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TESTING THE EFFECT OF XADO ADDITIVE ON THE PETROL ENGINE PERFORMANCE

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INTRODUCTION

This Report presents the results of testing the effect of XADO additive on the performance of a petrol engine installed in an automobile running under normal operating conditions. Tests were conducted by request of the firm "UKR-KAL"-commerce, Pokhorskog batal'on 7a, Belgrade, which supplied the additive (further referred to as "customer"). The effect of the XADO additive was determined by comparing the automobile performance prior to and after the XADO additive had been applied. By recommendation of the Customer, the automobile was to be driven under normal conditions up to 3,000 km after the additive had been applied. The automobile was tested in the experimental laboratory of the Automobile Motor Works "May 21", Belgrade, prior to and after the additive was applied. The automobile with a sealed hood was driven between these test measurements over a route selected by the Customer. Besides, after the first test, the Customer primed the necessary amount of XADO additive to the engine. By manufacturer's statement, applying the cermet-based additive reduces engine parts' wear and reconditions them to improve engine performance. One can find a description of the XADO additive effects declared by the manufacturer at the web site (www.xado.com).

For an all-round observation of the effect, the tests were planned to be conducted on several automobiles with a big mileage. The Customer selected the automobiles. Due to limited possibilities of automobile selection, the following ones were selected for testing: one automobile YUGO Skala, registration No. BG*244-828 with the engine DMB 1300 ccm (engine No. 8069211) with the kilometrage of 110,791 km (which was presumably at its ultimate wear limit), and one automobile LADA Niva, reg. No. KG*582-03, with a 1600 ccm engine and kilometrage of 12,336 km (after major overhaul). The scope of tests included the following: determining the effect of the XADO additive on the operating, power and environmental parameters of the engine, viz. tightness of the working volume, engine power boosting, reduction of engine fuel consumption and of toxic emission in the engine exhaust.

Specific tests were conducted on 26.11.2002 through 22.12.2002. The participants of the tests were the following persons: Prof., Dr. Stojan Petrovich, MFB, as the test Supervisor; Prof., Dr. Mirolub Tomic, MFB; Dipl. Eng. Aca Chupurdia, DMB; Dipl. Eng. Shume Uremovic, DMB; and Dipl. Eng. Petar Kolendic, MFB.

METHODOLOGY OF TESTING

The test program conducted on the two aforementioned automobiles consisted of the three following phases:

I. Phase 1 – determining the current condition of the automobile to be tested after all the regulation parameters were adjusted and new oil was filled into the engine. The tests were to determine the following parameters:

- the compression pressure in the engine cylinders. Measurements were carried out at warmed up engine at a fully open throttle;
- the lubrication oil pressure in the main oil line at different engine revolutions;
- the pressure in the cylinder block at a normally connected engine bypass channel;
- maximum engine power at full load (fully open throttle) at engine revolutions corresponding to the speed of 60 km/h (approximate number of engine revolutions n = 3,200 rpm), and to 90 km/h in 3rd gear (approximate number of engine revolutions n = 4,800 rpm);

- the no-load fuel consumption;
- fuel consumption for the so-called urban driving test, i.e. to ECE 84 Regulations;
- fuel consumption at constant automobile speed at direct drive transmission;
- automobile exhaust to ECE 83 Regulations, i.e. test which imitates urban or suburban driving.

All measurements as per the above program were made on the automobile YUGO Skala, whereas, by request of the Customer, the automobile LADA Niva was not tested for exhaust emission to ECE 83 Regulations and for fuel consumption during the urban driving test to ECE 84 Regulations. In addition, the engine power could not be measured because of its 4-wheel drive transmission.

II. Phase 2 was driving the automobile under normal conditions in a city and on a highway to run-in the engine and achieve an overall effect of applying the additive. By recommendation of the additive's manufacturer, this period was equivalent to driving over 3,000 km. Prior to this phase, the additive was applied to the engine as per manufacturer's procedures, and the car hood was sealed to prevent unauthorized readjustment of the engine.

During this phase, automobile YUGO Skala covered the entire 3,000-km route, whereas, by agreement with the Customer, the kilometrage of automobile LADA Niva was shorter to be 2,528 km. During these tests, there were no engine failures and intervention to it.

III. Phase 3 included all repeated measurements as per the Phase 1 program. Prior to testing, all the engines' regulation parameters were checked and adjusted, and brought to the values of those in Phase 1 (standard ignition angle, revolutions and fuel mixture composition, i.e. no-load CO_2 emission). Besides, 2 liters of oil was primed to the YUGO engine, whereas the LADA engine required no oil priming. After this, the automobiles were tested.

