Submerged Oil Response

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Although there have only been a small number of submerged oil spills,[1] the environmental and economic consequences resulting from these types of spills can be large. The underwater environment poses major response challenges such as poor visibility, difficulty in tracking oil spill movement, colder temperatures, inadequate containment methods and technologies, and problems with equipment interaction with water.


Sorbent material submerged oil recovery in the field. U.S. Coast Guard photo.

In the U.S. Coast Guard's experience, the first oil spills that generated a large amount of sunken oil (oil that accumulates on the seafloor) were in 1993, when three vessels collided off of Tampa Bay, and a spill in Puerto Rico in 1994. More recently, spills occurred when a bulk carrier punctured a fuel tank in the Delaware River in 2004, and a barge capsized off of Texas in 2005.[2]

The techniques used to find oil in these cases and similar ones included using divers, sonar, and water sampling. Each method had its challenges, such as the time involved and inconclusive results. For example, sonar could identify changes in mass density, but its readings were uncertain once the oil mixed with sediment.

Oil recovery was fairly primitive—using weighted sorbent materials and dragging them along the sea floor. After the first two spills, the National Academy of Science recognized these issues and developed a report that provided a baseline for responders, and subsequently the Coast Guard's Research and Development Center (RDC) launched a multi-year project to identify and develop techniques to better detect and recover sunken oil.

Developing New Detection Systems

The RDC developed various requirements for the new detection systems including:

- 80 percent detection probability,
- locate oil remotely from at least one meter away,
- provide near-real-time data,
- reasonable setup time,
- able to accommodate five-foot seas and 1.5 knot currents,
- able to cover a square mile area within a 12-hour shift.

From 2008–09, personnel at the Bureau of Safety and Environmental Enforcement Ohmsett facility tested four prototype sensors. These sensors located oil under testing conditions—clear water with a limited amount of turbidity or sand covering the oil.

In another test, a real-time mass spectrometer system detected oils in a calm water column. But it is not clear how much oil would be in the water column under more realistic circumstances, especially after several days or weeks or with current flow. This method would be useful for other applications like finding oil in the water column. A system laser fluorometer, adapted from an existing system, appeared to work in low light conditions. However, work is needed to reduce background light interference.

Although sonar systems have been used to locate submerged oil, the issue of concern is the turn-around time for interpretation. One manufacturer is addressing that issue; however, it is not clear how this system will perform in muddy conditions, where the difference in density between the oil and the bottom is closer than the conditions documented in this test.

Laser fluorometer equipment that projects a laser light out to 10 meters in clear water and the sonar system were chosen for further evaluation and testing. Both systems need further testing, evaluation, and development to become practical tools.

Generally speaking, the tests conducted for detection and monitoring showed:

- There is no single method that can cover 100 percent of the area with no false alarms.
- Resolution is still an issue:
  - o easier if oil stays together,
  - o random hits must be correlated.
- Turbid water and very soft bottom (such as in rivers and harbors) are also issues.
- Additional research is needed for real-time mass spectrometry systems.
- Use of multiple sensor types should reduce false detections.

Recovery Techniques

Existing oil recovery methods vary greatly, depending upon conditions. Most approaches are based on diver-assisted suction heads; however, this method becomes more difficult offshore and in deeper waters. When the

The Ohmsett facility uses a test tank filled with sand, rocks, oil, and seaweed to test recovery methods. U.S. Coast Guard RDC photo.

location of the oil is known and the seabed is not particularly sensitive, large dredges can be brought in. Both of these methods tend to collect a large amount of silt and water that must be processed. To address these issues, the RDC developed specifications and awarded three

Updated system uses three ROVs. Photo courtesy of Alion Science and Technology.

contracts to design a complete detection and recovery system.

Remotely Operated Vehicle Based System

A concept built around two remotely operated vehicles (ROVs) should be able to deploy multiple small systems and to respond rapidly. The sonar data appears to be capable of identifying clumps of oil or other objects.

In testing, however, it appeared that the system was underpowered to balance the weight of the hydraulic and recovery hoses and could only handle currents of less than 1.5 knots. The pump moved the test oils, but some oil did not make it all of the way to the recovery tank and remained in the recovery hose. The manufacturer has since built an updated version, using three ROVs to address performance.

