SEWAGE WATER TREATMENT USING NANOPARTICLES

Abstract

Water is a spontaneous and vitally important resource of every living organism on earth for survival. Due to advances in technology in developing countries, the contamination in water increases so as to change the composition of sewage water and to develop a stable and reliable method different research is going on, one among them is the use of nanoparticles. Nanoparticles are used to remove heavy metals, and organic and inorganic pollutants from sewage water and extract purified water. Metal oxides, carbon nanotubes, and graphene are only a few examples of the many nanomaterials that have been researched.

Nanoparticles limit the growth of bacteria and viruses in water resulting in suitable conditions for aquatic animals and the environment. The invention of nanomembranes is one of the most important uses of nanoparticles for water filtration. Nanomembranes are nanoparticles filled with thin-film membranes, which contain tiny pores that can effectively filter water of impurities while still enabling water molecules to pass through.

Keywords: Sewage water, globalization, nanoparticles, pollutants

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I. INTRODUCTION

In the present-day world, every living organism on earth depends on water as a natural and essential resource for survival, so it is necessary to alter the composition of wastewater in order to promote recreation and quality of life. Purification of sewage water results in the maintenance of aquatic and wildlife habitat. It also helps in the protection of public hygiene and public health concern. In addition, dyes, which are dangerous organic pollutants, have started to seriously contaminate water in recent years. As a result, the removal of harmful toxins from water is a requirement across the globe to guarantee the safety of humans and the environment. Ammonia is another harmful substance that can be found in water sources, and its contamination of wastewater and water sources has become a significant environmental issue. The treatment of nitrogen has been established using a number of methods.

There are THREE primary categories of sewage water:

- Domestic sewage
- Industrial sewage
- Agricultural sewage

1. Domestic sewage is the kind that comes from homes and other residential locations. This covers the water used in showers, laundry, sinks, and toilets. Organic materials, human waste, and numerous chemicals from daily household activities are commonly found in domestic sewage.

2. Industrial sewage is produced by industrial, commercial, and manufacturing operations. Depending on the industry, it can have a very diverse composition, but it frequently contains poisons, chemicals, and heavy metals that are unique to the industrial processes involved.

3. Agricultural sewage generates organic wastes which contains harmful chemicals in fertilizers, crop residues and pesticides which leads to the production of toxic ions.

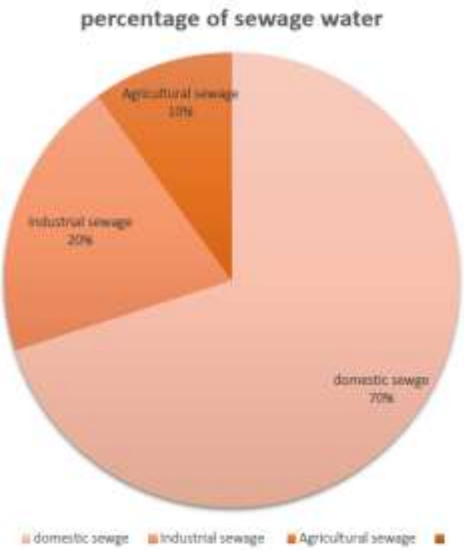


Figure 1: Pie Chart Showing Contributions of Sewage Water from Different Places.

In order to remove these toxic ions and chemicals from the sewage water, there are lot of conventional sewage water treatment methods being practiced like mixing flocculation, sedimentation, filtration etc. However, research is still taking place in order to provide stable and economical methods to reduce the drawbacks. In the current era nanotechnology is being researched on priority as it has multiple benefits specially in wastewater treatment as there have been multiple research on other methods with low results, whereas nanotechnology will have promising results if it has been processed.

II. NANOPARTICLES AND ITS IMPLEMENTATION

Materials called nanoparticles have structural elements that are between 1 and 100 nm in size in at least one dimension . Nanoparticles' unique characteristics make them very different from other materials in terms of their mechanical, electrical, optical, and magnetic capabilities.

