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Original Paper

Discussion on the Influence of Friction and Wear on the Reliability of Marine Diesel Engines

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Abstract

In view of the impact of friction and wear on the reliability of marine diesel engines, this article discusses the main causes of wear in marine diesel engines when analyzing the specific effects, including the impact of average effective pressure on friction loss, the impact of rotational speed on friction loss, the impact of cylinder number on friction loss, the impact of oil viscosity and cooling system temperature, and the impact of fuel injection pump pressure on friction loss The impact of the number of piston rings on diesel engines. In the analysis and discussion of the impact of friction and wear on the reliability of marine diesel engines, relevant suggestions were proposed for fault diagnosis, such as the application of the following diagnostic techniques: internal machine equipment gear wear fault analysis, bearing melting wear fault analysis, bearing wear deformation fault analysis, bearing pitting peeling fault analysis, diesel engine piston wear fault analysis, etc, And the following measures to avoid wear issues: reasonably reducing the speed of diesel engines, scientifically reducing the number of piston rings, and continuously optimizing the lubrication system.

Keywords

Marine diesel engine, Friction and wear, Reliability, Fault diagnosis, Preventive measure

1. Introduction

The power equipment of modern ships mainly consists of diesel engines, which are the core components of ship operation. Under complex operating conditions, the related components of diesel engines inevitably experience friction, and friction and wear problems are very common. The occurrence of this problem has a direct impact on the operational reliability of ship diesel engines. Due to severe friction and wear issues in diesel engines, faults such as bearing failure, cylinder liner wear, tooth surface wear, piston ring wear, and bearing bush wear occur, directly leading to a decrease in the reliability of diesel engine operation. Therefore, in the operation and maintenance management of ship

diesel engines, a thorough analysis should be conducted on the impact of friction and wear on the reliability of diesel engines.

2. Overview of the Effects of Friction and Wear on Marine Diesel Engines

Due to the precision of processing and manufacturing ship diesel engines, the compatibility of installation of various components, as well as the working environment and maintenance methods of diesel engine operation, friction and wear of diesel engines will be affected to a certain extent. For example, bearings, oil seals, connecting rod bearings, pistons, piston rings, valve guides, valve rocker shafts, cam tappets, cam bearings, traditional gear systems, traditional gears, oil pumps, water pumps, etc., all experience varying degrees of friction losses, resulting in a decrease in the operational technical status of various spare parts and cannot guarantee the safety and reliability of ship diesel engine operation.

3. The Main Causes of Friction Losses in Marine Diesel Engines

3.1 The Effect of Average Effective Pressure on Friction Loss

When the rotational speed of the diesel engine is constant, the average effective pressure inside the diesel engine will have a certain impact on the wear of related parts. As the pressure inside the diesel engine cylinder increases, the proportion of back pressure of the piston ring will increase, and the lateral pressure of the piston skirt on the cylinder wall will gradually increase, ultimately leading to increasingly severe wear of the piston and piston ring.

3.2 The Effect of Rotational Speed on Friction Loss

During the operation of the piston, the inertia force generated by the piston connecting rod will be directly affected by the speed, and at high speeds, the inertia force of the piston connecting rod continuously increases, resulting in an increase in the overall load pressure of the piston and bearing. During the operation of each friction pair, the relative friction loss increases, reducing the reliability of ship diesel engine operation.

3.3 The Effect of Cylinder Number on Friction Loss

In the process of ship operation, it is necessary to provide continuous and stable power output. Therefore, it is necessary to choose an appropriate diesel engine. Based on the analysis of mechanical efficiency indicators, it can be found that diesel engines with relatively more cylinder numbers have higher mechanical efficiency than engines with relatively fewer cylinder numbers. However, in the statistics of wear faults in diesel engines, it can be found that diesel engines with more cylinder numbers have more serious wear problems. It can be seen that the number of cylinders will have a direct impact on the friction loss of diesel engines.

3.4 The Influence of Oil Viscosity on Cooling System Temperature

After the temperature of the engine oil gradually increases, it will cause the viscosity of the engine oil to decrease, which can effectively reduce the adhesion between various moving components, thereby

directly affecting the wear phenomenon of diesel engines. It can be seen that during the operation of marine diesel engines, the viscosity of the oil and the temperature of the oil in the cooling and lubrication system will have a certain impact on the wear of spare parts. If an oil product with viscosity not affected by temperature and minimal friction can be selected, it can effectively prevent the wear of diesel engine parts.

3.5 The Influence of Fuel Injection Pump Pressure on Friction Loss

The oil pressure of the fuel injection pump in a diesel engine varies to a certain extent as the bearing speed and fuel supply increase. When the diesel engine is in the optimal combustion condition, it is difficult to continuously increase the injection pressure to avoid exacerbating the wear problem of diesel engine parts, resulting in peeling failure of the cam surface, which seriously affects the safety and reliability of diesel engine operation (Bi, Zu, Liu, et al., 2022).

