INLAND WATERWAY ENVIRONMENTAL SAFETY

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Abstract. The article presents the results of development of the main components of the environmental safety when operating vessels on inland waterways, which include strategy selection ensuring the environmental safety of vessels, the selection and justification of a complex of environmental technical means, activities to ensure operation of vessels taking into account the environmental technical means. Measures to ensure environmental safety are developed on the basis of the principles aimed at ensuring environmental safety of vessels. They include the development of strategies for the use of environmental protection equipment, which are determined by the conditions for wastewater treatment of purified sewage and oily bilge water as well as technical characteristics of the vessels, the introduction of the process of the out-of-the-vessel processing of ship pollution as a technology for their movement. This must take into account the operating conditions of vessels on different sections of waterways. An algorithm of actions aimed at ensuring ecological safety of operated vessels is proposed.

1. Introduction
In this article, the authors have identified that the nature of modern environmental requirements ensuring environmental safety, firstly, is aimed at prevention of environmental pollution with ship’s wastewater and oil-containing bilge water and, secondly, prevention of such pollution can be ensured by cleaning of the pollution mentioned above. Different studies of the environmental protection issues from the pollution during the operation of vessels on inland waterway [1-4] show that the solution of this problem is possible if two main strategies are used. The first one involves the use of the marine environmental protection equipment - ship installations for cleaning of waste and oil-containing bilge water. The second is the use of a set of extra-environmental protection equipment, which in turn includes a group of basic technical facilities - treatment facilities (floating or coastal) and a group of auxiliary means that provide displacement of vessel pollution (reception, transportation, temporary storage). The choice of a strategy depends on the technical characteristics of the vessels (capacity, dimensions, number and nomination, layout of the internal premises), as well as operation conditions, which primarily imply the intensity of navigation, availability of ports, population of the river banks, drainage of treated sewage and oil-containing bilge water, navigation conditions. The rationale for the strategy is therefore implemented for each group of vessels, taking into account the listed conditions for their operation.

2. Stages of analysis
In general, all activities in the field of ensuring environmental safety of the vessels on inland waterway should include two stages.
The first stage involves implementation of a set of measures that ensure the operation with the on-hand environmental equipment. And the second one includes a set of measures that ensure the effective use of environmental protection means.

The first step to solve the problem of ensuring environmental safety should be the selection and justification of necessary environmental protection means. The rationale for the strategy must begin with the analysis of wastewater disposal conditions of treated sewage or oily water in the reservoir.

The following results can be obtained from the analysis of conditions of wastewater disposal:

a) basing on the conditions of wastewater disposal, it is allowed to discharge sewage or oily water, purified to the standards set for ship installations for their cleaning;

b) basing on the conditions of wastewater disposal, it is required that the quality of sewage or oily bilge water should be purified, which results from the calculation of permissible discharge of pollutants into the body of water;

One of the circumstances that must be taken into account in the process of analyzing the conditions of water disposal is the possibility of the existence of different conditions for water disposal on different sections of waterways (see Fig. 1).

The result a) in general allows applying both strategies for equipping the vessels with the environmental and technical means. The choice between environmental protection equipment on the ship and out of the ship is carried out based on the analysis of the technical characteristics of the vessels in operation. These results should answer the question on the possibility of using ship environmental protection equipment in the process of operating the vessels. Therefore, the following conclusions can be made:

a) technical characteristics of the vessel (group of vessels) exclude the possibility of using ship environmental protection equipment;

b) technical characteristics of the vessel (group of vessels) allow using on-the-ship environmental equipment.

Basing on the result a) only out-of-the-ship environmental protection techniques can be used.

Basing on the result b) on-the-ship and out-of-the-ship environmental protection equipment is allowed to be used.

In general, it can be noted that for the choice of a strategy for equipping the vessel with the environmental protection equipment, two main factors are taken into account: wastewater disposal conditions of treated ship wastewater and bilge water, operating on the waterway section and technical characteristics of the vessels. The choice begins with the analysis of conditions of wastewater disposal, since the conditions of wastewater disposal occupy an important place.

In general, the selection of the environmental protection means based on the analysis of wastewater disposal conditions and technical characteristics of vessels can lead to one of the following results:

Figure 1. Diagram of conditions \( (Y_i) \) of wastewater disposal on different sections of waterways.

Basing on the result b) on-the-ship and out-of-the-ship environmental protection equipment is allowed to be used.

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In general, the selection of the environmental protection means based on the analysis of wastewater disposal conditions and technical characteristics of vessels can lead to one of the following results:
- possibility to use only out-of-the-ship environmental protection equipment;
- possibility to use both on-the-ship and out-of-the-ship environmental protection equipment.

