Research on quality evaluation of lubricating oil based on China's independent development

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Keywords: Lubricating oil, Quality assessment, API, China's autonomy.

Abstract. At present, China has become the largest automobile production and sales country in the world, and the second largest lubricant consumption country. It is of great significance to establish China's independent certification and evaluation system for lubricants.In recent years, China's heavy-duty diesel engine has basically realized the technology autonomy, and the mode of lubricant evaluation standard equivalent to API specification is not suitable for China's national conditions. It is imperative to develop a diesel engine oil quality evaluation research that is suitable for China's national conditions.This paper mainly introduces a series of research on the performance difference of JAC 2.0TCI engine based on the physicochemical, wear and sediment evaluation of different reference oils under the condition of fuel dilution.

1 Preface

At present, China ranks first in global engine and automobile production and sales, and second in lubricant consumption. In recent years, API lubricating oil evaluation standard system has been used in China, but the technical characteristics and road transportation conditions of heavy-duty diesel engines in China are quite different from those in the United States, and the requirements for lubricating oil performance are quite different, and API system can not fully meet the needs of long oil change cycle and high fuel economy. China's diesel engine technology has been basically independent. The SCR of China's heavy-duty diesel engine, the design features of high-pressure common rail EFI, the road transportation features of heavy load and overload, and the diesel oil used by vehicles are quite different from the EGR and DPF technologies and operating environment used by American diesel engines, which leads to the great difference in the performance requirements of lubricating oil. At present, China's diesel engine lubricating oil standard is equivalent to the API standard. Domestic lubricating oil manufacturers have proposed that the API standard is no longer applicable to the domestic diesel engine manufacturers' needs of long oil change period, convenience for users and reduction of maintenance cost.

It is of great significance to develop a bench test evaluation method for lubricating oil, which takes into account the characteristics of engine and aftertreatment technology, road

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conditions and fuel oil in China, so as to establish and improve China's independent lubricating oil standard system. China has been using API series lubricating oil standards to ci-4 stage, planning to develop its own lubricating oil standards and evaluation system from CJ-4. Since 1980, China's petrochemical sub Standard Committee began to lag behind in translating American API standards. Now the implementation of gb11122-2006 has increased the requirements for high-quality diesel engine oil products, and stipulated the quality index requirements for CC, CD, CF, CF-4, CH-4 and ci-4 diesel engine oils. Generally speaking, the introduction of corresponding specifications of diesel engine oils in China has been delayed for at least five years compared with foreign countries.

In order to avoid the long-term domination of China's lubricant evaluation standards, we want to establish an independent lubricant evaluation system suitable for China's national conditions. In 2016, Jin Donghan, Li Jun and Cao Xianghong jointly launched the China standard development and Innovation Alliance for lubricating oil, which was organized by China internal combustion engine society, China Automotive Engineering Society and national petroleum products and lubricating oil Standardization Technical Committee. A number of lubricants, additives, engine companies and third-party evaluation organizations participated in the work, focusing on the bench evaluation method of Chinese lubricants. The main work is to develop four comprehensive lubricating oil performance test methods, including Weichai, Xichai, Dongfeng and Jianghuai, aiming at the basic national conditions of Chinese engine technical characteristics, driving conditions, fuel oil and OEM technical requirements, aiming at the revision of GB 11122-2006.

2 Test device and method

In this paper, JAC 2.0 CTI engine is selected as the test engine. The engine has four cylinders in-line, double overhead camshaft, variable geometry turbocharging intercooling, 180MPa electronically controlled high pressure common rail, warm end EGR and bypass cooling, and "DOC+ DPF" post-treatment system and other advanced technologies, which meet the national five emission standards. The specific parameters are shown in Table 1.

The total test time of the test condition is 200 hours, each cycle is 25 hours, a total of 8 cycles, simulated road driving 40000 km. Each cycle includes idle condition, maximum torque condition, rated power point, medium speed and low load condition. Low load, low water temperature and high oil temperature will lead to high wear under idle condition; Under the maximum torque condition (2600r / min), high load, high water temperature and high oil temperature are conducive to accelerating oil oxidation, deposition and wear; Rated power point (3600r / min), high speed, high load, high water temperature and oil temperature are conducive to oil oxidation and deposit; The EGR rate is higher in medium speed and low load condition (1800r / min), and higher water temperature and oil temperature will be conducive to the formation of soot and sediment.

In order to evaluate the quality of lubricating oil under the condition of fuel dilution, this paper adopts the method of mixing diesel oil and oil to realize fuel dilution. The dilution ratio of diesel oil and oil is 8%, and the test oil sample is taken every 25 hours, and the oil level is filled to the initial level. Two reference oils were selected, the numbers were D1-R001 and D1-R002 respectively. R001 is CJ-4 reference oil, R002 is CK-4 reference oil, viscosity level is 15w-40.

Table 1. Engine parameters.

