International Journal of Engineering Innovation & Research
Volume 9, Issue 4, ISSN: 2277 – 5668

Study on the Influence of Laboratory Environment on the Performance of Marine Diesel Engine

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Date of publication (dd/mm/yyyy): 18/07/2020

Abstract **– There are many factors that affect engine performance in the laboratory, such as atmospheric environment, water temperature, oil temperature, fuel inlet temperature, air density and charge temperature before intercooler. In order to make it convenient for the laboratory to set up these environmental control settings in the future and to study and analyze the results of dynamic performance and economy changing with these environmental factors when the marine diesel engine is actually used. In this paper, on a Z6180ZLCZ-1 six cylinder, four stroke marine diesel engines, the ambient atmospheric pressure (102.0Pa) of the marine diesel engine is not changed, through several groups of comparative tests; the control variable method is adopted. This paper studies the influence of the temperature of supercharging before intercooler, the temperature of fuel oil entering engine, atmospheric environment and water temperature on the power and economy of marine diesel engine, and obtains the trend of the power and economy of marine engine changing with the environmental conditions of the laboratory.**

Keywords **– Engine Performance, Laboratory Environment, Economy of Marine Engine, Power of Marine Engine.**

I. INTRODUCTION

The environment of the laboratory plays an important role in the power, economy and emission of the engine, and has a far-reaching influence on the working efficiency of the engine [1]. The engine test has a higher request to the running environment, only has ensured the good environment, can obtain the accurate test result [2]. In the face of different operating conditions, the engine has encountered certain challenges [3]. As early as 1897, German doctor diesel made the first compression ignition “diesel” internal combustion engine, i.e. diesel engine [4]. Subsequently, the engine ushered in unprecedented development, and the invention and creation of these diesel engines is inseparable from numerous experiments. In recent years, the engine research is in full swing, a large number of achievements emerge in the world. Many of the engine performance have also been a qualitative leap. Although many researchers have done a lot of research on the effect of Engine Test Environment on engine performance [5], most of them have studied the effect of single environment on engine without considering the combined effect of many factors. For example, Wang Tao et Al [6] studied the effect of low temperature on engine performance, JIA et Al [7] studied the effect of intake temperature on diesel engine performance, and Niet Al [8] studied the effect of high temperature and high pressure on engine performance. In order to make up for many of the lack of engine research, get more on the engine performance of the factors affecting the conditions and more on the engine performance knowledge .This study will take into account many factors respectively study the impact of various factors on the engine, to come up with more suitable conditions for engine work, to lay the foundation for better engine work.

In this paper, based on a Z6180ZLCZ-1 six cylinder marine diesel engine, the boundary conditions of charge air temperature in front of intercooler, fuel oil inlet temperature, air pressure drop, air temperature and exhaust back pressure after turbine are changed in the laboratory, and the ambient air pressure (102.0Pa) of marine diesel engine is not changed. Then the power and economy of marine diesel engine are studied the influence of e

-conomy.

II. Test Object and Scheme

A. *Test Main Device*

Dynamometer, fuel consumption meter, Z6180ZLCZ-1 six cylinder marine diesel engine, marine diesel engine inter cooling system and cooling system are equipped in the laboratory.

Fig. 1. Experimental engine.

B. *Test Plan*

By changing the charge air temperature in front of the intercooler, the temperature of the fuel entering the engine, the atmospheric environment and the water temperature, the change of the dynamic and economic performance of the marine diesel engine is studied.

In the test, the ambient atmospheric pressure of marine diesel engine is always 102.0 PA. Some of the engine parameters are shown in Table 1 below. Other conditions are to follow the control variable method to measure, control other variables, to test the impact of a variable on the power and economy of marine diesel engine. During the test, the fuel system, high-pressure oil pump, injector, high-pressure oil pipe and other parts are not changed by using unified diesel oil and engine oil. Two sets of test data are recorded for each working condition. In order to have a good comparability, the test will be completed in about two hours as much as possible.

Table 1. Some parameters of the engine.

