

CONCEPT OF THE SKIMMER SPECIALIZED FOR OIL REMOVAL FROM THE PORT WATERS

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Abstract

Project analysis to meet needs for equipment customized to pumping out surface forms of oil in the port and other narrow basins are reported in this paper. New elements of the technical concept of the skimmer to eliminate the disadvantages of structurally similar devices are proposed - essential components of the new type of skimmer currently elaborating in the Student Scientific Society „Nautica“ (at Faculty of Marine Engineering of the Gdynia Maritime University) are demonstrated. The first motivation to this work is that the consequence of growing usage of ships in the world transport is necessity to search for more fast and efficient methods to remove oil pollutions from the water surface and the second one – preparation of appropriate training and research equipment for the continuous improvement of its construction as well as the manner of its use in variety conditions. Port areas are relatively small and they have numerous hard to navigate places, therefore oils which leaked from ships or transloading equipment are difficult to remove from the water surface. Those all factors promote the development of the new and innovative solutions for more efficient water treatment. New solutions of the technical concept of the skimmer are proposed here - among other the theoretically justifiable triangular inlet openings with the system of vertical positionning relative to the water surface.

Keywords: *oil-spill combat, maritime engineering, environmental protection*

1. Introduction

Technological development is associated with permanent growth of global demand and they are both powerhouse of global economy. Apart of this, they are also cause of never ending fight for quality of ecosystem. Especially sensitive, marine ecosystems are very exposed to hazards caused by maritime transport. Second decade of twenty-first century became century of the sea transport. Global society nowadays, uses more and more goods that need to be imported from long distance countries and factories. Constantly growing world demand and need for cost cutting are the main reasons for world transport to replace expensive land transport and air transport with the maritime transport, which because of large cargo capacity generates much lower unit costs. The consequences of growing usage of ships in the world transport are necessity to look for better and more efficient methods to remove purulent and petroleum pollutions. Although large maritime disasters are very spectacular and publicized by the world's media, they are not the biggest issue when talking about ship's pollution [1, 3, 4].

The significant amounts of leaks are placed in ports during the transshipment. Port areas are relatively small and as they have many, hard to reach places, oils leaked from ships are difficult to remove from the water surface. The more ships are serviced on the small area the more pollution needs to be removing from the port channels. The biggest challenge nowadays is not searching for new methods to neutralize large oil leakage on the high seas but ways how to deal with that smaller but much more harmful pollution in the ports area. A high volume of ship movements and big diversity of vessels on the relatively small and difficult to access areas of port facilities, promote the development of the new and innovative solutions for more

efficient water treatment.

Existing methods for purifying port waters are not very efficient and because of that research are carried out to find better ways for removing oils and other pollutions from ports [2]. The perfect example of the search for new solutions is the concept of skimmer, which main purpose is to eliminate the disadvantages of structurally like devices. In this paper we consider new type of skimmer, which should be relatively cheap solution to fight with pollution most of all in ports but it can be also use in bigger environmental disasters. Use of less complicated design solutions allows increasing its effectiveness. What is more its simple construction should be very resistant for mechanical damages and temperature, which favors its cheap exploitation.

2. Basic assumptions

The considered device - skimmer - is an element of the system for oil film removing from the water surface. Its task is to effectively suck the liquid substance floating on the water. The final system will consist of vacuum pump, elastic pipe with power cord, control unit and tank installed on the small vessel. The tank should also play a role of a gravity oil separator (then separated water could be turned to the sea or the port basin).

This efficiency is expressed by amount of oil collected per define time-period. Wherein in the oil-water mixture transported to the container amount of oil in relation to the amount of water should be as large as possible. Therefore it is considered the shape of holes through which the oil flows and possibility of vertical positioning of the inlets. The proposition is to apply triangular shape of inlets (Fig. 1). The parameter expressing above mentioned efficiently (e) shows following expression:

$$e = \frac{S_{oil}}{S_{oil} + S_{water}} = f(x, d). \quad (1)$$

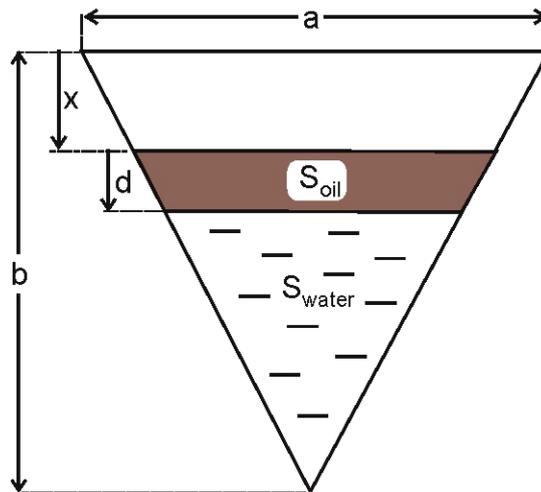


Fig. 1. Considered shape of inlets

Using symbols which sizing the inlet (a , b) oil film location (x) and thickness (d) variation of efficiency e were calculated as the function of x and d . Exemplary results of those analyses in Fig. 2 are presented.