Nanoparticles have recently found use in a variety of industries, including catalysis, medicine, sensing, and biology. Particularly, nanoparticles are utilized widely in water and sewage treatment because to their nano sizes, vast surface areas available for chemical and biological reactions, and high mobility of nanoparticles in solutions.

Nanoparticles are promising materials for the cleaning of waste and contaminated water because of their distinctive features. They can effectively absorb and remove a variety of contaminants, such as heavy metals, organic pollutants, and microbes, due to their small size and large surface area. Additionally, nanoparticles can be used as water purification and pollution degradation catalysts. There has been an increase in interest in using nanoparticles to purify water in recent years. Metal oxides, carbon nanotubes, and graphene are only a few examples of the many nanomaterials that have been researched. Heavy metals, organic pollutants, pathogens, and many other contaminants have all been successfully removed from wastewater using these compounds. The creation of nanomembranes is one of the most exciting uses of nanoparticles for water filtration. Nanomembranes are nanoparticle-filled thin-film membranes. They contain incredibly tiny pores that can efficiently filter water of impurities while still enabling water molecules to pass through. Some commercial water filtration systems have already used nanomembranes for purification.

Nanoparticles have a powerful antibacterial effect on a variety of microorganisms, including viruses , bacteria , and fungus, and are exceedingly destructive to them. These can attach to the microorganisms' bacterial cell walls and make the walls more permeable. They can quickly break through cell walls, causing structural alterations in the cell membrane that eventually cause the cells to die. Additionally, Ag nano particles produce free radicals when they come into touch with bacteria. They are thought to be the reason why cells die because they can harm the cell membrane.

III. POSITIVE EFFECTS ON HUMAN HEALTH BY USING NANO PARTICLES IN SEWAGE TREATMENT

1. **Lessened Risk of Contracting Infectious Diseases:** Sewage contains a wide range of dangerous organisms, including bacteria, viruses, and parasites. Numerous ailments, such as diarrhea, cholera, typhoid, and hepatitis A, can be brought on by these bacteria. Wastewater undergoes sewage treatment by using nanoparticles. It eradicates harmful

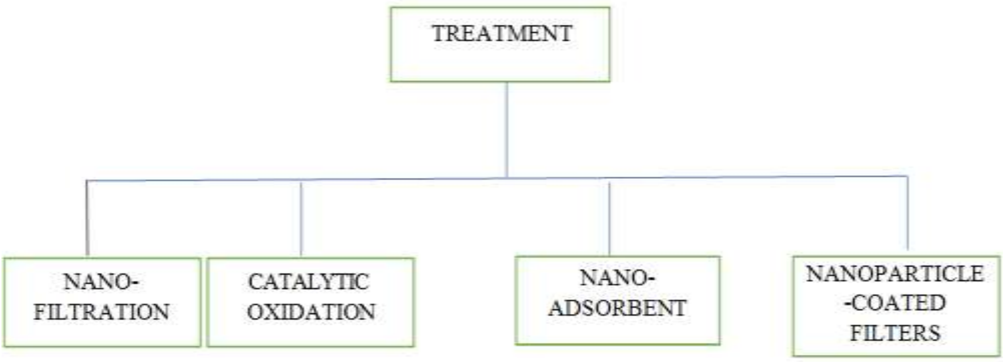
germs, making it suitable for reuse or disposal into the environment.

2. **Better Water Quality:** Sewage treatment also gets rid of organic matter nutrients, and heavy metals from wastewater. In order to make drinking water and other surface waters unfit for human use, these contaminants can contaminate them. By enhancing the quality of the water that we drink, swim in, and use for irrigation and pleasure. In thisway the nanoparticles we use for sewage treatment contributes to the protection of human health.

