Analysis of Microplastic Removal Efficiency of Synthesized Ferrofluids and the Development of an Automated Prototype for Aquatic Environments

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About 51 trillion microplastics (< 5mm size), which are proven to be harmful to living organisms, are present in water bodies worldwide. Filters, membranes, and nets, currently used to capture aquatic microplastics are costly and labor-intensive, limiting widespread usage. Ferrofluids (Fe3O4 and oil) are cheaper alternatives, which exploit the hydrophobic properties of microplastics and oil, allowing microplastics removal using magnets. In this research, varying volumes of used and unused, cooking oils and engine oils were combined with varying weights of Fe3O4 to synthesize ferrofluids to extract fixed amounts of PP, PE, and PET (< 2mm sized) microplastics and the magnetic removal efficiencies (MRE) were calculated. The results were used to understand the effect of different oils, oil volume, and Fe3O4 weight on microplastic removal efficiency with the goal of reducing cost and negative environmental impacts. An electromechanical prototype using Raspberry Pi was built to fully automate microplastic removal. Results indicate an inverse relationship between oil volume and MRE and a direct relationship between ferrite concentration and MRE. Unused cooking oil and used engine oil had the highest and lowest MRE respectively. Greater than 85% average MRE was observed for each tested plastic using the prototype. Laboratory and prototype investigations indicate that a high MRE is possible, illustrating that ferrofluids used to magnetically remove microplastics are a viable solution to the increasing aquatic microplastics problem.

Awards Won:

Second Award of $2,000

Florida Institute of Technology: Full Tuition Presidential Scholarship

Patent and Trademark Office Society: Second Award of $500