Serial Number	Name	Specifications
1	Model number	Z6180ZLCZ-1
2	Type	inline
3	Number of cylinders	six
4	Stroke	four

III. Test Results and Analysis

A. *Effects of Different Charge Temperatures before Intercooler on Power and Economy of Marine Diesel Engine*

In this paper, the opening of the cooling water through the intercooler is adjusted in a certain range, and then the intercooler temperature before pressurization is set differently. In the controllable range, the supercharging

temperature in front of the intercooler is different for the engine power and economy. When the supercharging temperature in front of the intercooler is 140 °C, 142 °C, 145 °C, 147 °C and 148 °C, the influence on the engine economy and power is different. If the supercharging temperature in front of intercooler is higher, the ignition condition of engine will be improved, and then the combustion temperature in the cylinder of diesel engine will increase. With the increase of combustion temperature in the cylinder, the fuel consumption will increase.

Fig. 2 shows the influence of the temperature change of different intercoolers before supercharging on the fuel consumption of the engine. As shown in Fig. 2, the fuel consumption of the engine increases with the increase of the supercharger temperature before the intercooler, so the economy of the engine decreases with the increase of the supercharger temperature before the intercooler. Fig. 3 shows the influence of the change of boost temperature before different intercoolers on the dynamic performance. As shown in Fig. 3, within the controllable range of pre charge temperature of intercooler, the power of engine will not change with the change of pre charge temperature of intercooler, so the power performance of engine will not fluctuate with the change of pre charge temperature of intercooler.

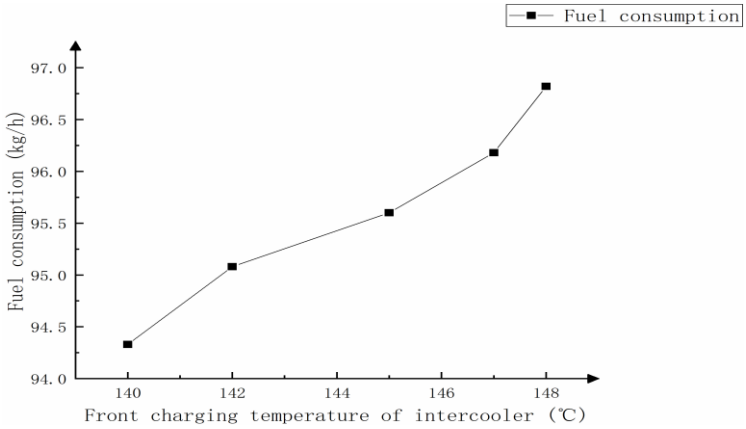

Fig. 2. Curve of fuel consumption versus pressure temperature in front of intercooler.

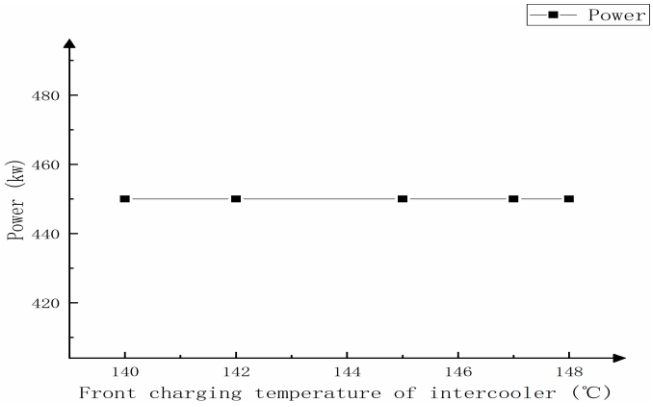

Fig. 3. Curve of power versus pressure temperature in front of intercooler.

In conclusion, it can be seen from Fig. 2 and Fig. 3 that within the controllable range of supercharging temperature in front of intercooler, when the supercharging temperature in front of intercooler is reduced and the intake air volume is increased, the combustion temperature will be reduced, the fuel consumption of engine will be reduced and the economy will be improved, but the engine power will not be changed. Therefore, at one stage, the power performance of the engine will not fluctuate.

B. *Effect of Different Fuel Inlet Temperature on Engine Power and Economy*

The change of fuel temperature has great influence on engine output torque, effective power, fuel consumption and fuel consumption rate [9]. When the diesel engine is tested, the fuel temperature is set. By adjusting the fuel temperature control valve in the test room, several groups of changes are compared to study the influence of fuel inlet temperature on engine power and economy.

