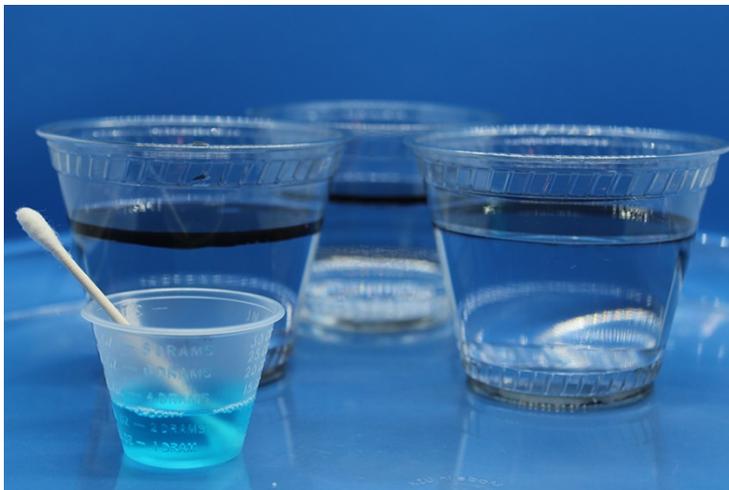


Cleaning Up Oil Spills with Chemistry

ACS Kids Zone activity for use at home or school



Our demand for plastics and fuels means that we are pulling petroleum out of the Earth at an alarming rate! We pump it from deep underground, including beneath the ocean floor, and we transport it across vast oceans and over land. All of this pumping and transporting increases the risk of accidental spills. In this activity, you will try four strategies to clean up an oil-spill in a small cup or bowl-sized ocean. Each strategy relates to an actual oil-spill cleanup method and brings its own set of advantages and disadvantages.

Question to investigate

- Which method works best to clean up spilled oil in the ocean?

Chemistry concepts

- Chemistry can help solve environmental challenges.
- Water is polar and is attracted to other polar substances,
- Oil is nonpolar and mixes with other nonpolar substances.
- Oil floats on water. Because oil is nonpolar and water is polar, oil and water do not mix.

Activity logistics

- **Ages:** 8-14
- **Time:** 20-30 minutes

This activity is adapted from [Cleaning Oil Spills with Chemistry](#) from the [Explore Science, Let's Do Chemistry](#) kit by the [National Informal STEM Education Network](#).

Be Safe

- Wear splash goggles and non-latex gloves for this activity.
- Use a tray, cookie sheet, or large cake pan to contain any accidental spills.

General Safety Guidelines

- Work with an adult.
- Read and follow all directions for the activity.
- Read all warning labels.
- Follow safety warnings or precautions written in the *Be Safe* section of each activity.
- Wear Personal Protective Equipment (PPE), such as goggles, safety glasses, or gloves.
- Tie back long hair, roll up sleeves, and secure loose clothing.
- Be sure to clean up and dispose of materials properly when you are finished with an activity.
- Wash your hands well before and after each activity.

What you'll need

- 4 wide cups or bowls
- 2 small cups, like the kind for dosing medication or portion cups
- Tray, cookie sheet, or large cake pan that can get wet or oily
- Water
- Vegetable or mineral oil
- Spoon
- Cotton swab
- Cotton ball or cotton make-up removal pads (squares, circles, or ovals)
- Oil absorbent mat, such as [3M Oil-Only Folded Sorbent Roll](#), or [Pig Oil-Only Absorbent Mat](#), or [3M Petroleum Sorbent Mat HP-156](#), cut to a size that can fit in a cup or bowl
- Dishwashing liquid, such as Dawn, Palmolive, Ajax or a generic alternative
- Paper towels, to wipe up drips and spills
- Optional:
 - Oil-based food color, such as [AmeriColor](#), [Wilton](#), or [ChefMaster](#) commonly used to color desserts with high-fat content such as buttercream frosting or white chocolate will color the oil. Use regular water-based food coloring if you would prefer to color the water.
 - Table covering, a large clean plastic trash bag works well. When you are finished turn it inside out and use the bag to collect and contain trash.

