POSSIBLE CONSEQUENCES FROM OIL TRANSPORT WITHIN KVARNER BAY
SOME SOLUTIONS FOR OIL MONITORING AND NEW KONSTRUCTION OF SHIPS

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Abstract

Oil transport within Kvarner bay is dangerous for the sea eco-system. Loading of cargo oil are directly related to the problem of oil tanker ballast waters retaining. Also, accidents can occur while an oil tanker is approaching, or leaving the bay, or they can occur in way of the oil terminal loading/unloading systems. In all such cases, leaking of smaller or more significant oil quantities to Kvarner bay sea can occur. Under such circumstances, it is necessary to enable determination of eco system status change caused by such disturbances. Changes can be determined by measuring several characteristics. In this paper, possibilities of optical fluorescent methods application for analysis of sea water pollution by oil were elaborated. Also, the problem of ballast water, i.e. the problem on invasion of unwanted aquatic organisms and pathogens, can be solved by introducing a new system of continuous exchange of ballast water on route. The new idea of solution on this problem for new construction was suggested.

Introduction

Optical fluorescent methods can be used for analysis of sea pollution by oil. This method enables comparation of clean sea water samples with ones polluted by oil, and also mutual comparation of polluted samples. Primary excitation radiation is within an ultraviolet range of the optical spectra, while a secondary fluorescent radiation is within its visual range. As any oil type and its derivates, have qualitatively different fluorescent spectra, it is possible to differentiate such samples (1, 2). Described procedure is needed and usable as for sea water monitoring, such as for expert witnessing of oil spots within oil pollution performer identification procedure. The authors have presented the measuring method and the preliminary measurement results. Second problem, within pollution of sea water by oil, there is a important problem of invasion of non domestically unwanted organisms, as it was elaborated in reports at sessions of Marine Environment Protection Committee in the IMO News, last decade. It has long been recognized that unwanted aquatic organisms and pathogens could be spread from one geographical area to another by ballast water. In many trades, such as the carriage of oil and bulk cargoes, ships only carry cargo one way. They return empty to the loading port and have to take on ballast water to make sure that ship's propeller and rudder are immersed and the ship has sufficient draught to be able to manoeuvre properly. The Resolution **A.747(18)** of 18th IMO Assembly on Tonnage Convention, concerns the tonnage measurement of segregated ballast tanks in oil tankers, when such tanks are reserved solely for the carriage of ballast water, and they never carry oil and consequently have no earning capacity. This resolution invites Governments to advise the port and harbour authorities to apply this recommendation for assessing fees based on the reduced gross tonnage for all tankers with segregated ballast capacity. Also, the resolution **A.774(18)** of 18th IMO Assembly give guidelines for preventing the introduction of unwanted aquatic organisms and pathogens from ships' ballast water and sediment discharge. It adopted the MEPC guidelines on same subject, and the long-term aim is to develop a new annex to MARPOL 73/78. But, the guidelines are not regarded as a complete answer to the problem. The circular emphasizes that there is still a clear need to research and develop improved ballast water management and treatment options. This water is then discharged near the loading port so that fresh cargo can be taken on board. The ballast water contains organisms which can in some cases prove harmful to local marine life. Revised version of resolution **A.774(18)** incorporates some new recommendation on tackling the problem, including how to lessen the chances of taking on board harmful organisms along with ballast water. The recommendation includes informing local agents and ship of areas where uptake of ballast water should be minimized. After recommendation, procedures for dealing with ballast water include also exchange of ballast water at sea and discharge to reception facilities, and in future, treatment of ballast water by heat and ultraviolet radiation. In the year 1999 the MEPC considered the different options for introducing the proposed regulations, referred also in IMO News. Options include: a new Annex of MARPOL73/78, adopted via a protocol to add the new Annex, a new Annex of MARPOL73/78, adopted via amendments, a completely new convention on ballast water management, under which the terms for entry into force would be determined by a conference, instead of having to comply with existing entry-into-force terms established by MARPOL 73/78.