The automobiles were tested on Schenk dynamometer rollers with inertial masses corresponding to the automobiles' reference masses. Fuel consumption was measured by the weight method using standard commercial leaded petrol Super 98. The exhaust emission was measured with gas analyzers Beckman to procedures and methodology of ECE 83 Regulations. All measurements were repeated several times, the mean value being taken as the valid one.

ENGINES' TEST RESULTS

According to the Report of the Experimental Laboratory DMB-FAM, the comparative results of measuring definite engine characteristics prior to and after the XADO additive had been applied to the automobile engine, as well as their percentage change, are shown in Figs. 1 to 9 in the end of the Report.

a) *Compression pressure in engine cylinders*

Fig. 1 shows the compression measurement results, i.e. the compression pressure of automobile YUGO Skala. Prior to applying the additive, the pressure in cylinder No. 3 was low. With account of the automobile kilometrage, in the remaining cylinders the pressure was satisfactory. After applying the additive and driving for 3,000 km, the pressure increased in all cylinders within 2 to 7 %. The greatest increase was observed in the third cylinder.

A still greater compression pressure increase was observed in the LADA Niva engine, Fig. 2. Here the compression pressure increased by more than 10 %. The greatest increase was observed in the cylinders in which compression was lowest prior to applying the additive.

Though the causes of compression pressure change may be different, it is very likely that this was facilitated by the XADO additive's reconditioning of the piston-cylinder system. To prove this, it would be necessary in the next cycle of tests to determine the baseline condition of the piston-cylinder system, and compare it with its condition after the additive had been applied. A lesser compression pressure increase in the YUGO Skala automobile can be accounted for by decreasing additive mass in the engine due to excessive oil loss.

b) ***Oil pressure in the main oil line***

Figs. 3 and 4 show the measured lubrication oil pressure change in the main oil line. Evidently, the difference in the lubrication oil pressure is within the measurement accuracy limits. Therefore, one can conclude that there are no special changes in the lubrication conditions.

c) ***Pressure in engine cylinder block***

The pressure in the engine cylinder block depends, basically, on the quality of tightness of the piston-cylinder system. Since in modern automobiles the cylinder block is ventilated through the intake system, according to regulations (in effect for a new engine), it is necessary to provide in the cylinder block at least minimal rarefaction. This is done to prevent escape of toxic bypass gases from the cylinder block to the atmosphere, namely, discharging these gases through the intake system to the operating space for afterburning. However, due to wear of the piston-cylinder system and loss of tightness in the working space, old engines may exhibit a pressure increase in the cylinder block. Therefore, it is of no surprise that, in both engines, this pressure was positive prior to applying the additive. Especially high pressure was observed in the YUGO Skala engine, whose compression was also worse.

Fig. 5 shows the pressure change in the cylinder block after the XADO additive was applied. Both engines demonstrate a pressure drop in the cylinder block, and the LADA Niva engine demonstrated even depression. This is in full accord with the previous assumption that applying the additive improves the tightness of the piston-cylinder system.

d) ***Engine power***

The engines' power was tested with the automobile being placed on dynamometer rollers. Hence, by measuring the power on the wheels, the engine power could be estimated. The maximum power, at a certain operating regime, was achieved by loading the engine to full capacity, i.e. to full opening of the throttle. The operating regime selected corresponded to the number of engine revolutions equivalent to the automobiles' speed of 60 and 90 km/hr in 3rd gear. This corresponds to about 3,200 and 4,800 rpm.

The results of measuring power at these two numbers of revolution are shown in Fig. 6. It is evident that, in both regimes, engine power increase was observed to be 6.5, i.e. 9.5 %. One of the possible causes of this can be better tightness of the working space. But, for correct conclusions on the additive effect on the power developed to be drawn, it is necessary nevertheless to measure the engine power as to the ECE 895 Regulations, i.e. as per standard engine testing conditions on a test stand with comparative measurements being made prior to and after the XADO additive had been applied.

e) ***Fuel consumption***

Fig. 7 shows the results of measuring fuel consumed by the automobile YUGO Skala under different test conditions. The greatest change was observed at no-load conditions (about 24 %). Though the absolute differences are small in this case (about 0.3 l/hr), which may be accounted for by the influence of different no-load adjustment factors, the percent decrease is nevertheless significant. Though this consumption decrease can be a consequence of decreasing mechanical losses due to the XADO additive application effect, nevertheless it remains unclear why then did fuel consumption increase at steady regimes (even up to 10 %). At the same time, in contrast to a significant increase in consumption at steady regimes, the consumption during the city-driving test decreased by about 10 %. The may be accounted for by the engine operating during the city driving test at low operating regimes with a considerable part claimed by the no-load regime. However, there could also be a certain spread of measurement results due to carburetor deregulation. Evidently, to obtain more reliable results, it is necessary to repeat measurements a greater number of times under the same test conditions.

