

The background of the slide is a vibrant blue ferrofluid, characterized by its shimmering, iridescent, and wavy surface. Scattered throughout the fluid are numerous small, colorful particles of microplastics in various shapes and sizes, including red, yellow, green, blue, and white. The overall effect is a dynamic and visually striking representation of the subject matter.

Ferrofluid Fix

Removing Microplastics

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Abstract

Microplastics are small plastic particles that contaminate water sources and learning how to remove them is important because it could help improve human health, marine life and the environment. The purpose of my experiment is to explore how effective the ferrofluid magnetic removal method extracts different types of microplastics from water. If the ferrofluid magnetic removal method is used on water containing different types of microplastics, then it will extract all types of microplastics because according to the chemistry rule 'like attracts like,' the microplastics should stick to the ferrofluid allowing them to be removed from the water using a magnet. I conducted an experiment using five different types of microplastics: polypropylene, polystyrene, polyvinyl chloride, acrylic, and polyethylene terephthalate. The ferrofluid magnetic removal method worked best on the PVC pipe (polyvinyl chloride) samples removing 98.2% and was the least effective on the styrofoam (polystyrene) samples removing 73.8%. My hypothesis was supported as the ferrofluid magnetic removal method successfully extracted all five varieties of microplastics from the water. Microplastics are a part of everyday life and they can be difficult to avoid. My goal is to continue to develop removal methods to treat larger bodies of water so we can have cleaner lakes, rivers, and oceans.

Research

- ❖ **What are microplastics?** Microplastics are small plastic particles that are less than 5mm in size. They can be harmful to the environment and human health. It is important to understand microplastics can be so tiny they are invisible, these tiny toxins make their way into the air we breathe, water we drink, food we eat, and clothing we wear.
- ❖ **Human Health:** Microplastics affect human health, marine life, and the environment in a negative way. They are carcinogenic, which means they can cause cancer in humans, so they are very bad for us. In the article *Microplastics in Water: Understanding the Risk* it says, “They pose potential health risks, including gastrointestinal irritation, and respiratory problems plus they can carry toxic contaminants.”
Microplastics have been found in human blood organs and even the brain! We consume microplastics every day and we eat five grams of microplastics per week, which is about a credit card size amount.



Image from istockphoto.com

Research

- ❖ **Environmental and Marine Life:** Microplastics impact the environment and marine life because when plastics are thrown into the ocean they break down into tiny particles that fish or other sea creatures consume, because they mistake it for food. It makes them sick or not want to eat and often causes them to die. In the article *What are Microplastics* it says, “Microplastics can attract and carry pollutants that are in the water.” This shows that microplastics are bad for marine life and the environment because they can get into the soil harming plant growth and disrupt the ecosystem. When they get into fruits and vegetables we eat, then we consume microplastics, which leads back to us getting cancer and respiratory diseases.



Purpose

The purpose of this experiment is to explore how well the ferrofluid magnetic removal method extracts different types of microplastics from water. This is important because microplastics are contaminating water sources and learning how to remove them could help improve human health, marine life, and the environment.

Variables

1. Does the **microplastic size** affect the amount of microplastic removal?
2. Does the **amount of water** affect the amount of microplastic removal?
3. Does the **temperature of the water** affect the amount of microplastic removal?
4. Does the **amount of microplastic** affect the amount of microplastic removal?
5. Does the **amount of ferrofluid** affect the amount of microplastic removal?
6. Does the **number of magnets** affect the amount of microplastic removal?
7. Does the **microplastic type** affect the amount of microplastic removal?

Microplastic types used in this experiment:

- Polyethylene
- Polystyrene
- Polyvinyl Chloride
- Acrylic
- Polypropylene

Question

How does the ferrofluid magnetic removal method affect different types of microplastics in water?

Constants

1. The amount of water
2. The temperature of water
3. The same scale used
4. The amount of vegetable oil and magnetite powder (ferrofluid)
5. The number of magnets
6. The amount of microplastics
7. The removal method
8. The same size beaker
9. The same glass stirring rod
10. The same metal file
11. The same test tube
12. The same mesh sieve

Hypothesis

If the ferrofluid magnetic removal method is used on water containing different types of microplastics, then it will extract all types of microplastics because according to the chemistry rule 'like attracts like,' the microplastics should stick to the ferrofluid allowing them to be removed from the water using a magnet.