3. Development strategy

After defining the strategy of ship pollution processing, the next task is the selection of the specific types or models of purification equipment, which can be a difficult task even in the case of the off the shelf equipment. For example, the operational experience [4] of ship installations for cleaning oily bilge water indicates that these installations do not completely provide the required purification. Therefore, the choice of finished equipment requires a certain amount of experience and knowledge in the field of wastewater and oily water treatment.

An establishment of a complex of out-of-the-ship environmental protection means is an even more complicated task, since such complex in general can (should) be developed for each waterway section, taking into account the specific operating conditions of the vessels mentioned above. This statement stems from the fact that the use of extra-ecological environmental protection means involves the implementation of a certain technology [5], which can be referred to as a technology for transportation of ship pollutions, including the collection of ship pollutions, their transportation, temporary storage, processing (disposal) and wastewater disposal. Such technology as a whole, as well as each of the above-mentioned separate operations, can be implemented with the help of various technical means. Hence, there is the possibility of choosing, and, consequently, the possibility of forming the most effective set of technical means for certain operating conditions of vessels on the section of waterways. It is to be recalled that the operating conditions are primarily determined by the conditions of wastewater disposal of purified sewage and oily water, which may be different for different sections of waterways.

There were several examples of technical means and the sequence of formation of a complex of out-of-the-ship environmental protection equipment for cleaning oily bilge water [4].

After choosing a set of environmental protection means, the following task arises: ensuring operation of the vessels using a selected set of technical means [7-11].

The issue of ensuring the process of operating the vessels with the environmental protection equipment can be solved in different ways [6]:
- application of the potential of the ship-building organization - intellectual, financial and production;
- acquisition of the off the shelf equipment and technical means, which are part of the structure of a chosen complex of the environmental protection technical means;
- order of the technical equipment (using your own project or a project developed in advance by a specialized project organization) from an outside enterprise;
- combination of the above-mentioned possibilities of solving the problem of equipping the vessels with the environmental protection equipment;
- acceptance of an offers of third-party organizations or companies in the field of cleaning and processing of ship pollution.

As the mentioned methods are commented in [6], they can be briefly described.

The use of the ship-building organization potential involves the design and engineering development through its own services, for example, technical department, as well as manufacturing or construction of technical means with the help of its own production facilities, for example, repair and maintenance services or ship repair enterprises. The effectiveness of solving the problem of equipment in such a way depends on the capacity of this potential, the level of its qualification and professional experience.

The second method involves acquisition of ready-made technical means offered by the market. The effectiveness of solving the problem in such a way depends on the variety of technical means offered by the market, which the ship-building organization is interested in, the level of its financial capabilities, and the correct choice of the acquired technical means. The correct choice means, first of
all, that the selected equipment ensures the compliance with the environmental requirements. For example treatment equipment which meets the purification requirements. It should be mentioned that such choice is simple only at first glance, because not all technical means offered by the market can be recommended for purchase.

The third way implies the production of necessary technical means by the third-party enterprises. At the same time, a project of technical means can be self-designed or can be developed by an outside project organization.

The latter method involves a combination of previous ways of solving the issue of equipping the vessels with the environmental protection equipment and, in most of the cases, represents an optimal solution to the equipment problem. It allows the maximum use of positive aspects of different methods (directions) and avoids the negative aspects of these methods. For example, a floating wastewater treatment plant for sewage treatment can be built on the basis of a finished barge hull part of the volume of which can be used as a treating facility. The rest of the cleaning equipment and auxiliary units can be purchased as ready-made equipment [10-12].

Another side of activities to ensure environmental safety is the provision of the effective use of environmental technology. In this case, above all, the correct methods of operation in accordance with the requirements of the operating instructions are implied. However, this activity implies the solution of a wider range of tasks. For example, the arrangement of out-of-the-ship environmental protection equipment on the section of waterways, which largely determines the economic efficiency of the implementation of the technology of ship pollution and, ultimately, the economic efficiency of activities to ensure the environmental safety of inland navigation vessels.

4. Conclusion

Thus, in this article, the main activities ensuring environmental safety of inland navigation vessels have been formed. These activities are represented as a set of measures to select and justify the strategy for the use of the environmental protection equipment. It is shown that the development of technical means depends on the conditions of wastewater disposal of treated sewage and oily bilge water operating on the section of waterways, as well as on the technical characteristics of the vessels in operation. The above-mentioned components of environmental safety activities include the organization of activities to ensure the operation of vessels with the environmental protection equipment, and the capacity of ship owners’ organizations to solve the issue of ensuring the operation of vessels by the described technical means. The effectiveness of the use of the environmental protection means as a process for implementing the technology of transporting ship pollution during the application of out-of-the-ship treatment depends on the provided technical means on the waterway sections. The task referring to technical means placement should be optimized.

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