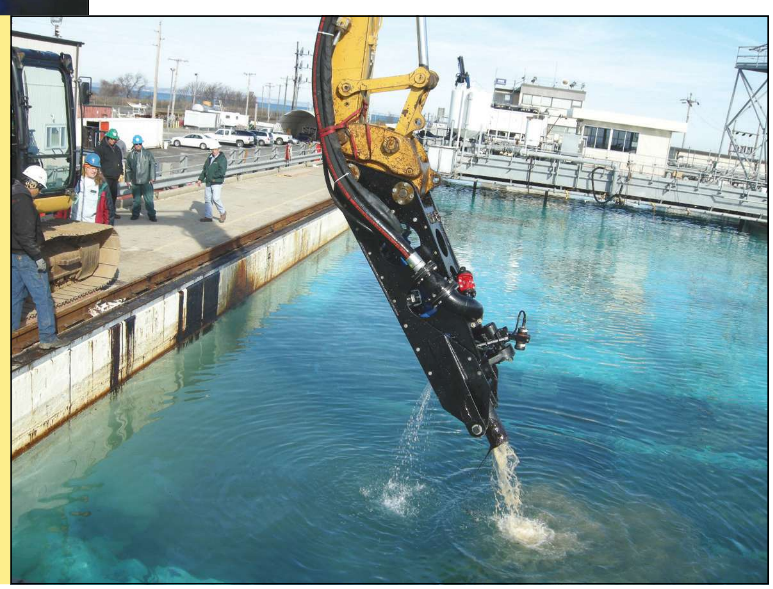
View of submersible with the skimmer head pointing backward. Photo courtesy of Marine Pollution Control.

Another manufacturer developed a system composed of a manned submersible with recovery capability and additional sensors, including an oil-discriminating sonar and fluorescence polarization sensor. Since the Ohmsett tank was too shallow to deploy the submersible, company personnel configured a test rig to represent the operational parts. The system easily picked up the oil, but also a large amount of sand and water. Testers then reduced the nozzle opening and pump power, which improved performance.

Underwater view of the rig fabricated for use in the Ohmsett test tank. Photo courtesy of Marine Pollution Control.

Auxiliary equipment interfered with the real-time sonar, but the sensor was successful in sensing oil in front of the nozzle as well as in the pump hose. Additionally, the oil separator system worked well, permitting water to be re-introduced into the Ohmsett tank.

A remote-controlled pumping vehicle relies on an external detection system for initial detection and utilizes underwater cameras mounted on the pump for recovery. This system was also too large to test in the Ohmsett tank, so the pump was mounted on an excavator and the mounted system, used for control with a closed-circuit monitor, was installed in the excavator cab. In



View of excavator-mounted recovery system. U.S. Coast Guard RDC photo.

the excavator configuration, the system is proposed as a viable oil removal tool in water depths up to 15 meters.

The manufacturer also deployed a full oil separation system that utilized a settling tank, mesh filter cloths, and two surface skimmers. Initially this system also recovered oil with a large amount of water, but refinements and increased operator experience resulted in better output later in the testing period.

Ongoing Development

All of these systems meet the required specifications for submerged oil detection and recovery. In addition, all of the vendors indicated that larger and possibly multiple collection tanks would be needed for a large spill.

For actual spill recovery, responders may need to adjust filter system size and utilize multiple steps to separate oil and sand. These systems can be also useful in combination for unique scenarios, such as deep water or in a surf zone.

Testing and developments are ongoing, as is another RDC effort aimed at ways to detect and mitigate oil in the water column.

About the author:

Mr. Kurt Hansen has served at the RDC for 20 years and has spent 15 years working on projects dealing with oil spill response. During the Deepwater Horizon *response, he served on the alternative response technology team. He is a member of the ASTM Hazardous Substances and Oil Spill Response Committee.*

Endnote:

1. For the purpose of this document, "submerged oil" is any oil that is not floating at or near the surface. Sunken oil describes the accumulation of bulk oil on the seafloor.
2. Visit www.uscg.mil/hq/cg5/cg545/ for more information.

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