Oil skimming technology "SORBMOP"

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Abstract

Accidental oil spills in estuaries, coastal areas, and the open sea are most probable in connection with severe storms. In the case of heavy sea state and strong currents, countermeasures must be taken very soon after spill, which is often impossible with the existing oil skimming technology. In addition, the existing systems have their shortages in the use in shallow waters.
Considering these shortcomings of conventional containment and recovery methods for oil spills a new system named SORBMOP was developed by EKU Entwicklungen Rostock.
The new skimming system SORBMOP consists of four components:

1. Oil adsorbing elements
2. Container for storage and placement
3. Surface controlled net
4. Conventional seagoing vessels with special fishery equipment or special vacuum cleaner

The system SORBMOP offers advantages in the clean-up of oil spills in open marine areas as well as in shallow marine and inland waters:

- Rapid action - start of operation within few hours after oil spill by using airplanes for transportation of adsorbing material (avoids pollution of plant, animal, and bird communities)
- Collection of oil containing adsorbers using conventional seagoing vessels
- Improvements in oil skimming in shallow waters

1 Introduction

Oil spills in marine environment have different causes, which can be separated in intentional and accidental spills. The daily pollution by ships giving their residual heavy oil illegally to the sea instead of legal disposal in harbours is belonging to the first group. Worldwide harbour regulations with flat rates not depending on the use or not use of waste management services can lower the number of this kind of oil spills significantly.
On the other hand, oil spills can be caused by accidents in shipping or offshore oil drilling. Improved safety regulations can lower the probability of these oil spills, but the possibility of their existence will remain.

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Worldwide, different attempts to control oil spills are in use (EPA 1999):

- Mechanical containment using booms
- Recovery of oil by using pumps, skimmer systems, or sorbents
- Chemical (dispersing agents) and biological (biostimulation and bioaugmentation) treatment of oil, often in conjunction with mechanical containment
- In-situ burning of oil spills in conjunction with mechanical containment
- Shoreline cleanup of oil spills using natural (evaporation, oxidation, biodegradation) and physical processes (wiping with sorbant materials, pressure washing, raking or bulldozing)

The effectiveness of these methods depends on a variety of factors such as characteristics of the oil itself and natural conditions like weather, water temperature, salinity, water depths, and bottom material.

One of the most important points in controlling oil spills in aquatic environments is the quickness of reaction to limit the rate of spreading due to currents, wind, and wave attack. Only few hours after a spill the oil can cover big areas and can move in direction of shallow water areas and shorelines where the oil-pollution can result in disastrous damages of aquatic habitats and recreation areas.

In addition, oil properties are changing rapidly after spilling. During the first 12 hours following a spill, up to 50 % of the light components eventually evaporate (EPA 1999). This decreases the toxicity of the spill over time, but it also thickens the residual oil. Consequently, the rate of natural biodegradation decreases, the oil forms dense, sticky black spheres like tar balls or emulsions which can linger in the environment for years or which are heavier than water and sink to the sea floor. The effectiveness of recovery measures, like use of skimmers or sorbents, chemical or biological treatment, and in-situ burning can decrease significantly.

A rapid reaction on oil spills is difficult especially in rough seas, where accidentally oil spills most often take place and spreading is strong. The polluted area can hardly be reached in time by ships for containment and recovery measures. In addition, containment by booms and recovery of oil by skimmers can easily fail in rough and choppy waters.

Considering these shortcomings of conventional containment and recovery methods for oil spills a new system named SORBMOP was developed by EKU Entwicklungen Rostock.

2. System SORBMOP for the use in open marine areas

The containment and recovery system SORBMOP for the use in open marine environments consists of four components:

1. Oil adsorbing elements
2. Container for storage and placement
3. Surface controlled net
4. Conventional seagoing vessels and fishery equipment

Up to now, sorbents are used as sole cleanup method in small spills only or for removal of residual traces of oil. The characteristic of the system SORBMOP is the use of adsorbent material as the basic method also for the cleanup of bigger

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oil spills. It consists of a special manufacture, transportation and collection system of the adsorbing material.
The oil adsorbers consists of foamed plastic (PE) elements with hydrophobic and oil adsorbing characteristics and a pore size according to oil viscosity (Fig. 1). The dimensions of prototype adsorbers are 5cm x 2cm x 1 cm. They are stored 1:3 compressed in special containers (Fig. 2), which can be transported to polluted areas by airplanes or conventional seagoing vessels. Transportation by airplanes can not be hindered by heavy sea state. Thus, enabling rapid action even under severe weather conditions. When placing the adsorbing material from air, the synthetics duck under and adsorb the oil when rising to the water-surface.

Fig. 1: Oil adsorbers partly filled with extremely viscous oil (IFO 380)

Fig. 2: Container (prototype) for storage and placement

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The second step of countermeasures is the collection of the oil-filled adsorbers, which should be started as soon as possible to avoid high rates of spreading. For this purpose, a net with surface controlled upper edge to collect floating adsorbers was developed (Fig. 3). Conventional seagoing vessels fitted for lowering and pulling the special net can be used (Fig. 4).