3.6 The Influence of the Number of Piston Rings on Diesel Engines

During the operation of a marine diesel engine, there is direct friction between the piston rings and the cylinder wall. Under the same combustion conditions, the more piston rings there are in the diesel engine cylinder, the relative increase in total friction generated. Therefore, when optimizing the design of modern diesel engines, it is necessary to scientifically and reasonably control the number of piston rings while ensuring that all operational performance of the engine meets the standards, in order to effectively reduce the wear of piston rings.

4. Analysis of the Influence of Friction and Wear on the Reliability of Marine Diesel Engines

When studying the impact of friction and wear on the operational reliability of marine diesel engines, the focus is on inspecting and evaluating the manufacturing process defects and usage issues of diesel engine related parts, in order to predict the service life of related parts and develop a scientific and reasonable plan for replacement and maintenance of parts. To effectively suppress the friction loss of diesel engine related components, it is necessary to continuously adjust and optimize the operating process parameters of each component of the diesel engine, effectively improving the operational reliability and durability of each component of the diesel engine.

When assessing the operational failure of related spare parts for ship diesel engines, relevant technical personnel should conduct objective evaluation and analysis of the friction and wear of related spare parts when the ship docks or the diesel engine is lifted. For example, for the internal diameter increment, cylindricity error, and roundness error of the piston and piston ring in the diesel engine, as well as for the lap gap, plane gap, and crankshaft arm pitch difference of the piston ring.

In order to obtain a fair and objective judgment, inspectors should evaluate from multiple aspects, such as the operating environment of spare parts, the material properties used in the production of spare parts, and the contact form between spare parts and other components. Under the influence of various factors, objectively evaluate the actual use efficiency of diesel engine related parts and adopt scientific and effective maintenance and repair technical solutions, effectively improving the operational safety

and reliability of parts.

When calculating and researching the wear rate of spare parts related to marine diesel engines, it is necessary to analyze the operating environment of the spare parts, the medium in contact with the spare parts, the quality of the spare parts processing and manufacturing process, and the operational level of relevant personnel. Because, under the influence of different factors, the fuel engine will experience varying degrees of wear and tear. It can be seen that the friction loss rate of spare parts belongs to a random variable. For a more objective and fair calculation, the method of average variance and average wear can be used for calculation.

When carrying out daily maintenance and management of diesel engines, staff need to objectively and accurately measure the wear amount of relevant parts, calculate the relevant values of wear, analyze the main causes of wear, obtain the limit values of parts, and optimize the maintenance and management plan of diesel engine parts, effectively avoiding potential safety hazards and faults, Ensure the safety and reliability of the overall operation of marine diesel engines.

In order to ensure the effectiveness of relevant data research work, it is necessary to flexibly use big data analysis technology, cloud storage technology, and cloud computing technology to analyze and organize massive monitoring data, and obtain relevant rules about the wear of diesel engine parts. This should be compared and analyzed with the instructions for the use of parts, in order to develop scientific and reasonable preventive measures around the key factors that cause the failure of parts, To ensure the improvement of overall operational reliability of diesel engines (Lu, Di, Zhang, et al., 2022).

Through the analysis of a large amount of data on ship diesel engines, it can be concluded that the friction and wear problems of spare parts will inevitably affect the reliability of diesel engine equipment operation. If core matching components such as piston rings, cylinder sleeves, and bearings are worn, the economic benefits and safety factors of diesel engine operation cannot be guaranteed. Based on the calculation and analysis of wear speed indicators, the variation characteristics of wear speed of different spare parts can be obtained. Based on the work arrangement of ship diesel engine operation, effective safety protection measures can be formulated to specifically suppress the wear phenomenon of diesel engines.

5. Diagnosis and Analysis of Mechanical Faults Caused by Friction and Wear during Operation of Marine Diesel Engines

5.1 Analysis of Gear Wear Faults in Internal Machinery and Equipment

During the operation of modern marine diesel engines, prolonged operation of internal mechanical equipment will gradually aggravate gear wear. Technical personnel must effectively diagnose their faults to ensure the safety of subsequent diesel engine operation. When diagnosing gear wear faults, relevant equipment and instruments should be used to detect and evaluate the specific situation of gear wear. For example, if there is a serious scratch fault on the gear or if the gear has peeling, it cannot guarantee the overall safety and reliability of the gear system operation. Therefore, when selecting gear

components, it is necessary to choose work pieces with better corrosion resistance to establish a safe foundation for the subsequent operation of internal equipment in diesel engines, effectively avoid gear wear faults, and provide power support for ship movement.

