Research on underwater radiation noise control technology of merchant ship

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Abstract

In order to reduce the negative effects of underwater radiation noise generated by international navigation ships on Marine life. At the same time, to prevent the pollution of Marine environment caused by underwater radiated noise from international navigation ships, the international maritime organization (IMO) has put forward a guideline to reduce the underwater radiated noise of merchant ships and its adverse impact on Marine life. This paper classifies the main noise sources of underwater radiated noise of merchant ships, analyzes the radiation mechanism of underwater noise of ships, and grasps the transmission characteristics of vibration noise of ships. Aiming at different noise sources, the underwater radiation noise control technology of merchant ships is proposed, which can effectively improve the environmental protection of ships through this study.

Keywords

Merchant Ship, Underwater Radiation Noise，Control Technology.

1. Introduction

IMO mepc.1 / circ.833 (2014) issued the guidelines for merchant ships to reduce underwater radiation noise to reduce the impact on Marine life. To reduce the underwater radiation noise produced by the international navigation ships to Marine life (especially the Marine mammals), short-term and long-term negative impact on preventing for international navigation ships produced by underwater radiation noise cause pollution of the Marine environment, the international maritime organization and the European Union in seeking ship quiet performance at the same time, also promote about ship radiated noise control and protection of the development of the internationalization of Marine life. Among them, the European Union proposed that "imported energy, including underwater noise, should be guaranteed not to have adverse effects on the Marine environment". IMO also made mandatory requirements for cabin air noise on ships in 2014.

In order to reduce the level of underwater radiated noise of merchant ships and reduce the negative impact of merchant ships on Marine life during navigation, this paper firstly classifies the main noise sources of underwater radiated noise of merchant ships and analyzes the main noise sources of ships. On this basis, the underwater noise radiation mechanism of different noise sources of ships is analyzed, and the transfer characteristics of ship vibration noise are mastered. Finally, aiming at the different noise sources of merchant ships, the underwater radiation noise control technology of merchant ships is proposed, which provides an important theoretical basis for the development and optimization design of quiet ships and promotes the development of green, healthy and environment-friendly ships.

2. Noise source classification

There are three main underwater noise sources: mechanical noise, propeller noise and hydrodynamic noise. Therefore, the evaluation of underwater noise is mainly based on the analysis and calculation of these three kinds of noise sources.

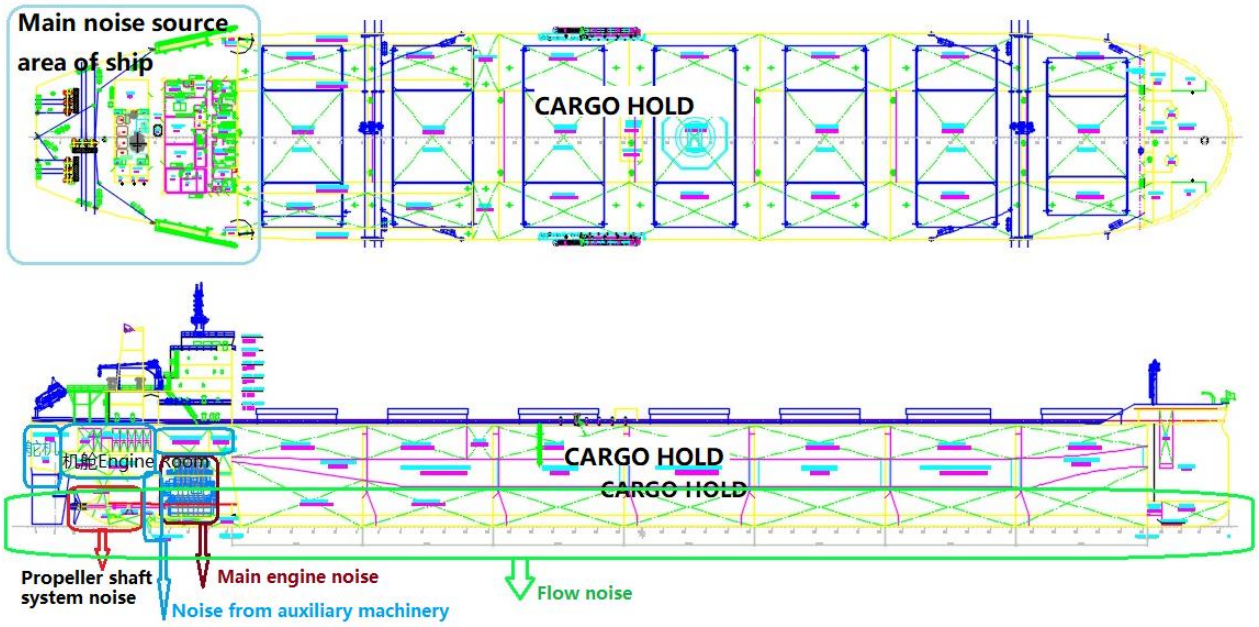

Fig.1 The major noise source of merchant shipping

Mechanical noise: mechanical noise refers to the noise formed by the mechanical vibration of various main and auxiliary machines radiating from the hull to the underwater. The main engine is the core of propulsion system, including diesel engine, motor and steam turbine. Together with the main engine, the propulsion system also includes shaft system, reduction gear box and so on. Auxiliary machinery is necessary to ensure the normal operation of the ship equipment, such as various generators, air compressor, air conditioning and ventilation systems and pumps. These machines do a lot of rotating or reciprocating motion, running vibration will be through the hull or pipe to the underwater radiation.

