

Lesson Plan for Oil Spills Part 2: Cleaning Up an Oil Spill

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Introduction

An oil spill is the release of a liquid petroleum hydrocarbon into the environment due to human activity, and is commonly a form of pollution. Oil spills are a major ecological and environmental problem. Often the term refers to marine oil spills, where oil is released into the ocean or coastal waters. The oil may be a variety of materials, including crude oil, refined petroleum products, or oil mixed in waste. Unfortunately spills can take months or even years to clean up. In this experiment, we will use a variety of materials to clean up a model oil spill and determine which materials are best for the job.



Background Info

It goes without saying that oil spills are a very serious and egregious environmental hazard. The oil presents a dangerous harm to the health of land and marine animals while often causing irreparable damage to the affected ecosystems. Further details of the environmental effects of oil spills can be found below. It follows that cleaning up oil spills is of paramount importance.

Environmental Effects of Oil Spills

In last week's lesson we saw how oil spills affect aquatic animals such as birds. Besides being extremely difficult to clean off of feathers, oil can penetrate the very structure of a bird's feathers. This reduces the insulating ability of the feathers, making the bird more vulnerable to temperature fluctuations and much less buoyant in the water. It also impairs bird's flight and its abilities to forage and escape from predators. As affected birds attempt to preen, they can ingest the oil that covers their feathers, causing kidney damage, altered liver function, and digestive tract irritation. This combined with the limited foraging ability quickly cause dehydration and metabolic imbalances. Hormonal balance alteration including changes in luteinizing protein can also result in some birds exposed to petroleum. Most birds affected by an oil spill die unless there is human intervention.

Marine mammals exposed to oil spills are affected in similar ways as seabirds. Oil coats the fur of Sea otters and seals, reducing its insulation abilities and leading to body temperature fluctuations and hypothermia. Ingestion of the oil causes dehydration and impaired digestions. Because oil floats on top of water, less light penetrates into the water, limiting the photosynthesis of marine plants and phytoplankton. This, as well as decreasing the fauna populations, affects the food chain in the ecosystem.

Methods and Equipment for Cleaning Up Oil Spills

Skimmers remove oil from the surface of the water. This method requires calm ocean waters.

Booms are large floating barriers that round up oil and lift the oil off the water.

Vacuums remove oil from beaches and the water's surface.

Dispersants act as detergents and break up the oil spill. This mobilizes the oil and makes the water look less damaged. Smaller oil droplets, scattered by currents, may cause less harm and may degrade more easily. However, the dispersed oil droplets can also infiltrate deeper water and lethally contaminate marine life.

Sorbents are large absorbent materials that soak up the oil.

Chemical agents help break down the oil.

Dredging removes oil that has sunk below the water's surface (oil that is denser than water).

Bioremediation is the use of microorganisms or biological agents to break down or remove oil.

Controlled burning can effectively reduce the amount of oil in water, if done properly. However, it can only be done in low wind conditions and even so can cause air pollution.

Watching and waiting is sometimes the best method, particularly in ecologically sensitive areas. Natural attenuation of oil may be most appropriate, due to the invasive nature of other methods of remediation.

Student Objectives

- Understand the environmental effects of oil spills.
- Understand the different methods of cleaning oil spills.
- Work as a team of engineers to identify the best method(s) for cleaning up a model oil spill.

Overview of the Lesson Process

- Review last week's discussion of oil spills. Have students recall the damage an oil spill can do to a natural environment, particularly how the oil effected bird feathers (5-10 min).
- Introduce the challenges of cleaning up an oil spill and what methods are used (5-10 min).
- Create a model oil spill and discuss the concept of a model (10 min).
- Assemble your team of engineers and systematically test the many different methods for cleaning up your model oil spill. Students should record their findings on their worksheets. (20-30 min).
- Discuss your findings and decide what methods worked the best. Explain how the different methods in our experiment related to the methods used in real life. Reiterate the benefits of using a model to solve a difficult or challenging problem (10-15 min).
- Discard the model oil spills and clean up any messes (5-10 min).

