Wear Test of Cylinder Liner and Piston Ring of Marine Diesel Engine Based on Computer Simulation Technology

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Abstract. With the development of computer technology, computer simulation has become a powerful tool to carry out liner - piston ring wear experiment of Marine diesel engines. Turbocharged diesel engine is a typical multi-system and multi-level complex power plant. There are many factors that affect the piston change and wear speed of diesel engine in practical operation, and many factors are interrelated and influence each other. Marine diesel engine is the most important mechanical equipment in Marine engine room, which has a complex system structure. If the diesel engine fails, it will seriously affect the navigation safety of the ship. In order to reduce the loss of Marine diesel engine piston ring wear, it is necessary to rely on fault diagnosis technology for timely and reliable diagnosis and maintenance.

Keywords: Computer Simulation, Marine Diesel Engine, Piston Ring Wear, Experiment

1. Introduction
In the past, the diagnosis and repair of liner - piston replacement wear of Marine diesel engines were generally carried out by experienced experts, which had strong dependence on expert experience and low reliability. The development of science and technology has brought the computer simulation technology. The fault diagnosis based on the computer simulation technology is based on the monitoring sample data of the equipment, and adopts machine learning and artificial intelligence algorithm to train the diagnosis model and identify the fault, which avoids the dependence on the expert experience. However, the computer simulation technology method which relies on small sample learning cannot learn complex mapping relationship from sample data, so the accuracy and reliability of fault diagnosis need to be improved. Deep learning method, which can obtain deep information from a large number of sample data, has become an important research hotspot in fault diagnosis field based on computer simulation technology. As a common algorithm in the framework of deep learning, deep belief network has good algorithm fusion and little requirement on data amount. Therefore, the application of fault diagnosis method based on deep belief network in Marine diesel engine is studied in this paper.

2. Overview of computer simulation technology
The simulation system is built on a multi-dimensional information space, and in a comprehensive integrated environment of combining qualitative and quantitative, perceptual knowledge and rational knowledge, the simulation environment of man-machine harmony is formed [2].

The simulation technology strives to form a virtual scene environment which is coupled with each other in time and space. The subsystem, new technology development and testing personnel, users and decision makers scattered in different places are connected together, so that each object of the system can effectively carry out information exchange. This not only enables the new technology and new concept to "feed forward" from the developer to the user, but also enables the current system efficiency to "feedback" to the new functional system developers and decision makers [3].

Computer simulation technology, the application of computer graphics and image software technology to establish a three-dimensional simulation model of the virtual simulation system, and through a series of experimental testing technology to create the completed three-dimensional model.

Imaginate ion means that the user immerses himself in the multi-dimensional virtual space and increases the effect of space conception in an all-round way by relying on the user's own perception and cognitive ability, so as to give full play to the subjective initiative and form new concepts [4,5].

3. Data acquisition and fault diagnosis method of Marine diesel engine
In order to solve the problems of the high cost of obtaining fault data of Marine diesel engines, the single data type and the inability to carry out effective model training, this chapter adopts the method of fault simulation to obtain data. Firstly, the main parameters and simulation model of MAN 8L51/60DF Marine diesel engine are introduced. In the condition of 100%, the main performance parameters of the model should be controlled within a certain range with the error of the measured data of the bench, so as to verify the effectiveness of the model. After that, the mechanism and characterization of Marine diesel engine faults are analyzed, and the main model parameters are modified to simulate the faults of Marine diesel engine, and a certain number of Marine diesel engine fault data sets are obtained. Finally, the principle and training methods of deep belief network are introduced [6].

![Figure 1. Diesel engine workflow](image)

3.1. Obtaining method
Due to the limited types and number of actual fault data of Marine diesel engines and the high acquisition cost, it is impossible to use the algorithm to carry out effective model training. Austrian AVL company for the thermal dynamic’s simulation analysis of internal combustion engines. The simulation objects include gasoline engine and diesel engine, and can be used for the steady state and transient performance simulation analysis of internal combustion engines. The MAN8L51/60DF Marine diesel engine is an eight-cylinder four-stroke Marine dual-fuel engine produced by MAN. It can be operated in both natural
gas and fuel oil modes 481. In this paper, the fuel model of the Marine diesel engine is used for fault simulation [7].