Note

- This is a very messy activity! Choose a suitable location that will be easy to clean afterward.
- Wear splash goggles and non-latex gloves while setting up, doing, and cleaning up from this activity. The gloves will prevent the oil absorbent pad from absorbing the natural oils from your skin as well as prevent staining from any added food coloring.

Procedure

Prepare for the activity

1. Pour 15 mL of oil into a small cup. Optional, add 5 mL of an oil-based food coloring. Stir to mix.
2. Pour 5 mL of water in a separate small cup. Add 5 mL of dish detergent and stir with a cotton swab. Place both small cups on a tray or cookie sheet.
3. Fill 3 wide cups or bowls about $\frac{2}{3}$ of the way up with water and arrange them on the tray or cookie sheet.



Place an empty cup or bowl on the tray, too.

4. Place a spoon, cotton pad, and piece of oil sorbent mat near the tray.
5. Create 3 oil spills by pouring the colored oil between the three cups or bowls on the tray that contain water.

Does the oil float or sink?



Test the following methods on one of your oil spills

6. **Using booms and skimmers:** People will put a floating barrier in place to keep the oil spill from spreading. Two boats within the containment boom, might pull a skimmer between them to scoop up as much oil as possible from the surface of the water.

- The edges of your cup or bowl represent a containment boom. Use the spoon to represent a skimmer collecting oil from the surface of the water.
- Place the oil in the empty cup or bowl on your tray and try a couple more times to scoop up and remove some oil.



7. **Using Dispersants:** A small plane may drop chemical dispersants onto an oil spill.

- Use a cotton swab to pick up some dilute dish detergent. The detergent represents a chemical dispersant. Hold the dry end of the cotton swab so that the wet end is over the oil spill. Tap the stick portion of the swab to drip surfactant over the remaining oil.
- Pick up more surfactant with the cotton swab and disperse it over the oil spill a few more times.

What change do you notice in appearance of the oil?





Compare two sorbent materials on the other oil spills

8. **Using sorbents:** People will spread a sorbent such as peat moss, hay, or a special material created by chemists over the surface of the oil spill and if possible scoop the oily sorbents up out of the water. Oily sorbents may also absorb water and sink, so collecting them is both labor intensive and challenging.

- Represent the use of peat moss or hay by placing a cotton ball or flat cotton shape on top of the oil spill. Give the sorbent a moment to soak up what it can. Then, pick it the sorbent up and lift it over the bowl with the oil you collected. Wring it out.
What do you notice coming out of the cotton?
- Represent the use of chemist-created sorbents by placing a piece of the oil-absorbing mat on top of the oil spill. Give it a moment to soak. Then, pick it up and wring it out as you did with the cotton.
What do you notice coming out of the sorbent mat?

9. Use the method or methods you found the most effective to remove the remaining oil from the surface of both oil spill cups.

How does it work?

Some of the methods used to clean up spilled oil use chemistry, while others are mainly physical methods. Because oil is less dense than water, it floats on the surface of the water. This property of oil means that most oil-spill-treatment methods take place at the water's surface.

Use of floating containment booms and skimmers are examples of physical methods used at the water's surface. Booms may be shaped like a giant long sausages or long sections of floating fence. They are placed to encircle as much of the oil slick as possible. This keeps it from spreading so that other strategies have a better chance of working. Skimmers are like scoops that collect oil and water from the surface. Special machines spin the collected oil and water mixture to separate the two liquids. The recovered oil is not "good as new" but it is of high enough quality that it can be sold and used for certain purposes. Booms and skimmers work best during the day, when the weather and water are calm, and soon after the accident that caused the oil to spill.

If the oil cannot be contained with booms, perhaps the waves are choppy and have already spread the oil slick out over a long distance, dispersants can be sprayed on top of the oil spill from a plane. Detergent works in a similar way to a chemical dispersant. One end of the large ion from the dispersant or detergent is attracted to water (polar), while the rest of it is not (nonpolar). The nonpolar ends of the dispersant point towards molecules of oil while the polar tips point toward water molecules. When enough of these ions from the detergent, molecules of oil, and water get together, the ions are pushed into a sphere-like arrangement, called a micelle, which contains small drops of oil on the inside and water molecules on the outside. These smaller drops of oil are easier for microorganisms to consume and spread the harm out over a long distance so that the damage is not concentrated all in one place. A big disadvantage to using dispersants is that the oil can form large tarballs that either sink and hurt aquatic life along the ocean floor or are washed to shore hurting aquatic life there.



