

Study on the Performance of the Model ZH1125 Single Cylinder Diesel Engine by Changing the Air Cleaner

Yang An-jie

Engineering training center
Henan University of engineering
Zhengzhou, China
Yanganjie163@163.com

Yang Jian-wei

College of Mechanical Engineering
Henan Institute of Engineering
Zhengzhou, China
ymww10@sina.com

Abstract—the new designed air cleaner for model ZH1125 single cylinder diesel engine was introduced in this paper. Comprehensive analysis of the engine power, economy and emission smoke level were taken out to study the effect of this new air cleaner, while the bench engine without air cleaner or different types of air cleaner were used as comparison. All the results showed that the new designed air cleaner would improve the power performance and economy significantly, as well as reduce the exhaust smoke level obviously.

Keywords—Single Cylinder Diesel Engine; Air Filter; Performan; smoke

I. INTRODUCTION

Single cylinder diesel engine (SCDE) is one important model in the diesel engines. There are many single cylinder diesel engine manufactories in our country, and the number of the production and ownership of this engine is standing first over the world[1]. However, the exhaust emissions from a single cylinder diesel engine have not been paying attention from the relative technical supervision departments, since the single cylinder diesel engine is mainly focused on supporting small tractors, three wheeled vehicle, low speed truck, agricultural drainage and irrigation machinery, generator sets, agricultural engineering machinery, ships and so on [2]. Single cylinder diesel engine is popular among customers since it's cheap, simple and easy to use. As it is designed for agricultural power, research is mainly focuses on the starting performance, power and reliability. However, emission, vibration, noise and energy-saving is not make much efforts [3]. The intake system of the engine has a direct impact on the performance of the diesel engine. Air cleaner is one of the important parts of intake system of the engine, which can filter out hard particles to provide cleaner air to the engine, and can prevent dust and other components from wearing the internal engine. The performance of the air cleaner not only determines the reliability of the engine and the engine's service life, but also affects the engine's power, economy, and even affects the atmospheric environment [4-5]. Here, we reported a new air cleaner with a new structure. Load characteristics test and speed characteristics test were carried

out using a ZH1125 single cylinder diesel engine with type-A air cleaner, type-B air cleaner or without air cleaner. The effects of output power, torque, fuel consumption, exhaust smoke level, oil temperature, exhaust temperature and other factors were tested and analyzed[6], which give us a comprehensive understanding of how the different air cleaners will affect the engine power, economy and emission smoke level.

II. EQUIPMENT

A. Test engine

The test engine is the model ZH1125 diesel engine. The technical parameters of the diesel engine is shown as table I .

TABLE I. TECHNICAL PARAMETERS OF THE DIESEL ENGINE

Diesel engine model	ZH1125
Combustion chamber type	Direct injection type
diesel engine type	horizontal single cylinder four stroke water evaporation
Bore×storke/mm	125×120
displacement /L	1.473
Compression ratio	17:1
Calibration power / speed /[kW/(r·min ⁻¹)]	18.38/2200
Fuel consumption/[g/(kW·h)]	≤240.7
Fuel Injector	52P
Injection pressure /MPa	19
Advance angle of fuel supply / °	22

B. The main equipment of testing

The main equipment of testing is shown as table II .

TABLE II. THE MAIN EQUIPMENT OF TESTING

Serial number	name	type specification	measurement accuracy
1	Automatic measurement and control system	ET2000	speed: $\pm 1(r \cdot \min^{-1})$
2	Eddy current dynamometer	DWD63	torque: $\pm 0.4\%F.S$
3	Intelligent fuel consumption meter	ET2500	$\pm 0.4\%F.S$
4	Smoke meter	YDJ-2000	$\pm 3\%$
5	opacity smoke mete	SV-5Y	0.1%

Blade ring of filter cap	—	The number of blades, $n=24$; Blade angle, $\alpha=32^\circ$
Outside diameter of oil bath filter/mm	150	220
Center tube diameter of outside diameter /mm	50	75
Precision filter height/mm	150	250
iron wire filter core total height/mm	75	100

C. Air cleaners – type A and type B

The structure of Air cleaners type A and type B for testing is different. The type A Air cleaner is shown as Fig.1. The type B Air cleaner is shown as Fig.2. The Structure parameter of Air cleaners is shown as table III.



