Mechanical Containment

And Recovery of Oil Following A Spill

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INTRODUCTION

TWO MAJOR STEPS involved in controlling oil spills are containment and recovery. This chapter outlines some of the techniques and equipment that are used to conduct oil spill control efforts.

CONTAINMENT

WHEN AN OIL SPILL occurs on water, it is critical to contain the spill as quickly as possible in order to minimize danger and potential damage to persons, property, and natural resources. Containment equipment is used to restrict the spread of oil and to allow for its recovery, removal, or dispersal. The most common type of equipment used to control the spread of oil is floating barriers, called *booms*.

Booms

Containment booms are used to control the spread of oil to reduce the possibility of polluting shorelines and other resources, as well as to concentrate oil in thicker surface layers, making recovery easier. In addition, booms may be used to divert and channel oil slicks along desired paths, making them easier to remove from the surface of the water.

Although there is a great deal of variation in the design and construction of booms, all generally share four basic characteristics:

- An above-water “freeboard” to contain the oil and to help prevent waves from splashing oil over the top of the boom
- A flotation device
- A below-water skirt to contain the oil and help reduce the amount of oil lost under the boom
- A “longitudinal support,” usually a chain or cable running along the bottom of the skirt, that strengthens the boom against wind and wave action; may also serve as a weight or ballast to add stability and help keep the boom upright

Booms can be divided into several basic types. Fence booms have a high freeboard and a flat flotation device, making them least effective in rough water, where wave and wind action can cause the boom to twist. Round or “curtain” booms have a more circular flotation device and a continuous skirt. They perform well in rough water, but are more difficult to clean and store than fence booms. Non-rigid inflatable booms come in many shapes. They are easy to clean and store, and they perform well in rough seas. However, they tend to be expensive, more complicated to use, and puncture and deflate easily. All boom types are greatly affected by the conditions at sea; the higher the waves swell, the less effective booms become.

Booms can be used to control the spread of oil.

Booms can be fixed to a structure, such as a pier or a buoy, or towed behind or alongside one or more vessels. When stationary or moored, the boom is anchored below the water surface.

It is necessary for stationary booms to be monitored or tended due to changes produced by shifting tides, tidal currents, winds, or other factors that influence water depth and direction and force of motion. People must tend booms around the clock to monitor and adjust the equipment.

The forces exerted by currents, waves, and wind may impair the ability of a boom to hold oil. Loss of oil occurring when friction between the water and oil causes droplets of oil to separate from the slick and be pulled under the boom is called entrainment. Currents or tow speeds greater than three-quarters of a knot may cause entrainment. Wind and waves can force oil over the top of the boom's freeboard or even flatten the boom into the water, causing it to release the contained oil. Mechanical problems and improper mooring can also cause a boom to fail.

While most booms perform well in gentle seas with smooth, long waves, rough and choppy water is likely to contribute to boom failure. In some circumstances, lengthening a boom's skirt or freeboard can help to contain the oil. Because they have more resistance to natural forces such as wind, waves, and currents, oversized booms are more prone to failure or leakage than smaller ones. Generally, booms will not operate properly when waves are higher than one meter or currents are moving faster than one knot per hour. However, new technologies, such as submergence plane booms and entrainment inhibitors, are being developed that will allow booms to operate at higher speeds while retaining more oil.

Other Barriers: Improvised Booms

When a spill occurs and no containment equipment is available, barriers can be improvised from whatever materials are at hand. Although they are most often used as temporary measures to hold or divert oil until more sophisticated equipment arrives, improvised booms can be an effective way to deal with oil spills, particularly in calm water such as streams, slow-moving rivers, or sheltered bays and inlets.

Improvised booms are made from such common materials as wood, plastic pipe, inflated fire hoses, automobile tires, and empty oil drums. They can be as simple as a board placed across the surface of a slow-moving stream, or a berm built by bulldozers pushing a wall of sand out from the beach to divert oil from a sensitive section of shoreline.