5.2 Analysis of Bearing Burning Wear Fault

By analyzing the current operation status of diesel engine bearings, it can be concluded that during the operation of bearings, there may be melting wear faults, which directly affect the safety of diesel engine operation. Through the analysis of its faults, it can be concluded that during the operation of the bearing, local protrusions may occur due to changes in position, and the protrusion position will generate high-speed friction with other components, resulting in a rapid increase in local temperature. When the temperature reaches the critical value, it may cause the bearing to experience burning wear, directly affecting the safety and reliability of bearing operation. At the same time, due to quality issues in the lubrication system during bearing operation, it can also lead to concentrated outbreaks of bearing wear issues. To effectively avoid related problems, timely maintenance and management of the lubrication system should be carried out to ensure that the lubrication system can play a certain role and value.

5.3 Analysis of Bearing Wear and Deformation Faults

By analyzing the wear and deformation faults of bearings in marine diesel engines, it can be concluded that there are insufficient precision in processing and manufacturing some bearing components, which poses a safety hazard for subsequent bearing operation. To effectively avoid this problem, professional test runs should be conducted before the diesel engine is put into operation to obtain true and effective data information, and abnormal situations in bearing operation should be analyzed, Timely identify the root cause of the problem and handle it as soon as possible to ensure safe and stable operation of the bearing. At the same time, relevant technical personnel need to accurately measure the fit clearance of bearings, evaluate whether the fit degree of bearing installation meets technical standards, so as to eliminate potential wear hazards as soon as possible and ensure the safety and effectiveness of the overall operation of marine diesel engines.

5.4 Analysis of Bearing Pitting and Peeling Failure

Through analysis of such faults, it can be concluded that during the operation of marine diesel engines, the bearing bears a greater force. Under abnormal operating conditions, bearing deformation may occur. After the deformation of the bearing, it will cause direct friction between the bearing and other components. Under high-frequency friction and wear, the bearing may experience pitting corrosion, resulting in bearing spalling, which cannot ensure the normal operation of the diesel engine and increases the safety risk of ship operation.

5.5 Analysis of Diesel Engine Piston Wear Fault

The piston is an important component in the operation of diesel engines, and prolonged high load operation will cause certain wear and tear on the piston. With the continuous severity of wear and tear issues, the operational safety performance of diesel engines will be directly affected. In order to

diagnose the degree of piston wear as soon as possible, staff need to regularly inspect and evaluate the piston, objectively understand the specific situation of piston wear, and analyze the main causes of piston wear during operation, in order to take targeted solutions and reasonably reduce piston friction and wear, in order to ensure the safety and reliability of diesel engine piston component operation.

6. Research on Avoidance Measures for Friction Loss Faults in Ship Diesel Engine Operation

6.1 Reasonably Reducing Diesel Engine Speed

In order to effectively prevent solid and fluid friction in marine diesel engines, it is necessary to scientifically and reasonably control the speed of diesel engine operation, in order to ensure the reliability of diesel engine operation. Given the unique nature of diesel engine oil operation, in order to effectively prevent wear and tear on diesel engine parts, it is possible to reasonably and effectively reduce the speed of the diesel engine. Through a large amount of research data analysis, it can be seen that after the speed of the marine diesel engine decreases, the wear of various parts of the diesel engine has improved to a certain extent.

6.2 Scientifically Reducing the Number of Piston Rings

In a large amount of data research, it has been found that the proportion of piston ring friction loss during diesel engine operation is relatively high. Due to the unique design performance of piston rings, friction and wear cannot be avoided. However, in order to effectively reduce the wear of diesel engines, the number of piston rings can be appropriately reduced. For example, a certain ship's diesel engine was originally made of aluminum pistons, but after design and transformation, it was transformed into ductile iron pistons. The number of piston rings was changed from the previous four gas rings and two oil rings to three gas rings and one oil ring, thus effectively controlling the wear of the diesel engine piston group.

6.3 Continuously Optimizing the Lubrication System

Through the analysis of operating test data of diesel engines, it can be seen that during the use of liquid lubricants, the friction force of spare parts during operation will gradually decrease with the gradual increase of oil temperature. From this, it can be seen that when avoiding friction and wear issues in diesel engines, continuous optimization should be carried out for the lubrication system of the diesel engine. At the same time, when selecting lubricating oil, priority should be given to selecting high-quality engine oil whose viscosity is not affected by temperature, and achieving scientific control of engine oil temperature, in order to fully utilize the operational value and role of the lubrication system and reduce the wear and tear of spare parts.

7. Conclusion

In summary, taking the operation of marine diesel engines as an example, the author focuses on analyzing and demonstrating the impact of friction and wear on the operational reliability of diesel engines, aiming to illustrate the negative impact of wear issues on the operational reliability of diesel

engines, and how to take corresponding preventive measures to eliminate the negative impact of wear and tear, in order to ensure the overall safety and reliability of diesel engine operation. In the future, during the operation of marine diesel engines, it is necessary to continuously summarize wear data and prevention work experience, explore new wear prevention technology solutions, and achieve effective avoidance of wear issues in diesel engine parts.

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