

Preventing oil pollution of the sea

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KURZFASSUNG: Verhinderung der Ölverunreinigung des Meeres. Bisher ausgeführte Versuche und Maßnahmen, die ergriffen wurden, um eine Verunreinigung des Meeres durch Öl von Schiffen zu verhindern, werden diskutiert. Eine kurze Geschichte der juristischen Situation wird gegeben. Das "load-on-top"-Verfahren, das von den meisten Ölgesellschaften praktiziert wird, um Verunreinigungen durch Tanker zu verhindern, wird beschrieben. Der Untergang der „Torrey Canyon“ im März 1967 hat in besonders eindringlichem Maße gezeigt, daß es notwendig ist, Überlegungen und Untersuchungen anzustellen, um die Verunreinigungen, die auf Grund von Unfällen auf dem Meer entstehen können, so gering wie möglich zu halten. Einige Vorschläge hierzu werden unterbreitet und diskutiert.

INTRODUCTION

The two major ways in which pollution of the sea by oil from ships can arise, each presenting its own distinctive problems, are, firstly, pollution resulting from a deliberate discharge of oily wastes and, secondly, accidental spillage consequent upon collision, shipwreck, or misuse or malfunction of equipment. In either case the measures adopted to deal with oil pollution once it has occurred present essentially a localised – or sometimes a national – problem, although of course there is international interest in a world-wide research into the various methods of tackling such pollution.

More important, however, is what measures can be taken to prevent the pollution from occurring in the first place? It is with this aspect, which demands a co-operative international approach, that the present paper is concerned.

Pollution arising from deliberate discharge is obviously open to some form of control and the control measures already taken by the oil companies are described. Pollution by accident is less amenable to control because of its large dependence on human error. Nevertheless, steps can and have been taken to minimise the probability of accidental spillage and some of these are discussed.

Before going into detail, however, it is useful to consider briefly the events which led up to the adoption earlier this year of stricter limiting measures, on an international basis, for discharge of oil at sea.

THE 1954 CONVENTION AND THE 1962 AMENDMENTS

Early recognition of the international nature of the problem is evidenced by attempts in 1926 at a conference in Washington, and some years later under the sponsorship of the League of Nations, to introduce sea pollution prevention measures. These initial efforts did not produce any agreement but the international conference held in London in 1954 under the aegis of the British Government, and at which some 40 countries were represented, led to a more successful outcome. At this conference, the International Convention for the Prevention of Pollution of the Sea by Oil was drafted. The Convention, which came into force internationally on 26th July, 1958, a year after the necessary number of ratifications had been acquired, prohibited the discharge of persistent oil or oily mixtures in designated prohibited zones. (The term "oily mixture" means a mixture with an oil content equal to or greater than 100 ppm.) Generally speaking, these zones were within 50 miles of the coastlines of most of the world excepting Eastern Canada (100 miles) and Australia (150 miles), with a special larger zone, including the whole of the English Channel and the North Sea, extending from the coasts of N.W. Europe well over 1,000 miles out into the mid-Atlantic.

In June, 1959, the duties and functions of the Convention Secretariat were transferred from the UK Government to the Inter-Governmental Maritime Consultative Organisation (IMCO). It had become apparent by the early 1960's that, despite the provisions of the 1954 Convention, pollution of the sea by oil was not being effectively prevented. IMCO called a further international conference in 1962 to review the situation and this conference passed a number of amendments to the 1954 Convention with the object of strengthening it. Before these amendments could come into force they required ratification by two-thirds of the signatories to the 1954 Convention and this stage was reached during 1966. The subsequent operative date was fixed at May 18th, 1967 and the Amended Convention has thus been in force internationally for 4 months. At the time of writing, and with a few minor reservations, 35 Governments have accepted the 1954 Convention and 23 have accepted the 1962 amendments. Broadly speaking, the major effects of the amendments are to extend the minimum discharge distance of oil or oily mixture to 100 miles from coastlines for existing ships, and to be still more restrictive for ships of 20,000 gross tons and above for which the building contracts are yet to be placed or were placed on or since 18th May, 1967. For these ships, discharge is now prohibited anywhere at sea except that in special circumstances and with certain provisos, discharge of oil or oily mixtures may be effected outside the "prohibited" areas.

The terms of acceptance of the Convention by a country require that country to give effect to the provisions of the Convention (and, where applicable, the 1962 amendments) under its own laws. To take the UK as an example, the Oil in Navigable Waters Act, 1955, gave effect to the 1954 Convention (and, incidentally, came into force in September, 1956 although, as already mentioned, the Convention itself did not come into force internationally until July, 1958). The Oil in Navigable Waters Act, 1963, brought the 1955 Act up to date regarding the provisions of the 1962 amendments; the 1963 Act came into force on the same day as the 1962 amendments - 18th May, 1967.