RECOVERY OF OIL

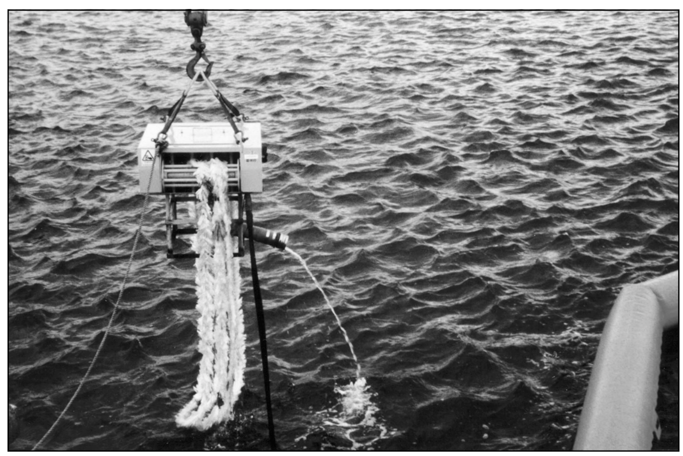
ONCE AN OIL SPILL has been contained, efforts to remove the oil from the water can begin. Three different types of equipment—*booms, skimmers,* and *sorbents*—are commonly used to recover oil from the surface.

Booms

When used in recovering oil, booms are often supported by a horizontal arm extending directly off one or both sides of a vessel. Sailing through the heaviest sections of the spill at low speeds, a vessel scoops the oil and traps it between the angle of the boom and the vessel's hull. In another variation, a boom is moored at the end points of a rigid arm extended from the vessel, forming a "U"- or "J"-shaped pocket in which oil can collect. In either case, the trapped oil can then be pumped out to holding tanks and returned to shore for proper disposal or recycling.

Skimmers

A *skimmer* is a device for recovery of spilled oil from the water's surface. Skimmers may be self-propelled and may be used from shore or operated from vessels. The efficiency of skimmers depends on weather conditions. In moderately rough or choppy water, skimmers tend to



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Oleophilic skimmer.

Photo courtesy of RO-CLEAN DESMI

Suction skimmer.

recover more water than oil. Three types of skimmers—*weir, oleophilic,* and *suction*—are described below. Each type offers advantages and drawbacks, depending on the type of oil being cleaned up, the conditions of the sea during cleanup efforts, and the presence of ice or debris in the water.

Weir skimmers use a dam or enclosure positioned at the oil / water interface. Oil floating on top of the water will spill over the dam and be trapped in a well inside, bringing with it as little water as possible, The trapped oil and water mixture can then be pumped out through a pipe or hose to a storage tank for recycling or disposal. These skimmers are prone to becoming jammed and clogged by floating debris.

Oleophilic (oil-attracting) skimmers use belts, disks, or continuous mop chains of oleophilic materials to blot the oil from the water surface. The oil is then squeezed out or scraped off into a recovery tank. Oleophilic skimmers have the advantage of flexibility, allowing them to be used effectively on spills of any thickness. Some types, such as chain or "rope-mop" skimmers, work well on water that is choked with debris or rough ice.

A suction skimmer operates like a household vacuum cleaner. Oil is sucked up through wide floating heads and pumped into storage tanks. Although suction skimmers are generally very efficient, they are vulnerable to becoming clogged by debris and require constant skilled observation. Suction skimmers operate best on smooth water where oil has collected against a boom or barrier.

Sorbents

Sorbents are materials that soak up liquids. They can be used to recover oil through the mechanisms of absorption, adsorption, or both. Absorbents allow oil to penetrate into pore spaces in the material they are made of, while adsorbents attract oil to their surfaces but do not allow it to penetrate into the material. To be useful in combating oil spills, sorbents need to be both oleophilic and hydrophobic (water-repellant). Although they may be used as the sole cleanup method in small spills, sorbents are most often used to remove final traces of oil, or in areas that cannot be reached by skimmers. Once sorbents have been used to recover oil, they must be removed from the water and properly disposed of on land or cleaned for re-use. Any oil that is removed from sorbent materials must also be properly disposed of or recycled.

