

Eddy Current Non-Destructive Testing Application Research of Marine Engines

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Abstract

Exist forms and criticalities of disfigurements of marine engines were studied from main propulsive engine, auxiliary facility and hull. Eddy current Non-destructive testing method was brought forward to disfigurement inspection of marine engines with advantages such as celerity and nicety. Cracks, as one form of disfigurements, testing of marine engines were demonstrated in detail, and the developing prospect of it was pointed out.

Keywords: Marine Engines; Eddy Current; Non-Destructive Testing; Crack

1.Introduction

Ship manufacture is a kind of industry with dense labor, technique and capital. Its development makes important effect on national defense, economy, export, and domain configuration upgrade. Recent years, international merchant shipping is booming and ship requirement is increasing. With development of technique, automatic and intelligent level of ship manufacture is rises step by step[1]. With the advances of science and technology, shipbuilding technology develops so fast. The development of the marine equipment puts forward severe challenges to the maintainers, including automation, intelligent and the increased complexity. If in the ship there is no advanced equipment for monitoring, it's difficult to find the major hidden causes of accidents, which may lead to great losses. Eddy nondestructive testing method has so many advantages, such as simple, rapid and accurate and so on. It can be quickly found potential flaws in equipment, to play a role in the prevention of accidents.

2.Defect inspection in maintenance of vessels

With the long-term running of the Shipping equipment, the gradually changes happen to the geometry of the mechanical parts and mutual location accuracy, precision and surface quality, or produce corrosion, cracks and other damage appear. Which result to the declining of the technical state of machinery and the use of performance, even a fault. That causes some or all the loss of the ship's mechanical functions, so that to stop the ship. It's found that all the faults were originated in

different forms of material defects in accident analysis. With the external force, a stress concentration formed in the defects which caused cracks and gradually growth, weaken the structure of the actual carrying capacity. At last, the cracks expanded rapidly, leading to the destruction of the structure.

2.1.Vessel Inspection and Condition Maintenance Based on the Result of Test

The existence of deficiencies will seriously affect the operation of the ship's stability, reliability. In order to ensure the safety of ships, and to prevent such accidents taking place, it must inspect, maintain and repair the ship regularly or irregularly, so that repair or replacement of defective components will be carry out on time[2]. With the development of science and technology, many countries are studying the use of modern means of detection instead of the traditional ones. Testing has been changed from passive activities into proactive systems engineering which is with the center of the reliability.

In vessel inspection system, for a long time, in order to ensure the safe of marine machinery, the ship classification societies adopted maintenance of machinery regular inspection system long-term, such as: annual testing, the middle test, particular inspection, etc. In the corresponding norms, there ship machinery should be regular separated and checked. With the advanced detection technology, the defects can be found in the regular tests and the maintenance of control can be carried out before serious harm occurred. Condition based maintenance, developing in recent years, also known as Condition Monitoring maintenance, does not require its maintenance period, but according to the operation of equipment status. It takes a reasonable choice of the timing of maintenance based on the status of the trend analysis of data. It runs monitoring and fault diagnosis by the advanced technology. Through testing, comparison and analysis to determine the state of the equipment or parts, and to ascertain the need of repair, thus effectively reduce accidents.

2.2.Eddy Current Testing in the Vessel Test

Eddy current testing is an important electromagnetic nondestructive testing methods. Eddy current generated by electromagnetic induction, when detected it does not contact with the workpiece, so eddy current testing can improve detection sensitivity of the conductive material on the surface and near surface crack, and reflect the depth of the crack of information. Also it can test efficient automated and use in the particular occasions such as high temperature and so on. The industrial applications of eddy current testing is numerous, its typical applications are testing of main thickness, material composition, defects, state of heat treatment, surface hardening depth, precision measurement, size detection, etc^[3]. Therefore the use of eddy current testing of the ship equipment nondestructive testing and evaluation has a great theoretical and practical significance.

3.Eddy Current Testing in the Main Propulsion Device Defects

Large low-speed two-stroke diesel engine has the advantages of high power output, a good run economy and of direct transmission and so on, occupying a dominant position in bulk carriers, container ships and oil tankers. The large main propulsion device formed a complex and organic whole, and each part coordinates closely to work

perfectly, and realize the changes from chemical energy into mechanical energy, and to promote the ship go ahead. The structure and functions of all systems and components are different, so the testing for host should give full consideration to all the differences of the systems and components and appropriate means of monitoring and fault diagnosis method need to select. Common deficiencies of marine diesel engine which can be testing by eddy current testing are cylinder, cylinder head, shaft, the pistons and the crackle of the exhaust valve.

3.1.Eddy Current Testing in Cylinder Crackles

Cylinder liner is working under the conditions of high-temperature, high pressure and corrosive and withstanding the effects of the lateral pressure and the friction of reciprocating action by Detroit pistons. Therefore, the cylinder liner is easy to damage. And the surface crack is one of the defects present often. Cylinder crackle will cause a water cylinder, to run white smoke in exhaust pipe when burning. Even a major accident will happen when it is serious. The main reasons for causing crackle are uneven heating of each part of the cylinder sets and fatigue crackle caused by additional stress.

Now, commonly use on ships for detecting cylinder crackle is the method of penetration testing. It is simple, less operating constraints, and the shortcomings revealed intuitively. It also can check the crackles in the cylinder surface in all directions and various forms. If there are crackles in surface of cylinder, it should be replaced to eliminate hidden accidents. However, the penetration testing can only detect open-surface crackles. And it needs more processes. Furthermore, there are other disadvantages existing, such as: the sensitivity of detection by the human factors, less repeatability of the crackle testing. However, eddy current testing can overcome these shortcomings and realize high-speed accurate measurement.