3. **Lessened Environmental Contamination:** By lowering the amount of pollution released into rivers, lakes, and seas, sewage treatment with nanoparticles contributes to environmental protection. Sewage pollution can damage aquatic habitats and life, as well as taint supplies of drinking water. By lowering our exposure to environmental pollutants, sewage treatment contributes to human health protection.

IV. EFFICACIOUS SEWAGE WATER TREATMENT USING NANO PARTICLES:

The use of nanoparticles in water and sewage treatment has the potential to improve the efficiency of several treatment methods. Using nanoparticles can increase the effectiveness of sewage treatment plants overall and in the removal of impurities. Effective applications for nanoparticles include the following:



1. **Nano-Filtration**: Filtration membranes can incorporate nanoparticles like carbon nanotubes or graphene oxide. These nanoparticles can efficiently filter out smaller particles, organic debris, and even some viruses because to their high surface areas. The nanofiltration method, which is used to separate components with sizes close to the nanometer order, is situated between reverse osmosis (OI) and ultrafiltration (UF).

   Monovalent salts and non-ionized organic substances with molar masses less than 200 g/mol are not retained by this kind of membrane. On the other hand, multivalent ionised salts (such as calcium, magnesium, aluminium, sulphates, etc.) and non-ionized organic molecules with a molar mass more than 250 g/mol are maintained .Because reverse osmosis demands higher pressures, nanofiltration uses less electrical energy .The nanofiltration method is based on two mechanisms for separation: separation under the influence of size for uncharged solutes and separation under the influence of electrical repulsion for charged species.

Electromigration, diffusion, and convection are the main transport modes used in nanofiltration. Atomic ions can travel via the membrane's molecular structure's channels between molecular groups. The kind and size of these passageways, as well as ionic size, shape, pore density, pore diameter, and membrane surface charge, all contributed to the nanofiltration membrane's selectivity.

2. **Catalytic Oxidation:** When exposed to ultraviolet (UV) light, nanoparticles like titanium dioxide (TiO2) act as photocatalysts to decompose organic molecules. They can be utilized to eliminate persistent organic pollutants in advanced oxidation processes (AOPs). In the process of treating sewage water, catalytic oxidation makes use of catalysts to speed up the oxidation of organic and inorganic pollutants. Here's a quick rundown:

   - **Principle:** To encourage the oxidation of inorganic chemicals and the breakdown of organic molecules in sewage water, catalytic oxidation uses catalysts, frequently metal-based materials like titanium dioxide (TiO2) or noble metals (such as platinum, palladium).

   - **Contaminant Removal:** It is successful at dissolving a range of pollutants, including:
     - Volatile organic compounds (VOCs), organic dyes, and medicines are among the organic contaminants that can be oxidized catalytically.
     - Pathogens: Although not the main disinfection technique, it can help to lower the microbial burden in sewage water.
     - Toxic metals: such as arsenic and chromium, can be transformed or removed with the help of some catalytic processes.

   - **Advanced Oxidation Processes (AOPs):** Catalytic oxidation is frequently included in advanced oxidation processes (AOPs), which boost the effectiveness of treatment by combining oxidation with other methods like ultraviolet (UV) light or ozone.

   - **Photocatalysis:** UV light activates catalysts in photocatalytic oxidation, producing extremely reactive species such hydroxyl radicals. The disintegration of pollutants is brought on by these radicals.

   - **Environmental Benefits:** Because catalytic oxidation does not significantly rely on chemical additives, it may be environmentally benign. It can aid in lowering the levels of hazardous and persistent organic contaminants in sewage water.

3. **Nano-Adsorbent:** Wastewater Utilizes Nano-adsorbents. Adsorbent and adsorbate affinities serve as the primary regulating force in adsorption. With an increase in adsorbent surface area, adsorption progresses more quickly. The adsorbent plays a crucial role in determining the adaptability, effectiveness, and cost-effectiveness of the adsorption process. Commercial activated carbons, zeolites, commercial activated alumina, silica gels, ion-exchange resins, and other adsorbents are quite effective at removing heavy metal ions and other types of pollutants, although they do have significant limits.

