A new path of energy saving and emission reduction based on the choice of matching engine oil for traditional energy vehicles

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Abstract. Comparative test research for the same and different models with matching type oil has been carried out under same and different conditions. The results show that the parameters such as idle speed, load calculation value, absolute position of throttle, injection pulse width and fuel repair value of all the tested engines are reduced to different degrees by using the matching type oil. Energy consumption, emissions and other indicators of vehicles with matching type of oil have been improved after long-term tracking, especially large diesel vehicles.

1. Introduction
By the end of 2020, the number of traditional energy vehicles in China was 276 million, accounting for 98.25 percent of the total; the total amount of fuel consumption is as high as 60000 tons/day, and the emission of pollutants has accounted for more than 70% of the air pollution index. The amount of energy consumption and pollution index is very alarming. It can be seen that while the automobile provides convenience for people, it also brings huge energy and environmental problems.

Engine lubricating oil is commonly called oil, known as the "blood" of the engine. Oil lubrication performance has a great impact on the engine speed, load, injection pulse width and other parameters and these indicators directly affect the energy consumption and emissions of the vehicle. Research shows that friction loss of engine is the main cause of engine energy loss. Lubrication technology is the most effective way to reduce friction loss⁴. It requires the adoption of a series of lubrication measures for the engine, such as the adoption of oil matching optimization, rapid temperature rise and other technical measures to achieve energy saving and emission reduction⁵.

In this paper, the matching type oil is selected to carry out a comparative test on traditional energy vehicles. A new path of energy saving and emission reduction is found in the link of engine oil
selection. Hopefully, it can accelerate the promotion among the car owners in order to make contributions to energy saving and environmental protection.

2. The influence of lubrication performance on engine technical parameters

2.1. Affect idle speed

Idle speed is the lowest stable speed to overcome the friction resistance inside the engine. We watched the greater the friction resistance, the higher the idle speed and fuel consumption. According to the research statistics, it takes 30%~40% of the fuel consumption on overcoming the internal friction resistance of the engine[3]. Which is not only related to the viscosity, but also to the antiwear materials of the oil[4]. The internal friction resistance of the engine is reduced by 30% ~ 50% with the matching type of low viscosity, high antiwear oil. The idle speed will be reduced, so as the fuel consumption, equivalent to the city comprehensive energy consumption decreased by 5% ~ 15%. Fig 1 shows the influence of different oil antiwear agents on the engine friction coefficient[5].

![Friction coefficient vs. Softening temperature](image)

2.2. Affect load calculation value

The calculated value of engine load is related to the engine load characteristic curve. Engine load characteristic refers to the relationship between the fuel consumption rate (g/kW.h) and other indicators with the change of load (throttle opening) when the engine speed is constant. The greater the engine load, the greater the load the engine will bear, the more air and fuel injection will be needed, and the higher the fuel consumption, the greater the emissions, and the heavier the wear.

It can be seen from the engine load characteristic curve that 100℃ kinematic viscosity of different oil, engine load calculation value is different under the condition of the same brand and level. The engine load characteristic curves of 5W-40 oil with kinematic viscosity of 15.3mm2/s and 14.4mm2/s at 100℃ were compared and tested, as shown in Fig 2.

![Load characteristic curves](image)
By contrast, it is an important reason for the fuel saving of low viscosity oil when the kinematic viscosity is 14.4mm²/s, the engine load characteristic curve is relatively flat.

Under the premise of satisfying engine lubrication, sealing and anti-wear, the kinematic viscosity decreases by 1mm²/s, engine idle fuel consumption decreases by 1%, and urban comprehensive energy consumption decreases by 0.3% ~ 0.5%[6].

The fuel consumption is generally reduced by 3% ~ 12% after the selection of matching type oil under the same conditions. As fuel consumption decreases, pollutants discharged naturally decrease, especially the amount of CO, HC and PM.

2.3. **Affect injection pulse width**

Injection pulse width refers to the length of each injection time of the engine computer control injector. The unit is millisecond (ms). Longer injection time causes larger displayed values and higher fuel consumption. The injection pulse width changes with the engine speed, load and intake volume, especially with the engine load, the larger the load, the greater the injection pulse width, the higher the fuel consumption. The fluidity and dynamic viscosity of lubricating oil are closely related to the size of engine load (i.e. moving load, expressed by pressure), and directly affect the energy loss of the engine. Fig.3 shows the relationship between the dynamic viscosity of the oil and the pressure at normal operating temperature after selecting the matching type oil[5].

![Fig. 3 Relationship between oil dynamic viscosity and pressure at different temperatures](image)

Studies have shown that the matching type oil added with viscosity index improver and extreme pressure antiwear agent can quickly establish oil film on the friction surface, reduce running resistance, and tolerate higher pressure[4].

3. **Comparative test of matching type oil**

3.1. **Comparison test of fuel consumption and emission of the same model under the same conditions**

The same grade of matching type oil was selected on a 2.5L Toyota Reiz automatic transmission gasoline car under the same conditions, and the Yuanzheng X-431 decoder was used for reading data stream of the comparative test. The results are shown in Table 1.
Obviously, the parameters affecting the engine fuel consumption, such as engine speed, load, throttle opening and fuel repair value, have decreased to varying degrees.