3.2.Eddy Current Testing in Shaft Crackles

Crank shaft is the most important components in the large shipping diesel engines. Its function is transforming the pistons reciprocating to the rotary movement through crank linkage and then outputting useful torque. As the power transfer, it is directly responsible for all diesel engines power output, so it withstands strong load and high-power^[4]. In case of accident cases, crank shaft may be caused bending and reverse deformation, which result in fatigue crackles and even crankshaft fracture. Crankshaft fracture is a highly potential emergency without any symptom before occurring, so engineer is difficult to predict in the daily management. Crankshaft fracture will cause great economic losses to the ship and tremendous potential risks for security operation.

To avoid and prevent such accidents from taking place, to extend the life of crankshaft, the destruction of its early form of crack detection method is of great practical value and academic significance. At present, the method is always accounting the stress in the design, or inspecting after the accident^[5]. However, due to the reasons of the installation debugging error, uneven combustion of the engine cylinder engine and organ wear, ageing, and shaft disalignment by vibrating, the actual state of stress is difficult to maintain the state of design, so that shaft fracture, like engines or tail shaft,

and other repeated incidents have occurred.

Eddy current testing can test the surface defects of crankshaft. When the crankshaft surface crackles appeared, voltage signal from the eddy current sensor will change obviously. By analyze integrated with a series of acquisition circuit and data processing, voltage changes can display through the screen, or store by memory storages. The location, width, and other basic information of crackles can be analyzed. Therefore, nondestructive testing and evaluation to crackles of the surface crankshaft by eddy current testing are of great theoretical and practical significance.

4.Eddy Current Testing in Aids' Defects of Vessels

Marine auxiliary boilers is an important part in the auxiliary ship which is for heating fuel, lubricating oil, host warm-cylinder, driven auxiliary machinery and miscellaneous living. During the voyage, the composition auxiliary boiler of fuel emissions will heat the boiler water into steam by high-temperature exhaust gas discharging by hosting, to supply the gas for the ship. When the ship stopped in port or sail automotive, ignite the fuel boilers for steam. Auxiliary boiler works under the poor working conditions such as high temperature, high pressure and corrosion. With the technological development, the boiler monitoring system develops continuously, so does the level of automation and intelligence. And the working parameters, thermal efficiency and heat load of marine boilers increase. But, the fault diagnosis and forecast are to be further tap potential. Therefore, the boiler inspection and repair in daily maintenance are particularly important.

Now, the common testing methods on ships are eye-measurement, water pressure test. The purpose is to determine whether the surface crackles, scarring, slag, stratified, creases, leakage, pipe in the scope of inspections. However, the eye-measurement and water pressure test are of low efficiency and influence by the subjective factors. They can not make accurate quantitative expression and are disadvantage to field detection. With the through eddy probe, testing the ship auxiliary boiler by eddy current testing equipment, you can achieve in the short-term parking bays in the daily use, and rapidly detect the defects, and to repair in time and prevent the accidents.

5.Eddy Current Testing in Hull

From the beginning of 2003, vessels in constant prices on the rise, also led the Marine steel prices rose. The first quarter of 2007, the price of the marine steel plate increase from \$580 each ton by the end of September 2006 to \$610 each ton^[6]. But with the increase in the number of ship construction, heavy accidents have increased significantly. Few years ago in our country, continuous several new ship occurred fracture put in operation soon after^[7]. Manifestations of the accident, in the central part of the hull hatch panels, deck, longitudinal bulkhead and side panels, and other parts of Weld, a big range of plate cracked. Fracture is the most dangerous failure of the project components, no obvious symptoms before damage, and often caused catastrophic accident. Research found, the majority of accidents occurred in the marine steel under the conditions of low temperature, the place of the welding, the high stress and the serious corrosion. Direct damage reason due to the structure of the steel has produced defects caused fracture, and then expanded into larger cracks caused by the steel

structure fracture.

In the Shipbuilding industry, a large number of steel structure and all kinds of different specifications of the plate are used. The steels for shipbuilding generally refer to the steels for hull structure. The steels for hull structure which manufacture according to construction specifications of the classification society, include ship plates, structural sections, and so on. In order to ensure the safety and life of the ship, a series of demands are taking forward to the material of hull structure, including the method of smelting, chemical composition, mechanical properties and process performance^[8]. Marine steels for hull structure are based on requirements of specialized production which have higher requirements on materials. Their chemical composition and mechanical properties (tensile strength, yield point, elongation, toughness, etc.) are different from ordinary steel. Ship plate is of low sulphur and phosphorous elements, and high manganese, so that it is toughness.

At the present time, the tests for the control of the ship plate and the quality of the weld are magnetic detection, magnetic memory and four-probe potential difference method and other nondestructive testing methods. However, each of them has certain limitations. They are influence by width effect and the speed of the probes. Generally, the rate of detections is a little low and the results need further verification. Testing the ship auxiliary boiler by eddy current testing equipment, you can achieve in the short-term parking bays in the daily use, and rapidly detect the defects, and to repair in time and prevent the accidents.

6. Conclusion

Crackles are a class of defects which are easy to caused serious accidents in ship equipments. Effective tests are so need to be used for early diagnosis that operation of equipments can be stop before the crackle into a fracture, so as to avoid damage to the accident, reducing the accident loss. As an important electromagnetic nondestructive testing method, eddy current testing is very sensitive to the surface characteristics of the conductivity workpiece. The sensors do not need to contact with the workpiece during detecting and it can be highly effective automated detection. So eddy current testing has a very good prospect in the area of the shipbuilding.

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