Fig. 4 and Fig. 5 show the effect of different fuel inlet temperature on fuel consumption and power of the engine. Fig. 4 shows the effect of different fuel inlet temperature on engine fuel consumption, and Fig. 5 shows the effect of different fuel inlet temperature on engine power. Because the density of diesel will change with the change of temperature, when the temperature is low, the density of diesel will become high, when the temperature is high, the density of diesel will become low. The fuel system of the engine has a certain volume of fuel supply in each cycle. When the temperature is low, the density of diesel oil is large. In fact, the amount of diesel oil injected into the combustion chamber will increase at this time. On the contrary, when the temperature is high, the density of diesel oil is low. In fact, the amount of diesel oil injected into the cylinder will decrease at this time. As shown in Fig. 4, in the controllable range of fuel inlet temperature, with the increase of fuel inlet temperature, the fuel consumption of the engine will also increase, so the economy of the engine will become poor. As shown in Fig. 5, within the controllable range of fuel inlet temperature, the engine power will decrease with the increase of fuel inlet temperature, so the engine power performance will become worse within a certain range.

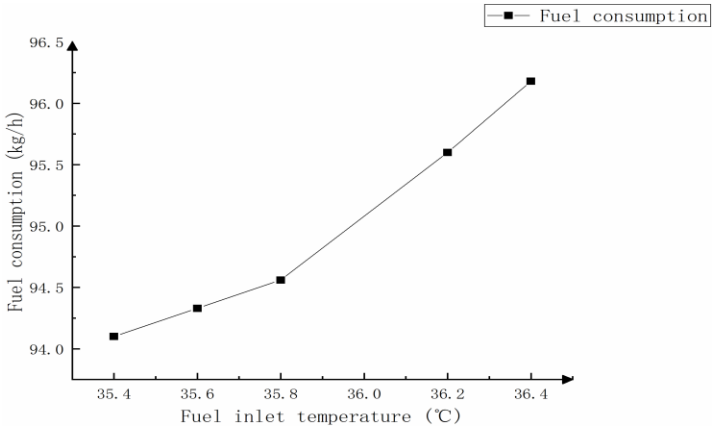

Fig. 4. Curve of fuel consumption versus fuel inlet temperature.

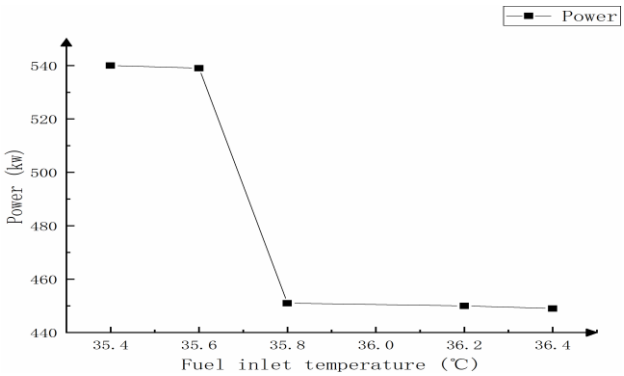

Fig. 5. Curve of power versus temperature of fuel inlet.

To sum up, it can be seen from Fig. 4 and Fig. 5 that the fuel inlet temperature within a certain range has a very obvious impact on the power and economy of the engine. In the controllable range of fuel inlet temperature, when the fuel inlet temperature increases, the engine power decreases obviously, and its power

performance will become worse. At this time, with the increase of the fuel inlet temperature, the fuel consumption of the engine will increase, so its economy will become worse. When the temperature of fuel entering the engine is low, the power of the engine increases obviously, but when the power increases to a certain extent, it will not increase again, indicating that the combustion is sufficient, the actual diesel oil quantity will be reduced, at this time, the fuel consumption will be reduced, and the economy will be better.

C. *Effect of Different Atmospheric Environment on Engine Power and Economy*

There are many kinds of effects on engine performance and economy in atmospheric environment, such as atmospheric pressure, atmospheric temperature and relative humidity. The external environment is complex and changeable, which will affect not only the fuel economy of the engine, but also the working safety of the engine [10].