Materials

- **Plastics to create microplastic samples**
- **Metal file**
- **Scissor**
- **Petri dishes (15)**
- **250 ml glass beaker**
- **Glass test tube**
- **Glass stirring rod**
- **Room temperature bottled water**
- **Measuring teaspoons (1/4 & 1/8)**
- **Light vegetable oil (1 bottle)**
- **Magnetite powder (100g packet)**
- **Fine mesh sieve**
- **18mm round magnets (10)**
- **Digital Mg Scale**
- **Gloves**
- **Protective eye wear**



Procedure

Preparation: I used a metal file to create microplastic samples out of water bottles, styrofoam and PVC pipe, then I used scissors to cut the acrylic clothing fibers and plastic straws. I researched how to make ferrofluid and bought my ingredients: vegetable oil and magnetite powder. After a few trials, I found that 1/4 teaspoon of vegetable oil combined with 1/8 teaspoon of magnetite powder worked best.

Background Information: An inventor named Fionn Ferreira used a ferrofluid mixture to attract and collect microplastics with a magnet, effectively removing them from water.

Ferrofluid is a magnetic liquid made with vegetable oil and magnetite powder. Magnetite powder, also known as black iron oxide, is a magnetic mineral powder.



Photo taken by Author



Photo taken by Author

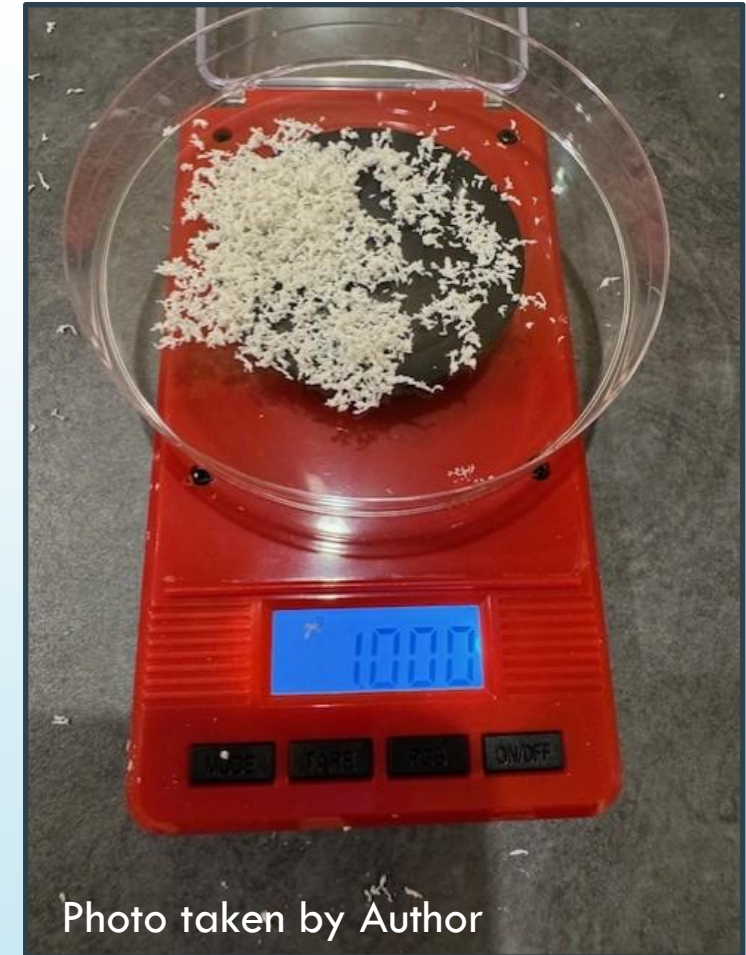
Procedure

Run 1 (Control – Polyvinyl Chloride without Removal Method)

Run 2 (Water Bottle - Polyethylene)

1. Using a 250 ml beaker, add 150 ml of room temperature bottled water
2. Place an empty petri dish on a scale and zero it out
3. Carefully add the polyethylene sample into a petri dish until the scale reads 1g
4. Add the 1g microplastic sample to the water
5. Add 1/4 teaspoon of light vegetable oil to the water and stir with glass stirring rod
6. Add 1/8 teaspoon of magnetite powder to the water and stir with glass stirring rod
7. Insert glass test tube with 10 round magnets inside to extract microplastics
8. Pour the remaining water through a mesh sieve
9. Wait a day to let the leftover microplastics dry
10. Weigh the remaining microplastics