Sorbents are materials such as peat moss, hay, feathers, or polypropylene (plastic with recycle code 5). All of these are primarily nonpolar substances, like oil. You likely have polypropylene at home. It is used to make containers to package hot soups and sauces for take-out or take-away meals. In chemistry, people say that “like dissolves like.” Because both polypropylene and petroleum are nonpolar, they may be pushed together by polar molecules like water. Polypropylene sorbent mats have many small fibers so that there are many places for the petroleum to be absorbed by the mat. A chemical reaction occurs, which holds the oil in the mat. It is not held too tightly because you can wring the reacted oil out of the mat. Unfortunately, this mixture is a little different than the original spilled oil and so cannot be sold or refined as originally planned. It can be burned for heat, though. Another downside to sorbents is that collecting the oil-soaked sorbents is difficult. These materials are best for smaller oil spills.

There must be a better way, right? Chemistry is coming to the rescue with new materials to help people remove spilled oil from challenging aquatic environments, recover and reuse the oil, and greatly reduce the damage done to birds, fish, and other aquatic organisms!

The chemistry of coloring the oil

Most food coloring sold in grocery stores is water-based and dissolves in water, coloring only the water-containing parts of food. Usually in food, such as baked goods, frostings, and candies, the water is mixed throughout the item and so the entire item appears to be one color, rather than having spots of color. Remember the phrase, “Like dissolves like.” If you want to make a buttercream frosting or color candy that is high in fat, like white chocolate, oil-based food coloring will provide a more uniform and vibrantly colored product.

Clean up

- Use the two sorbent materials to absorb the oil that you recovered. Place these and the cotton swab in your home or school trash.
- Pour the water remaining from your two model oil spills down the sink.
- Use the detergent solution in one of the small cups to wash the cups and/or bowls. You may need to add a little extra detergent to clean the small cup that contained the oil.

References

- Find the SDS for the 3M Sorbent Pad HP-156 for your location and language preference
https://www.3m.com/3M/en_WW/sds-search-select-location/
- Pig Oil Only Absorbent Mat (Quirky product video contains science!)
<https://www.newpig.com/pig-oil-only-absorbent-mat-pad/p/MAT415>
- How Do Oil Spills out at Sea Typically Get Cleaned Up?
<https://response.restoration.noaa.gov/about/media/how-do-oil-spills-out-sea-typically-get-cleaned.html>
- 10 Methods for Oil Spill Cleanup at Sea (Like a Top 10 list)
<https://www.marineinsight.com/environment/10-methods-for-oil-spill-cleanup-at-sea/>
- Reassessing Guidelines for Oil Spill Cleanups (Open Slideshow)
<https://www.whoi.edu/oceanus/feature/reassessing-guidelines-for-oil-spill-cleanups/>
- Oil-absorbing Cellulose Developed for Oil Spill Cleanup (Slime solves a problem?!)
<https://www.aiche.org/chenected/2017/07/oil-absorbing-cellulose-developed-oil-spill-cleanup>
- Low-cost Polyurethane Sponge Cleans Oil Spills: (Great short video showing the product)
With graphite-nanoparticle coating, sponges are chemically selective, magnetic, and reusable
https://cen.acs.org/materials/coatings/Low-cost-polyurethane-sponge-cleans/98/i22?ref=search_results
- What did we learn from the Deepwater Horizon disaster?
10 years after the largest accidental oil spill in history, scientists look back on insights gained about how microbes and chemical processes degrade oil. And they still see gaps that need to be filled before the next big spill
https://cen.acs.org/safety/industrial-safety/learn-Deepwater-Horizon-disaster/98/i35?ref=search_results
- Photo by U.S. Air Force Technical Sergeant Adrian Cadiz, showing a C-130 Hercules plane spreading dispersant over water as part of the Deepwater Horizon Response effort.
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https://commons.wikimedia.org/wiki/File:C-130_support_oil_spill_cleanup.jpg