Efficiency parameter e depends on b , x and d , while is independent on the width of inlet a . Presented results of theoretical analyse are based on assumption that the water surface is plane. In the real conditions final value of the parameter x will be adjusted experimentally due to possibility of remotely steering of vertical position of the inlet openings.

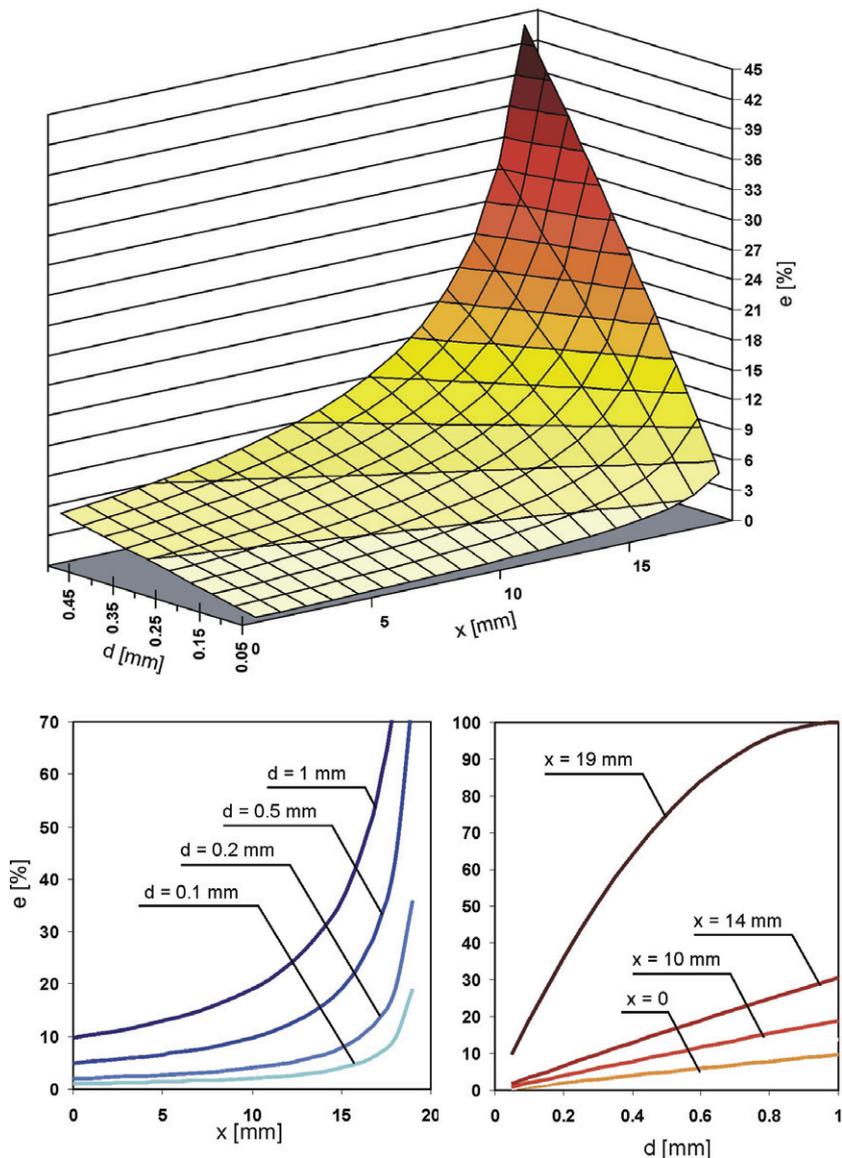


Fig. 2. Efficiency parameter 'e' in the function of both oil film location 'x' and their thickness 'd' - as 3D chart (upper) as well as individual examples: as the function of oil location (lower, left) and as the function of oil film thickness (lower, right)

3. Structural assumptions

Considered device should include a means of features that allow experimentation for finding optimal structure and relative position of elements including positioning of the arms which connect the buoyancy floats with the body of device. Fig. 3 shows an overall idea of structure of the skimmer. The arms have possibility to be moved in both directions: vertical and horizontal. For this purpose three pivoting connections for each arm are provided.

In the final version of the skimmer aligning of the position of the inlets is provided by applying the stepper electric motor connected with a worm gear.

