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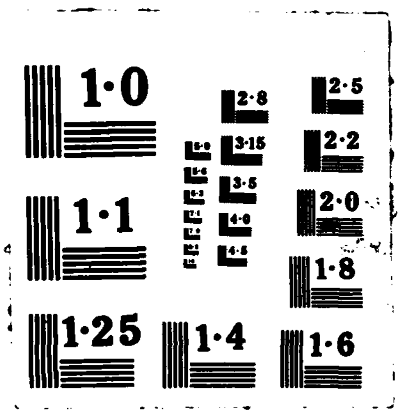
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FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

AN EVALUATION OF EFFECTIVENESS OF PTFE-TYPE FRICTION REDUCERS ON REDUCING FRICTION AND WEAR

by

Guo Yiming

FOREIGN TECHNOLOGY DIVISION

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An Evaluation of Effectiveness of PTFE-Type Friction Reducers on Reducing Friction and Wear

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Abstract

Friction reducer containing colloidal polytetrafluoroethylene (PTFE) is one of the new lubricating materials recently developed abroad for automobile engines. This paper mainly reports: (1) the effectiveness of friction reducers (three American products and one Chinese product) on the anti-friction and fuel-saving of Chinese multi-cylinder gasoline engines; and (2) the effectivess of these friction reducers on the anti-wear of Chinese gasoline engines.

The evaluations were conducted in Beijing, Shanghai, and Guangdong with identical test procedures. Results obtained from various methods at various places provide a better basis for correlation. These results prove that friction reducers are effective in reducing friction and wear, when applied to Chinese gasoline engines. It was found that the fuel consumption at a constant speed decreased about 4%, the fuel consumption during 100 km operation decreased about 3% and the wear of engine cylinder decreased about 10% to 40% (Chinese translations).

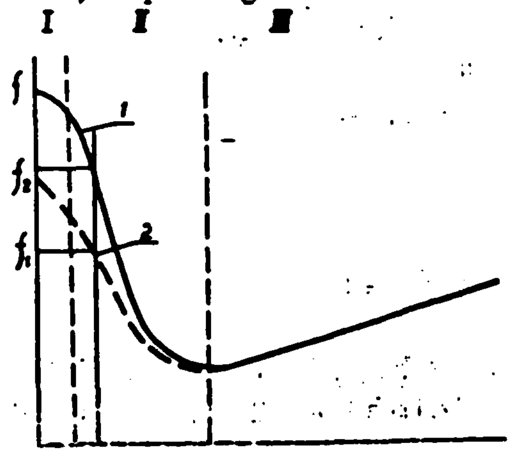
1. Friction Reducer and Engine Lubrication

Friction reducer is an additive which can lower friction coefficients under boundary or mixed lubricating conditions. The friction reducers can generally be categorized into two classes: oil-soluble additives and solid lubricants. Figure 1 illustrates the relationship between lubricating conditions and friction coefficients It can be seen from this figure that fluid lubrication is the ideal lubricating condition. Within the regions of boundary or mixed lubrication, lubricating oil containing friction reducer can form a boundary lubricating film on the friction surfaces, thereby significantly lowering the friction coefficients and resulting in energy saving.

The lubricating conditions of various friction pairs in engines are not always fluid lubrication. Bearing for crank axle is sliding bearing. Except for the moments right after starting or stopping, the main function of bearing is performed under fluid lubricating condition. Rotor and valve tappet, considered as a linear contact friction pair and having great variations in load and motion speed, are mainly under the mixed condition of elastic fluid lubrication and boundary lubrication. The geometric shape of working surfaces in the piston ring and cylinder sleeve is similar to that for sliding bearing. However, because of high temperature, hot and high-pressure gas, drastic change in speed, and vibration, etc., boundary lubrication exists on the working surface of rotor and cylinder sleeve. Therefore, the lubricating conditions in an engine are very complex and the friction losses are quite large. Statistics indicate that only about one third of the heat energy generated from fuel burning in a gasoline engine is converted to the indicated engine power; about 20% of this power is wasted because of friction inside the engine and its ancillary parts.

PTFE is characterized by its chemical stability and has excellent lubrication properties. Under boundary lubricating conditions, PTFE can reduce friction and wear and is a solid lubricant having relatively wide applications. Friction reducer containing colloidal PTFE grain is a concentrated and suspended solution. Added in accordance with the prescribed volume ratio to the motor oil of an operating engine, the PTFE solid powders can be readily carried to the working surface of various friction pairs and begin its lubricating function. Such lubrication can prevent direct contact between the protruding metals and reduce friction coefficients under mixed and boundary lubricating condition, thereby improving the lubricating condition of an engine.

Friction Coefficient



$Z(\frac{nu}{p})$ Lubrication Characteristics Coefficient

Figure 1. The Relationship between Lubrication Characteristics Coefficient and Friction Coefficient.

