Research on vibration and noise control technology of marine power plants

Guoqi Wu[1,a], Hong Shen[1,b], Chunlei Zhang[1,c]

Dalian Scientific Test and Control Technology Institute. 16 Binhai Street. Dalian, 116013, China.

[a] 12124259@qq.com, [b]shenhong111@126.com, [c]zhangchunlei@126.com

Abstract

Vibration noise is easily produced in the process of ship power plant operation, which interferes with the high quality of ship operation. Ship power equipment vibration noise as a key control project, through the maintenance of turbine vibration noise control stability, therefore, this article through to ship power equipment vibration noise is studied, the main reason for the vibration analysis of ship power plant, on this basis, the diesel engine vibration control method is proposed, the shafting vibration control measures and the propeller noise control method.

Keywords

Marine Power Plants, Vibration, Control Technology.

1. Introduction

The vibration and noise produced in the operation of ships will do harm to the hull, machinery and personnel. In order to improve the reliability and comfort of ships, it is necessary to study the mechanism of ship vibration and noise, and put forward the corresponding control methods. Merchant ship vibration of the main excitation source are: main engine, auxiliary machinery and other mechanical equipment, screw, shaft caused by propeller shaft, water fluid incentive three of hull, propeller shaft and mechanical equipment vibration caused by noise is more outstanding, host speed within the range of critical speed will cause whole ship resonance, will lead to the rudder propeller cavitation engine deafening paroxysmal hammer produces sound interference, some improper design can lead to severe vibration, superstructure bridge equipment, instrument failure or damage. Therefore, ship designers study the mechanism of ship vibration and noise from sound source, transmission path and other aspects, and formulate corresponding control measures according to the mechanism analysis. Taking the noise of Marine power plant as an example, this paper analyzes the mechanism of its noise generation, analyzes the vibration noise control, and puts forward Suggestions on vibration noise control.

2. Composition of Marine power plant

Marine power plant is the power equipment installed to ensure the normal operation of the ship. It is to provide the ship with various energies and use these energies to ensure the normal navigation of the ship, the normal life of the personnel and the completion of various operations. Marine power plant is the generation of all kinds of energy, transmission, consumption of all machinery, equipment, it is an important part of the ship. Marine power plant includes three main parts: main power plant, auxiliary power plant, other auxiliary machinery and equipment.

The main power plant of the ship provides propulsion power for the ship, including the main engine and its auxiliary equipment, which is the heart of the whole ship. The main power unit includes the main engine, transmission equipment, shafting, propeller, etc. When the main engine is started, the drive gear and shafting can be driven to make the propeller work. A propeller, usually a propeller, can move a ship forward or backward as it spins through the water. The main engine of modern commercial transport ships is diesel engine, which takes the absolute advantage in quantity.