Parameters/units	Parameters
Number of cylinders	4
Cylinder diameter / mm	83

Stroke / mm	92.4
emission standard	China VI
Rated speed / rpm	3600
Total displacement of piston / L	1.999
Rated power / kw	102
Maximum torque / (n · m)	320(2600r/min)

Table 2. Test conditions.

parameter	Stage 1	Stage2	Stage3	Stage4
parameter	1	6	6	12
Time / h	780±5	2600±5	3600±5	1800±5
Speed / (R / min)	0	100	100	/
Load rate /%	record	record	record	80±2
Torque / (nm)	38±2	38±2	38±2	38±2
Fuel inlet temperature / ℃	25±2	25±2	25±2	25±2
Intake air temperature / ℃	30±2	45±2	45±2	30±2
Intake manifold temperature / ℃	40±2	95±2	95±2	88±2
Coolant outlet temperature / ℃	60±2	125±2	125±2	100±2
Oil temperature of main oil passage / ℃	record	record	40±1	record

3 Physical and chemical analysis

The results showed that the 100 ℃ kinematic viscosity of the two reference oils began to increase with time. The 200 hour growth rate of R001 reference oil was 5.45%, and that of R002 reference oil was 1.76%; For 40 ℃ kinematic viscosity, R001 reference oil increased by 4.63% after 200 hours, while R002 reference oil decreased by 2.36% after 200 hours. Compared with the R001 reference oil, the viscosity of R001 reference oil increased rapidly, which is due to the relatively small content of additives related to the content of dispersant, which makes it show poor viscosity performance.

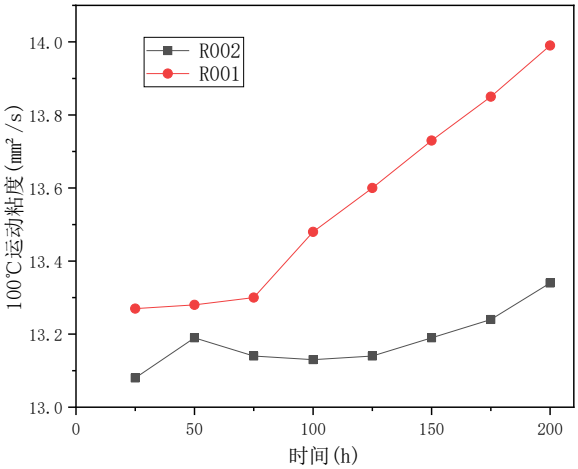

Fig. 1. KV100 of two reference oils in 200 hours.

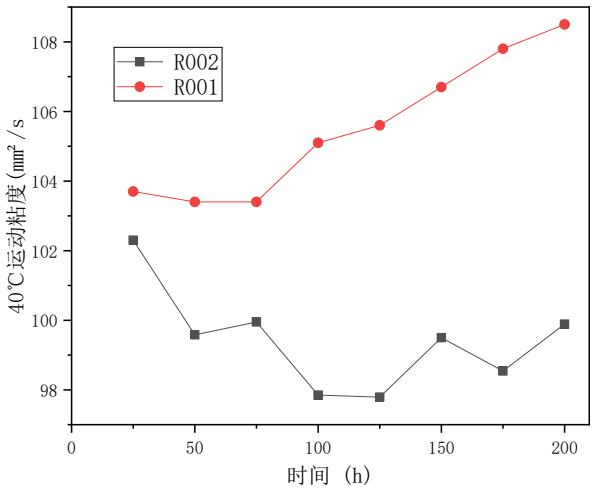

Fig. 2. KV40 of two reference oils in 200 hours.

With the extension of the test time, the TAN and TBN of lubricating oil will also change. TAN has an important influence on the corrosion resistance of lubricating oil and the anti-aging properties of TBN. The difference of TBN between the two reference oils is small, the initial values are similar, and the measured values are almost the same after the test. For Tan, the initial Tan of R001 oil is larger than that of R002 oil, and it always keeps a trend of larger than that of R002 oil during the whole test, which indicates that the corrosion resistance of R001 oil is always higher than that of R002 oil in the overall test, and the corrosion resistance is poor.

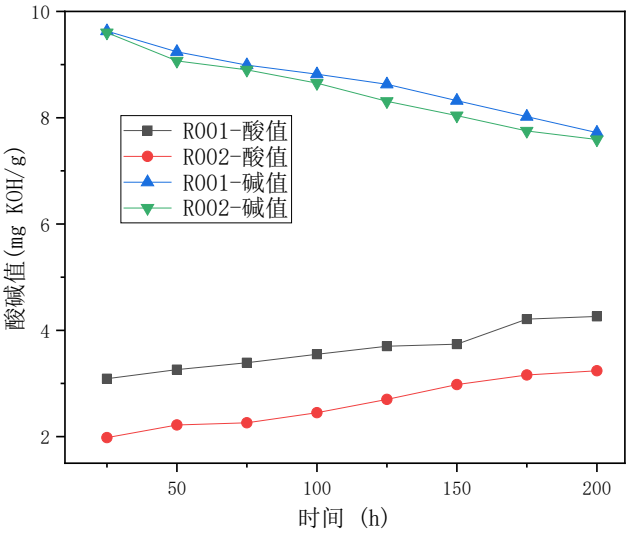

Fig. 3. TAN and TBN of two reference oils in 200 hours.