I - Boundary Lubrication Region; II - Mixed Lubrication Region;
III - Fluid Lubrication Region; n = speed; u = viscosity;
p = pressure (load) $f_2 > f_1$. 1 - without friction reducer, 2 - with friction reducer

2. Evaluation Method and Equipment

(1) Methods

At the present time, there is no establised standard method to evaluate the relationship between lubricating oil in automobile engines and fuel economy. As a result of research and development on the energy-saving lubricating oil, work involving the evaluation and test in this area has been progressing quite well. Because of the complexity of engine lubrication, platform test of engines and road test of automobile are the methods popularly adopted. Among them are engine performance test and friction power test. Electrical power-measurement device with reverse-drag method provides better and effective measurements of frictional power in engines. The reason is that it can eliminate many factors influencing the fuel consumption of engines. For instance, fuel consumption in an engine is greatly affected by adjusting fuel-electricity systems of carburetor or electrical distribution board than by lubricating oil. For the road test of automobiles, the chassis power-measurement device with simulation method is widely adopted abroad. This method uses the actual driving conditions as parameters to conduct repetitive tests under various working conditions. In addition, there is a provision for automated oil change. Road test of automobiles is also one of the evaluation methods.

For evaluating the effectiveness of friction reducers on anti-friction, the conclusion derived from lots of measured data via long-term testing would be more reliable. We conducted the following evaluation tests on various types of PTFE-containing friction reducer.

1. Engine performance tests per Chinese Government standards;
2. Friction power test of engines.

Methods for conducting these tests consist of the following two kinds:

‹1› Cylinder Extinguishing Method

On the engine platform, comparison tests were successively conducted to determine frictional power for cases of lubricating oil with or without friction reducer. During the test, the power at 2800 rpm was determined when the throttling valve was completely open. Immediately following that, the high pressure line of a spark plug for one cylinder was pulled out to shut off the cylinder. The power was determined after load was adjusted and the [illegible] speed was increased to 2800 rpm. Once the powers were successively determined after various cylinders were extinguished, the frictional power can be calculated by the following formula.

$$N_m = \sum N_i - N_e$$

where $\sum N_i$ = sum of the indicated power for various cylinders,

N_e = the average effective power when engine is operated at a specified speed,

N_m = friction power.

(2) Reverse-Drag Method with Electrical Power-Measurement Device

1. Friction Power Tests for Hot Engines

This test was conducted at a specified rotating speed when the engine's throttling valve was completely open. After maintaining the temperature of coolant at 80±2°C and the temperature of motor oil at 85±2°C, fuel supply was shut off and the residual fuel in the pipe was rapidly and completely burned. Then cut off the electric source for firing and apply the D.C.-operated power-measuring device to reversely drag the engine. While maintaining the throttling valve completely open and gradually decreasing the speed from the specified speed to the lowest speed, we selected test points for measurement at every 400 rpm increment. Later on, when the speed was increased gradually to the specified speed, test points for measurement were also selected at every 400 rpm increment. Average value of these two tests is taken as the result.

2. Friction Power Tests for Cold Engines

Temperature of the coolant and motor oil in engines started with ambient temperature. While its coolant was not recirculating and throttling valve was completely open, the engine was reversely dragged by an electrical power-measuring machine. The speed was gradually increased from low rotating speed to the specified speed and oil temperature also increased from 20 °C to 50 °C. Test points for measurement were selected at every 400 rpm increment and at every 5 °C increment of oil temperature. (For example, 400 rpm and 20 °C; 800 rpm and 25 °C, etc.)

3. Road Tests of Automobiles

Road tests were conducted in accordance with the applicable Chinese National Standard GB1334-77, "Road Test Methods for Weight-Carrying Automobiles and Trans-Country Automobiles."

4. Operation Tests

Evaluation of the effectiveness of friction reducers containing PTFE on anti-wear was based on the data actually measured from long-term comparative tests of engine operation at the following three operation test stations. At the Beijing Public Transit Yard No. 1, tests were conducted for two years on forty-five public buses equipped with engines of modified Liberation CA-10B type. These tests were conducted strictly in accordance with actual operating condition of vehicles. At the Yard No. 4 of Shanghai Automobile Transportation Company, fifteen trucks of East Wind EQ 140 type were selected for 40,000-kilometer operation tests. Piston ring and cylinder sleeve are the representative friction pair for measurement. The measurement location for cylinder ring is the upper stop point. At Kangjang Transportation Company, 15 long-trip passenger buses equipped with engines of modified Liberation CA-10B type were divided into three groups to form a special test fleet. Prior to being placed into normal operation, all of these test vehicles were uniformly maintained and inspected and had same quality of engine materials. Wear was measured at the upper stop point of cylinder sleeve for every 10,000 kilometers. Engines were taken apart at 80,000 kilometers to measure the wear of various friction pairs.