1. *Influence of different Atmospheric Temperatures on Engine Performance and Economy*

Fig. 6 and Fig. 7 show the effect of different atmospheric temperature on fuel consumption and power of diesel engine within the controllable range. Fig. 6 shows the effect of different atmospheric temperature on the fuel consumption of the engine, and Fig. 7 shows the effect of different atmospheric temperature on the engine power. As shown in Fig. 6, in the controllable range of atmospheric temperature, with the increase of atmospheric temperature, the fuel consumption of the engine will decrease in a certain range, so the economy of the engine will be better in this range. As shown in Fig. 7, in the controllable range of atmospheric temperature, with the rise of atmospheric temperature, the power of the engine will fluctuate in a certain range, so in this range, the power of the engine will fluctuate. When the temperature rises to a certain extent, the power of the engine will reach a peak. As the temperature continues to rise in a certain range, the performance of the engine will have a small degree the engine will continue to work and the power will rise again.

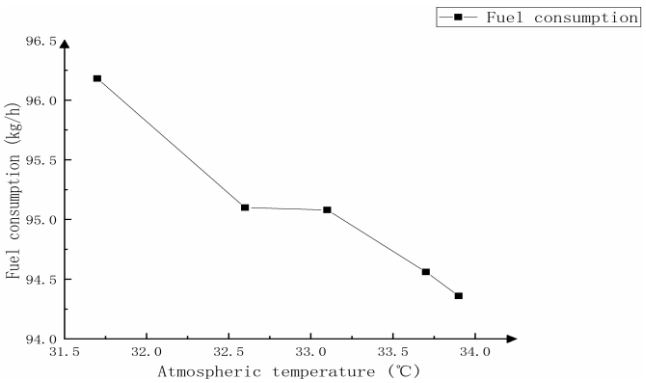

Fig. 6. Curve of fuel consumption versus atmospheric temperature.

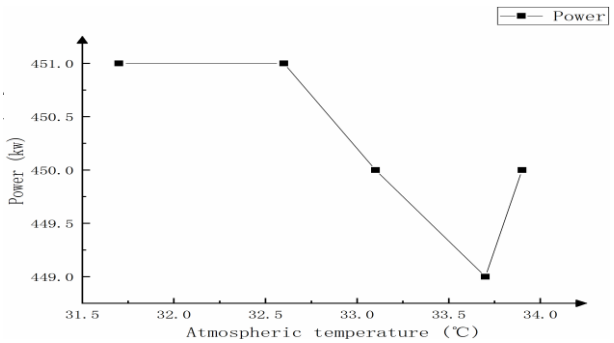

Fig. 7. Curve of power versus temperature of the atmosphere.

In conclusion, it can be seen from Fig. 6 and Fig. 7 that the atmospheric temperature in a certain range has a very obvious impact on the power and economy of the engine. In the controllable range of atmospheric temperature, when the atmospheric temperature rises, the fuel consumption of the engine decreases obviously, so its economy will be better in this range. At this time, with the increase of the atmospheric temperature, the power of the engine will be reduced, so its power performance will also be poor. When the air temperature is low, the power of the engine will decline obviously, but when the power drops to a certain extent, it will not decline again, but there is a small increase, indicating that there is a surplus of diesel oil, which burns fully in a short time, and the power will increase at this time, so the power performance will be better.

2. *Effect of Different Relative Humidity on Engine Power and Economy*

The change of atmospheric humidity has a certain influence on the performance and working characteristics of the engine, which is tested on the ground bench in summer. Fig. 8 and Fig. 9 show the effect of different relative humidity on fuel consumption and power of diesel engine within the controllable range. Fig. 8 shows the effect of different relative humidity on the fuel consumption of the engine, and fig. 9 shows the effect of different relative humidity on the engine power. As shown in Fig8, in the controllable range of relative humidity, with the increase of relative humidity, the fuel consumption of the engine will increase in a certain range, so the economy of the engine will become worse in this range. As shown in Fig. 9, in the controllable range of relative humidity, with the rise of relative humidity, the power of the engine will fluctuate in a certain range, so in this range, the power of the engine will fluctuate. When the humidity rises to a certain extent, the power of the engine will drop to a peak, and with the rise of humidity in a certain range, the performance of the engine will fluctuate. However, when it reaches a certain level, the engine will maintain a certain power and continue to work. After a period of continuous operation, with the increase of humidity, the power will again show a downward trend.

