Removing Microplastics from Water Using Ferrofluids

Project title: Removing Microplastics from Water Using Ferrofluids

Name of the student: Muhammed Hibban

Name of school: Sana Model School

City & state: Chennai, Tamil Nadu

Introduction:

Plastic pollution in water is a large issue around the world. In fact, around the globe, the production or creation of plastic has nearly doubled from 2005-2025 alone. Removing plastics from water is challenging, but it can be overcome with the use of ferrofluids. Ferrofluids are known as liquid magnets. They contain a suspension of ferromagnetic particles in a solvent, like oil.

Selection of problem:

Up to 83% of tap water worldwide has been found to contain microplastics.

Microplastics have even been found in fresh Antarctic snow.

79% of plastic waste has been either buried or discarded.

Only 9% of plastic waste has even been recycled.

Microplastics, defined as plastic particles smaller than 5 mm, have been widely detected in oceans, rivers, and even drinking water. Traditional filtration methods are not always effective at removing such fine particles. Ferrofluids, which are colloidal suspensions of magnetic nanoparticles, have shown potential in capturing microplastics through magnetic separation. This research problem has societal importance as it addresses environmental pollution, water safety, and public health. If successful, this approach may provide a sustainable solution for microplastic contamination in both urban and rural settings.

Purpose:

Can micro plastic be removed from water with ferro fluid? Can water really be cleaned with ferro fluid?

The problem has to be solved because it can cause widespread illness, including diseases like cholera and typhoid, due to bacteria and viruses. If animals lack access to clean water, they can suffer from dehydration, weakened immune systems

The study will vary the ferrofluid concentration (independent variable) to measure changes in microplastic (dependent variable), while maintaining constant control conditions.

Hypothesis:

It is hypothesized that increasing the ferrofluid concentration in contaminated water will significantly increase the removal efficiency of microplastics, up to a certain saturation level beyond which the effect may plateau.

Variable:

Independent Variable: Concentration of ferrofluid (% volume added).

Dependent Variable: Removal efficiency of microplastics (%).

Controlled variables:

- PH of water
- Temperature of water
- Initial concentration of microplastics
- Size and type of microplastics
- Mixing time and speed
- Magnetic field strength and exposure time
- Volume of water sample
- Contact time of ferrofluid with microplastics
- Equipment and procedure

Materials:

- Commercial ferrofluid
- Sample microplastics
- 250 mL beakers
- Strong neodymium magnet (covered in plastic)
- Syringes or pipettes for dosing ferrofluid
- Gloves, goggles, lab coat
- Distilled water and salt

Methods:

Preparation of Samples

- Prepare water samples with a known concentration of microplastic particles (measured in mg/L).
- Maintain consistent particle size ranges (e.g., 100–500 μm).

Addition of Ferrofluids

- Add ferrofluid to separate water samples in varying concentrations (e.g., 0.5%, 1.0%, 2.0%, 3.0% v/v).
- Stir samples using a magnetic stirrer at a fixed speed for 10 minutes.

Magnetic Separation

- Place strong external magnets near the sample container to attract the ferrofluid–microplastic complexes.
- Allow 15 minutes for full separation.

Measurement and Data Collection

- Filter the remaining water using microfiltration membranes.
- Count residual microplastics under a microscope

Data tabulation:

Sample ID	Ferrofluid concentration	Initial microplastic count	Final microplastic count	Removal Efficiency
Control	0.0			
Test 1	0.5			
Test 2	1.0			
Test 3	2.0			
Test 4	3.0			

Sample	**Contact time**	**Initial particles/L**	**Final particles/L**	**Removal %**

Ferrofluid amount	Weight of microplastic	Number plastic pieces (before)	Number of plastic pieces removed (after)	Percent efficency of plastic removed

Risk and Safety

- Handling ferrofluids will require gloves and protective eyewear to avoid skin staining or accidental contact.
- Magnets must be handled with care to prevent pinching injurie

Data Analysis

Data will be analysed by calculating the removal efficiency at each ferrofluid concentration. Statistical analysis, including mean, standard deviation, and analysis of variance (ANOVA), will be used to determine the significance of the results. Graphs will be plotted to show the relationship between ferrofluid concentration and microplastic removal efficiency.

Result: After experiment

Discussion: In progress

Bibliography:

- **Baldwin et al. (2016, September 14).** ***Plastic Debris in 29 Great Lakes Tributaries: Relations to Watershed Attributes and Hydrology.*** **Retrieved May 7, 2025.**
- **O'Sullivan, C. (2014, December).** ***Microplastics: An Issue of Scale.*** **Retrieved May 12, 2025.**