(2) Engines and Automobiles Used in the Evaluation Tests

1. Liberation CA-10B model or other modified engines, and the automobiles assembled from their parts
2. East Wind EQ-140 trucks
3. Beijing BJ-130 trucks

(3) Lubricants and Friction Reducer Used in the Tests

1. No.14 diesel motor oil (used in the East Wind EQ-140 vehicles)
2. No.10 gasoline motor oil (for other engines and vehicles)
3. Four types of PTFE-containing friction reducers; three of them are American products, the other is a Chinese product. Name, manufacturer, and symbol are shown in Table 1.

Table 1. Product List of Friction Reducers

Name	Manufacturer	Symbol
FJM	Plant 621, Petrochemical Co., China	FJM
Tufoil	Fluora mico Company, USA	TFL
Lubri	Lubri-Lon Company, USA	L-L
TMT	Spery OWN LTD Co., USA	TMT

The above-mentioned friction reducers were added to engine oil strictly in accordance with the proportion specifed in the products' information sheets. No friction reducer was added when motor oil was replaced or replenished. During its combined maintenance period, friction reducer was added for every 16,000-kilometer operation of the test automobiles from Beijing Public Transportation; while friction reducer was added for every 20,000 kilometers for the automobiles tested in Shanghai and Kanchang.

There was a delay phenomenon for the functioning of PTFE-containing friction reducers and no immediate effects could be seen after they were added to motor oil. As explained in the product information sheet, the effectiveness of these friction reducers will be realized when the car has been operated for about 1,000 kilometers. Therefore, in the engine platform test, the data used for comparsion were collected after the engine containing friction reducer in its motor oil had been operated for 35 hours (1,200 rpm). The comparative road tests to evaluate the effectiveness of friction reducers in motor oil were also conducted after the car had operated for about 1,000 kilometers.

3. Evaluation Index

(1) Rate Change of Friction Power in Hot-Engines (η_H)

This index is calculated using the following formula:

$$\eta_H = \frac{\sum_{i=1}^{n} \frac{(A_i - B_i)}{A_i}}{n} \times 100\%$$

where A_i and B_i are respectively the hot engines' friction powers (horsepower) measured at any specified test speed before and after friction reducers were added to motor oil while the engines operated more than 35 hours; n is the number of points specified in the test.

(2) Rate Change of Friction Power in Cold-Engines (η_C)

This index is calculated using the formula:

$$\eta_C = \frac{\sum_{i=1}^{n} \frac{(A_i - B_i)}{A_i}}{n} \times 100\%$$

where A_i and B_i are respectively the cold engines' friction powers (horsepower) measured at any specified test speed before and after friction reducers were added to motor oil while the engines operated more than 35 hours; n is the number of points specified in the test.

(3) Average Fuel-Saving Rate on Fuel Consumption of Standard Shift at Constrant Speed (n_E)

This index is calculated using the following formula:

$$\eta_E = \frac{\eta_{20} + \eta_{30} + \eta_{40} + \eta_{50} + \eta_{60}}{5}$$

where η_{20}, η_{30}, η_{40}, η_{50} and η_{60} respectively represent the fuel-saving ratios of motor oil with andwithoutfriction reducer for automobiles with operating speeds of 20 Km/h, 30 Km/h, 40 Km/h, 50 Km/h and 60 Km/h.

(4) Fuel-Saving Rate on Fuel Consumption per 100 Kilometers (η_{100})

This index is calculated using the following formula:

$$\eta_{100} = \frac{G_1 - G_2}{G_1} \times 100\%$$

where G_1 and G_2 are respectively the absolute quantities of fuel consumed in 100 miles by the test cars before and after friction reducer was added to the motor oil.

The overall evaluation of improved fuel consumption economy by friction reducers can be demonstrated graphically by fuel-saving bands.

4. Test Results and Discussion

(1) Engine Performance Tests

Results of engine performance tests indicated that friction reducers such as FJM, L-L and TMT had no obvious effects on fuel-saving based on external characterization tests. There were fuel-saving bands when friction reducers FJM and L-L were used in the load characterization test (see Figures 2 and 3).