Run 3 (Styrofoam – Polystyrene) | Run 4 (PVC Pipe – Polyvinyl Chloride) | Run 5 (Acrylic Fibers – Acrylic) | Run 6 (Plastic Straws – Polypropylene) ♦ Repeated procedure described in Run 2 for Runs 3-6

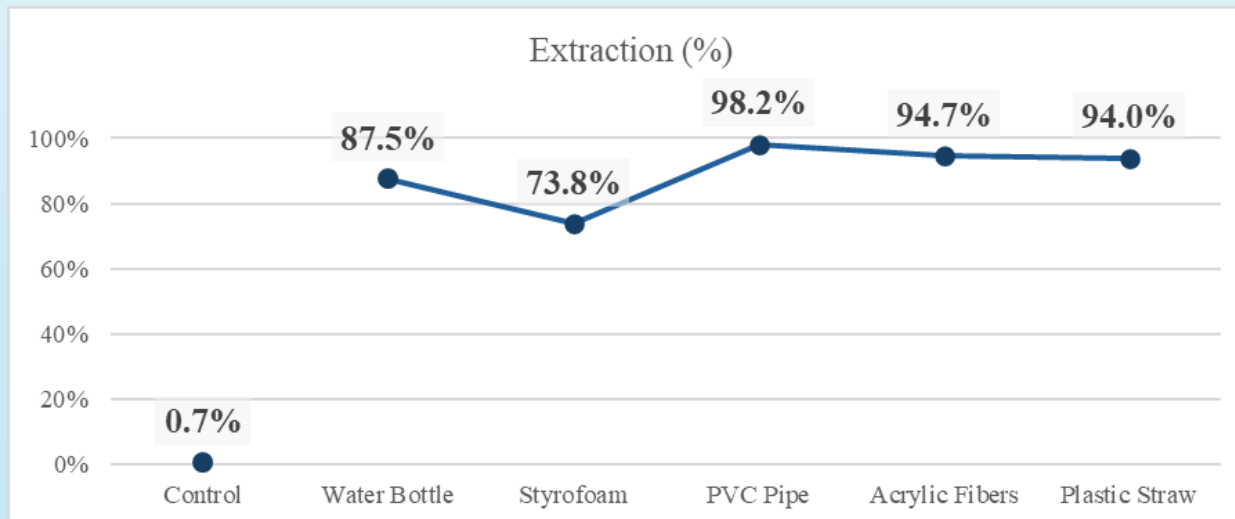
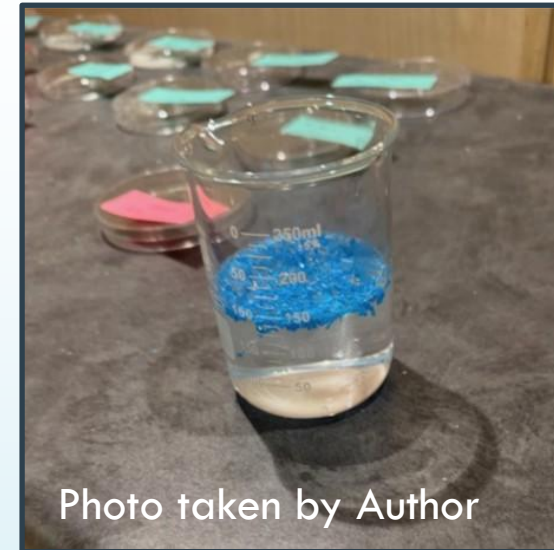
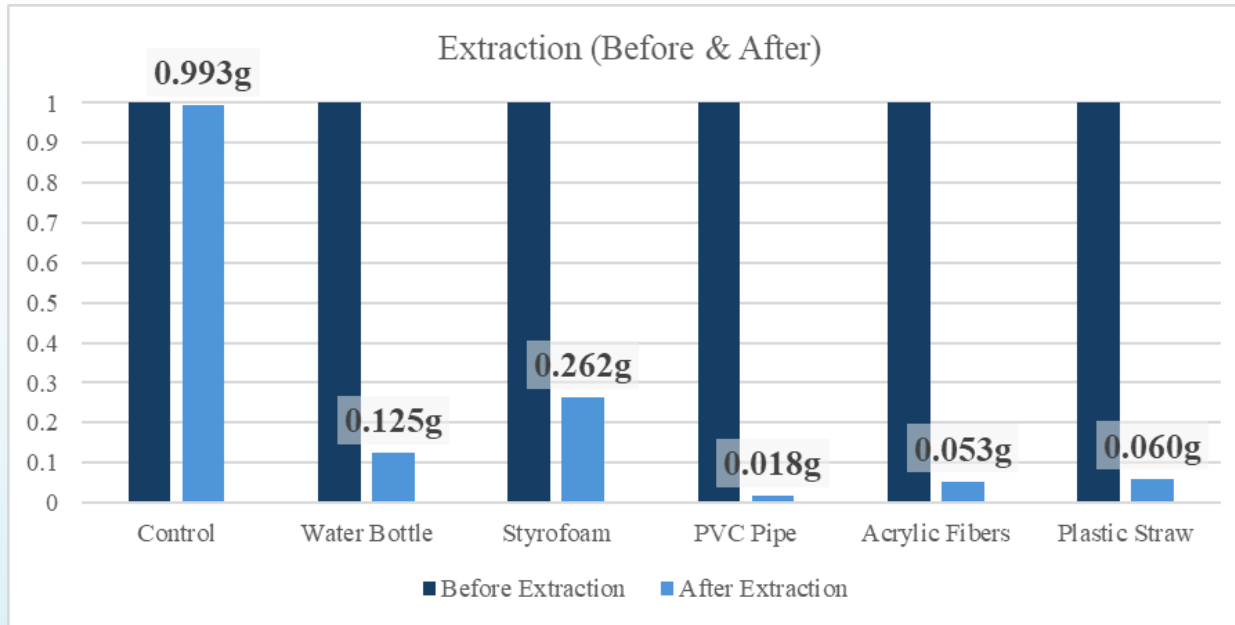


