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Removing oil spill from water by ferrofluid

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oil spill, ferrofluid, environment

Abstract
Oil spill is a type of environmental pollution caused by the release of liquid petroleum hydrocarbons into the environment due to human activity, especially in the seas. Unfortunately, oil spills are increasing every day in the world's oceans. Also, the enormous task of cleaning up oil spills in oceans and seas has been burdening industry, government, and environmentalists for decades. In order to find a solution to this significant environmental threat 11th grade student has started a project to remove oil spills from water. With the help of ferrofluids and strong magnets separating the most common types of oils in the oceans: sunflower oil and olive oil is aimed. Due to increasing Covid-19 cases research is completed, and experiment is conducted at home under the guidance of an instructor. According to his experiments and analyzes at home on both types of oils approximately 66% of oil is removed from the water.

Introduction

The increase in oil production, transportation and use around the world has caused environmental pollution at sea in different levels. Some leaks in the process of oil production and various accidents at oil production platforms gave rise to marine pollution. Also, the frequent occurrence of floating oil residues in the oceans at measurable levels in most of them carried this issue on a global scale.

Due to the increasing danger of marine oil pollution a project has been started to clean up oil spills from water with the use of ferrofluid and a strong magnet. With the help of nanotechnology, not just developing a new technique to clean up oil spills in water is aimed, but also helping industries, governments and environmentalists which have been facing this

enormous issue of cleaning up oil spills involving great amounts of time, resources and money. The influence of school culture on environmental education has also contributed to the student's perspective on the environment and encouraged him to launch this project. The main reason for this is that the individual's environmental awareness raises and is nourished in the preschool period and primary education, takes shape until the end of university. (Cermik and Akcay, 2020)

The aim of this study is to compare the efficiency of separating sunflower and olive oil from water using various amounts of ferrofluid and a strong neodymium magnet. The project and research started at school; however, due to rapid spread of Covid 19 the schools have been closed, thus the experiment is done, and its results are analyzed at home.

Background information

Ferrofluid is a colloidal liquid made of nanoscale ferromagnetic particles which are able to stay suspended in liquids. The ferrofluids behave as liquids when no strong magnetic field is present. For example, they flow. However, when a strong magnetic field is introduced, ferrofluid becomes very magnetized and pulled to the magnet. By taking advantage of this property of ferrofluid, in our experiment ferrofluid has been added to oil spilled water, and the spilled oil became magnetic. (Berger and Adelman, 1999) The carrier fluid mixed with the spilled oil and sank to the bottom, but the water stayed on the surface because of the immiscibility between water and oil. Lastly, neodymium magnets have been used to separate magnetized oil and water.

Variables

In this experiment, oil spills have been cleaned up from the water by using a ferrofluid and a strong magnet. The aim of this experiment is to test and compare the efficiency of removing an olive oil spill from the water and a sunflower oil spill from the water by applying the same methodology. Variable called efficiency are shown in Equation 1.

Equation 1: efficiency = volume of removed oil / volume of original spill

Independent variable: Type of oil separated from water.
Dependent variable: Efficiency of ferrofluid and neodymium magnet in removing oil from water.
Control variables: Type of water, ferrofluid, neodymium block magnet used in the experiment. Experimental procedure implemented under the same conditions including temperature, place...

Experimental procedure

Before the experiment has started, the apron and gloves are worn in order to take safety precautions. After making the necessary preparations, the experimental procedure started with

preparing waters. Two petri dishes are filled with 13 milliliters of tap water in each. One or two drops of food coloring added to both petri dishes to increase the visibility. Both petri dishes are mixed to facilitate the dissolving of the food coloring in the water. Then, oil spills are prepared. 3 milliliters of olive oil is poured into one of the petri dishes, and 3 milliliters of sunflower oil is poured into the other petri dish. Following this, ferrofluid is prepared. The bottle of ferrofluid is shaken before opening it. Four drops of ferrofluid are added in each petri dish. Ferrofluid distributed itself over the oil spill in both petri dishes. After these, both mixtures transferred into two different graduated cylinders. Later, the neodymium magnet is put in one of the corners of the plastic bag. Magnet, enclosed in the plastic bag, moved through the graduated cylinder in one movement. The magnet in the bag is passed through the graduated cylinder a second time. The same procedure is repeated for the last time. The magnet is passed through the oil three times for each of the graduated cylinders. Oil left top on the water in both graduated cylinders. The volume of oil left on the water in both graduated cylinders are determined and recorded in order to find the efficiency of removal for each type of oil. Readings are recorded to the table shown in Table 1. Total of 3 tests are made for each type of oil and the same procedure is implemented.

	Volume of removed sunflower oil (mL ± 0.1 mL)	Volume of removed olive oil (mL ± 0.1 mL)	Initial volumes of oils (mL)
TRIAL 1	2.1	1.8	3.0
TRIAL 2	1.9	2.0	3.0
TRIAL 3	2.0	2.1	3.0
AVERAGE	2.0	1.96	
EFFICIENCY (%)	2.0 / 3.0 = 66.6	1.96 / 3.0 = 65.3	

Table 1. Volume and efficiency of removing sunflower and olive oil

Results

For the Test 1, 2, 3 in the cleaning procedure of sunflower oil from water: 2.1 mL, 1.9 mL, 2.0 mL of oil removed, respectively. With an average of 2.0 mL of oil removed. Efficiency of this method

on the removal of sunflower oil is 66.6 percent. For the Test 1, 2, 3 in the cleaning procedure of olive oil from water: 1.8 mL, 2.0 mL, 2.1 mL of oil removed, respectively. With an average of 1.96 mL of oil removed. Efficiency of this method on the removal of olive oil is 65.3 percent. When the extracted oil averages are compared for the two types of oils, 0.04 mL more sunflower oil is removed from the water than olive oil. Overall efficiency of removing sunflower oil spill is approximately 1.3 % greater than the efficiency of removing olive oil spill. Lastly, the recorded readings on the table for the two types of oils are very close and do not demonstrate any significant differences.

Discussion

This experiment studied the efficiency of separating a certain type of oil from water using various amounts of ferrofluid and a strong neodymium magnet. Results demonstrate that approximately 66% of both types of oils are removed from the water. Considering the experimental procedure and the results of it, there are advantages and disadvantages of this experiment: removing oil from water by ferrofluid. For the advantages, it is cheap, and the time required for it is very short. For the disadvantages, the efficiency rate of the removal of the oil is not very high, 34% of oil still remains in the water. Monitoring the results and evaluating the favorable and unfavorable factors of this experiment, it may be worth investigating this method at a larger scale with the objective of using it to clean up oil spills at sea; however, the amount of ferrofluid and magnetism required for a cleaning procedure of sea might be unaffordable, also efficiency rate of this methodology is not guaranteed for every type of oil spill might found in sea. Conducting this experiment at home rather than in the lab has caused several limitations. In this experiment only the volumes of removed oils are determined; however, any further information is not given about them because they could not be sent to laboratories for analysis.

Conclusion

This experiment mainly focused on testing and comparing the efficiency of removing a certain type of oil from water by ferrofluid. Overall efficiencies demonstrate that in the cleaning procedure of both types of oil more than 65% of the oil is removed from the water, which is satisfying when the time required, and the cost of the experiment is considered. The data indicate that, in general, the type of oil used in extraction does not affect or has a very small impact on the volume of removed oil ,and the efficiency of this method.

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