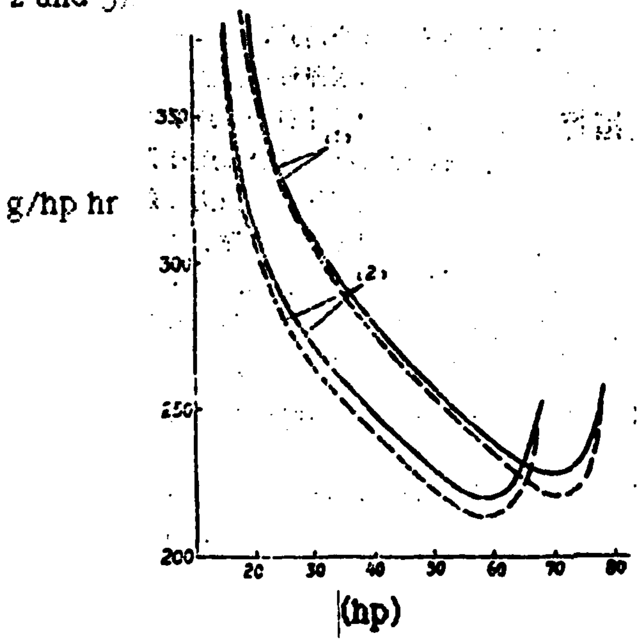


Figure 2. Load Characteristics of CA-10B Engines

— No. 10 gasoline motor oil .... No. 10 gasoline motor oil with FJM
(1) n= 2000 rpm. (2) n= 1600 rpm

(hp)

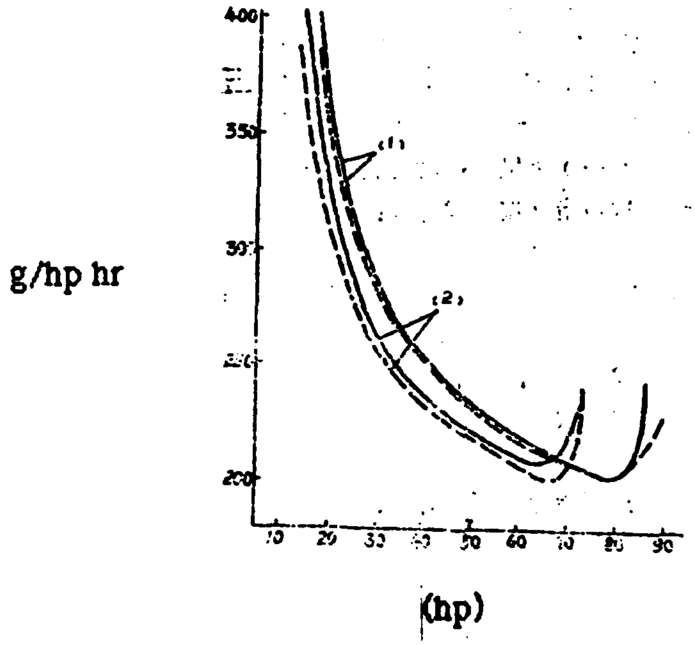


Figure 3. Load Characteristics of CA-10B Engines

— No. 10 gasoline motor oil .... No. 10 gasoline motor oil with L-L
(1) n= 2000 rpm, (2) n= 1600 rpm

(2) Engine Friction Power Test

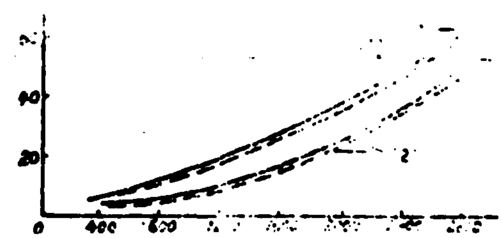
The results of cylinder-extinguishing tests indicated that friction reducers L-L and FJM respectively lowered the friction power on the engines of the Liberation CA-10B type by 1.7% and 6.8%. Table 2 and Figures 4 and 5 show the variation in friction power from hot and cold engines as measured by the electrical power-measurement device with the reverse-drag method before and after adding friction reducers into No.10 gasoline motor oil.

Table 2. Percent Variation in Engine Friction Power after Addition of Friction Reducers into No. 10 Gasoline Motor Oil.

Item	Friction Reducer	Rotating Speed (rpm) 400	800	1200	1600	2000	2400	2800	η_H or η_C
Hot Engine	FJM	0	2.4	13.3	12.3	9.1	6.9	3.4	6.4
	L-L	11.3	3.0	0.2	- 1.4	2.8	4.1	4.2	3.8
Cold Engine	FJM								8
	L-L	8.8	8.6	6.5	3.9	3.7	3.4	1.9	4.9

Using electrical power-measurement device with reverse-drag method on the Red Flag engines in May 1982, Long Spring No. 1 Automobile Manufacturing Plant measured the impact of FJM friction reducer on friction power under different motor oil temperature. Test results are shown in Figure 6.