It should be appreciated that not all countries in which ships are registered have signed the Convention; and still fewer have ratified the 1962 amendments. Even accepting a Utopian situation of total international legality of the measures now accepted by some governments as being in force, one must still acknowledge the tendency to more frequent infringement of the law where detection of the offender is difficult, and this is very often the case at sea as recent experience in the English Channel has emphasised. In this connection, the acceptance of the Convention by a country entitles that country to report the vessels of other accepting countries if they are detected outside territorial waters in breach of any of the provisions adopted. It may also be noted that an accepting country's vessels must observe the terms of the Convention all over the world.

Following the 1962 Conference, and appreciating the likely delays and difficulties in dealing with the problem by law, the major oil companies established a voluntary procedure aimed at preventing the discharge at sea of oil from tankers. This procedure, which is known as Load-on-Top (LOT) and which is currently being applied to about three-quarters of the crude oil tonnage moved by sea, has been operating satisfactorily for some years, and within BP since mid-1964. The wide experience already gained will undoubtedly be valuable in assisting a quicker and more effective implementation of the 1962 Amendments to the 1954 Convention.

THE LOAD-ON-TOP PROCEDURE

Four points will be considered in turn. Why was it necessary to introduce LOT, how does it operate, what has been the effective result and what are some of the attendant problems?

Although after discharging her cargo of crude oil a tanker's cargo spaces are passed as empty, there still remains a certain amount of oil adhering to internal surfaces and retained in pumps and lines. The quantity remaining will depend on several factors, including the ship's draining characteristics, the type of crude, the length of voyage and cargo temperature at discharge. A figure approaching 0.5 per cent of total carrying capacity may be taken as giving some idea of the amount of oil which may be retained, although this figure can often be exceeded. The refilling of one third or so of the cargo tanks with sea-water for stability during the ballast voyage will therefore result in "dirty" ballast; that is, ballast water having some free oil floating on the surface and a much smaller amount mixed with it. In most cases, the dirty ballast cannot be accepted at the ship's next loading port since slops reception facilities are not widely available at crude oil loading terminals.

It may be noted here that although the 1962 Amendments require the adopting countries to install oily-water receiving facilities at their ports, such facilities are an impracticable proposition at most crude oil loading ports; indeed, the practice of LOT has now rendered this unnecessary in the latter situation. As far as the transport of white products is concerned, there is no need to operate LOT since product tankers load at refineries, where slops reception facilities are available.

Because of the necessity for a tanker to arrive at the crude loading terminal with

only clean water in the tanks in order to prevent local pollution on discharging the ballast, it had for many years been accepted practice to wash the tanks with sea-water and discharge the washings, including the oil, at sea. As inferred above, this meant the discharge to sea of anything up to half a per cent of previous cargo which in the light of, say, about 600 million tons of crude shipments per year, amounted to a significant quantity. The necessity for preventing this discharge led to the adoption of LOT, the principle of which may be simply described as follows – although in practice, variations, some of which entail rather more sophisticated techniques, are adopted.

One tank, referred to as the slop tank, is first selected to act as a reservoir for the oil to be retained on board and tank washing is then commenced after sailing on the ballast passage. The tanks required for clean ballast are always cleaned thoroughly but as few extra tanks as possible are washed because, firstly, washing accelerates corrosion and secondly, there is no problem involved in the loading of fresh crude onto the crude remaining in a ship's tanks from the previous cargo. Special circumstances sometimes dictate that extra tanks are cleaned – as is the case, for example, with all tanks when black products have been carried since drainings may contaminate the next cargo; when a ship is due for dry dock; when tanks are required to be gas free; or for the maintenance of a reasonable standard of cleanliness.

The tank washing is effected by means of special apparatus lowered into the tank and fed normally with cold but sometimes with hot water under pressure at around 180 psig. The washings are pumped from these tanks on a continuous basis into the top of the slop tank, the transference rate varying with the number of machines in use at the time. A rate of 70 to 140 tph would be considered normal for tankers in the 50 000 dwt region. The washing water gradually becomes less contaminated and the oil accumulates in the slop tank. By suitable adjustment of tank levels and with due allowance for settling, discharge of clean water may be effected from the bottom of the slop tank or any other intermediate tank if required. The situation is eventually reached where the ship has clean ballast, other tanks clean as required and a slop tank containing a top oil layer, an intermediate emulsified layer and a bottom water layer. Repeated settling and pumping of the water layer to sea, taking care to stop pumping as the water/emulsion interface is reached, leads to the slop tank's containing the retained oil, some still in emulsified form, resting on a water bottom of a few inches. Due to emulsion settling difficulties the total water content of the slop tank at the completion of the operation is often of the order of 30 per cent.

