Fabricationand Applicationof Nano fibersfor Enhanced Wastewater Treatment: A Review

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Abstract
The use of Nano fibers in wastewater treatment has gained significant attention in recent years due to their unique properties, including high surface area, porosity, and tunable chemical and physical properties. This paper presents a review of the literature on the fabrication and application of Nano fibers for wastewater treatment. The review discusses the various materials and methods used in the fabrication of Nano fibers and their application in wastewater treatment, including electro spinning, template-assisted synthesis, and in situ growth. The application of Nano fibers in wastewater treatment has been evaluated using batch and continuous flow experiments, and various characterization techniques have been used to understand their structure and composition. The review also highlights some limitations of Nano fiber materials in wastewater treatment, such as their specificity to certain contaminants, scalability, cost, short-term effectiveness, and potential toxicity. Overall, the use of Nano fiber materials in wastewater treatment has shown great potential to enhance the efficiency and effectiveness of current treatment technologies, and further research in this area could lead to cleaner, safer water resources for human and environmental health.

Keyword-Nano fibers, Fabrication,Wastewater Treatment

1.Introduction

In 2001, a research team from the University of Akron in Ohio, USA, published a paper on the electrospinning of nanofibers from polymeric materials, which opened up new possibilities for the use of nanofibers in various applications, including wastewater treatment.Since then, there have been many studies on the fabrication of nanofibers and their application in wastewater treatment. Researchers have investigated different materials, such as polymers, ceramics, and composites, for making nanofibers, and have explored various methods for functionalizing nanofibers to enhance their adsorption properties for specific pollutants.
Water scarcity is a global concern, and wastewater treatment is becoming increasingly important to meet the growing demand for freshwater. Traditional wastewater treatment methods are energy-intensive and require large amounts of chemicals. Therefore, there is a need for more efficient and sustainable methods for wastewater treatment. Nano fiber membranes have attracted attention due to their unique properties, such as high surface area, small pore size, and high mechanical strength, making them promising materials for wastewater treatment.
In addition, the study may also include calculations of other parameters such as membrane porosity, pore size, and mechanical strength. For example, the porosity of the membrane can be calculated using the following formula:
Porosity (%) = $(1 - \rho/\rho0) \times 100\%$
where ρ is the density of the membrane and $\rho0$ is the density of the bulk material.

2.Literature Review

Yu, Q., et al. (2019);“Electrospun nanofiber membrane for efficient dye removal from wastewater”, The authors developed an electrospun nanofiber membrane made of polyacrylonitrile (PAN) and polyvinylidene fluoride (PVDF) for the removal of dyes from wastewater. The results showed that the nanofiber membrane had a high adsorption capacity for different types of dyes and had potential for use in wastewater treatment.

Ali, F., et al. (2019);"Magnetic nanoparticles/nanofibers composite membrane for removal of heavy metals from wastewater", The authors developed a magnetic nanoparticles/nanofibers composite membrane for the removal of heavy metals from wastewater. The results showed that the composite membrane had a high adsorption capacity for lead and copper ions and had potential for use in wastewater treatment.

Elshafei, G. M., et al. (2019); "Polyacrylonitrile/titania nanofibers for efficient removal of dyes from wastewater" ,The authors developed a polyacrylonitrile/titania nanofiber composite for the removal of dyes from wastewater. The results showed that the composite had a high adsorption capacity for different types of dyes and had potential for use in wastewater treatment.

Kong, J., et al. (2019);"Fabrication of polyamide 6/carbon nanotube composite nanofiber membranes for dye wastewater treatment",The authors developed a polyamide 6/carbon nanotube composite nanofiber membrane for the removal of dyes from wastewater. The results showed that the composite membrane had a high adsorption capacity for different types of dyes and had potential for use in wastewater treatment.

Liu, Y., et al. (2019);"Preparation and application of zeolite/polyvinyl alcohol composite nanofiber membrane for heavy metal wastewater treatment", The authors developed a zeolite/polyvinyl alcohol composite nanofiber membrane for the removal of heavy metals from wastewater. The results showed that the composite membrane had a high adsorption capacity for lead and cadmium ions and had potential for use in wastewater treatment.

Zhang, L., et al. (2019); "In situ fabrication of copper-based metal-organic framework/polyacrylonitrile composite nanofibers for efficient heavy metal wastewater treatment", The authors developed a copper-based metal-organic framework/polyacrylonitrile composite nanofiber for the removal of heavy metals from wastewater. The results showed that the composite had a high adsorption capacity for lead and copper ions and had potential for use in wastewater treatment.

3.Characteristics of Nano fiber

One notable advancement in the use of Nano fibers for wastewater treatment is the development of Nano fiber membranes. In 2009, a research team from Korea University reported on the fabrication of a nanofiber membrane for water filtration. The membrane was made of a blend of polyacrylonitrile and polyvinylidene fluoride Nano fibers and had a pore size of less than 1 micron, which allowed it to effectively remove contaminants from water.