Frictional Power (hp)



Rotating Speed (rpm)

Figure 4. Friction Loss Curve for the Liberation CA-10B Modified Engine

—— No. 10 gasoline motor oil .... No. 10 gasoline motor oil with L-L
(1) Cold Engine (2) Hot Engine

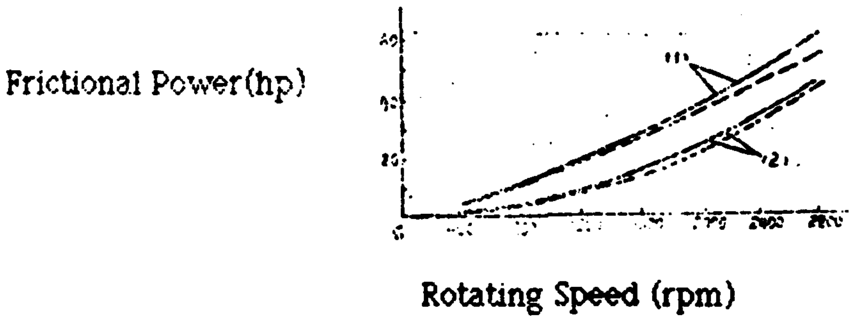


Figure 5. Friction Loss Curve for the Liberation CA-10B Modified Engine

— No. 10 gasoline motor oil .... No. 10 gasoline motor oil with FJM
(1) Cold Engine (2) Hot Engine

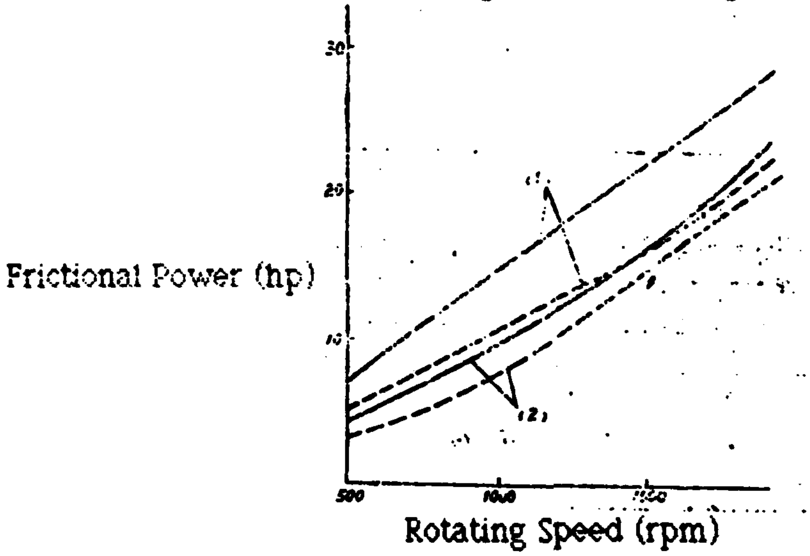


Figure 6 Friction Loss Curve for the Red Flag (92 x 85) Engine

—No. 10 Gasoline Motor Oil .... No. 10 Gasoline Motor Oil w/ FJM
(1) Oil temperature 17-20 °C (2) Oil temperature 38-40 °C

Based on the results of comparative tests on the friction power of engines, the anti-friction effect gained from the uses of PTFE-containing friction reducers is obvious. The effect varies with engine types and test conditions. Friction loss lowered by friction reducer FJM on the hot and cold engines averaged about 3% to 6% when the engines of the Liberation model were tested under specified rotating speed and motor oil temperature.

(3) Road Tests of Automobiles

<1> Results of fuel consumption tests for standard shift at constant speed are summarized in Table 3 and Figures 7 through 10.

Table 3. Test Results of Fuel Consumption for Standard Shift at Constant Speed

Vehicle Model & Friction Reducer	Fuel-Saving Rate (%) Liberation L-L	Liberation FJM		East Wind 140 FJM	Beijing 130 FJM	Liberation TFL	Liberation TMT
Speed (Km/h)							
20	0	2.78	3.7	3.49	5.3	1.90	6.2
30	2.73	4.78	3.9	3.60	4.6	3.50	2.0
40	5.79	3.40	5.8	4.0	5.1	5.0	3.5
50	6.25	3.60	2.9	3.98	4.4	5.4	1.4
60	4.18	2.94	---	3.62	4.0	---	2.6
70	---			---	4.8	---	---
[illegible]	3.79	3.65		3.70	4.70	3.90	3.14

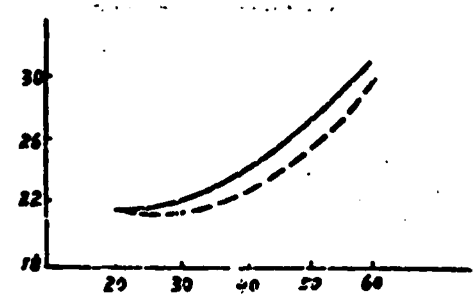


Figure 7. Fuel Consumption at Constant Speed for Trucks of Liberation CA-10B Type

