PROBLEMS OF OIL POLLUTION ON COASTAL WATERS AND BEACHES

Uwe Carow

Landesamt für Wasserhaushalt und Küsten
Scholeswig-Holstein, Germany

In the coastal regions of the North- and Baltic-Seas of Germany more collisions with oil tankers have occured since 1955. These collisions have been followed by extreme pollution of the sea and coastal areas. In the following report the possibility of computing in advance the time and place of the landing of sludge, the advantages and disadvantages of chemical and mechanical treatment for the removal of the oil, the natural influences on the decomposition of the oil and the differences between oil-pollution on coasts with tides and on coasts without tides are explained and critizised.

- - -

Coastal areas and beaches are in danger of being polluted by oil. One part is the uncontrolled disposal of waste oil causing permanent pollution, the other part is the result of collisions with vessels. This danger is most threatening on much frequented shipping routes and in limited and relatively small sea-areas and bays of low depth, as it is the case with the North-and Baltic-Seas in the North of Europe.

6 oil tanker collisions since 1955 have caused considerable pollution in these areas. In the last three years 60 % of all oil-accidents have happened in coastal waters. You all remember the collision of the "Torrey-Cannyon" at the coast of Cornwall/ England causing a catastrophic oil-pollution. 90.000 to of oil ran out and the expenses for removing amounted to 1,6 Million Dollars.

The scope and the success of the technical measures taken against the oil are depending on different factors:

For instance cause, place and time of the accident, loaded and runout quantity of oil, kind - to say boiling point - of the oil as well as meteorological conditions.

Most important with the regard to a successfull fighting against the oil is to come in action quickly and expertly.

Generally an oil-pollution is governed by the following successive events: Outflow and spreading of the oil, drift of the contaminants, landing of the contaminants.

The outflow of oil is depending on the kind of damage done to the tanker, a damage that may assume many forms. Resonable measures applied to the ship herself are apt to prevent the outflow of considerable amounts of oil. These measures consist primaryly in rendering the ship floatable again to enable her to be towed into a safe port. In many cases it will not be an advantage to burn out the wreck because by that the pollution is loaded into the atmosphere.

The kind of oil plays an important part in its expansion on the water. Precise measurements relative to speed of expansion and layer thickness of oil fields are not available. Following observations, a 1 mm to 4 mm thick layer will be buildt up very quickly. An oil-film of a thickness of one micron to 0,1 mm passing finally will be a little bit slower in forming.

We made an experiment spilling 11 to Arabian Light oil into the calm sea. 25 minutes later the oil had spread out on an 200 m wide and 400 m long expanse, the layer was 14-hundredth mm. After 6 hours the layer was 1,4 thousandth mm and extended to an expanse diameter of 1,7 n.m. (nautical miles).

Direction and speed of further expansion and drifting of oil fields are influenced by wind, state of sea, tidal currents and the so-called residual currents (that are streams without periodical proportions). In the German Bay just the flood-tide current has a speed of approximately 1.9 to - 2.8 n.m./h, the ebb-tide current a rate of round about 1,9 - 5,0 n.m./h. The drift of layers on the water surface can, thanks to tests with "drift cards" in plastic envelopes, be supposed to be 4,2 % of wind velocity in wind direction (German Bay). This value has been confirmed by observing drifting oil fields. In the case of prolonged drifting, there may arise an incertainty factor of ± 1 day. Therefore such drift computations should be verified by interim observations from airplanes and ships. But also without these crafts it will be possible (during fog and gale) to deliver relatively precise and timely forecasts as to the coastal areas, where the oil will land, thus facilitating an efficient control of the oil. In one case it was possible to recalculate - on the basis of the landed oil - the way back to the place of the accident, with the conjectured place of accident thus being confirmed and the responsible tanker being found.

The control and calculation of the drift-way has three significant advantages:

1. You can follow the way also when it is not possible to observe from ships or airplanes.
2. If you know wind-velocity and wind-direktion you can forecast, which coastal region will be in danger to be polluted and you can warn the neighbour-land.
3. If there are larger oil-fields being sighted on the sea or being landed on the beach it is possible to pursue back the way of drifting in order to find the ship occasioning the pollution.

When it comes to "depositing" there exist - apart from the already mentioned influence factors - sea levels, vertical and horizontal coastal configurations, surf and "off-shore" factors which matter. The latter factors constitute a computational value composed of ebb-currents, surf streams and off-shore residual and drift currents. In the German part of the North Sea coastal area this parameter is assumed to be 0,5 n.m./h in direction NW. The medium residual current in the open sea amounts to 0.2 n.m./h, direction NE.