Propeller noise: propeller noise is the underwater radiation noise generated by the rotation of the propeller, including propeller cavitation noise, rotation noise and eddy noise.

Hydrodynamic noise: when the ship sails, the boundary layer of the object surface develops from laminar flow to turbulent flow. Random velocity disturbance in turbulent boundary layer generates random pulsating pressure. On the one hand, the random pulsating pressure of the boundary directly generates radiation noise; on the other hand, the elastic structure of the exciter surface vibrates and generates radiation noise, which is collectively referred to as hydrodynamic noise.

3. Underwater noise control technology

Underwater radiated noise should be controlled throughout the design and construction of the ship. Underwater noise control includes many different aspects from the initial conceptual design to the end of service life, such as practical underwater noise control targets, propeller noise control, propulsion equipment, auxiliary machinery and other equipment installation and structural dynamic performance, underwater noise radiation, propagation and verification measurement of the whole ship.

3.1 Mechanical noise control technology

In order to reduce mechanical noise, the following measures can be taken:

(1) Noise control should first deal with sound source control. Strictly control the loading equipment, select weak vibration and low noise equipment, put forward reasonable technical indicators, carefully install the ship and adjust the shaft system balance; Design the rotating speed of various mechanical

equipment to avoid resonance frequency coincidence and coupling resonance. The configuration and installation of various equipment in the cabin have a great impact on the distribution of vibration intensity and radiation noise of the whole ship. Therefore, the proper and reasonable layout of many equipment in the cabin has a good effect on the suppression of vibration and noise of the whole ship.

(2) Vibration transmission test and analysis of the structure and vibration isolation measures can effectively control the radiation noise. Vibration isolators shall be installed as far as possible between the equipment base and the hull. Generally, the vibration isolator can guarantee the insertion loss of low frequency dozens of Hertz. Since the resonance of the plate and shell and the structure will decrease significantly at the higher frequency, the adoption of the shock absorber plus the composite structure platform or the multi-composite layer vibration isolator can guarantee the large insertion loss in the wide band range. In view of the number of auxiliary machines on board, "vibration isolation floating raft" can be adopted, which can not only reduce the resonance fundamental frequency, but also widen the vibration isolation frequency band through the design of multi-layer vibration isolation structure. Mechanical operation equipment can adopt composite material decoupling and vibration absorption.

3.2 Propeller noise control technology

Propeller excitation is one of the main excitation sources of ship vibration. Propeller excitation can be divided into two categories: pulsating pressure near the propeller caused by propeller operation; the uneven wake of a propeller running near the hull.

In order to reduce propeller noise, the most effective method is to reduce the excitation. In order to reduce propeller excitation, it is necessary to consider the matching of ship line, propeller parameters and propeller shaft, as well as the matching of vibration characteristics of ship structure.

The control method of propeller noise mainly includes the following aspects:

(1) Improve wake field

At the stage of ship design, propeller excitation, resistance and propulsion performance should be considered comprehensively. In order to reduce propeller noise, wake distribution should be improved. The wake field can be improved by modifying the cross-section shape in front of the propeller. The profile was modified according to the position of the wake peak in the propeller plane to control the center position of bilge vortices.

(2) Reasonable selection of propeller elements

The propeller bearing force is closely related to the number of blades, and the number of blades should be selected reasonably according to the propulsion efficiency, the cooperation between the main engine and the propeller, the optimization of wake field and other factors.

(3) Reduce propeller excitation energy transfer

The transmission of excitation is reduced and the energy of excitation is consumed so as to reduce the vibration response. Vibration absorber holes can be set on the bottom plate of the ship above the propeller to reduce the propeller surface force transmitted to the ship, thus reducing the vibration response of the ship's tail.

4. Summary

The main conclusions drawn from the results of this study are listed as follows:

(1) Noise sources of ships include mechanical noise, propeller noise and hydrodynamic noise.

(2) Mechanical noise control includes noise source and transmission channel. Low-noise equipment can be used. Vibration isolators can be installed in the main transmission channel to effectively reduce mechanical noise.

(3) In the design and manufacture of ships, the matching of propeller efficiency, cavitation, vibration and noise performance should be optimized. Tip unloading technology and large side slant technology can be adopted to reduce the pulsating pressure induced by propeller.

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