— No.10 Gasoline Motor Oil .... No.10 Gasoline Motor Oil w/ Friction Reducer L-L

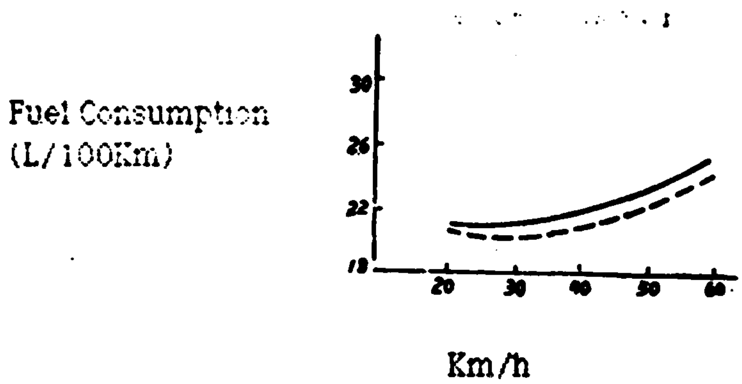


Figure 8. Fuel Consumption at Constant Speed for Trucks of East Wind EQ-140 Type

— No.14 Diesel Motor Oil .... No.14 Diesel Motor Oil w/ Friction Reducer FJM

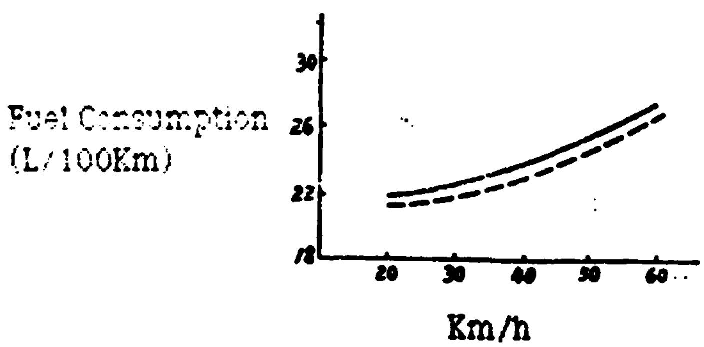


Figure 9. Fuel Consumption at Constant Speed for Long-Trip Passenger Buses of HB661 Type

— No.10 Gasoline Motor Oil .... No.10 Gasoline Motor Oil w/ Friction Reducer FJM

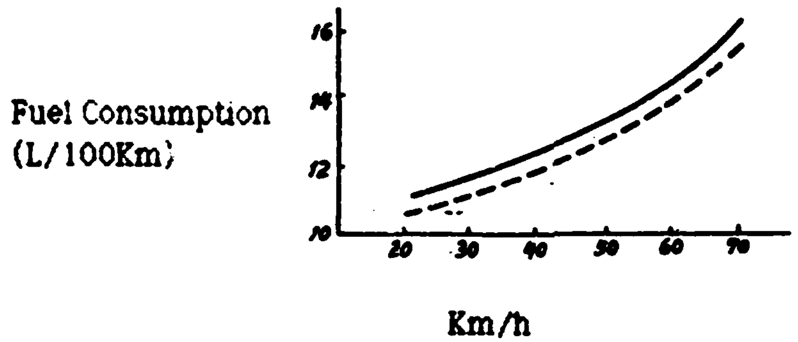


Figure 10. Fuel Consumption at Constant Speed for Vehicles of Beijing BJ-130 Type

— No.10 Gasoline Motor Oil .... No.10 Gasoline Motor Oil w/ Friction Reducer FJM

(3) The effectiveness of various friction reducers on fuel-saving, obtained from the tests on fuel consumption per one-hundred kilometers is summarized in Table 4. Results from vehicle road tests demonstrated that PTFE-type friction reducers could lower fuel consumption of vehicles. These friction reducers could increase the fuel economy of vehicles by 3% to 4%. Among them, friction reducer FJM resulted in average fuel-saving rate of 3.7% for every 100-kilometer use of three Chinese-manufactured vehicles of gasoline engines.

(4) Operation Test

Beijing, Shanghai, and Kangjang were the three test locations. The measured data for engine wear of tested automobiles and for oil sample analysis amounts to more than 25,000. Tables 5 through 8 and Figure 11 summarize the engine wear data of tested automobiles at these test locations.

Table 4. Fuel-Saving Rates by Friction Reducers Based on the 100-kilometer Fuel Consumption Tests

Automobile Model	Liberation	Liberation	East Wind 140	Beijing 130	Liberation	Liberation	Avg Fuel Saving Rate for 3 Models
Friction Reducer	L-L	FJM	FJM	FJM	TFL	TMT	FJM
Fuel-Saving Rate η_{100} (%)	1.66	4.40	3.14	3.60	4.80	0.02	3.7

Table 5. Cylinder Wear Tests on the Public Buses of the Modified Beijing CA-10B Engines