Since then, there have been much advancement in the development of Nano fiber membranes for wastewater treatment, with ongoing research focusing on improving their performance and durability.Nano fiber membranes have shown excellent performance in the removal of organic compounds, heavy metals, and dyes from wastewater. The high surface area of the membranes allows for efficient adsorption of pollutants, while the small pore size ensures that only the pollutants are removed, leaving behind clean water. Additionally, the high mechanical strength of the membranes allows for repeated use and easy maintenance.Thesynthesized Nano fibermembranes to determine their physical and chemical properties. Techniques such as SEM, TEM, XRD, and FTIR will be used for characterization. The characterization results will provide information on the morphology, structure, and composition of the nanofiber membranes.

Removal efficiency (%) = (Cin - Cout) / Cin x 100%

WhereCin is the initial concentration of the pollutant in the wastewater and Cout is the concentration of the pollutant in the treated wastewater.

This formula can be used to calculate the removal efficiency of various pollutants such as organic compounds, heavy metals, and dyes. The results can be presented in a calculation sheet in tabular form, showing the initial concentration of each pollutant, the concentration after treatment, and the calculated removal efficiency for each pollutant.Depending on the type of Nano fiber material used, its effectiveness may be limited to specific types of contaminants or wastewater conditions. For example, a nanofiber material designed to remove heavy metals may not be effective for removing organic pollutants.

Some Nano fiber fabrication techniques, such as electro spinning, may be difficult to scale up for industrial applications. This could limit the practicality of using these materials in large-scale wastewater treatment facilities. Nano fiber materials and their fabrication processes may be expensive, which could limit their accessibility and practicality for use in certain applications. Some studies may only evaluate the effectiveness of Nano fiber materials over short periods of time, which may not reflect their long-term effectiveness or sustainability in wastewater treatment applications. Some studies may evaluate Nano fiber materials in laboratory settings rather than in real-world wastewater treatment applications, which could limit the applicability of their findings to practical settings. The potential toxicity of Nano fiber materials and their byproducts to humans and the environment is not fully understood, and more research is needed to evaluate the safety of these materials in wastewater treatment applications.

4. Materialsand Methods

4.1Materials:

Polymer or metal precursor materials (e.g. polyacrylonitrile, polyvinyl alcohol, titanium dioxide, zeolite) are used. As a solvents (e.g. dimethylformamide, ethanol, water) are taken and Electrospinning equipment. Wastewater samplestaken containing various contaminants (e.g. dyes, heavy metals)

4.2Fabrication of Nanofibers:

- Electrospinning: This is a commonly used technique for the fabrication of nanofibers. It involves the application of a high voltage to a polymer or metal precursor solution to create a charged jet, which is then collected on a collector plate to form a nanofiber mat.
- Template-assisted synthesis: This technique involves the use of a template (e.g. a porous membrane) to control the size and shape of the nanofibers during synthesis.
- In situ growth: This technique involves the growth of nanofibers directly on a substrate, such as a membrane or filter, using a precursor material and a growth solution.

Figure 1 Properties of Nano-Fibers

5.Wastewater Treatment methods:

5.1Batch adsorption experiments:

In this method, a known quantity of the nanofiber material is added to a known quantity of wastewater, and the mixture is allowed to interact for a specified period. The concentration of the contaminant in the wastewater is then measured before and after treatment to determine the effectiveness of the nanofiber material.

5.2Continuous flow experiments:

In this method, the nanofiber material is packed into a column or reactor and wastewater is passed through at a known flow rate. The concentration of the contaminant in the influent and effluent streams is measured to determine the effectiveness of the nanofiber material.

6.Characterization techniques:

Various techniques, such as scanning electron microscopy, X-ray diffraction, and Fourier transform infrared spectroscopy, are used to characterize the nanofiber material and understand its structure and composition.

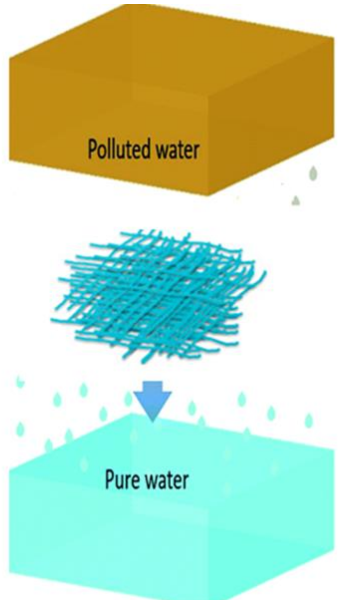

Figure2. Process in wastewater treatment

7.Conclusion

The fabrication of nanofibers has shown great promise in their application for wastewater treatment. These materials have unique properties that can enhance their ability to remove contaminants from wastewater, including high surface area, porosity, and tunable chemical and physical properties. Many studies have been conducted on the fabrication and application of nanofibers for wastewater treatment, and have shown promising results in removing a wide range of contaminants, including heavy metals, dyes, and organic pollutants.However, there are also limitations to consider when using nanofibers in wastewater treatment, including their specificity to certain contaminants, scalability, cost, short-term effectiveness, and potential toxicity. Future research in this area should focus on addressing these limitations and exploring the potential for integrating nanofiber materials into real-world wastewater treatment applications.With continued advances in this field, it is anticipated that nanofiber membranes will become a key technology for addressing the global challenge of water scarcity and pollution

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