Sorbents can be divided into three basic categories: natural organic, natural inorganic, and synthetic. Natural organic sorbents include peat moss, straw, hay, sawdust, ground corncobs, feathers, and other carbon-based products. They are relatively inexpensive and usually readily available. Organic sorbents can soak up from 3 to 15 times their weight in oil, but they do present some disadvantages. Some organic sorbents tend to soak up water as well as oil, causing them to sink. Many organic sorbents are loose


Photo courtesy of US Coast Guard

Application of sorbents.

particles, such as sawdust, and are difficult to collect after they are spread on the water. Adding flotation devices, such as empty drums attached to sorbent bales of hay, can help to overcome the sinking problem, and wrapping loose particles in mesh will aid in collection.

Natural inorganic sorbents include clay, perlite, vermiculite, glass, wool, sand, and volcanic ash. They can absorb from 4 to 20 times their weight in oil. Inorganic substances, like organic substances, are inexpensive and readily available in large quantities.

Synthetic sorbents include man-made materials that are similar to plastics, such as polyurethane, polyethylene, and nylon fibers. Most synthetic sorbents can absorb as much as 70 times their weight in oil, and some types can be cleaned and reused several times. Synthetic sorbents that cannot be cleaned after they are used can present difficulties because they must be stored temporarily until they can be disposed of properly.

The following characteristics must be considered when choosing sorbents for cleaning up spills:

- Rate of absorption—The rate of absorption varies with the thickness of the oil. Light oils are soaked up more quickly than heavy ones.
- Oil retention—The weight of recovered oil can cause a sorbent structure to sag and deform. When it is lifted out of the water, it can release oil that is trapped in its pores. During recovery of absorbent materials, lighter, less viscous oil is lost through the pores more easily than heavier, more viscous oil.
- Ease of application—Sorbents may be applied to spills manually or mechanically, using blowers or fans. Many natural organic sorbents that exist as loose materials, such as clay and vermiculite, are dusty, difficult to apply in windy conditions, and potentially hazardous if inhaled.

SUMMARY

THE PRIMARY tools used to respond to oil spills are mechanical containment, recovery, and cleanup equipment. Such equipment includes a variety of booms, barriers, and skimmers, as well as natural and synthetic sorbent materials. A key to effectively combating spilled oil is careful selection and proper use of the equipment and materials most suited to the type of oil and the conditions at the spill site. Most spill response equipment and materials are greatly affected by such factors as conditions at sea, water currents, and wind. Damage to spill-contaminated shorelines and dangers to other threatened areas can be reduced by timely and proper use of containment and recovery equipment.

CLEANING UP AN OIL SPILL: AN EXPERIMENT YOU CAN DO AT HOME

THIS EXPERIMENT is designed to help you to understand the difficulties with oil spill cleanups. You will need the following equipment:

- two aluminum pie pans, each half-filled with water
- a medicine dropper full of used motor oil
- cotton balls (use real cotton)
- nylon string
- paper towels
- liquid detergent
- feathers

Before you begin, make a list of predictions about the action of oil and water. You might want to answer the following questions in your list:

- What will happen to the oil when you drop it on the water?
- Will it sink, float, or mix in?
- Which material will clean up the oil in the least amount of time? Cotton, nylon, paper towel, or string?
- How might wind and waves affect the combination of oil and water?

Complete each of the following steps, and observe what happens.

1. Put five drops of motor oil into one of the “oceans” (your aluminum pie pans). Observe the action of the oil, and record what happens. Was your prediction correct?
2. One at a time, use the different materials (nylon, cotton, string, and paper towels) to try to clean up the oil from the water, keeping track of the amount of oil each material was able to clean up and how fast it worked. (These materials are what booms and skimmers are made of.) Which cleaned up the oil the fastest? The best?
3. Add five drops of oil to the second pan. Add five drops of liquid detergent. (This represents the chemical dispersants.) Observe what happens. Where do you think the oil would go in the “real” oceans?
4. Dip a feather directly into some oil. What happens to it? How do you think this might affect a bird’s behaviors, such as flying, preening, and feeding?

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