When fresh crude is taken on board at the loading terminal, part of the cargo is "loaded-on-top" of (and mixes with) the contents of the slop tank, in which a further separation of water may occur. Where possible, this is removed during the subsequent loaded voyage to minimise the water content of the cargo at the discharge port.

Provided, during removal of the water bottom from the slop tank, the water/emulsion interface is not too closely approached, the 100 ppm Convention limit is not exceeded. Nevertheless, in order to keep the free water present to a reasonable minimum, and despite preventive efforts, small amounts of emulsion-entrained oil do sometimes escape. Wide experience has, however, established that the total quantity escaping in this way is unlikely to be more than about 1 ton; and this is distributed over hundreds of miles and dispersed in the wake of the ship. Further ways and

means of preventing even this small quantity from escaping are currently being examined – for example, by the use of more advanced instrumentation for continuous monitoring of small quantities of oil in sea-water.

Heating of the slop tank contents and/or the use of demulsifying chemicals are other measures being investigated in an effort to ensure that the 100 ppm discharge limit is at no time exceeded and, concurrently, to ensure minimal retention of water on board. The latter is, of course, important in that water is dead freight and is also undesirable from the accepting refiners' point of view – of which more later. If the quantity of water still remaining at the discharge port is unacceptable to the receivers – a rare occurrence nowadays – the bottom of the slop tank contents may be transferred to an empty cargo tank when one becomes available and retained on board.

Our third question, on the effective results of LOT operations, is best answered by illustration but it is first necessary to make some assumptions. We will assume that the average quantity of oil previously discharged at sea, and now retained on board due to LOT, is 0.35 per cent of the carrying capacity of the ship (a figure very close to that found in practice by BP) and also that LOT is practised in respect of 75 per cent of crude oil shipments. These figures, given current total international crude oil shipments of about 620 million tons a year, lead to the following approximate conclusions: (1) If LOT were not operated the total oil discharge to sea would be in excess of 2 million tons per annum. (2) LOT operation currently prevents the discharge of over 1½ million tons per annum. (3) About ½ million tons per annum is still discharged at sea by ships not operating LOT.

In BP's own operations about 115 million tons of crude per annum are currently transported by sea. LOT thus results in the Company's retaining some 400,000 tons per annum which would otherwise be discharged to sea. This contribution to cleaner seas represents at the same time an apparent saving but against this must be set the complicating technical and economic consequences of LOT; which leads to our fourth question – what of the attendant problems?

Briefly, the increased salt content of the crude is at the heart of the technical problem, because of its potentially deleterious effects on refinery crude oil distillation, unit corrosion and heat exchanger blockage and on fuel oil quality (increased sodium and ash content). Experience within BP has indicated that LOT results in roughly doubling the salt content of the cargo, although the actual figures may vary within fairly wide limits. For refineries already equipped with desalting equipment, removal of the extra salt water does not cause any serious difficulty although marginal additional expenditure is incurred. Accepting a typical figure of 90 per cent desalting efficiency, about 10 per cent of the extra salt due to LOT will enter the distillation unit. The normal practice for dealing with the increased corrosion potential due to this additional salt is to add extra soda but this of course results in an even greater increase in the sodium content of atmospheric residue. This means that if there should be a demand for fuel oils with lower sodium contents than are currently acceptable – a demand which would present a problem even without LOT – the situation would be still further aggravated.

It is clear that refineries not equipped with desalters are in a more difficult position and must take alternative steps to remove most of the salt before processing

the crude. Normal residence time in refinery crude oil tanks allows for adequate settling in many cases, and in others either the whole or the more aqueous part of the slop tank contents may be diverted to the refinery slops reception system for separate treatment. Where neither desalters nor slops treatment facilities are available, water settling in and removal from tankage is essential.

The wider economic implications of LOT cannot be adequately discussed in a general paper of this nature but it may be mentioned that arrangements are made to ensure that chartered tanker operators suffer no financial loss and that the crude oil customer, although as already indicated incurring additional processing costs, actually gains overall as a result of LOT. This does result, of course, in some loss of income to the supplier. The effect of LOT on refinery costs has been described recently (BRUMMAGE, MAYBOURN & SAWYER 1967).