We differ between and mechanical methods of oil-removal at sea and on the beaches:

In eliminating oil pollution at sea, the following experiences have been gathered:

Although it is known that detergents together with oil are more toxic than chemical substances alone, emulsifying agents have been employed at sea. At some distance from the coast and with the sea being rough, immediate success was not noted. The mixture ratio of 1 : 1-necessary for a stable emulsion-has certainly never been reached. It may, however, have facilitated the dispersion of the oil-surfaces. On the Baltic Sea, however, we had succeded in dispersing a thin-layer oil field, drifting immediately in front of a crowded bathing beach, by sprayed-on emulsifying agents and turbulence caused by screw propellers.

The application of emulsifying agents shouldn't be declined at any rate, you see, but it must be said, that emulsifiers - needed in mixture 1 : 1 - are very expensive.

In many cases it will be better to use binding-agents of solid substances. This is a kind of mineral-absorbent with a high surface area. It is hydrophobic and not toxic. The particle diameter is varying from 0,1 to 2 mm. Brought up to the oil, the floating mix will drift to shore in a very readily collectable form and it can be removed together with the bound oil. But there is one disadvantage: as a consequence of the little weight of the binding agents a strong wind will blow it away, so that you can use it only in times with low wind-velocities.

Swimming oil barriers - as a mechanical way - only may be used in calm waters as in rivers, river-mouths, creeks and harbours. In the rough sea or in the surf the oil will flow over or under the barrier under the influence of waves and currents.

In Germany just have been made successfull tests by dropping binding agents with helicopters. In contrast to wing-airplanes they have a slow dropping-speed, low flying-depth and a high loading-capacity.

On the beaches, the oil was primarily removed in a mechanical way. On the tidal beaches the oil is often spread by ebb and rising tide over a large expanse as far as to the foot of the dunes. To use bulldozers peeling off the oil-polluted sand layer, proved to be most efficient. Individually distributed oil areas or oil clods could be removed with shovels. The removal of oil on grassgrown dikes is very difficult. Damage done to the sod endangers the security of the dike. Here you have to proceed with caution and to remove carefully and manually the oil with the aid of shovels.

From the stone covers the oil only could be removed to a certain extent by means of emulsifying agents.

On the beaches not subject to varying tides - as on the shores of the Baltic-Sea - oil fighting is easier. Due to the limited fluctuations of the sea level, the landed oil will remain in only a small shore area. With the surf being strong, it has proved a success to heap up a sand mound at a distance of some meters from the water line to keep the remaining beach free from oil.

Nature, too, is very helpful in eliminating oil pollution on beaches. A quick disintegration of oil also was observed in deeper sand layers (up to 20 cm). Particularly efficient are high tides or storm tides returning the partially disintegrated oil into the sea, where it continues to be further decomposed.

The differences of the oil as to quantity and composition, in the place of the accident and on the beach, reveal a considerable influence of the natural disintegrating forces. These primarily are consisting in the evaporation of the volatile constituents of the oil, the photo-oxidation by sunrays and the decomposition by bacteria.

Model tests with four different types of crude oil have shown four manners of decomposition processes:

1. The evaporation of low-boiling compounds up to a loss of approximately 20 % of weight is a short-time process.
2. Further the formation of a water-oil-emulsion under influence of precipitation and water turbulence is a quickly developing reaction, causing a fundamental change in the properties of the oil.

3./4. Ageing and biochemical degradation are long-term processes. The first one especially changes the viscous properties and the second one effects the chemical composition.

During the Torrey-Cannyon accident there have been made tests with decomposition by bacteria. There were found in 1 ml at "oil in water" 1,5 millions of microorganisms and in "oil saturated sand" 24 millions of bacteria. It was also observed, that the bacteria are relatively resistant against chemical agents as for instance emulsifiers. Many model-tests are necessary to find more about the influence and effect of bacterial-decomposition on oil.

Last not least something about the identification of the responsible ship causing the oil pollution: In many cases we were succesfull to identify the run out oil on the beach and the oil loaded from the tanker. We are using chemical-analysis in a manner of infra-red-spectrum or atomic-absorption-spectral analysis. But it must be provided that the time between accident and landing - respectively moment of sampling - is short enough, so that above named decomposition processes won't have changed the characteristic properties of the oil.

Every tanker accident and the pollution resulting from that occur under different conditions. For that reason, each case requires special measures. Experience has shown, that to fight oil at seas is in many cases more expensive than on the beach. In view of the natural-disintegrating-forces any reasonable use of control mediums should also consider the time relative to the bathing season on the beaches. In the last analyses all the measures should be taken under careful consideration of all the above named influence factors, duly estimating the danger of oil pollution to the existence of man, animal and plant life.

This is not a hopeless task, but the problem of oil pollution will only be solved by international teamwork and by exchanging practical experiences on technical and organisational lines. The protection against the "black tide", however, is as difficult as the protection of our shores and beaches against the forces of sea-waves and - currents.