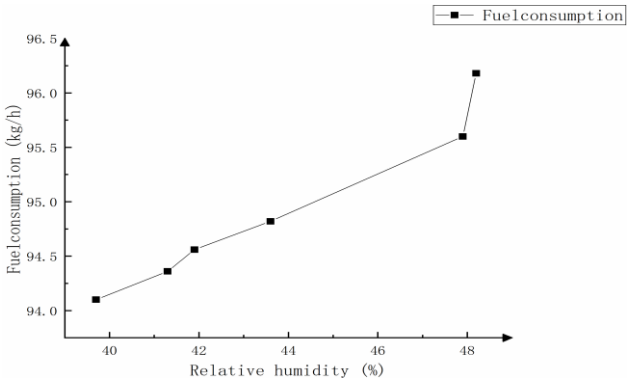

Fig. 8. Curve of fuel consumption versus relative humidity.

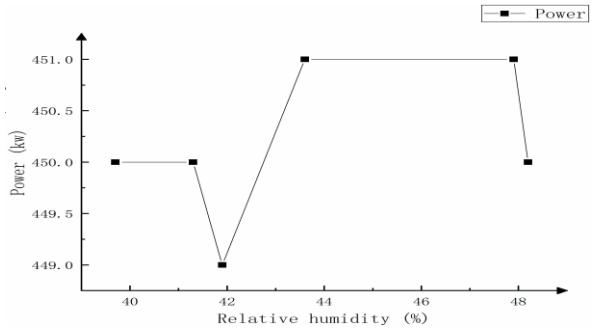

Fig. 9. Curve of power versus relative humidity

In conclusion, it can be seen from Fig. 8 and Fig. 9 that the relative humidity within a certain range has a very obvious impact on the power and economy of the engine. In the controllable range of relative humidity, when the relative humidity increases, the fuel consumption of the engine increases obviously, so its economy will become worse in this range. At this time, with the increase of relative humidity, the power of the engine will be reduced, so its power performance will be poor. When the relative humidity is low, the power of the engine will decrease obviously, but when the power is reduced to a certain extent, it will not decrease again. On the contrary, with the continuous increase of the relative humidity, the power will increase to a certain extent, and after the power is increased to a certain extent, it will keep stable. With the increase of the relative humidity, the power will decrease, and the dynamic performance will be worse at this time.

IV. CONCLUSION

In this paper, a series of experiments are carried out to study the effects of various external environments on engine performance, and the conclusions are as follows:

1. Firstly, in the controllable range of the pre-intercooler supercharging temperature, the fuel consumption of the engine decreases with the decrease of the pre-intercooler supercharger temperature, and the economy of the engine improves with the increase of the pre-intercooler supercharging temperature. The power of the engine does not change with the change of the pressure temperature before the Intercooler, and the power of the engine does not fluctuate with the change of the pressure temperature before the intercooler.

2. Secondly, in a certain range of fuel into the engine temperature, the engine fuel consumption with the increase in fuel into the engine temperature will increase, the economy will become worse. When the temperature of fuel into the engine is low, the power of the engine increases obviously, but when the power increases to a certain extent, it will not increase.

3. Thirdly, in the controllable range of atmospheric temperature, the fuel consumption of the engine decreases with the decrease of atmospheric temperature, so its economy will be better in this range. The power of the engine decreases as the temperature of the atmosphere increases.

4. Finally, the relative humidity in a certain range has a very obvious influence on the power and economy of the engine. In the controllable range of relative humidity, the fuel consumption of the engine increases with the increase of relative humidity and the power of the engine decreases with the increase of relative humidity. The power of the engine decreases with the lower relative humidity, but when the power decreases to a certain extent, it will not decrease again. Power increases to a certain extent, keep stable, with the relative humidity increases again, the power will be reduced.

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