Two different reference oils were analyzed from the perspective of element analysis. In the 200 hour durability test, the iron content of R002 oil increased from 12ppm to 78ppm, and that of R001 oil increased from 17ppm to 91ppm. The iron content of the two oils increased linearly with time, and the difference between R002 oil and R001 oil increased with time.

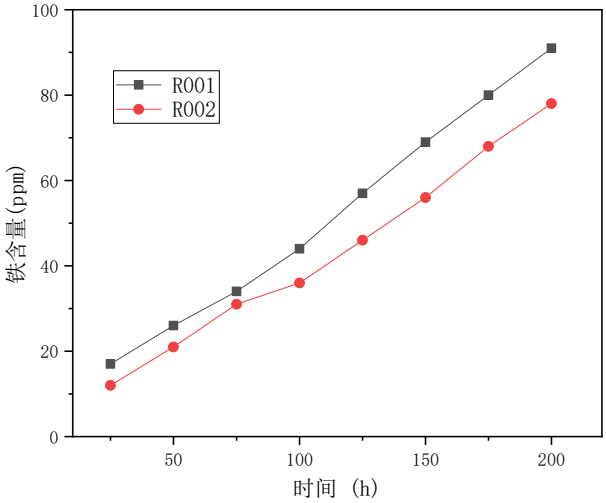

Fig. 4. Iron content of two reference oils in 200 hours.

4 Wear and sediment analysis

In addition to the physical and chemical analysis of different reference oils, the engine was disassembled and evaluated after the test run, mainly aiming at the influence of lubricating oil on the key parts of the engine. The wear depth of the exhaust camshaft and the score of piston deposit show obvious distinction in this test.

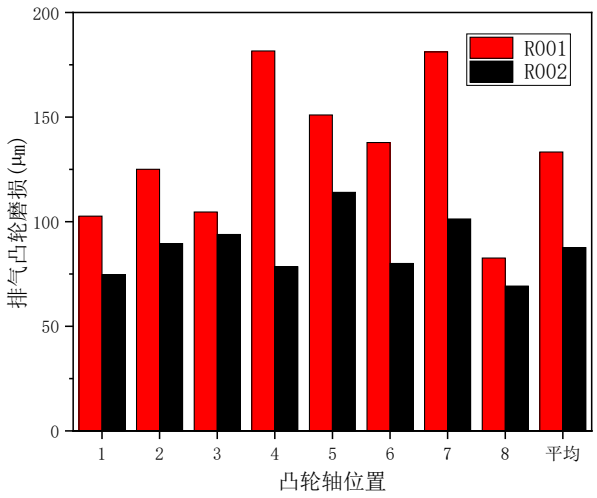

Fig. 5. Exhaust camshaft worn.

Based on the analysis of the influence of the two kinds of reference oil on the wear depth of the exhaust camshaft, the results show that the wear of the reference oil R002 in different positions is more uniform than that of the reference oil R001, the fluctuation is relatively small, and the overall average wear is relatively low; Compared with the reference oil R001, the wear depth of different cam positions varies greatly, showing a

trend of high in the middle and low on both sides. The overall average wear is 133.336um, which is significantly higher than that of reference oil R002 87.639um.

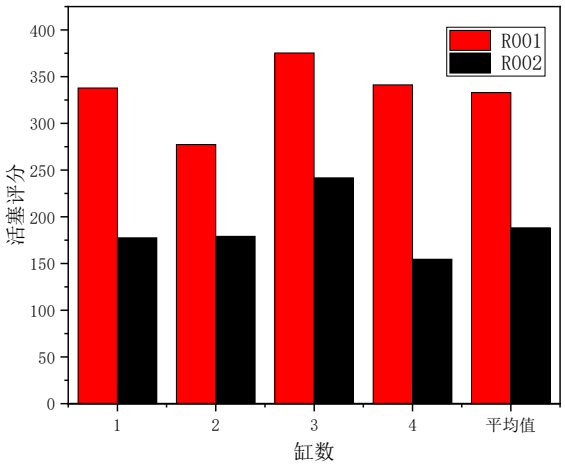

Fig. 6. Piston score.

Lubricating oil plays an important role in engine operation, such as lubricating parts, cleaning and dispersing, and radiating heat. Lubricating oil plays an important role in the clean heat dissipation of piston body, which has a strong impact on the formation of piston deposits. The piston score of R001 reference oil is not only higher than that of R002 reference oil in each cylinder, but also in the average value. The average score of R001 reference oil was 332.939, which was 76.85% higher than that of R002 reference oil 188.263.

5 Conclusions

Based on a JAC engine, this paper studies the performance of lubricating oil under the condition of fuel dilution. Two different grades of reference oil are used for engine test. There are obvious differences between the two reference oils in physical and chemical analysis, exhaust camshaft wear, piston score and so on, which confirms the effectiveness of the development of JAC lubricating oil bench method, and the related work effectively promotes the construction of China's independent lubricating oil quality evaluation system.

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