite membrane etc. Various organic chemicals are absorbed more efficiently by using carbon nano tubes (CNT) than activated carbon. Organic compounds which have carboxylic, hydroxyl, amide functional groups also form hydrogen bond with the graphitic CNT surface which donates electrons.CNT have high adsorption competence for metal ions and therefore is a good alternative for activated carbon. Nanoscale metal oxides like iron oxides like ferrous oxide, TiO2, Al2 O3 are effective, low cost adsorbants for heavy metals and radio nucleides. Dendrimers (polymeric nanomaterials) are capable of removing both organics and heavy metals. Nano-adsorbents are used as powder, beads or porous granules loaded with nano-adsorbants. Nanomembranes are a particular kind of membranes modified with nanofibres which utilized to remove microsize particles from aqueous phase with a high elimination rate with reduced fouling propensity. Such membranes are used as pretreatment method used proceeding to ultrafiltration or reverse osmosis. Large number of studies on membrane nanotechnology has focused on creating multifunction membrane by adding nanomaterials into polymeric or inorganic membranes known as nanocomposite membranes. The addition of metal oxide nanoparticles including alumina, silica, zeolite and TiO2 to polymeric ultra filtration membranes has been shown to amplified membrane surface hydrophilicity, water permeability, or fouling resistance. Inorganic membranes containing nanoTiO2 or modified nanoTiO2 have been used effectively for reductive degradation of contaminants, particularly chlorinated compounds.The use of TiO2 immobilized on a polyethylene support and a TiO2 slurry in combination with polymeric membranes has proved very effective for degradation of 1,2-dichlorobenzene and pharmaceuticals, respectively. Nanostructured composite of TiO2 and Fe2O3 incorporated into ultra filtration membranes successfully reduced the fouling burden and improved the permeate flux. Aluminazirconia-titania ceramic membrane coated with Fe2O3 nano particles was observed to reduce the dissolved organic carbon better than the uncoated membrane enhancing the degradation of natural organic matter. Finally, ceramic composite membranes of TiO2 and CNTs have resulted in enhanced membrane permeability and photo catalytic activity. Antimicrobial nonmaterial's such as nanosilver are doped or surface grafted on polymeric membranes to inhibit bacterial attachment and biofilm formation on the membrane surface. It also inactivates viruses and can reduce membrane bio-fouling. Developments of thin film nanomaterial membrane mainly focus on incorporating nanomaterials into the active layer of thin film composite membrane via doping in the casting solutions or surface modification. The effect of nanoparticles on membrane permeability and selectivity depends on the variety, dimension and quantity of nanoparticles added. Many biological inspired membranes are highly selective and permeable. The use of nanofibrous composites membranes for water/wastewater treatment is very limited and a stand-alone system (Figure 2) is proposed for removing all types of contaminants including bacteria/viruses, heavy metals and ions, and complex organic compounds.

Fig-2

Schematic of a proposed composite nanofibrous media/membrane filters for complete removal of contaminants from wastewater

Nanotechnology Applications

1. Medicine
2. Electronics
3. Fuel Cells
4. Solar Cells
5. Batteries
6. Fuels
7. Better Air Quality
8. Cleaner Water
9. Chemical Sensors
10. Sporting Goods
11. Fabric

1.Medicine:

In, nano technology medice is used in

Drug delivery: One application of nanotechnology in medicine currently being developed involves employing nanoparticles to deliver drugs, heat, light or other substances to specific types of cells (such as cancer cells). Particles are engineered so that they are attracted to diseased cells, which allows direct treatment of those cells. This technique reduces damage to healthy cells in the body and allows for earlier detection of disease.

Therapy techniques : Researchers have developed "nanosponges" that absorb toxins and remove them from the bloodstream. The nanosponges are polymer nanoparticles coated with a red blood cell membrane. The red blood cell membrane allows the nanosponges to travel freely in the bloodstream and attract the toxins.