Data & Results

Based on the data I collected, the ferrofluid magnetic removal method worked best on the PVC pipe microplastics removing 98.2%, acrylic clothing fibers 94.7%, plastic straw 94.0%, the plastic water bottle 87.5%, and the least amount of microplastics removed was from the styrofoam sample which was 73.8%.

Sample	Microplastic Type	Before Extraction _(a)	After Extraction _(b)	Difference _(a - b)	Extraction% _([a-b]/a)
Control	Polyvinyl Chloride	1g	0.993g	0.007g	0.7%
Water Bottle	Polyethylene Terephalate	1g	0.125g	0.875g	87.5%
Styrofoam	Polystyrene	1g	0.262g	0.738g	73.8%
PVC Pipe	Polyvinyl Chloride	1g	0.018g	0.982g	98.2%
Acrylic Fibers	Acrylic	1g	0.053g	0.947g	94.7%
Plastic Straw	Polypropylene	1g	0.060g	0.940g	94.0%

Data Analysis



Conclusion

- ❖ My hypothesis was supported, the data from my experiments confirms the ferrofluid magnetic removal method effectively removed all five different types of microplastics from water. Both chemistry and physics played a role in the success of my experiment. The oil in the ferrofluid successfully adhered to all five varieties of microplastics because both oil and microplastics are non-polar and per my hypothesis 'like attracts like.' The magnetic particles in the magnetite powder, suspended in oil, reacted to the magnetic field. The ferrofluid successfully attached to the microplastics in all five samples and the magnet easily extracted the microplastics leaving behind clear water with significantly less microplastics.
- ❖ The data and results demonstrate the effectiveness of the ferrofluid magnetic removal method across the water bottle, styrofoam, PVC pipe, acrylic fibers, and plastic straw samples. I learned that the ferrofluid magnetic removal method works really well. At best it removed 98.2% of the microplastics and the least it removed was 73.8%, which is still the vast majority of microplastics. In my experiment, I used some of the most common types of microplastics found in water and my data shows the ferrofluid magnetic removal method has the potential to be used on larger bodies of water.
- ❖ Microplastics are a part of everyday life and they can be difficult to avoid. If the removal method shown in my project continues to be developed, it could be used to have cleaner lakes, rivers and oceans. I learned that microplastics are everywhere. Understanding where microplastics come from, the effects they have, and how to reduce them is the best way to help solve the problem of microplastic pollution.

References

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