Fig. 3: Field investigations with a prototype of a surface controlled net

Fig. 4: Conventional seagoing vessel with equipment to lower and to pull the special net (prototype)

After collection the oil can be separated mechanically from the adsorbers, e.g. in a land-based plant to reuse both materials, adsorbers for oil spill recovery as well as oil e.g. for the production of thermal energy. A deposition of used adsorbers in a waste disposal site is also possible.

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3. System SORBMOP for the use in shallow waters

Oil spills in shallow water areas can be caused directly in shallow water zones or by drift of spills from deep to shallow water. Shallow water areas, esp. tidal flats usually contain rich plant, animal, and bird communities. Deposited oil can cause tremendous ecological damages esp. if the oil is allowed to seep into the muddy bottoms of flats.

The system SORPMOP can offer rapid remedy also for oil spills in shallow waters. The adsorbing material can be brought into the spoiled area by airplane thus being independent of water depth and weather conditions. Pollution of the bottom material as well as harm of animals can be reduced significantly. The adsorbers can be collected in shallow water by special keel-less ships with a surface controlled net or at the shoreline by vacuum cleaner. The adsorbing material can keep the oil over a long period of time, allowing longer integrals between containment of oil and collection of adsorbers.

4. Field and laboratory testing

First field and laboratory testing of suitability and handling of the system SORBMOP was carried out in the years 2001 and 2002.

Laboratory tests show very good results in the rate of adsorption using different kinds of oil (light and heavy oil) and in the rate of oil retention. In addition, the small hydrophobic and oleophil adsorbers are tracking oil spills for containment. The oil-contaminated adsorbers can keep adsorbed oil over a period of several days. According to first tests, they are loosing only 3 %vol. oil after impact on a concrete basis from a height of one metre. Therefore, wash up of used adsorbers does not bring significant harm to the shoreline and can be allowed.

Laboratory investigations with dead birds show that only a very small amount of oil will stay in feathers after cleaning an oil spill with adsorbers (Fig. 5).

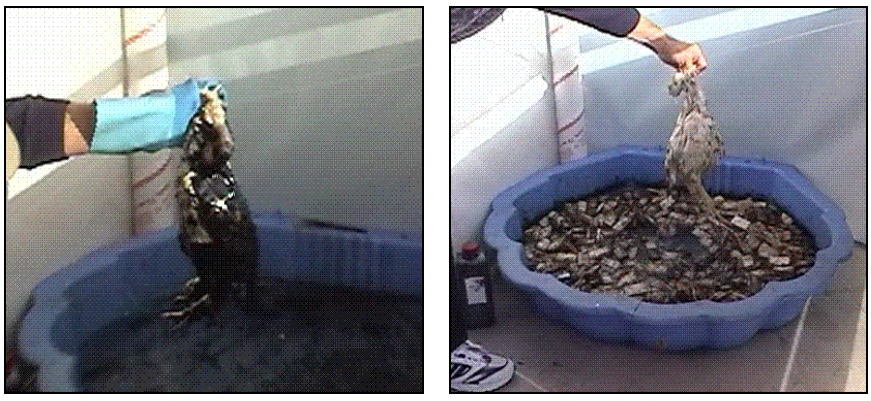

Fig. 5: Impact of oil (IFO 380) contaminated seawater on the life of birds
a) without use of adsorbers b) with use of adsorbers

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Field tests with a prototype of a surface controlled net for collecting adsorbers have been carried out successfully at the Baltic Sea near Thiessow / Island of Ruegen (Germany) in March 2002. A width of 150 - 200 m can be covered by the prototype net dragged by two vessels (Fig. 6). The weather conditions were rough with wind-force up to 9 Beaufort (45 knots of wind).

Fig. 6: Field tests with a prototype of a surface controlled net at the Baltic Sea near Thiessow / Island of Ruegen (Germany)

5. Conclusions and prospects

The system SORBMOP offers a number of advantages in the clean-up of oil spills in open marine areas as well as in shallow marine and inland waters:

- Rapid action - start of operation within few hours after a spill by using airplanes (avoids of oil pollution of plant, animal, and bird communities)
- Collection of oil containing adsorbers using conventional seagoing vessels with equipment to handle a surface controlled net
- Improvements in oil skimming in shallow waters

For the practical use of the system SORBMOP further investigations with special respect to the following questions have to be carried out in future:

- Spreading of adsorbers in an oil spill, e.g. tracking characteristics
- Rate of adsorption using different kinds of oil (light and heavy oil) in different marine environments (e.g. water temperature, salinity, sea state, currents)
- Rate of long-term retention of adsorbers using different kinds of oil
- Rate of oil retention of adsorbers after impact on obstacles
- Improvement of surface controlled net for collecting adsorbers

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- Improvement of vacuum technique for collecting adsorbers washed up at the shoreline
- Mechanical separation of adsorber and oil after use for recycling and / or disposal
- Logistical and financial aspects

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