Type of Oil Tested	No. of Engines	Cast Iron Wear (um) per 10000 Km Horizontal	Cast Iron Wear (um) per 10000 Km Vertical	Type of Oil	No. of Engines	Cast Iron Wear (um) per 10000 Km Horizontal	Cast Iron Wear (um) per 10000 Km Vertical	No. of Engines	Boron Steel Wear (um) per 10000 Km Horizontal	Boron Steel Wear (um) per 10000 Km Vertical
No.10 Gasoline Motor Oil	16	10.2	7.2	No.10 Gasoline Motor Oil	16	10.2	7.2	6	5.3	3.5
No.10 Gasoline Motor Oil w/ FJM	13	5.8	4.3	No.10 Gasoline Motor Oil w/ TFL	6	4.6	5.9	4	2.5	2.1
Wear Reduced (um)		4.4	2.9	Wear Reduced (um)		5.6	1.3		2.8	1.4
Wear Reduction Rate (%)		43.1	40.3	Wear Reduction Rate (%)		54.9	18.1		52.8	40

The Beijing Public Transit Yard No 1 was the test location.

Table 6 Cylinder Wear in 40000 Kilometers for Test Vehicles w/ Friction Reducers FJM and TMT

Friction Reducer	No. of Vehicles	Max. Cylinder Wear Avg. (um)	Max. Cylinder Wear Decrease (%)	Max. Cylinder Dullness Avg. (um)	Max. Cylinder Dullness Decrease (%)
No. 14 Diesel Motor Oil	5	17.9	—	13.2	—
No. 14 Diesel Motor Oil w/ FJM	4	15.3	14.5	9.4	28.8
[illegible] Diesel Motor [illegible]	[illegible]	14.3	20.1	[illegible]	[illegible]

Table 7. The Comparison of Engine Cylinder Wear for Test Vehicles in Kangjang

Friction Reducer	Wear Reduction (%) FJM		Wear Reduction (%) L-L	
Measurement Location / Milage (in 10000 Km)	Upper Section	Middle Section	Upper Section	Middle Section
0 - 1	21.0	63	+5.7	31
0 - 2	1.1	19	+3.3	+7.7
0 - 3	3.6	40	0	—
0 - 5	4.7	37	+ 27	—

Table 8. Results of Wear on Engine Parts for 80000-Km Operation of Test Vehicles in Kangjang

Part Name / Friction Reducer	Relative Wear Reduction Rate (%) Ceompered to No.10 Gasoline: Diameter of Crank Axle Connecting Rod	Diameter of Main Crank Axle	Rotor Up-movement	Diameter of Main Rotor Axle	Weight of Valve Shaft	Weight of Connecting Rod Axle Tiles	Weight of Main Axle Tiles	Diameter of Valve Shaft
FJM	33	0	23	4.8	40	24	17.8	27
L-L	6.3	+[illegible]	+8.7	+43	+60	+12	2.2	+26

Friction reducers FJM and L-L were tested in Kangjang. Before test vehicles reaching a 50000-Km operation, friction reducer FJM had obvious anti-wear effect on the upper and middle sections of engine cylinders. When reaching 60000 to 80000 kilometers, the average wear in the upper cylinder section exceeded that of the vehicles using No.10 gasoline motor oil; however, the wear in the middle section was still lower. After the end of 80000-kilometer test, engines were taken apart and inspected. The measurements for the rest of friction pairs indicated that the friction reducer FJM had significant anti-wear effect. However, the friction reducer L-L did not reveal any anti-wear effect.

Because no maintenance work was done to replace the piston ring, etc. after 40000-kilometer operation of Kanjang test vehicles, the piston ring was in the abnormal working condition after the test vehicles had been operated for 80000 kilometers. Analyses of waste-oil samples indicated a decrease in viscosity. Inspection after an 80000-kilometer operation [illegible] found that [illegible]

Based on the parts wear data measured from long-term operation tests at 3 test locations, it was found that four PTFE-type friction reducers except for the imported L-L, had obvious anti-friction effects. Tests conducted in Beijing Public Transit Yard No. 1 indicated that friction reducers FJM and Tufoil lowered the cylinder wear by 40% and 18%, respectively. Friction reducers FJM and TMT from the tests in Shanghai Transportation Yard No. 4 lowered the cylinder wear by 14% to 41%. Based on the test results at Kangjang Transportation Company, the FJM friction reducer lowered the wear on cylinder diameter by about 10% and lowered the wear on the other friction pairs in engines by about 20%. The test results at the Kanjang test location are shown in Figure 11.