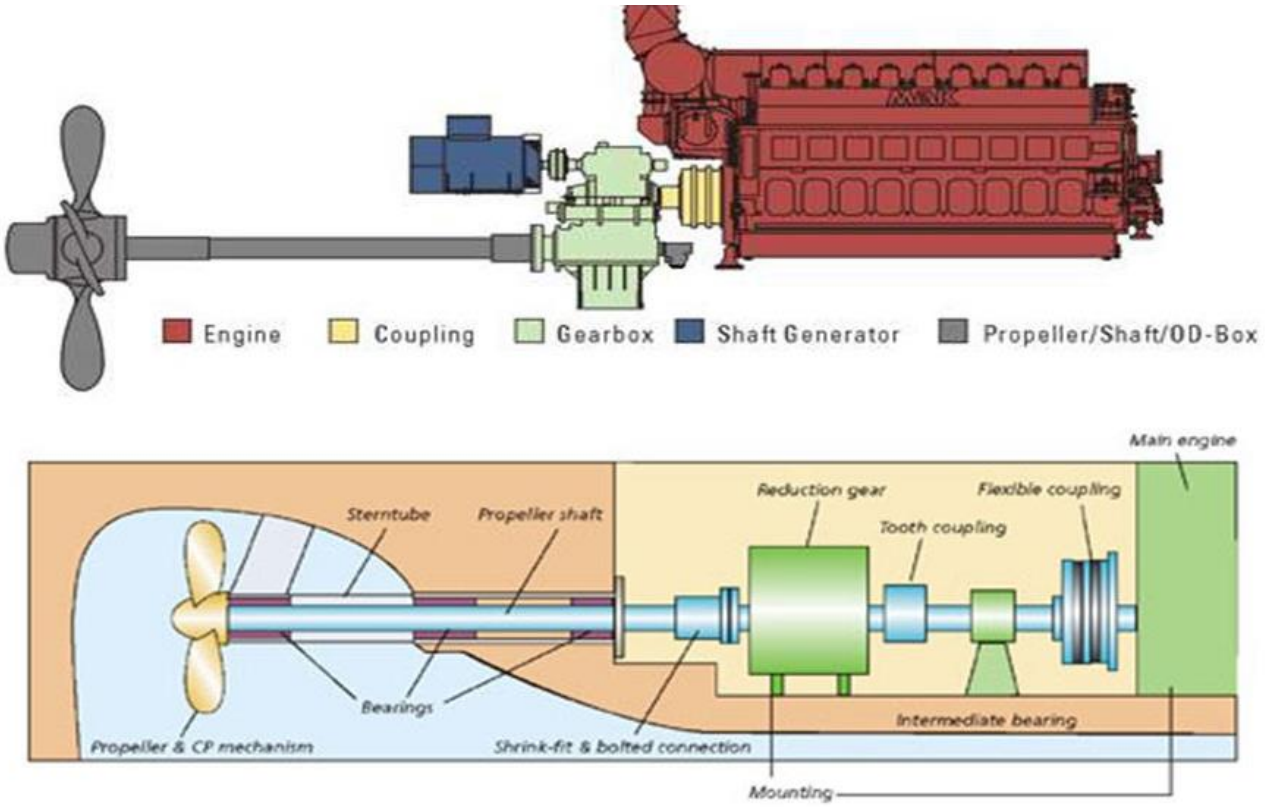

Fig.1 Composition of Marine power plant

3. Vibration and Noise Control Technology of Marine Power Plants

Vibration of ship power plant is the main noise source of ship, including main engine vibration, shaft vibration and propeller noise. Based on the analysis of three main noise sources, the vibration and noise control technology of Marine power plant is studied.

3.1 Main engine vibration control technology

Diesel engine is one of the main excitation sources of ship vibration noise. Therefore, at the initial stage of ship design, under the condition of meeting the indexes of power, speed, size and quality, attention should be paid to selecting diesel engine with small unbalanced force and unbalanced torque as the main engine of ship.

(1) Reduce the incentive force

For diesel engines with external unbalanced force or unbalanced torque, the vibration excitation force can be reduced by installing a compensation device. This is a widely used measure to prevent harmful vibration.

The balancing and compensating device is used to make the eccentric mass rotate at the same speed as the vibration frequency of the main engine. Devices with this balancing and compensating function are collectively referred to as balancers. According to the mode of operation drive balancer can be divided into two categories: one is driven by the motor, or electric balancer; The second is directly mounted on the main engine by crankshaft drive. According to the form of balanced excitation, it can be divided into a primary moment balancer, a secondary moment balancer and a combined balancer.

(2) Anti-vibration support

Because of the long stroke and ultra-long stroke, the transverse vibration of modern Marine large diesel engine frame is a prominent problem and becomes one of the exciting sources of hull vibration. For low-speed two-stroke large diesel engines, the amplitude on the top is generally limited to 0.7mm or less. When the transverse vibration is relatively large, the transverse anti-vibration support can be installed between the upper part of the main engine and the port and starboard side of the ship to

connect the hull. Generally, the lateral vibration amplitude of the frame can be reduced by more than 50%, and the natural frequency can be increased by 5%~50%. Installing longitudinal anti-vibration support between the front and rear ends of the main engine and the engine room partition can also reduce the longitudinal vibration amplitude of the frame by more than 50% and increase the natural frequency by about 25%. At present the commonly used anti-vibration support mainly has the mechanical type, the friction type and the hydraulic type three.