   Many of them are extremely expensive, some need pretreatment, and another issue is with their disposal and regeneration. Adsorbents that have surmounted these restrictions, such as magnetic adsorbents, Saudi natural clay, and nano-adsorbents, have been employed to remove pollutants recently.

Due to their many sorption sites, high specific surface area, low-temperature modification, porosity, surface functionalities, short intraparticle diffusion distance, and ion binding capabilities, nanoparticles are chosen over other adsorbents. The form, size, chemical composition, crystal structure, physicochemical stability, surface energy, surface area, and surface roughness of nano-adsorbent materials are additional physicochemical characteristics that have an impact on their characteristics and effectiveness. According to research, nanomaterials can become more reactive as their size decreases, increasing their surface area relative to volume.

Additionally, surface charge has a significant impact on the toxicity of nanoparticles because it controls a variety of properties of nanomaterials, such as colloidal behaviour, selective nanoparticle adsorption, blood-brain barrier integrity, plasma protein binding, and transmembrane permeability.

Along with surface coating and surface roughness, crystal structure and composition are also important factors in the toxicity of nanoparticles.Numerous other kinds of nanomaterials have recently been created based on these physicochemical characteristics. many of them are polymeric nanoparticles, carbon nanotubes, metal nanoparticles, nanowires, and many others. These physicochemical qualities may also be influenced by other elements, including as sizes, intrinsic compositions, innate surface features, external nano-adsorbent materials and functionalization.

4. **Nanoparticles Coated Filters:** Filters that have been coated with nanoparticles can better absorb small particles and organic materials, resulting in cleaner effluent. For improved efficacy in the treatment of wastewater, nanoparticles can be deposited onto filters. In order to remove more impurities, nanoparticles might increase the surface area of the filter. It is also possible to functionalize nanoparticles to selectively target and eliminate the particular pollutants.

The authors concluded that nanoparticle-coated filters have the potential to be a promising technique for wastewater treatment. However, further study is required to create scalable and economical approaches for manufacturing and utilizing nanoparticle-coated filters.

In general, there is still much to learn about the treatment of filtered wastewater with nanoparticle coating. The results, however, are encouraging and indicate that this technique may one day prove to be a useful tool for the treatment of wastewater.

It's crucial to remember, though, that the use of nanoparticles in the treatment of sewage also raises questions regarding possible environmental effects and the necessity of properly removing both the nanoparticles and the cleansed sludge. Further investigation and evaluation are also necessary to determine the cost-effectiveness and long-term impacts of utilizing nanoparticles in large-scale sewage treatment facilities. To ensure a safe and successful implementation, regulatory agencies and wastewater treatment specialists are continually investigating and evaluating the potential advantages and hazards related to employing nanoparticles in sewage treatment.

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V. CONCLUSION

In recent years, nanofiltration (NF) has gained attention as a potential separation method for making drinking water from several sorts of water sources. In this chapter, we summarized the development of materials/fabrication and NF membrane applications in various scenarios, such as surface water treatment, groundwater treatment, water reuse, brackish water treatment, and point-of-use applications, in order to provide a thorough review of the progress of NF-based drinking water treatment. The removal of significant concern micropollutants, such as disinfection byproducts, per- and polyfluoroalkyl compounds, and arsenic, was taken into consideration in addition to summarizing the removal of target main pollutants (such as hardness, pathogens, and natural organic matter).

The potential for water and wastewater treatment to be revolutionized is suggested by nano adsorbents. To create more effective and affordable nano adsorbents, as well as to better understand the long-term effects of their use on the environment and human health, further study is still required. A study of sewage water treatment using nanoparticles shows that nanoparticles have high-quality in effect in clearing the contaminants, resulting in purified water. A study of sewage water treatment using nanoparticles shows that nanoparticles have high-quality in effect in clearing the contaminants, resulting in purified water.

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