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| **Project 5.1.3 Oil Spill Clean-up** |

Introduction

Of all the natural resources that people take for granted, none is more plentiful or more fragile than water. Oceans cover about three-fourths of the Earth’s surface. Even though we don’t drink ocean water, it is important to human life. Much of the food we eat, the weather that affects us, and the moisture in our air comes from the oceans.

Unfortunately, even our largest oceans are becoming contaminated. About 14 billion pounds of trash and garbage are dumped into the oceans every year. Each year about 2.3 trillion gallons of liquid waste are discharged directly into the coastal waters of the United States. The April 20, 2010 explosion of an offshore oil rig in the Gulf of Mexico caused a catastrophic oil spill that has affected local economies, wildlife and the coastal ecosystem.

Oil is a pollutant that prevents organisms from getting the nutrients and oxygen that they need to live and continue growing. When an oil rig or tanker accidentally spills oil into the water an oil slick forms. Since oil is less dense than water and floats, the oil sticks to the bodies and surfaces of birds, plants, fish, and other aquatic organisms. Affected birds cannot use their wings or fly. When the feathers and fur of birds and otters become coated with oil, they lose their insulating qualities. Animals are unable to stay warm in a cold environment. When fish become coated with oil, their gills become clogged and they can no longer breathe. The oil kills the small marine organisms that eat food or drink water contaminated with it. This kills the larger animals that feed on them. Affected plants cannot carry on the process of photosynthesis. The longer the oil remains on an organism, the more damaging it is.

There are three major ways in which oil injures wildlife:

1. The oil gets on the fur and feathers and destroys the insulation value. Birds and mammals then die of hypothermia (they get too cold).
2. Animals eat the oil, either while trying to clean the oil off their fur and feathers or while scavenging on dead animals. The oil is a poison that causes death.
3. The oil impacts animals in ways that do not lead to a quick death, such as damaging the liver or causing blindness. An impaired animal cannot compete for food and avoid predators. Oil also affects animals in non-lethal ways such as impairing reproduction.

Cleaning up an oil spill is a complex task. First the oil must be contained. The oil then needs to be removed or dissolved and the environment needs to be restored so that it is once again safe for wildlife. Animals harmed by an oil slick need special assistance before they are able to return to the ocean. People must locate and clean each animal and release it to an unaffected area.

One method that people use is to surround the oil slick with something called a containment boom, a large float that surrounds the slick. As the boom is pulled into a boat that skims the oil off of the top of the water, the oil slick shrinks, until finally it is completely cleaned up. Although it is possible to clean a slick by this method, containment booms are mainly useful for containing oil slicks which will be cleaned up by other means.

Another method to clean a slick is to spray a detergent solution on it. When detergent is sprayed on oil slicks, the oil breaks up into clumps which sink to the bottom of the ocean. Although these clumps are themselves hazardous, the problems caused by the clumps are much easier to deal with than the problems caused by oil slicks.

Another way to accomplish clumping is through the spreading of absorbent sand. The oil is absorbed into the sand and is then dragged to the bottom of the ocean in sandy clumps.

Recently, oil-eating bacteria have been designed which can actually use the oil slick as food. As the bacteria reproduce, they eat more and more of the slick until it finally vanishes. When the slick is gone, their food source is gone and the bacteria die, leaving nothing behind at all.

If oil slicks are extremely small and contain highly flammable compounds, they are sometimes set on fire to eliminate the oil. While an effective method of eliminating some oil spills, this is very rarely done. Burning the spill releases toxic compounds into the air. Additionally, most oil slicks simply aren’t very flammable.

If the slicks are very small, as in fresh water settings, the oil can sometimes be absorbed into special absorbent pads. When the pads are full of oil, they can easily be removed from the surface of the water.

In this project your job will be to clean up a mini oil spill using materials similar to the ones used by petroleum and chemical engineers.

Equipment

* GTT notebook
* Pencil
* Play money
* Supplies needed for each group:
* Clear plastic container
* Salt water
* Sand and small rocks, to make a small beach area
* Flora and fauna – shrub clippings, fur scraps, feathers, pom-poms, etc.
* 50 ml vegetable oil (corn, olive, sunflower, sesame, soy)
* Paper bathroom cup
* Clean-up supplies: tweezers, cotton balls, biodegradable packaging peanuts, string, cloth rags, paper towel strips, sponges, medicine dropper, various non-toxic soaps, detergents, cleaners and plastic cup
* Large zip-lock bag

Procedure

Your teacher will divide you into teams of 4-5 students to clean up your oil spill. There are many tasks to complete; each team member should record in their engineering notebook their responsibilities, accomplishments, and disappointments.

1. Prepare your ocean. Fill the clear plastic container 2/3 full of salt water. Build a beach with the sand and rocks; add shrub clippings to represent trees and feathers and fur scraps to represent animals. You must have both flora and fauna in the ocean, on the beach and inland. Mark the side of your container at the shore line. Pour vegetable oil into the bathroom cup, which will serve as your oil tanker. To simulate an oil spill, holding the cup close to the water, poke a small hole in the cup below the water line to let the oil leak into the ocean. Place the cup in the water. Do not disturb the ocean scene. Clean up will occur during the next class period. Record your observations in your engineering notebook.
2. Your teacher will describe the clean-up procedure. Your team will discuss what materials you will purchase to clean up your oil slick. Each team will be given a $20,000,000 budget for the project.

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| Material | Cost | Quantity | Total Cost |
| Tweezers (each) | $1,000,000 |  |  |
| Packaging peanuts | $7,500,000 |  |  |
| Cotton balls | $7,500,000 |  |  |
| String | $1,000,000 |  |  |
| Cloth rags | $5,000,000 |  |  |
| Paper towel strips | $5,000,000 |  |  |
| Sponges | $1,000,000 |  |  |
| Medicine dropper | $10,000,000 |  |  |
| Detergent | $2,500,000 |  |  |
| Total Cost of all Materials: | | |  |

1. One team member will be responsible for keeping a detailed log of the process you use and the money you spend.
2. Day 2:

With tweezers carefully and slowly lift the oil tanker out of the ocean, this should give the left over oil an opportunity to spill.

Use your purchased supplies to clean up the ocean, flora, and fauna. Rules of clean up:

* You will have 15 minutes to clean the oil spill.
* Each engineering team must purchase at least one set of tweezers.
* Styrofoam peanuts, cotton balls, paper towels, sponges, string, and cloth rags cannot be touched with fingers, only tweezers.
* Detergent used on the ocean must be applied by using a medicine dropper.
* Purchase of detergent allows one student the use of the Wildlife Rehabilitation Center.
* Place oil removed from container into a plastic cup.
* Carefully dispose of oil and clean-up supplies in the zip-lock bag.

1. Discuss with the class your clean-up method, how successful it was, and how much money was spent.

Conclusion

1. List the job titles that might be included in an engineering team responsible for cleaning up an oil spill.
2. How do you think oil spills can be minimized in the future?
3. Propose an effective new method for cleaning up a real oil spill. Defend your method with evidence.
4. How much water was removed during clean-up? What potential problems could this create?
5. There are seven resources used in every technological problem. Describe what resources you used and what they might simulate in an actual oil spill:

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| --- | --- | --- |
| Resource | Used | Simulate |
| Capital |  |  |
| Time |  |  |
| Information |  |  |
| Materials |  |  |
| People |  |  |
| Energy |  |  |
| Tools and Machines |  |  |