Fig. 8 shows the results of fuel consumption by the automobile LADA Niva at steady operating regimes. As opposed to the previous case, this automobile demonstrates a decrease of fuel consumption at steady regimes. A maximum decrease (about 10 %) was measured at high-speed regimes.

With account of the results of measuring the fuel consumption on these two automobiles, it is impossible to draw a general conclusion on the XADO additive effect on fuel consumption decreasing, though it may be stated that a real possibility of such decreasing exists.

f) *Automobile exhaust emission*

As mentioned earlier, exhaust emission was measured only on automobile YUGO Skala to ECE 83.04 Regulations, i.e. to a cycle imitating urban and suburban driving. The results of measuring emission of toxic components: carbon oxide CO, non-combusted hydrocarbons HC, nitrogen oxides NOx as well as carbon dioxide CO_2 are shown in Fig. 9. As expected, emission levels were very high because the car was an old one, which was selected after prolonged service, so that the level of emission exceeded admissible limits by several times. However, since comparative tests were conducted here, this level has no significant effect.

It is worth noting that the level of toxic components emission (as per ECE 83 Regulations, for this type of automobile, CO and HC+NOx emission is controlled) dropped from 5 to 10 % after the additive was applied. This, probably, cannot be accounted for by the additive's effect, but rather by a slight deregulation of the mixture composition after running for 3,000 km. Slight mixture leaning is also proven by the fact that, with a decrease in CO and HC emission, the NOx and CO_2 emission has increased.

Since the current opinion is that CO_2 emission reflects fuel consumption, an erroneous conclusion may be drawn that the test has determined an increase in average fuel consumption due to an increase in CO_2 emission. However, this rule does not hold here because CO and HC emission is high. Therefore, if we estimate the average fuel consumption by exhaust emission based on "carbon balance" (by the formulas in ECE 101 Regulations, which cover this subject), an approximately equal fuel consumption of about 15 liters /100 km will be obtained in both cases.

CONCLUSIONS

Based on the experimental tests conducted and comparative measurements of automobiles' performance after driving over 2,500 and 3,000 prior to and after XADO additive had been applied, the following general conclusions can be drawn with respect to the effect of applying additive XADO to the engine:

1. Engine compression, i.e. compression pressure increases in all cylinders.
2. Pressure in the cylinder block drops, pointing (together with item 1) to the possible better tightness of the working space,
3. Oil pressure in the main oil line remains the same.
4. Engine power tends to increase (which can be accounted for by items 1 and 2), but for examining the additive effect more accurately, the engines should undergo standard tests on a test bench.
5. Fuel consumption tends to increase under no-load conditions, though more accurate examining of this effect over the entire engine operating range requires measuring fuel consumption on a test bench prior to and after the additive has been applied.
6. There are no appreciable changes in the exhaust emission level (decrease in CO and HC emission, and increase in NOx and CO_2 emission).

Evidently, the changes noted depend significantly on an engine's condition, and therefore, they relate only to the engines being tested. To draw more general conclusions, it is necessary to conduct more detailed statistical tests by repeated testing on a greater number of engines with a certain condition of engine parts prior to and after applying the XADO additive. This is to be done to eliminate the effect of change in engines' performance due to other influences that may appear during testing. As was earlier stated, it is important to check the additive effect on the power and fuel consumption by standard testing of engines on a test bench prior to and after applying the XADO additive.

Рис. 1

Обратите внимание, компрессия это тоже, что и давление

Компрессия в цилиндрах двигателя	Pressure in cylinders of the engine
Компрессия	Pressure
Эффективность	Effectiveness
Цилиндр	cylinder

Рис. 3

Давление масла в центральной магистрали	Oil pressure in the main oil line
Давление	Pressure
Без ХАДО	Not using XADO
С ХАДО	Using XADO
После применения ХАДО	After using XADO
Обороты в минуту	RPM

Рис. 5

Обратите внимание! В русском варианте названия рисунка применяется термин остов двигателя, который мы переводили как блок цилиндров, а перевод с словенского картер двигателя. Если где-то ошибка надо это исправить

Давление в картере двигателя	Pressure in crankcase
Давление	Pressure

Рис.6

Мощность двигателя	Power of the engine
Мощность	Power
Повышение, увеличение, эффективность	Increase
Эффективность	Effectiveness

Рис.7

Расход топлива	Fuel consumption
Холостой ход	Idling
Городской цикл	Urban cycle

Рис. 9

Эмиссия двигателя (токсичность)	Emission of engine
Эмиссия	Emission