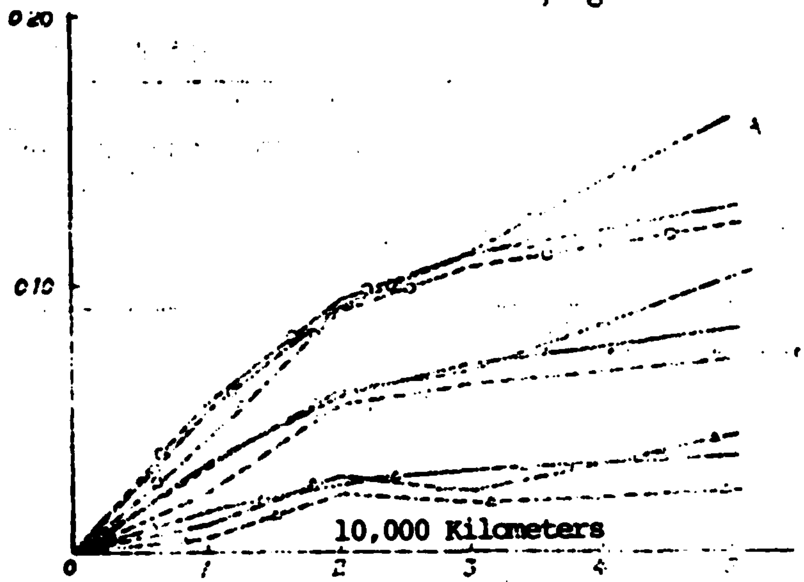


Figure 11 Cylinder Wear Curves for Test Vehicles with 50000-Kilometer Operation at Kangjang

—— Combined Average Wear for No. 10 Gasoline Motor Oil
...... Combined Average Wear for No. 10 Gasoline Motor Oil Containing FJM
------ Combined Average Wear for No. 10 Gasoline Motor Oil Containing L-L
o Upper Stop Point ▲ Middle Section

(5) Results of Automobile Exhaust Tests and Cylinder Pressure Tests

According to product information sheet of foreign-made friction reducers, use of these PTFE-containing friction reducers can lower CO and HC contents of the automobile exhaust, and can lower its noise level as well. Based on our test results, we found that adding FJM friction reducer to No.10 gasoline engine oil slightly lowered the CO and HC contents of the automobile exhaust, but [illegible] no changes in the noise level. The measured concentrations of CO [illegible] and its noise levels were all within the Chinese National [illegible] are shown in the Tables 9 and 10.

There was a general increase in cylinder pressure for those engines utilizing friction reducers. The measured data on the cylinder pressure at various test stations are shown in Table 11.

Table 9. Analysis of Automobile Exhaust

Item / Friction Reducer	Engine Rotating Speed (rpm)	CO (%)	HC (ppm)
No.10 Gasoline Engine Oil	400	3.4	2200
No.10 Gasoline Engine Oil + FJM Friction Reducer	400	1.3	2600

Table 10 Noise Test of Automobiles

Friction Reducer	No.10 Gasoline Motor Oil		No.10 Gasoline Motor Oil w/ FJM	
Location / Item	Left Side	Right Side	Left Side	Right Side
Avg. Noise Level (dB) during Acceleration	82.3	83	82.6	83.1
Avg. Noise Level (dB) at Constant Speed	78.8	78.6	78.2	78

Table 11. Summary of Engine Cylinder Pressure Tests

Test Location	Item	Number of Cylinders 1	2	3	4	5	6	Avg. Value (%)
Beijing Public Transit Co., Station No. 1	w/o Friction Reducer	7.03	7.1	7.31	6.19	6.4	7.17	
	w/ FJM Friction Reducer	7.42	7.1	7.35	6.96	7.03	7.45	
	% Increase	5.5	0	0.48	12.5	9.89	3.92	5.38
Shanghai Automobile Transportation Research Inst.	w/o Friction Reducer	7.8	8	8.1	8.3	8	8.2	
	w/ FJM Friction Reducer	10.1	10.1	10.3	10.4	10.1	10.4	
	% Increase	29.5	26.3	27.2	25.3	26.3	26.8	26.9
[illegible]	[illegible]	6.679	6.398	[illegible]	6.75	5.626	6.679	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

According to the tests conducted jointly by No. 1 Plant, Beijing Public Transportation Company and Highway Sciences Research Institute, Ministry of Communications, engine pressure was measured for the engine operating for a half hour after the friction reducer was added to engine oil. The Shanghai Tranportation Research Institute measured the engine pressure after the motor oil with friction reducer was used for 1000 kilometers. It can be seen from the data (see Table 11) that the effectiveness of friction reducers on improving motor-oil sealing increased significantly after the gasoline engines had run 1000 kilometers.

5. Conclusion

1. When applied to the Chinese-made automobiles of Liberation model, the imported PTFE could improve lubrication, decrease friction loss, and save fuel about 3%. The effectiveness of Tufoil and TMT on anti-friction was very obvious. The friction on cylinder sleeve decreased 18% and 20%, but the additive such as L-L increased the wear.

2. The Chinese-made FJM friction reducer lowered engine friction when applied to gasoline engines of Chinese-made automobiles such as the East Wind EQ-140 type, modified type of the Liberation CA-10B and Beijing 130 type. The average fuel consumption rate for these three models of automobile at constant speed decreased by 4%, the fuel consumption during 100-km operation decreased about 3%, and the wear of engine cylinder decreased by 10% to 40%.

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