Safety of Ships Navigation in Ice and Operational Effectiveness

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ABSTRACT
The solving of the ice navigation problems depends not only on the safe operation of ships, but on the safety of harbors operation in the ice conditions. These tasks are important for navigation in Russia, as decreases the set of acting icebreakers and increases the number of foreign ships, calling at these harbors. The Russian Maritime Register of Shipping (Register) introduced in 2012 the process of researches of ships ice-going properties and certification of ship’s ice suitability (assigning of the Ice Navigation Certificate). Requires the accumulation of experience and development of the appropriate techniques to choose the most important characteristics that affect the ice-going properties of ship, as well as the definition of ship ice-going properties criteria. This study reports on the methodological approaches to assess the safety of the navigation in broken ice and the ice-going properties of ships, both in autonomous navigation and in course behind the icebreaker in the caravan.

KEY WORDS: merchant ship; ice navigation; technical condition; ice captivity; running property, strength of ship; navigation safety; effectiveness criteria; Ice Navigation Certificate; Register

INTRODUCTION
One of the most important features associated with the safety of ice navigation is the speed of the vessel. Varying parameters of the vessel operation affecting the ice-going properties serve too: the displacement of the vessel at a given load, the design characteristics of ship and the technical condition of shell plating. Evaluation of the ice-going properties of ship is made depending on the thickness of the ice, on the density of the ice (cohesion) and on it compression. The safety and effectiveness of navigation in ice depends not only on the ice conditions, but on the large extent of decisions taken at the selection of general characteristics of the vessel when design and on vessel’s structural elements.

A key issue is the definition of the optimality criterion based on the concepts of economic efficiency of ship and on the evaluation of design constraints, in other words, on the determination of input data to determine the design characteristics of the ship. It should be noted that the efficiency and safety of navigation of ships, designed to operate in ice, to a large extent interconnected, and in evaluating the effectiveness of the vessel with the economic criteria need to take into account the additional costs required to provide a given level of the navigation safety in the ice conditions that have impact on the value of the economic efficiency criterion.

Russia is one of the few countries which in the main harbors used in ice conditions of navigation in the definite periods. During these periods the intensity of navigation and freight turnover of harbors decreased. The overall efficiency of the marine transportation system could reduce.

Ships with the structural reinforcements for ice navigation and of the corresponding categories are of the relatively small segment of world tonnage. These ships when used in regular conditions are more expensive in construction and less effective economical. In these circumstances the way of efficiency improvement by increasing the number of ice-going ships in operation is not promising. Moreover, owners of conventional ships (not adapted for navigation in ice) are interested probably in the most degree to access these cargo traffics.

A possible alternative way, – the navigation in ice of conventional ships and the ships with low ice categories. The use of these ships in ice conditions require the assistance of the icebreaker or the ice-going tug in the harbor as a rule. Therefore comes out the issues of safety, which, in turn, required innovative solutions. Russian sailors have long experience of ice navigation, including in the extreme conditions of the Arctic Ocean and the Northern Sea Route. Regular navigation of the merchant ships in extreme ice conditions in the 30-th of the twentieth century has raised concerns about the quantitative indexes of ship’s ice-going properties.

The captains of the merchant ships passed in the books the experience of navigation in ice. Shipbuilders have greatly improved their understanding of the strength and propulsion of ships in ice based on theoretical modeling and field studies. One of the first attempts to address the issue made by the Academician Y. Shimansky, who called the «suppositive» the indexes of ship's ice-going properties.

Simultaneously marine classification societies developed national systems of ship’s ice-going classification. With an understanding of the suppositive characteristics of ice-going categories as criteria of ship’s ice-going properties marine classification societies adopted the table of