Features of Ship Vibration in Ice Operation Conditions

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ABSTRACT

The results of investigations of vibration for perspective icebreakers and ice-going ships operating in difficult climatic conditions are presented. These investigations were performed to reduce the vibration of such category of ships to acceptable levels providing vibrational strength, fail-safe exploitation of equipment and normal inhabitation conditions for crew. The features of vibration recorded on icebreakers and ice-going ships and reasons of its amplification are analyzed. The main aspects of calculation algorithms and experimental estimation methods of forces inducing hull vibration in ice operation mode are discussed. The methods of estimation and reducing hull vibration and vibrational action on crew are proposed. New approaches to ice vibrational normalization are proposed.

INTRODUCTION

Nowadays on the score of growing interest in developing arctic hydrocarbon deposits we are to evolve arctic fleet. One of serious problem for icebreakers and ice ships is increasing of its vibration in ice operation conditions. This increasing is conditioned by excitation forces structure changing as compared to its structure in open water operation conditions. When there is no ice the main vibrational excitation forces are stipulated by machinery and by periodical forces arising in system “hull-propeller”. When ship is operating in ice in apart from mentioned sources of forced vibration forces of interaction of hull and propulsive agents with ice are added.

Increased vibration may cause fatigue damage of structures, equipment failure and also creates unfavourable conditions for crew habitation. According to above mentioned factors reducing the vibration is necessary to provide high performance of perspective ice-going ships. Maximal vibration levels are usually observed on icebreakers because of its heaviest operation conditions. The next by maximal vibration level observed are transport ships of ARC7 class which are equipped by stern superstructure and low-speed diesel engines.

RUNNING VIBRATION STIPULARITIES IN ICE OPERATION CONDITIONS

Experimental vibration investigations of ice ships in Russia have been started in 1980-s owing to building nuclear-powering icebreakers kind of “Arktika” (Icebreaker 9, hull length 148 m., displacement 23500 tons, capacity 55MW). Among publications on this topics (Boudanov, Nikolsky, 1996) and (Matusiak J,1982) should be mentioned. Up to date this problem is not fully investigated.

Consequently after analysis of the data recorded on Russian arctic ships during its exploration there was showed that ice field surrounding the ship hull increases its damping characteristics. However it doesn’t decrease vibration level because forces of hull and ice interaction have continuous spectrum. These forces excite hull vibrations with its first few modes, see fig 1–2.

Fig. 1. Time-domain function of vibrational displacements of diesel-electric icebreaker “Sankt-Peterburg” operating in ice with thickness 1 m.