4. Final remarks

The experimental skimmer structure considered above is the concept currently been performed in the Student Scientific Society (at Faculty of Marine Engineering of the Gdynia Maritime University). It is assumed that in addition to the didactic function, this device will provide information useful for

the tasks of construction of specialized equipment, the structure of which will be adjusted to define environmental condition, that is in accordance with the wave power spectra characteristics for define marine area. The point is that the device could efficiently collect surface film despite the rippling surface of the water. It is expected, that the final-combative device will be equipped with simplified-optimized arms permanently joined to the skimmer body (without moveable pivots).

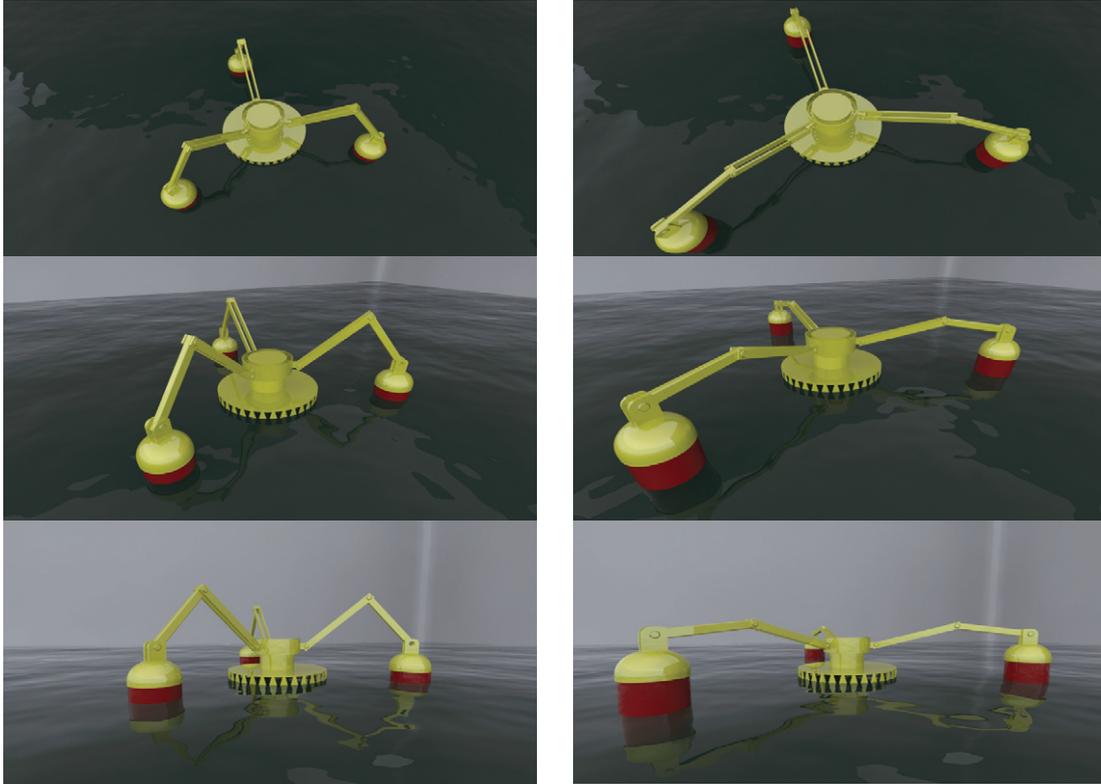


Fig. 3. Visualisations of the skimmer during experimentation for optimal sizing and spatial configuration of the elements of the device (prepared using the software "Autodesk 3d studio max")

There are known numerous commercial offers of the skimmers, however small, easy to transport on the small boat device is required for effectively use in the narrow and crowded harbor areas. In the other words - on the one hand: high power, massive or large and on the other hand: expensive in production and exploitation skimmer is relatively easy to construct, whereas considered in this paper device is a difficult challenge but is real and worth to be constructed.

Currently prototype of this skimmer is constructing to carry out in the near future field experiment with collecting of non-toxic substance which mimic oil on water surface – probably vegetable oil.

References

- [1] Global Marine Oil Pollution Information Gateway (GPA), *Estimates of global inputs of oil to the marine environment*, <http://oils.gpa.unep.org/facts/sources.htm>, access June 30, 2013.
- [2] Fingas, M., *Oil Spill Science and Technology*, Elsevier Corp., 2011.
- [3] Michel, R. B., *International Oil Pollution in the Sea*, The MIT Press, 1994.
- [4] World Ocean Review, *How oil enters the sea*, <http://worldoceanreview.com/en/worldoceanreview/1/pollution/oil/>, access June 30, 2013.