

Oil Spill Remediation

Using Dispersants and Bioremediation in the Environment

On April 20, 2010 the largest accidental marine oil spill in the history of the petroleum industry occurred in the Gulf of Mexico. The leak was finally stopped 13 weeks later.

When oil is spilled into a body of water (such as the ocean) it spreads over the surface, through the water, and forms a slick. This is harmful because the oil that is floating on the surface releases toxic substances into the environment as well as coating any substance that it contacts, including birds, mammals and shorelines.

There are several methods that are used to clean up oil-spills. The effectiveness of each method depends upon a variety of factors including environmental variables, type of oil spilled, economic resources and location of spill. There is no single best method for cleaning up an oil spill. In fact, most oil spill clean-up efforts utilize a combination of methods. The three major categories of oil spill remediation methods are **containment and removal**, **application of dispersants**, and **bioremediation**. The goal of this lab is to determine which method creates the most stable emulsion.

Scientists began working with BP to contain and clean up the largest oil spill in history. The Deepwater Horizon well leaked nearly five (5) billion barrels of oil into the Gulf of Mexico. To put this in perspective:

184,181: Times you could drive a Toyota Prius (48 mpg highway) around the Earth at the equator using the lost oil

69,068: Times you could drive a Hummer H3 (18 mpg highway) around the Earth

311: Olympic-size swimming pools that could be filled with the oil that leaked from Deepwater Horizon

13,208: Homes that could have been heated for one year (approximately 2 gallons of heating oil are produced from one barrel, with an average American household using 742 gallons per year)

16.5 million: Gallons of oil chemically dispersed by National Incident Command

32.9 million: Gallons of oil naturally dispersed, which means it has broken into droplets smaller than the diameter of a human hair

51.5 million: Gallons of oil evaporated or dissolved. This differs from natural dispersion because instead of breaking down into small droplets, the oil breaks apart at the molecular level and dissolves into the water.

6.2 million: Gallons of oil skimmed off the Gulf by the more than 830 skimming vessels used in the response

35 million: Gallons directly recovered from the wellhead into ships through the riser pipe and top hat systems

11.4 million: Gallons of oil that have been removed by a series of 411 controlled burns

53.5 million: Gallons of oil still remaining in the water or washed ashore

95.6 million: Potential gallons of gasoline leaked from the wellhead (approximately 19.5 gallons of gas can be derived from one barrel of oil). That's about one-fourth of daily gas consumption in the United States.

10.4 million: Feet of sorbent boom (8.7 million) and containment boom (2.7 million) deployed to contain the oil

1.8 million: Gallons of both surface and subsea dispersant used by Unified Incident Command

47,000: Total number of personnel deployed in response to the spill.



Birds are seen at an oiled marsh July 19, 2010 near Pointe Aux Chenes, LA.
Source: http://www.huffingtonpost.com/2010/04/30/louisiana-oil-spill-2010_n_558287.html#s116457

Source: <http://www.popularmechanics.com/science/energy/coal-oil-gas/bp-oil-spill-statistics>

IDENTIFY POSSIBLE CLEANUP METHODS

List three ways oil is being removed from the Gulf of Mexico in response to the spill:

EXPERIMENT

Today, we will be looking closely at two methods of oil clean up. Each method has possible positive and negative effects.

Chemical dispersants help to dissolve the oil into smaller particles. The long-term effects of these chemicals are unknown.

Bioremediation uses microorganisms to return the environment to its previous condition. Effects of bioremediation are also unknown.

Which solution do you think will be more effective in cleaning up the oil? Why?

You will need the following materials and equipment:

Water	Micropipette & tips	Graduated cylinder
Three containers with lids	Tape	Feather
Disposable transfer pipettes	Plastic disposable cup	Motor oil
Oil Eating Microbes (OEMs)	Marker	Dawn dishwashing liquid

PART ONE: OBSERVE THE EFFECTS OF OIL ON MARINE WILDLIFE

1. Fill the disposable plastic cup halfway with distilled water. **What do you think will happen to a feather if we submerge it in water?**

2. Dip the feather into the cup. **How did the water affect the feather?**

3. Remove the feather from the cup. Add 1,000 μ L of motor oil directly to the cup. **What do you think will happen to the feather if we submerge it in the oil and water?**

4. Dip the feather into the cup. **How did the oil and water affect the feather?**

PART TWO: OBSERVE THE EFFECTS OF AGITATION ON AN OIL AND WATER MIXTURE

- 5. Measure 20 mL of distilled water into each of your three empty tubes at your station.
- 6. Create three oil spills. Add 2,000 μ L of motor oil to each of the containers using a disposable transfer pipette.
- 7. Observe the three oil spills you have created. **How does the oil interact with water?**

An **emulsion** is a suspension of small globules of one liquid in a second liquid with which the first will not mix. How would you create an emulsion?

- 8. Tightly cap your containers. Vortex each container for five (5) seconds. What happens to the oil spill?
- 9. Let settle without any agitation for one (1) minute. **After one minute do any of the flasks still contain an oil-in-water emulsion?**

PART THREE: OBSERVE THE EFFECTS OF SURFACTANTS & BIOREMEDIATION

- 10. Label each of the following as a control, surfactant or bioremediation

Dawn dishwashing detergent: _____

Oil-eating microbes: _____

Distilled water: _____

- 11. Label the side of the three oil spill containers you created **DAWN**, **OEMS**, and **WATER**. Make sure to label the side of the container instead of the lid!
- 12. Add 2000 μ l of each solution to the corresponding container. Make sure to label each container with the treatment solution you have added! Do not shake. What happens to the oil spill? **Record your observations immediately after adding each solution.**

DAWN dishwashing detergent:

Oil-eating microbes:

Distilled water:

What is the purpose of setting up the oil spill with added distilled water?

PART FOUR: EFFECT OF AGITATION ON OIL & WATER MIXTURE

13. Vortex each container for five (5) seconds. What happens to the oil spill? Record your observations immediately after swirling each flask.

DAWN:

Oil-eating microbes:

Distilled Water:

Which of the treatments has produced the most stable emulsion?

Make a prediction of what will happen to the tubes in a week, month, and year.

14. Tape your three tubes together. Label them with your initials and class.

CONCLUSION

Make your own conclusion. Based on the results of your experiment, which method(s) would be most effective in the remediation of an oil spill? Can surfactants be used to clean an oil spill? How do they work? Use a drawing to illustrate your explanation. What would be the effect of combining a surfactant with OEMs? How does oil affect wildlife?