Methods

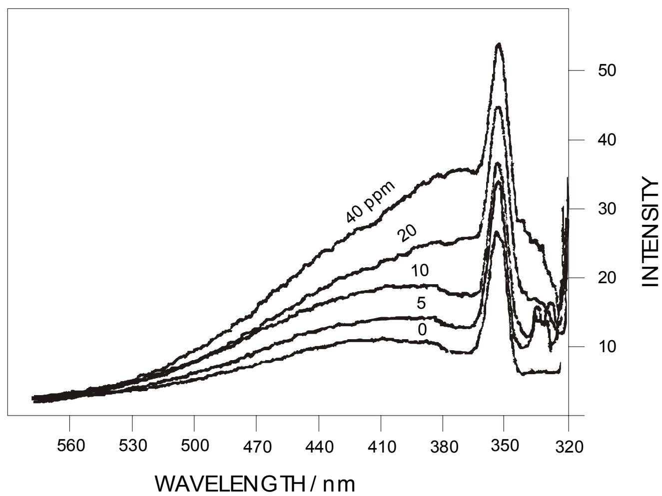
The most frequently used equipment is based on the principle of measuring the intensity of fluorescence within oily water. Measuring technique physical principle is based on fluorescence spectrum measurement (3). Therefore, the measuring equipment in laboratory conditions, preparation of known concentration standards and ways of preparing samples for measuring are presented. Characteristic fluorescent spectra of fluid samples are measured by spectrometer PERKIN ELMER 650-10S. The measuring, due to ultraviolet excitation is done in quartz cells. A xenon lamp was used as a source of excitation. The excited wavelength of 310 nm was extracted from its spectrum, which was proved the most efficient in examined samples. Fluorescent light is measured by photomultiplier predicted for 220 – 730 nm. This enabled the inter calibration, and therefore denotation of the correct wavelength of the stimulated radiation, and, based on that, the calibration of the measured fluorescent radiation in the visible spectrum. As mean, distilled water which was used as "background", has a simple single spectrum with specified peak at 350 nm and continuity to cca 500 nm.

Results

Measurements were performed on standardised oily water samples, made by adding exact quantities of crude oil to distilled water. Produced concentrations are in mg l^{-1}

(ppm). Standards were prepared in concentrations up to 200 ppm, and that lower up to 40 ppm. Results are presented in figure 1. Stabile peak at 350 nm wavelength is noticed as well as is the case with distilled water, which originates from it. In the same figure the spectrum of distilled water is denoted as a concentration standard of 0 ppm. That peak is superposed on quasi continued spectrum of specimens of different concentration.

Figure 1: Fluorescence spectra up to 40 ppm samples concentrations

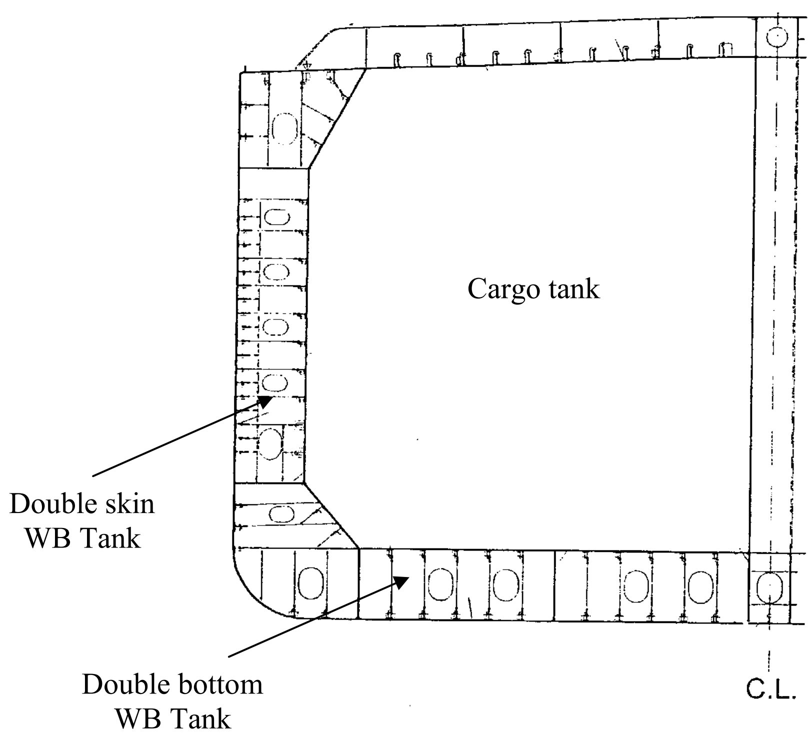


But it also presents more extreme phenomenon of one smaller peak placed left from the mentioned one. Fig. 1 presents spectrum of sample concentration up to 40 ppm. The reason for presenting such interval lies within conventions, which recommend measuring of such small concentrations. Samples of concentrations of 5 ppm, 10 ppm, 20 ppm and 40 ppm are measured.