ACCIDENTAL POLLUTION

The grounding of the "Torrey Canyon" has highlighted some of the problems which can arise following tanker wreckage and large scale oil pollution of coastal waters. The massive clean-up operations which have involved the use and trial of many methods, some of which have proved much more successful than others – and some virtually useless – are outside the scope of the present discussion and will be dealt with elsewhere (BEYNON 1968).

The incident has, however, given fresh impetus for considerations on how the future occurrence of such mishaps might be minimised or, more hopefully, prevented. The problems, which must again be tackled internationally, also embrace a necessity for the introduction of measures for attempting to reduce the incidence of collisions at sea involving tankers.

Collection of complete statistics in this field is difficult but information obtained largely from reports of the Liverpool Underwriters Association indicates, for the period June, 1964 – April, 1967, that in 91 tanker grounding incidents there were 17 cases of cargo spillage or leakage. Seven of these tankers were abandoned, of which 4 were either in ballast or carrying a non-persistent cargo. World-wide tanker collision statistics obtained from the same sources for the same period indicate that 238 tankers were involved in 196 collisions. Twenty-two resulted in cargo spillage and 9 in the total loss of a tanker; it is believed that the 9 losses involved only tankers either in ballast or carrying a non-persistent cargo. The oil pollution hazard over the period under consideration thus appears to have been of the same total order for both grounding and collision incidents. The greater number of collisions, however, indicates that the potential for accidental pollution is greater in the case of collision than in the case of strandings.

Despite these figures it must be emphasised, firstly, that general standards of navigation are extremely high and, secondly, that in relation to the enormous number of sailings the number of collisions and strandings at sea is extremely small. As in any other field it becomes increasingly difficult to reduce the chance of mishap when that chance is already small and in this area, in addition to technical considerations, economic considerations assume an ever increasing importance.

It is nevertheless recognised that there is a need for navigational equipment on large tankers – and other vessels – over and above the minimum mandatory. The international Safety of Life at Sea (SOLAS) Conventions only require radio direction finders and one or two elementary items. Responsible owners, however, equip their ships to a higher standard than these Conventions require. This is evident from a recent survey of 370 British tankers, during which a check on navigational equipment showed that: 328 had Decca Navigators, 356 had VHF, 360 had Radar (the other 10 were all below 1600 tons) and 349 had Echo sounders.

The possible installation of this type of equipment or its equivalent as an international requirement for ships above some specified tonnage would seem to be desirable. The International Chamber of Shipping and IMCO are, respectively, surveying and considering requirements for navigational aids on ships but it will obviously take some considerable time, even after final recommendations have been made, for international agreement to be reached and implementation effected.

Another possible navigational aid is that of providing guidance from on-shore stations to shipping in port approaches or in narrow waters. Despite complicating factors, for example language difficulties, this aspect appears to warrant more serious consideration. The suggestion has been made that special shipping lanes might be delineated for tankers and other large vessels to follow but it is believed that specific routing would increase the accident and pollution risk rather than reduce it. Recommended, rather than specific, routes may serve a useful purpose in narrow waters but there is always the added difficulty that all ships – not only tankers – would need to follow any agreed routes and this would be, again, a matter for international consideration. An example of this is the acceptance by IMCO that there should be a general understanding on routing in the Dover Strait.

The collision in 1966 off the mouth of the Elbe between the Norwegian 40,000 tons tanker “Anne Mildred Brövig” and a small British coaster illustrates the impracticability of special routes for, or prohibition of special areas to, ships of a particular type or size or which carry a special cargo. The tanker was proceeding immaculately when she was hit in fog by the coaster, the latter being entirely responsible for the accident. One might suggest, then, that it was the coaster which should have been on a special route.

The ever-increasing size of tankers, the largest currently in service being a Japanese 205,000 tonner, has given rise to thoughts as to whether, in view of safety considerations, some limitation should be placed on tanker size. There appears to be no reason, however, for holding to this point of view. Manoeuvrability of these large ships compared to much smaller ones is, length for length, almost identical and to change course is, for a very big ship, proportionately easier on a tonnage basis than for a smaller one. The big tankers have a turning circle of about half a mile and can change course rapidly. Change of course would be the normal procedure for avoidance of an unexpected hazard rather than to carry out an emergency stop. Incidentally, the stopping distance is less than two miles for these large tankers. It should also be borne in mind that the larger the unit, the less is the chance of collision and subsequent pollution because there are fewer units at sea. A final point on tanker size is, of course, the economic advantage of operating the larger vessels. In this connection, any

country which placed a limit on the size of tankers using its ports would be at a serious economic disadvantage if other countries did not act similarly.

