

Hong Kong Student Science Project Competition 2022

Template of Extended Abstract (Investigation)
(Word Limit: 1,000 words, Pages: 2 pages only)

Team Number: SBBC277

Project Title: Aqua Plastic Extraction (絕「膠」)

Project Type: Type B - Investigation

To our best knowledge and after thorough literature research, as at ___/___/___ , there are / are no* similar works. If there are, the reference links are as below:

N/A

The enhancement our project has made for the existing related products or research is summarized as below:

N/A

I. Background

Plastic becomes necessary things in our daily life. However, according to a survey by the United Nations and Greenpeace, plastic accounts for 60% to 80% of the world's marine debris and at least 8 million tons of plastic waste end up in the ocean every year. Microplastics, which are plastic debris that are less than five millimeters in length, can be found in tap water, table salt, sea salt etc easily which will be ingested by humans. The toxins like polycyclic aromatic hydrocarbons (PAHs), and dichlorodiphenyltrichloroethane accumulate in the human body and affect the immune system and nervous system. Therefore, our aim of the experiment is to reduce the microplastic in the sea to alleviate the effect on humans and aquatic life.

II. Objectives

To find out the degree of removal of microplastics using the ferrofluid
Finding out the effect of temperature on the removal of microplastics

III. Hypothesis

When oil comes into contact with microplastics, some of the microplastic instantly sticks onto oil due to polarity. It can be seen that the oil instantly dissolves into microplastic upon contact. But oil only sticks to plastic but not other solids. It is because of the polarity. Ferrofluid is used in the experiment due to its magnetic property and the ease of extraction with the aid of magnets, also its viability of application in the ocean. The size of the plastics used in the investigation is not as small as microplastics. The length of the plastics used is 1 millimeter while microplastics are plastic debris that are less than five millimeters in length. However, the polarities of the plastics used and microplastics are comparable and the results of the experiment can be applied to microplastics.

IV. Methodology

Materials used:

1. Vegetable oil 2. Iron Powder 3. Magnets 4. Sea water 5. Expanded polystyrene

First, seawater was added into a beaker with 18 pieces of expanded polystyrene about 1 millimeter in length. Second, vegetable oil was added to the beaker and stirred for 15-30 seconds. Third, iron powder was added to the oil after stirring to make ferrofluid. Then, magnets were put into a small container and sunk into the seawater to attract the ferrofluid, extracting the expanded polystyrene stuck onto the ferrofluid. The process was repeated several times to ensure all plastic is extracted.

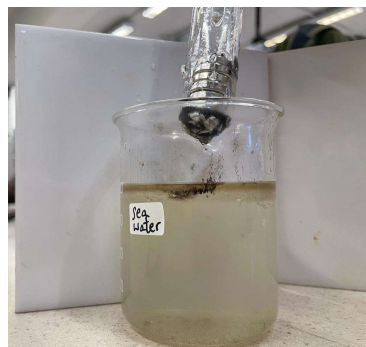
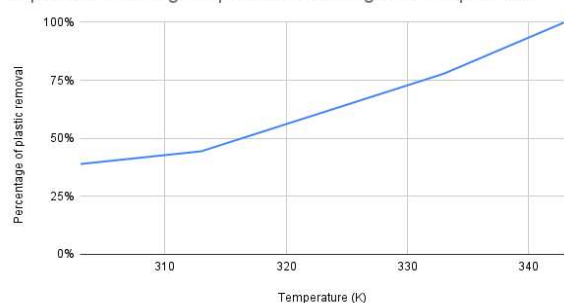
Microplastics and oils are hydrocarbons. They are molecules that consist mainly of carbon and hydrogen. They are held by van der Waals force therefore there is no dipole moment between them. Therefore, it is a nonpolar compound. Polar compounds tend to bind with polar compounds, as 'like dissolve like'. It works the same with nonpolar compounds. Oil is immiscible with water as they are substances with different polarities. When oil is poured into a pool of water filled with plastic. Oil will stick to and even dissolve into plastic. Binding themselves with the plastic as both are nonpolar hydrocarbons. They can then be easily removed via filtration or other oil extracting means.

V. Results

Data Collected: (Temperature against the % of plastic removal)

Temperature (°C)	Temperature (K)	Number of Plastic Remained (Initial # of plastic : 18)	Percentage of plastic removal
70	343	0	100%
60	333	4	77.8%
50	323	7	61.1%
40	313	10	44.4%
30	303	11	38.9%

A plot of Percentage of plastic removal against Temperature



The experiment was repeated several times with different temperatures, from 303K to 343K. The higher the temperature of the solution mixture with plastic, the higher the percentage of removal of plastic. The temperature is directly proportional to the percentage removal of plastic in a mixed solution.

The limitation of this experiment set-up is the concentration of microplastic in the solution, it is an assumption set-up during the investigation and it may not directly reflect the real ocean situations.

VI. Conclusion

According to the experiment investigation, vegetable oil and fine iron powders can effectively remove the micro-plastic contained in the water. The effectiveness can be measured by calculating the percentage removal of plastics. With different temperatures, the higher the temperature, the higher the percentage of plastic removal by oil and iron powders. Different ways of extraction were presented such as freezing the water and extracting the oil out, supermembrane, oil skimmer and ferrofluid. Ferrofluid is chosen because of its cost and ease of extraction, also of its viability of application in the ocean.

□ **Our project is developed based on our school's previous project and the enhancement is as below:**

More variables can be tested for example the pH of the solution, the type of microplastic or the number of iron powder added. We can also make a simulation setup for the removal of microplastics in seawater with a remote-controlled boat, a big tub and an oleophobic filter.