The 10000km road test was conducted under the same conditions, compared with the conventional oil, the average fuel saving was 0.8L per 100km driving on the expressway and 0.6L per 100km driving on the urban comprehensive road. According to the national gasoline car number of 250 million calculation (released by the Ministry of Public Security in December 2020), the amount of gasoline saved is amazing, if more than 10% gasoline cars choose matching type of oil.

The exhaust gas analyzer was used to detect the pollutants emitted by the vehicle. The results are shown in Table 2.

As can be seen from Table 2, after the selection of matching type oil, the content of CO and HC in engine emission pollutants decreased, especially the HC content, and the environmental protection of the vehicle improved significantly.

A Jiefang diesel car was selected with engine model 51601232, power 390KW, body length 17.5m, height 2.85m, deadweight 9ton and load capacity 30ton. Under the same conditions, matching type oil of the same grade was selected for long-distance comparative test, and the results were shown in Table 3.

The diesel vehicle can save up to 8.3% fuel per 100km after selecting the matching type oil.

If more than 50% of diesel vehicles choose matching type oil, the amount of saving diesel fuel is very considerable; emissions of pollutants will also be significantly reduced, according to the national diesel vehicle number of 29.44 million calculations (released by the Ministry of Public Security in June 2020).
3.2. Comparative testing of fuel consumption and emissions of different models under different conditions.

Five gasoline vehicles with different models and different mileage were using to do test about engine load calculation value, absolute position of throttle and injection pulse width and other parameters with Yuanzheng X-431 and Volkswagen specified diagnostic instrument, under different conditions by different grades of matching type oil. The results were shown in Table 4.

The technical parameters affecting fuel consumption and emissions of all the tested models were reduced to varying degrees. Among them, the calculated load value decreased 1.456% and it’s reduced by 6.32% on average; the throttle opening decreased 1.2% and it’s reduced by 9.05% on average. The injection pulse width was shortened by 0.123ms or reduced by 5.55% on average.

4. Conclusion

The long-term tracking test on thousands of gasoline and diesel vehicles with the same or different models, different fuels and different mileage shows that the fuel can be saved by 3% ~ 12% and the exhaust emission can be reduced by 5% ~ 20% by using the matching type of engine oil. Therefore, the choice of matching type oil for traditional energy vehicles is currently the most economical, simple, fast and effective new path of energy saving and emission reduction. Matching type oil should be promoted quickly.

Table 4 Comparison test results of engine parameters of different gasoline vehicles

| test model | mileage (km) | original oil | testing oil (matching type) | engine parameters analysis |
|------------|--------------|--------------|-----------------------------|---------------------------|
| Toyota Reiz 2.5AT | 41001 | toyota original oil (SN/SW-30) | Sandi US (SM/SW-40) | engine load decreased 1.11%, reduced by 3.3% |
| | | load calculation value (%) | load calculation value (%) | |
| | | 33.3 | 32.2 |
| | | throttle absolute position (%) | throttle absolute position (%) | |
| | | 15.7 | 15.3 |
| | | throttle opening decreased 0.4%, reduced by 2.55% | |
| | | injection pulse width (ms) | injection pulse width (ms) | |
| | | 2.74 | 2.70 |
| | | injection pulse width decreased 0.04ms, reduced by 1.5% | |
| Honda Accord 2.4AT | 113000 | Mobil (SN/SW-40) | Sandi UH (SM/SW-30) | engine load decreased 1.18%, reduced by 4.7% |
| | | load calculation value (%) | load calculation value (%) | |
| | | 25.10 | 23.92 |
| | | throttle absolute position (%) | throttle absolute position (%) | |
| | | 16.9 | 14.9 |
| | | throttle opening decreased 2%, reduced by 11.8% | |
| | | injection pulse width (ms) | injection pulse width (ms) | |
| | | 2.74 | 2.70 |
| | | injection pulse width decreased 0.04ms, reduced by 1.5% | |
| Benz E260 1.8T | 108550 | Benz original oil (SM/SW-40) | Sandi US (SM/SW-40) | engine load decreased 0.8%, reduced by 3.8% |
| | | load calculation value (%) | load calculation value (%) | |
| | | 21.2 | 20.4 |
| | | throttle absolute position (%) | throttle absolute position (%) | |
| | | 6.3 | 5.9 |
| | | throttle opening decreased 0.4%, reduced by 6.3% | |
| Nissan Tianna 2.3AT | 97630 | original oil (UQ/MOL AASN/SW-30) | Sandi (SM/SW-40) | engine load decreased 3%, reduced by 15% |
| | | load calculation value (%) | load calculation value (%) | |
| | | 20 | 17 |
| | | injection pulse width (ms) | injection pulse width (ms) | |
| | | 2.1 | 1.8 |
| | | injection pulse width decreased 0.3ms, reduced by 14.3% | |
| Audi A6 2.4L | 213172 | Castrol EDGE (SN/SW-40) | Sandi (SN/SW-50) | engine load decreased 1.2%, reduced by 4.8% |
| | | load calculation value (%) | load calculation value (%) | |
| | | 25.0 | 23.8 |
| | | injection pulse width (ms) | injection pulse width (ms) | |
| | | 3.51 | 3.48 |
| | | injection pulse width decreased 0.03ms, reduced by 0.85% | |

Research project

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