Fig.1 Photo of type-A air cleaner



Fig.2 Photo of type-B air cleaner

TABLE III. THE MAIN STRUCTURE PARAMETER OF AIR CLEANERS

The Structure parameter	Type	
	Type-A	Type-B
Outer diameter of filter cap/mm	—	180

III. TEST METHOD

All the tests were carried out using a ZH1125 engine. The influence of the air cleaner on the engine power, economy and smoke emission level was analyzed. Three experiment settings were used by (1) without air cleaner, (2) type-A air cleaner (old design) and (3) type-B cleaner (new design).

IV. RESULTS AND DISCUSSION

Figure 3 shows all the load-characteristic curves including the tests without air cleaner, with type-A air cleaner (old design) and with type-B air cleaner (new design). Performance test results summarize as follows:

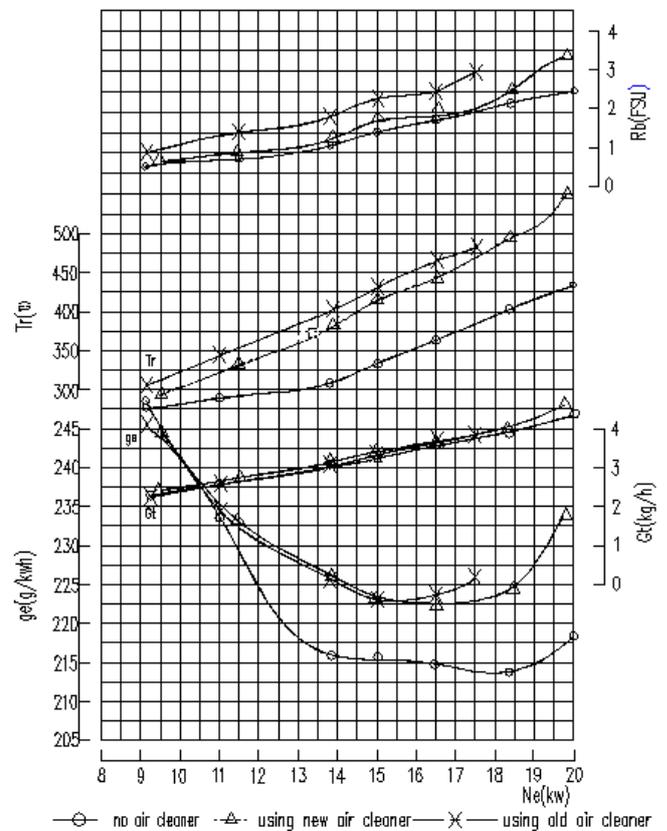


Fig.3 Load-characteristic curve of different air cleaner

A. Maximum power of engine

At calibrated rotation speed, the maximum power of engine can be 19.67 KW without air cleaner, 20.52 KW with type-B air cleaner, and only 17.14 KW with type-A air cleaner. Surprisingly, the real power increases by 13.5% and calibrated power increases by 19.7% when our newly designed type-B air cleaner is used compared with the type-A air cleaner.

B. Fuel consumption rates

The fuel consumption rates of all three settings are very close in the 9-11 KW range. Above 11 KW, The fuel consumption rate using no air cleaner is obviously low, while in the 11-15 KW range, the fuel consumption rates using the type-A and type-B air cleaner settings are still very close. Above 15 KW, the fuel consumption rate using the newly designed type-B air cleaner setting is much lower compared with the one using type-A air cleaner. At calibrated load condition, the modified fuel consumption rate using type-B air cleaner is 222.6g/(kW·h), while the modified fuel consumption rate using type-A air cleaner is 226 g/(kW·h). A 1.5% decrease is achieved. At 75% load condition (13.78KW/2200rpm), the modified fuel consumption rates using type-B and type-A air cleaner are 225.8g/(kW·h) and 226.3g/(kW·h), which are very close.

C. Exhaust temperature

In the whole power range, the exhaust temperature without using air cleaner is obviously on the low side, while the one using type-A or type-B air cleaner is higher. Also, the exhaust temperature gradually increases with the increasing of load.

D. Smoke emission

In the whole power range, the smoke emission without using air cleaner is obviously on the low side, the one using the type-A air cleaner is apparently high degree, the one using type-B air cleaner is in the middle. Again, the exhaust smoke obviously increases with the increasing of load. The smoke value without using air cleaner is 2.2 FSU, and the smoke value using type-B and type-A is 2.5 FSU and 3 FSU. A decrease of 20% is achieved when replacing type-A with type-B air cleaner.

