MoDRN Molecular Design Research Network

Dispersants and how effective they are in cleaning oil in water

Summary

Difficulty	Easy
Time required	1 hr
Prerequisites	Oil spills (what they are), immiscibility of oil in water
Material Availability	Very Easy
Cost	approx. $10
Safety	Kitchen materials - don't get the soap in your eye!
Green Chemistry Principle	Two things that don't normally mix can be made to mix using compounds called surfactants. These can be used to prevent the need to clean up beaches in oil spills. However, these materials may be hazardous, so you need to understand how well they work as well as how harmful the may be and balance the two.

Background

The most recent, large-scale oil spill - the *Deepwater Horizon* oil spill - occurred in the spring of 2011 and involved the released over 200 million gallons of oil into the Gulf of Mexico. In the past, oil spills have led to large amounts of oil deposited onto beaches - a mess that is incredibly hard to clean up and harmful to wildlife. To prevent the beaching of oil, clean-up crews used chemicals called "dispersants" to attempt to dissolve the oil into the ocean rather than allow it to

float on top. These dispersants were effective, but many questioned their safety and whether or not adding hazardous chemicals was worth preventing oil from reaching the beaches.

As you may know, oil generally floats on oil, and a mixture of water and oil will always separate. This is because oil is "hydrophobic" (think *hydro* = water and *phobia* = fear) and does not mix with water. Dispersants are examples of chemicals called surfactants which allow hydrophobic chemicals to dissolve in water. Soap is one common example of a surfactant used every day. We use it to wash off oils on our hands and grease off of dishes with water. This experiment will require observations of the effect of surfactants on dissolving oils as well as keeping track of the amount of soap necessary to dissolve cooking oil in water. Students should keep in mind that this same basic principle is used to clean oil spills and consider the much greater scale compared to this kitchen-experiment.

Materials

- Materials & Equipment
  - Water
  - Cooking oil - vegetable, canola, etc.
  - Spoon for mixing
  - Hand soap - generic, unscented
  - Dish soap - generic, unscented
  - Kitchen liquid measure
  - Measuring spoons
  - Internet access

Procedure

1. Measure 1 cup of water in a glass using a liquid measure
2. Add 2 tablespoons of oil to the glass

a. Repeat this once so that you now have two glasses of oil in water

b. Label “glass 1” and “glass 2” with a marker/tape/etc.

3. Allow the oil and water to separate

a. Try mixing the two together with the spoon - they’ll separate back out with time

Glass 1 - hand soap

a. Add ½ teaspoon of hand soap, stir the mixture, and wait to see if the mixture separates back

b. Continue adding ½ teaspoons of hand soap until the mixture does not separate

c. Keep track of how much you’ve added!

d. Record your observations as you add more soap

i. How is the solution changing?

Glass 2 - dish soap

a. Repeat the procedure for glass 1 - this time use dish soap

b. Keep observations of the solution as you add more dish soap

Toxicity

c. Check on the back of the soap bottle and read the active ingredients list

d. Look up the active ingredients on http://pubchem.ncbi.nlm.nih.gov/

i. Type in the compound name into the search bar and if it appears after your search, click on it to access its information page

ii. Look for a contents bar on the left

- Click on "toxicity"

Record the LD50 value for each compound--this stands for "lethal dose 50%" and corresponds how much of the chemical was necessary to kill half a test sample of mice (or another test animal); a lower value means that less of the chemical was necessary, so the chemical is *more* toxic

Consider on which soap type has more hazardous chemicals in it and fill in the comparison table below:

Soap Type	**Observations while mixing with water**	**Amount required to dissolve oil**	**Active Ingredients**	**LD50 values**
Hand Soap				
Dish Soap				

Observations/ Questions

- Which soap was better at dissolving the oil?
- Which soap has more toxic ingredients in it?
- Consider the Deepwater Horizon oil spill

- 1.84 million gallons of a dispersant called “Corexit” was used
- What types of experiments would you use to test this dispersant before using it in the ocean?
- What other information would you want to know before using Corexit (especially so much of it)

- Do you think using dispersants to clean up oil spills is a good idea? Can you think of any other ways that might be better for cleaning up large amounts of oil in the ocean?

Variations

A simple modification could include shining a laser pointer through the oil-water mixture, to distinguish an emulsion from a solution.