Diagnostic Techniques: Researchers at Worcester Polytechnic Institute are using antibodies attached to carbon nanotubes in chips to detect cancer cells in the blood stream. The researchers believe this method could be used in simple lab tests that could provide early detection of cancer cells in the bloodstream

Anti-Microbial Techniques: Researchers at the University of Houston are developing a technique to kill bacteria using gold nanoparticles and infrared light. This method may lead to improved cleaning of instruments in hospital settings.

Cell Repair: Nanorobots could actually be programmed to repair specific diseased cells, functioning in a similar way to antibodies in our natural healing processes.

2.Electronics:

Nanoelectronics holds some answers for how we might increase the capabilities of electronics devices while we reduce their weight and power consumption. Some of the nanoelectronics areas are under development.

Improving display screens on electronics devices. This involves reducing power consumption while decreasing the weight and thickness of the screens.

Increasing the density of memory chips. Researchers are developing a type of memory chip with a projected density of one terabyte of memory per square inch or greater.

Reducing the size of transistors used in integrated circuits. One researcher believes it may be possible to "put the power of all of today's present computers in the palm of your hand".

3. Fuel Cells:

Nanotechnology is being used to reduce the cost of catalysts used in fuel cells to produce hydrogen ions from fuel such as methanol and to improve the efficiency of membranes used in fuel cells to separate hydrogen ions from other gases such as oxygen.

Fuel cells contain membranes that allow hydrogen ions to pass through the cell but do not allow other atoms or ions, such as oxygen, to pass through. Companies are using nanotechnology to create more efficient membranes; this will allow them to build lighter weight and longer lasting fuel cells.

Small fuel cells are being developed that can be used to replace batteries in handheld devices such as PDAs or laptop computers. Most companies working on this type of fuel cell are using methanol as a fuel and are calling them DMFC's, which stands for direct methanol fuel cell. DMFC's are designed to last longer than conventional batteries. In addition, rather than plugging your device into an electrical outlet and waiting for the battery to recharge, with a DMFC you simply insert a new cartridge of methanol into the device.

4. Solar Cells:

Using nanoparticles in the manufacture of solar cells has the following benefits:

Reduced manufacturing costs as a result of using a low temperature process similar to printing instead of the high temperature vacuum deposition process typically used to produce conventional cells made with crystalline semiconductor material.

Reduced installation costs achieved by producing flexible rolls instead of rigid crystalline panels. Cells made from semiconductor thin films will also have this characteristic.

Currently available nanotechnology solar cells are not as efficient as traditional ones, however their lower cost offsets this. In the long term nanotechnology versions should both be lower cost and, using quantum dots, should be able to reach higher efficiency levels than conventional ones.

5. Batteries:

Using nanotechnology in the manufacture of batteries offers the following benefits:

Reducing the possibility of batteries catching fire by providing less flammable electrode material.

Increasing the available power from a battery and decreasing the time required to recharge a battery. These benefits are achieved by coating the surface of an electrode with nanoparticles. This increases the surface area of the electrode thereby allowing more current to flow between the electrode and the chemicals inside the battery. This technique could increase the efficiency of hybrid vehicles by significantly reducing the weight of the batteries needed to provide adequate power.

Increasing the shelf life of a battery by using nanomaterials to separate liquids in the battery from the solid electrodes when there is no draw on the battery. This separation prevents the low level discharge that occurs in a conventional battery, which increases the shelf life of the battery dramatically.

6.Fuels:

Nanotechnology can address the shortage of fossil fuels such as diesel and gasoline by:

Making the production of fuels from low grade raw materials economical Increasing the mileage of engines

Making the production of fuels from normal raw material more efficient.

Nanotechnology can do all this by increasing the effectiveness of catalysts. Catalysts can reduce the temperature required to convert raw materials into fuel or increase the percentage of fuel burned at a given temperature. Catalysts made from nanoparticles have a greater surface area to interact with the reacting chemicals than catalysts made from larger particles. The larger surface area allows more chemicals to interact with the catalyst simultaneously, which makes the catalyst more effective. This increased effectiveness can make a process such as the production of diesel fuel from coal more economical, and enable the production of fuel from currently unusable raw materials such as low grade crude oil.