Materials

Water			
Clear plastic tubs	1 per group	Smart&Final	\$8
Vegetable oil	½ cup per group	Smart&Final	\$5
Cocoa powder	1T per group	Smart&Final	\$5
Spoons	1 per group	Smart&Final	\$5
Cheesecloth or gauze	6" per group	Smart&Final	\$5
Cotton balls	5 per group	Blick (61431-0100) 100 cotton balls	\$3
Pipettes or eyedroppers	1 per group	Fisher (13-711-9AM) 500 pipettes	\$15
String or twine	12" per group	Blick (77284) 500 yards	\$10
Dishwashing detergent	A few drops per group	Smart&Final	\$3
Polypropylene cloth	6" per group	Grainger (1ECC1) 3x50ft	\$18

Total \$77

Procedure

Part 1: Create the oil spill model

1. Pour water into the plastic tub until it is about 2/3 full. Keep lots of towels and newspaper handy!
2. Create your crude oil by mixing ½ cup vegetable oil and 1 tablespoon cocoa powder. *How do we use oil in our everyday lives? Some examples: running vehicles like cars and planes, providing electricity and heat to our homes, making materials like plastics.*
3. Gently pour the crude oil onto the water so that it forms an oil slick on the top of the water. *How do oil spills happen? Why would oil be in the ocean in the first place?*
4. You have now created a model oil spill. Discuss this term with the students. *This particular model is helpful because it will let us practice cleaning up an oil spill without having to create a real one.*

Part 2: Clean Up the Oil Spill

5. It is now up to you and your team of engineers to determine the most effective way(s) to clean up this model oil spill. Systematically test the different methods and record your findings. *With each method, consider its effectiveness at removing the oil as well as the potential effect it could have on the environment. Where does the oil go once you have removed it from the water?*
 - a. String (booms). Try to contain the oil spill with a piece of string.
 - b. Spoon (skimmer). Try to skim oil off the surface of the water with the spoon.
 - c. Pipette/eyedropper (vacuum). Try to siphon oil from the surface.
 - d. Sponge, cotton balls, cheesecloth, polypropylene fabric (sorbents). Try to absorb oil from the surface of the water. How effective are each of these materials? Which works the best?
 - e. Dishwashing detergent (dispersant). Try breaking up the oil spill with the detergent. Try using a spoon or a small fan to simulate water currents: where does the oil go?

Part 3: Discuss Your Findings

6. As a group, discuss the pros and cons of your different clean-up methods. How do our methods relate to real clean-up methods? Which methods would the students try on a real oil spill?
7. Brainstorm and discuss additional ways to remove oil, such as controlled burning and biochemical remediation, that we did not try on our model oil spill.
8. Review the concept of a model. *Why would scientists and engineers use a model?*

A note on the science behind the polypropylene sorbent. Polypropylene is a synthetic type of cloth material. As you saw, the polypropylene fabric removed the oil much better than the sponge, cotton balls, or cheesecloth. When oil and water are mixed together it becomes an immiscible solution. This means they cannot mix together and will forever separate into layers. Polypropylene and oil are both nonpolar substances composed of carbon and hydrogen. Because of this they are attracted to each other – like attracts like – and the polypropylene can effectively soak up the oil.

References

Polymer Oil Spill Experiment: <http://weirdsciencekids.com/Oilspillexperiment.html>
 Envirosapes Oil Spill Activity: <http://www.envirosapes.com/oil-spill-activity.html>

Worksheet for Oil Spills Part 2

There has been a giant oil spill off the California coast! It is up to you and your trusty team of engineers to figure out how to clean up the oil spill.

Using your **model** oil spill, test the following materials and record your observations. How well does each item clean up the oil?

String:

Spoon:

Eyedropper:

Sponge:

Cotton Balls:

Polypropylene Fabric:

Dishwashing Detergent:

Now that you have tested all of the materials, what cleaned up the oil the best?

With help from your mentor, draw lines to match the materials you used today with these real-world methods for cleaning up oil spills:

String

Vacuums suck oil off the water

Spoon

Sorbents absorb and remove oil

Eyedropper

Booms surround and contain oil

Polypropylene Fabric

Dispersants break up the oil

Skimmers

Skimmers scoop oil off the water

How might cleaning up an oil spill affect the plants and animals in the ocean?