Nanofiber Membranes: Cleaning Out Contaminants

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Introduction:

Clean water is essential to our health because contaminated water exposes us to disease-causing microbes and pathogens [1]. By utilizing nanofibers, we can create membranes that filter out such contaminants, thus improving global health and hygiene.

Background:

Here are some numbers that illustrate the current need for new innovations in water treatment technology [2]:

- 1.2 billion people can hardly obtain safe drinking water
- 2.6 billion have little or no sanitation
- Millions of people die from waterborne diseases each year
- 80% of illnesses in developing countries are linked to poor water and sanitation conditions

Separation Membranes:

Electrospun nanofibers operate as size exclusion membranes. This is due to the fact that the nanofibers typically range anywhere between 200-800 nanometers in diameter (Figure 1) [3].

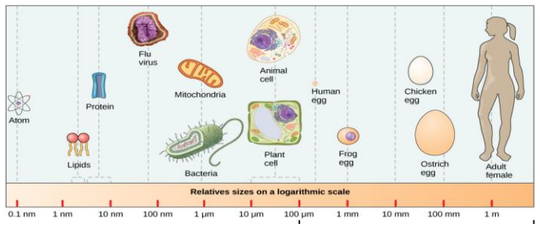

Fig.1 - Bacteria and other contaminants are typically one micrometer or larger. Nanofibers are much smaller than bacteria, hence why they make an effective filter. [4]

However, nanofibers are porous enough to still have a high amount of water flow. This opens up new avenues of application of nanofiber membranes for the pretreatment of water before reverse osmosis [5].

Can Developing Countries Use This Technology?

In regions with high poverty and poor infrastructure, it's not economically viable to set up large water treatment plants that can utilize nanofiber membranes. However, one company has already paved the path for the usage of nanofiber membranes in portable products and household appliances (Figure 2).

Fig.2 - Here we see a nanofiber cartridge installed under the nozzle of a water bottle. These nanofiber cartridges have been mass produced to be installed in water bottles, faucets, pitchers, etc. [6]

Affinity Membranes:

In regions with water treatment plants, we can improve the process by giving separation membranes the properties of affinity membranes. They operate by removing contaminants based on their chemical or biological properties. Relying on the specific immobilized ligands on the surface, nanofibers can capture nanoparticles, ions, bacteria, etc. in a customized manner (Figure 3) [2].

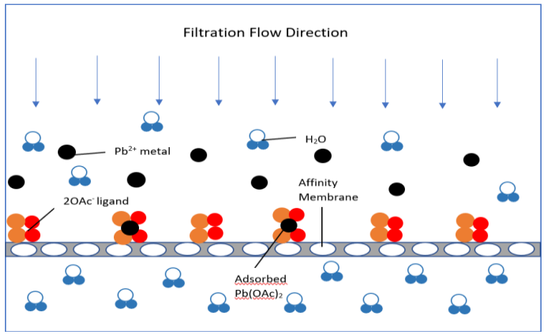

Fig. 3 – A $2OAc^-$ coated nanofiber affinity membrane is designed to filter out Pb^{2+} ions [7].

Future Implications:

Due to the nature of nanofibers, with their porousness and high surface-area to volume ratios, nanofibers are ideal candidates as materials for a variety of fields for purposes such as [4]:

- Defending first responders with new and improved hazardous material suits
- Protecting hospitals and buildings with improved air filters
- Improving energy density in polymer batteries
- Increasing sensitivity to toxic fumes in sensors
- Paving a new way for drug delivery in therapeutics

Conclusion:

The field of nanofiber technology is as vast as it is exciting! Whether you're interested in healthcare, defense & security, energy, or biotechnology, nanofibers have a place in it. It's important that we keep researching about the uses of nanofibers in order to improve on the process of its creation, and discover more effective ways to help save the world and improve lives.

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