7.Better Air Quality:

There are two major ways in which nanotechnology is being used to reduce air pollution: catalysts, which are currently in use and constantly being improved upon; and nano-structured membranes, which are under development.

Catalysts can be used to enable a chemical reaction (which changes one type of molecule to another) at lower temperatures or make the reaction more effective. Nanotechnology can improve the performance and cost of catalysts used to transform vapors escaping from cars or industrial plants into harmless gasses. That's because catalysts made from nanoparticles have a greater surface area to interact with the reacting chemicals than catalysts made from larger particles. The larger surface area allows more chemicals to interact with the catalyst simultaneously, which makes the catalyst more effective.

Nanostructured membranes, on the other hand, are being developed to separate carbon dioxide from industrial plant exhaust streams. The plan is to create a method that can be implemented in any power plant without expensive retrofitting.

8.Cleaner Water:

Nanotechnology is being used to develop solutions to three very different problems in water quality.

One challenge is the removal of industrial water pollution, such as a cleaning solvent called TCE, from ground water. Nanoparticles can be used to convert the contaminating chemical through a chemical reaction to make it harmless. Studies have shown that this method can be used successfully to reach contaminates dispersed in underground ponds and at much lower cost than methods which require pumping the water out of the ground for treatment.

Another challenge is the removal of salt or metals from water. A deionization method using electrodes composed of nano-sized fibers shows promise for reducing the cost and energy requirements of turning salt water into drinking water.

The third problem concerns the fact that standard filters do not work on virus cells. A filter only a few nanometers in diameter is currently being developed that should be capable of removing virus cells from water.

9.Chemical Sensors:

Nanotechnology can enable sensors to detect very small amounts of chemical vapors. Various types of detecting elements, such as carbon nanotubes, zinc oxide nanowires or palladium nanoparticles can be used in nanotechnology-based sensors. These detecting elements change their electrical characteristics, such as resistance or capacitance, when they absorb a gas molecule.

Because of the small size of nanotubes, nanowires, or nanoparticles, a few gas molecules are sufficient to change the electrical properties of the sensing elements. This allows the detection of a very low concentration of chemical vapors. The goal is to have small, inexpensive sensors that can sniff out chemicals just as dogs are used in airports to smell the vapors given off by explosives or drugs.

The capability of producing small, inexpensive sensors that can quickly identify a chemical vapor provides a kind of nano-bloodhound that doesn't need sleep or exercise which can be useful in a number of ways. An obvious application is to mount these sensors throughout an airport, or any facility with security concerns, to check for vapors given off by explosive devices.

These sensors can also be useful in industrial plants that use chemicals in manufacturing to detect the release of chemical vapors. When hydrogen fuel cells come into use, in cars or other applications, a sensor that detects escaped hydrogen could be very useful in warning of a leak. This technology should also make possible inexpensive networks of air quality monitoring stations to improve the tracking of air pollution sources.

10.Sporting Goods:

If you're a tennis or golf fan, you'll be glad to hear that even sporting goods has wandered into the nano realm.

Current nanotechnology applications in the sports arena include:

Increasing the strength of tennis racquets by adding nanotubes to the frames which increases control and power when you hit the ball. Filling any imperfections in club shaft materials with nanoparticles; this improves the uniformity of the material that makes up the shaft and thereby improving your swing.

11.Fabric:

Making composite fabric with nano-sized particles or fibers allows improvement of fabric properties without a significant increase in weight, thickness, or stiffness as might have been the case with previously-used techniques. For example incorporating nano-whiskers into fabric used to

IFERP connecting engineers... developing research

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make pants produces a lightweight water and stain repellent material.

II. CONCLUSION

1) Now after the completion we came to know about nano materials, how it is treated in waste water and needs for waste water treatment.

2) The future that we were watching just in science fiction movies will in the near future be real.

3) In the future nanotechnology may be used in every aspect of life

4) As a conclusion to this topic I would like to say that Nanotechnology is a brand new technology that has just began, it is a revolutionary science that will change all what we knew before.