3.2. Failure analysis and setting
Due to the high cost of acquisition of Marine diesel engine fault data, the single data type and the small amount of data, it is impossible to train the diagnosis model effectively. Therefore, this section by modifying the parameters of the diesel engine simulation model to simulate the ship diesel engine cylinder oil reduce, supercharger inefficient, low efficiency, fuel injection timing lags air cooler and exhaust valve clearance is too large and piston ring wear the six kinds of thermal failure, and obtain a certain number of Marine diesel engine fault data samples. These six faults will affect the exhaust temperature, effective power and fuel consumption rate of Marine diesel engine, and lead to the reduction of the economy of Marine diesel engine. In reality, these faults cannot be detected directly and effectively. Therefore, in this paper, data from multi-source signals are analyzed and processed in a data-driven way to achieve the purpose of rapid and efficient diagnosis. In addition, the faults described are simulated in a single component of a Marine diesel engine, i.e., by modifying the corresponding model parameters in the compressor, turbine, manifold or cylinder. Before the fault simulation, the manifestation and cause of the six kinds of Marine diesel engine faults are analyzed firstly, and then the corresponding parameters are modified according to the mechanism of different faults, so as to achieve the purpose of fault simulation [8].

4. Marine diesel engine liner - piston ring wear test analysis method

4.1. Friction coefficient analysis
The friction coefficient represents the ratio between the friction force between the friction surfaces and the normal load. It is related to the surface roughness of the friction pair, and has nothing to do with the size of the contact area. In tribology, the friction coefficient can be used to distinguish different lubrication states: one can distinguish different lubrication states by the ratio of oil film thickness to the surface roughness of friction pairs; the other can distinguish different lubrication states by the friction coefficient, and refer to the Steinbeck curve values under different lubrication states to compare them. In most mechanical equipment friction pair operation, the oil film thickness is very thin and difficult to measure, so most of the friction coefficient is measured to determine the lubrication [9].

![Friction coefficient analysis](image)

Figure 2. Friction coefficient analysis

4.2. Wear weightlessness analysis
The wear weightlessness is caused friction pair in mutual abrasion quality can reduce the phenomenon, and the wear quality will increase with the increase of time slowly, namely, the wear weightlessness and time period are a function relation, under different time length measured ground loss weight will be different, the wear weightlessness rate also will change with the change of time. Therefore, according to the wear weight loss and the wear weight loss rate, the wear state changes of the friction pair in different wear time periods can be distinguished, which can be used as a method for tribology quantitative analysis of wear process [10].

4.3. Surface texture feature analysis
The surface geometry of friction pairs has a great influence on the friction, wear and lubrication characteristics of the working faces with friction interaction. The surface geometry of friction pair is generally described by surface roughness, which describes the irregularity of surface topography. Surface smooth degree of surface roughness is reflected parts is an important parameter, a surface roughness changes depending on the equipment operation condition, lubrication condition and the original form of the original topography, at different time points of friction pair surface roughness measurement, internal friction pair wear can be indirectly analysis work time changes.

5. Conclusion
Cylinder-piston ring is one of the most important friction pairs in Marine diesel engines. Its working condition has a great influence on the power performance, reliability and durability of Marine diesel engines. The diesel engine has good running-in effect before use, and the combination of cylinder liner and piston ring pair is good, which will improve the lubrication, reduce abnormal wear and prolong the reliability and life of cylinder liner and piston ring. Therefore, the study of cylinder liner-piston ring wear of diesel engines can optimize the selection of load, speed and other working conditions in the running-in period, accelerate the running-in, which is of great economic and technical significance for improving the efficiency of diesel engines, saving fuel and prolonging service life.

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