Figure 4 shows all the speed-characteristic curves including the tests without air cleaner, with type-A air cleaner (old design) and with type-B air cleaner (new design). Performance test results summarize as follows:

A. Fuel consumption rates

At determined throttle, the fuel consumptions of all three setting are almost the same under different speed; while for fuel consumption rate, no air cleaner is the lowest, type-B air cleaner is in the middle and type-A cleaner is the highest. When using type-A air cleaner, the fuel consumption rate is 232.9g/(kWh) under the maximum torque (97.58 N·m/1650rpm). When using type-B air cleaner, the fuel consumption rate is 223.9g/(kW·h) under the maximum torque (101.62 N·m/1650rpm), which is 3.9% lower than the one using type-A.

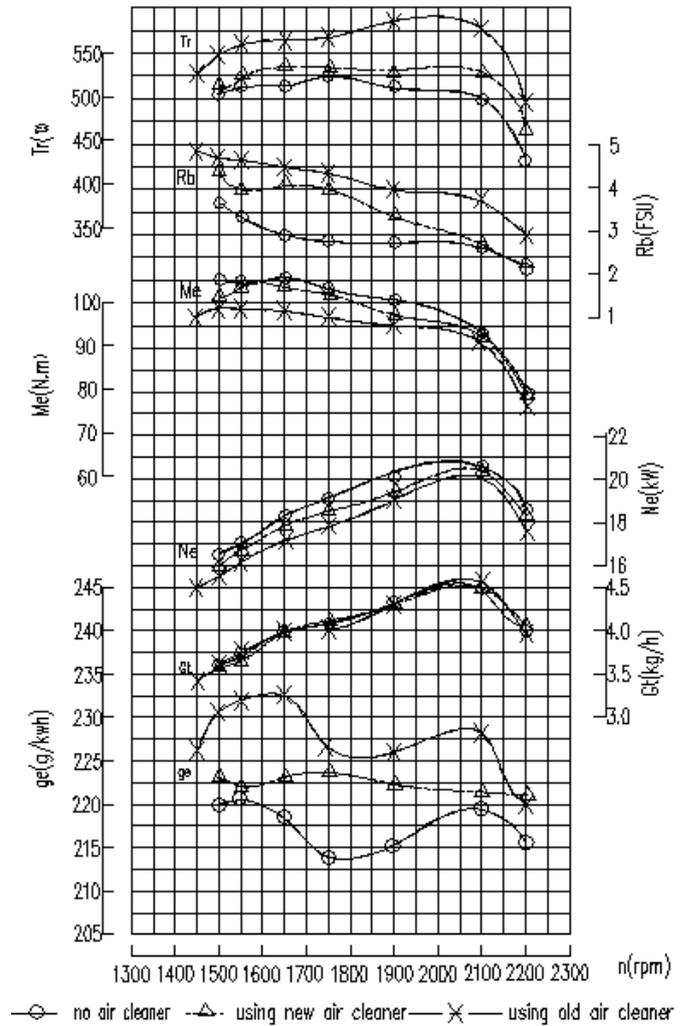


Fig.4 Speed characteristic curve of different air cleaner

B. Torque

The torque at all three settings increase with the increasing loading and decreasing rotation speed, while the maximum torque appear at the range of 1500-1700 rpm. When using the type-B air cleaner, the maximum torque is 101.64 N·m/1650rpm, and the torque reserve rate is 27.4%. When using Type-A air cleaner, the maximum real torque is 97.58 N·m/1500 rpm, and the torque reserve rate is 22.3%. When using no air cleaner, the maximum real torque is 103.64 N·m/1650 rpm, and the torque reserve rate is 29.9%..

C. Rotation speed rate at maximum torque

75% for no air cleaner, 68.2% for type-A air cleaner and 75% for type-B air cleaner.

D. Smoke emission

The smoking level at all three settings with the increasing loading and decreasing rotation speed. At the maximum torque, the smoking level at no air cleaner, type-A and type-B setting is 3.0, 4.7 and 4.1 FSU; and the maximum opacity value (optical absorption coefficient) at no air cleaner, type-A and type-B setting is 0.95, 2.65 and 1.89 /m-1

E. Heat emission

At all the power range, the heat emission at no air cleaner setting is the lowest, type-A is the highest, while the type-B is in the middle. Additionally, the heat emission increases with the increasing loading.

V. CONCLUSIONS

The prototype test results show that compare with the old air cleaner (type-A), the using of the new designed oil bath composite air cleaner (type-B air cleaner) on the single cylinder (125mm) diesel engine can significantly improve the power and economy efficiency, and lower the emission smoke level.

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