Regarding tanker architecture, we may dismiss fears that the larger tankers are more liable to break in half; neither is there reason for believing that "jumbo-ised" tankers present any additional hazard. Another point that has been raised is the possible provision of a double skin. This is undesirable because it would create an additional fire hazard. Further, the chance of an oil spillage on collision or shipwreck would not be significantly reduced by this means; in the case of the "Torrey Canyon", for example, there was a rock penetration of some seventeen feet.

ACTION FOLLOWING AN ACCIDENT

Whatever steps are taken it must nevertheless be admitted that accidents will inevitably occur. Accepting this, what measures can then be taken to minimise the amount and extent of pollution following an accident; that is, as distinct from any cleaning-up operations.

The first, and probably most important, is salvage – preferably of both the ship and as much of the cargo as possible. One of the lessons learned from the "Torrey Canyon" episode, when it eventually became clear that the ship could not be salvaged – and even prior to that stage in the sequence of events – was that effective means for salvaging the cargo were not available under the prevailing conditions. There is an undoubted need for a close examination of salvage equipment research and development requirements, how such equipment may best be operated and, indeed, how best to organize the administrative arrangements so that speedy action can be taken when necessary.

Tied in with this obvious need for prompt action is a recognised requirement for some procedure whereby any country liable to be affected by pollution following an accident at sea, whether it be from oil or any other hazardous cargo, may be quickly warned of any possible danger and the nature of the cargo so that appropriate remedial action may be taken. No such specific warning system is operable at the moment but the possibilities are currently under review internationally through IMCO.

In the event of its being impracticable for some reason to salvage the cargo following an accident in the vicinity of a coastline, and provided of course that the tanker is afloat or can be refloated, then if oil is still leaking or there is an immediate danger of leakage, it could be advisable to tow or steam out to sea for subsequent action. There are, however, too many possibilities for generalisations to be made; each situation must be treated individually in the light of prevailing circumstances.

Inevitably, following the difficulties which arose in the bombing of the "Torrey Canyon" and the firing of part of her cargo, suggestions have been put forward for built-in charges to be located in strategic positions, ready for selective use in an emergency. Apart from the definite inadvisability of burning as a general approach anyway, installation of specialized equipment can be a costly matter and, unless carried out by all tanker owners, could result in an economic disadvantage for those who fitted such equipment. One must also consider that to install special equipment

throughout the world's tanker fleet of some 4,300 ships, based solely on what was undoubtedly a freak disaster, would be to lose all sense of values.

What about the use of booms around ships as a means of containing escaping oil? It is evident from the general lack of merit – and often disintegration – of a wide variety of booms recently used at harbour entrances and estuary mouths in Cornwall that for use in more open waters, especially under rough conditions, a boom would need to have both considerable submerged depth and freeboard apart from adequate strength and the ability to remain sensibly upright. Bearing in mind also the length required for encircling especially the larger vessels and the most probable need to get a boom into place quickly, it is very doubtful if booms can be considered a practical proposition as far as ships are concerned.

On the other hand a fairly strong case could be made for research into the design of booms for effectively protecting harbours against an external spillage, as well as for containing any internal spillage of considerable size on the rare occasions that this occurs.

What, then, of the future? All of the above considerations, and others too, are being actively discussed by many interested bodies, both national and international, embracing the petroleum, shipping and other industries, professional institutions and government departments. The spur given to their deliberations by recent events, which have also highlighted and given a more thorough appreciation of some of the problems involved, will, it is hoped, hasten the development and adoption of further practical measures for combating oil pollution of the sea.

Finally, returning to the concepts discussed under deliberate discharges, there is no technical reason why the Load-on-Top procedure cannot be eventually practised by all tankers. It is, however, evidently bound to take some time for most, if not all, of the remaining quarter of the world's tanker fleet to adopt this scheme, especially when one bears in mind some of the attendant difficulties.

The degree of success achieved and the time taken to accomplish the aims involved will depend, above all, on willingness to co-operate at the international level. The advances made over the last five to ten years, both legally and voluntarily, suggest that we may look to the future with increasing confidence.

SUMMARY

1. The International Convention for the Prevention of Pollution of the Sea by Oil (1954) and its amendments (1962) are discussed.
2. An account is given of the load-on-top procedure, which is designed to prevent oil pollution of the sea by tankers and which is currently practised by about three-quarters of the world's tanker fleet.
3. The grounding of the "Torrey Canyon" has highlighted some of the problems which can arise following tanker accidents and has prompted consideration of how accidents might be minimised. Some possible accident and pollution prevention measures are discussed briefly and a few pointers are given to areas in which future development is desirable.

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