3.2 Propulsion shaft vibration control technology

Propulsion shaft vibration includes torsion vibration, longitudinal vibration and cyclotron vibration.

3.2.1 The harm of propulsion shaft vibration

The ship shafting is driven by the diesel engine, propeller bearing force and other periodic torques, which results in torsional deformation of the propulsion shafting. Torsional vibration of shafting may cause the following hazards:

(1) Fracture of crankshaft, thrust shaft, intermediate shaft and stern shaft;

(2) Failure of coupling;

(3) Accelerated wear of main engine parts;

(4) Abnormal output voltage fluctuation of diesel generator set;

(5) Hull resonance, superstructure vibration, etc.

Serious longitudinal vibration of shafting may cause the following hazards:

(1) Bending fatigue failure of crankshaft;

(2) The thrust bearing produces excessive alternating load;

(3) Longitudinal vibration of diesel engine frame;

(4) Hull vibration, superstructure longitudinal vibration, engine room local vibration, etc.

Serious rotatory vibration of shafting may cause the following hazards:

(1) Overheated stern bearing or aggravated wear;

(2) Propeller shaft fatigue failure;

(3) Hull tail structure vibration;

(4) Destroy the seal of the stern tube.

3.2.2 The vibration control technology of propulsion shaft vibration

The vibration characteristics of propulsion shafts are the internal factors of the structure of ship low-frequency vibration acoustic radiation spectrum. It mainly includes the influence of bracing stiffness and damping on the dynamic behavior of shafting, longitudinal, transverse and torsional coupling vibration of multi-span statically indeterminate propulsion shafting, etc.

The preventive measures of torsion vibration are as follows:

(1) Change the natural frequency of the shaft system. The additional inertia is added to the position with larger amplitude in the shafting; Change the stiffness of shaft section, increase or decrease the diameter of shaft;

(2) Increase the damping. Install coupling with high damping and elasticity; Increase the flywheel inertia.

(3) Reduce the exciting force of propulsion shaft system. Change the ignition sequence of diesel engine; Change the position of the nodes in the shafting.

The preventive measures for longitudinal vibration of propulsion shafting mainly include: changing the longitudinal stiffness of shafting; Additional mass installed in shafting; Change the number of propeller blades; Install FM shock absorber, etc.

The preventive measures of cyclotron vibration of propulsion shafting mainly include: adjusting the distance between bearings; Change the size of shafting; Change the number of propeller blades; Reasonable alignment of shafting; Reduce the incentive force, etc.

3.3 Propeller noise control technology

The noise caused by propeller rotation motion includes cavitation noise, rotation noise, turbulence noise and wake noise, as well as the noise generated by propeller pulsating pressure directly motivating the tail structure and through shaft system.

For propeller noise control, the technologies of large diameter, low rotation speed, large pitch and low noise adjustable pitch propeller and air curtain noise reduction are mainly adopted. Propeller noise is usually the most important noise source, whether it is underwater radiated noise or the vibration noise in the stern area of a ship. Therefore, propeller noise control is the key point of ship vibration noise control.

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

(1) Sufficient clearance between propeller arrangement and hull is reserved;

(2) Reduce propeller load, reduce ship resistance, optimize overall ship parameters, optimize prismatic coefficient Cp curve and appendages, etc.;

(3) Fairing the wake field of propeller region at the tail;

(4) With large slant blade, the blade profile slant properly can delay cavitation, increase cavitation number and restrain cavitation noise, but it is easy to appear "singing" if it is too large.

(5) The propeller has a relatively deep immersion depth.

(6) Increase the blade blade ratio and reduce the blade load, reduce the noise intensity;

(7) Use damping materials or high-strength plastic blades to increase the energy absorption of blades;

4. Summary

This paper introduces the composition of Marine power plant and analyzes the causes of its vibration and noise. Based on this, the following conclusions are drawn:

(1) Put forward the diesel engine vibration control method of reducing excitation force and installing anti-vibration support;

(2) The harm of propulsion shaft vibration is analyzed, and the preventive measures of torsional vibration, longitudinal vibration and cyclotron vibration of propulsion shaft are proposed;

(3) The effective propeller noise control method is given.

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