Discussion

From the ship construction experience its is well known that ballast tanks are needed for ship stability as to maintain draft which will ensure, while ship is traveling empty, i.e. without cargo, a safe voyage with required stability and seaworthiness. Loading of seawater in ballast tanks generally ensures such condition. Before ship's arrival to the cargo loading port, sea water must be emptied from ballast tank. This procedure can cause sea pollution. To prevent pollution of eco system within loading port waters, existing systems are equipped with additional arrangement for treatment of loaded ballast waters, which treatment should be performed at least before ballast waters discharging into environment. In general, such systems are aimed to prevent live organisms introducing to other eco systems. Such influence prevention is intended to realize through special systems, when ballast water composition is changing by partial or complete changes with flushing ballast tanks during navigation at open sea without cargo. Arguments for such approach are based upon cognition such as that deposition of ballast tanks content within a closed sea area while loading cargo in confrontation to continuous or within several time intervals changes during navigation in ballast condition at open sea, by substantial different relative concentration pollutant is influencing an eco system. The technological solution of periodical ballast water exchange is simple due to by computer controlled pump system during navigation, ballast water from particular tanks on existing vessels is discharged and in such way stability is not endangered. After that, needed quantity is suctioned to particular emptied ballast tank, until whole water quantity is not exchanged within all tanks for a predicted number of time. The reason for such logics is in the fact that biological systems of geographically distant seas can vary significantly, and of closed ones are similar. Possible difference is as large as the distances are larger. By mixing sea waters containing different local eco-system organisms, a specific eco-system within enclosed seas, can be drastically endangered. By continues ballast water exchange during navigation, also continually is changing the pollutant content within tanks, and therefore differences are smaller than while ones loaded ballast is transported from the ballast loading area up to final destination of the cargo loading port. Within new constructions, required can be obtained by changing displacement quantities, through introducing flow-in-flow-out tanks or flow-through tanks. For both these tank types, within ship hull construction, it is necessary to predict, as within present ships, spaces and all other structural elements as for conventional ballast tanks, figure 2. The differences are caused due to equipment for water inlet and outlet.

Figure 2 : Cross section of tanker with ballast tanks



Flow-in-flow-out tanks are such tanks to which sea water is entering and exiting simultaneously and continuously during navigation, through specially performed hull openings, as to ensure the pressure at inlet opening of each tank is greater from the pressure at the outlet opening, while ensuring water flow in direction contrary of navigation course. In the starting moment, when ship is empty they are opened and the water is flooding tanks. The ship is loosing displacement while increasing the draft to the point that would be obtained also by conventional way of ballasting. Up to this point of consideration, there is no difference in ballast tanks acting function, from the conventional case. During navigation, depending of ships speed, water is permanently entering and exiting from tanks, performing their ballast function as they are completely filled with water, which is slowly flowing through tanks while flushing them. Flow-through tanks are of such performance as pressures on inlet and outlet opening are similar, ensuring the ship practically to "navigate through ballast". In that case water flow velocity through tanks is higher than in the previous case. Such ballasting model is known within animal world, when sea animals while swimming, without stoppage, are filtering through own organism the sea water, separating plankton from it. By swimming through sea water, one of its parts is travelling through the animal with the purpose of feeding the animal.

Conclusion

The optical fluorescent spectroscopy is a reliable method for determining the volume concentration of oil in sea water at intervals of from 0 - 40 ppm. To determine the concentrated volume of oil, the index is the size of the fluorescent peaks and their position, that is the wavelengths. With the increase of volume of oil concentrates in water, the size of the peaks increase and cause a small shift in their position. For volume concentrations of 0 - 40 ppm peaks are fixed wavelengths and their size grows in proportion to the concentration of oil. Also in the same way, their distinctiveness and size is increased. In the testing carried out, it was proved that the age of the sample does not influence the existence of peaks that has been proved over a longer time period. Pollution elimination can be performed by introducing a system of continuous ballast exchange than, except oil pollution elimination, also organisms transport from one sea area to another is eliminated. Similarly to such model, the ship is navigating through sea water (ballast water) while during whole navigation, she is suctioning the surrounding sea, which encircled by her ballast tanks volume, is playing the ballast role. By exchanging of this water during navigation, importing of waters from distant eco systems is prevented to protected closed seas. At ballast voyage beginning, the ship ballast tanks are filled with local sea water, while at the ballast voyage end, the sea water which is empted before cargo loading is containing sea water from a closed eco-system which after discharging cannot endanger the close local sea water eco-system.

Acknowledgments

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References

(1) J. Dobrinić, B. Milotić, Optical fluorescence of the sea water polluted by oil, Engineering Review, **17,** 9-16, (1997)

(2) J. Dobrinić, B. Milotić, Optical fluorescence of water polluted by crude oil at concentrations up to 200 mg l^{-1}, Engineering Review, **19,** 1-5, (1999)

(3) M. Thomas, (Quantitative Methodology), Ultraviolet and Visible Spectroscopy, Second edition, Vol. 1, John Wiley / Sons, Ltd, Chichester, West Sussex, England, (1996)

(4) MARPOL 73/78