Self-Recycling System for Microplastic Removal: Development of a Novel Ferrofluid-Based Filtration Technology for Affordable Water Treatment

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The NOAA defines microplastics as "plastic pieces less than five millimeters long." Microplastics have been found from the Mariana Trench to Mount Everest, and from the human brain to the placenta of unborn fetuses. Microplastic exposure is linked to an increased risk of cancer, neurodegenerative disease, and hormonal disruptions, and disproportionately affects underserved populations. Microplastics enter water through runoff, effluent, and plastic plumbing. Traditional water filtration systems' high costs, reliance on chemical treatments, and maintenance requirements make them inaccessible to underserved areas. A ferrofluid-based system using magnetic separation for microplastic removal has the potential to be a cost-effective, energy-efficient, and sustainable solution to the microplastic crisis. However, there is currently no way to use ferrofluids for this application. This project aimed to create an automated system using an oil-based ferrofluid for microplastic removal. A prototype was designed to pump ferrofluid into microplastic-contaminated water. The mixture is processed through a magnetic separator and layered filter to remove microplastics and separate the ferrofluid, allowing purified water to exit the system while recycling the ferrofluid for reuse. The prototype removed 95.52% of microplastics from water, recycled 87.15% of the ferrofluid used, and effectively filtered PET particles according to a t-test, showing similar results to conventional filtration technologies, but at a lower cost and higher efficiency. The system developed offers a potential alternative to existing filtration technologies, and in regions facing barriers to clean water access, could turn the tide on the way water pollution is addressed.

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