

## Testing Facility “Universalneftekhim” of VTil Ltd.

Accreditation certificate granted by the National Accreditation Agency of Ukraine

№ 2T 495, valid until August, 29, 2018 in accordance with the requirements of DSTU ISO/IEC 17025:2006 (ISO/IEC 17025:2006)

Approved by:

Director of the Testing Facility “Universalneftekhim”

\_\_\_\_\_ P.V. Karnozhitsky

16 December 2013

## Confirmation of efficiency

**Product:** Multifunctional additive to oil “1 Stage Maximum Atomic Metal Conditioner”, package 225.0 ml (hereinafter XADO Maximum 1 Stage)

**Manufacturer:** XADO-Technology Ltd., 23 Avgusta Lane 4, 61103 Kharkov, Ukraine

**Field of application:** four-stroke diesel and gasoline engines of vehicles with the run of more than 20,000 km and the oil system capacity of up to 5.0 L

Kharkov 2013

- Content of the test run:**
1. Research of the efficiency of XADO Maximum 1 Stage atomic metal conditioner during application in gasoline and diesel engines of cars relative to the following parameters: exhaust toxicity, fuel consumption, compression volume in cylinders, noise and vibration level, oil pressure.
  2. Analysis: restorative properties of XADO Maximum 1 Stage on friction parts of engine, change in motor oil lubricity, metal content of oil.

## **1. Description**

The test subject was determination whether use of XADO Maximum 1 Stage leads to change in geometry of friction parts of the engine, exhaust toxicity, fuel consumption, engine capacity, noise and vibration level, oil pressure, oil lubricity.

## **2. Performed tests**

1. Compression measurement with the help of recording equipment (ZECA 362, ZECA 363, Motometer) according to the application instructions.
2. Restorative properties of the product and stability of the size of parts were determined by direct measurements during micrometering of the engine parts according to GOST 14846-81.
3. Pressure measurement in the oil lubrication system of the engine.
4. Measurement of exhaust toxicity in a gasoline engine (CO and CH) according to DSTU 4277-2004, as well as in a diesel engine (smoke) according to DSTU 4276-2004.
5. Measurement of fuel consumption according to GOST 20306-90.
6. Analysis of the noise and vibration level of the engine according to GOST P 53838-2010, GOST ISO 10816-1-97.
7. Determination of metal content in the oil according to GOST 27860-88.
8. Analysis of tribological properties of a motor oil according to GOST 9490-75.

The test was held during the period from October, 2010 till August, 2013.

The following test vehicles were used:

### **Analysis according to § 1**

VAZ-21099 (YOM 2004, 1.5 L, gasoline, 246,456 km of run),  
Karsan - Peugeot J 9 (YOM 2003, 2.3 L, diesel, 293,007 km of run);  
Daewoo Lanos (YOM 2006, 1.5 L, gasoline, 203,355 km of run),  
Toyota Hi-Ace (YOM 2001, 2.4 L, diesel, 585,831 km of run);

### **Analysis according to § 2**

Daewoo Lanos (YOM 2006, 1.5 L, gasoline, 203,355 km of run)

### **Analysis according to § 3**

Toyota Hi-Ace (YOM 2001, 2.4 L, diesel, 585,831 km of run)

### **Analysis according to § 4**

VAZ-21099 (YOM 2004, 1.5 L, gasoline, 246,456 km of run),

Karsan - Peugeot J 9 (YOM 2003, 2.3 L, diesel, 293,007 km of run);

### **Analysis according to § 5**

Dacia Logan (YOM 2008, 1.4 L, gasoline, 208,630 km of run)

### **Analysis according to § 6**

Toyota RAV 4 (YOM 2003, 1.8 L, gasoline, 123,690 km of run),

### **Analysis according to § 7**

Chevrolet Aveo (YOM 2005, 1.5 L, gasoline, 117,000 km of run)

VW Caddy 1,9 TDI (YOM 2005, 1.9 L, diesel, 241,000 km of run);

### **Analysis according to § 8**

Chevrolet Lacetti (YOM 2007, 1.8 L, gasoline, 174,200 km of run),

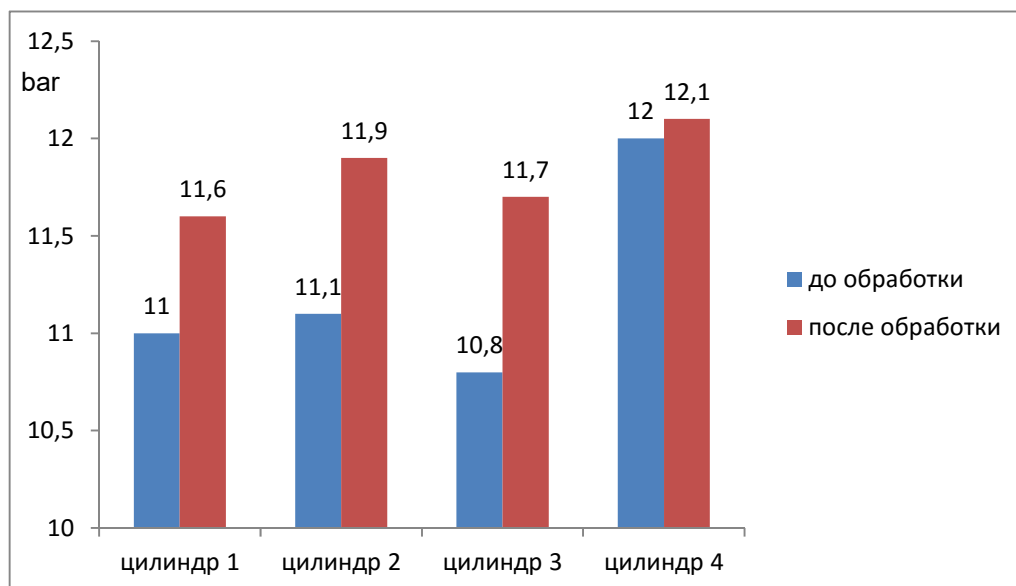
Volga GAZ 31105 (YOM 2005, 2.4 L, gasoline, 57,653 km of run).

## **3. Results**

The series of conducted tests presents measuring and recording of current values on chosen vehicles before and after the application of XADO Maximum 1 Stage.

### **3.1 Compression**

Application of the product increases and equalizes the compression in the engine cylinders (fig. 1—4). During the initial measurement before the application of XADO Maximum 1 Stage uneven compression pressure in the cylinders was observed. On average fluctuations between the cylinders was up to 2.7 bar for gasoline engines and 3.5 bar for diesel engines. After application of the product the variations between the compression pressure values decreased. Fluctuations of the compression pressure in the cylinders were on average not more than 0.5 bar.



До обработки – Before the application  
 После обработки – After the application  
 Цилиндр 1, 2, 3, 4 – Cylinder 1, 2, 3, 4

Fig. 1 Average compression values in the cylinders of the VAZ-21099 engine before and after application of XADO Maximum 1 Stage.

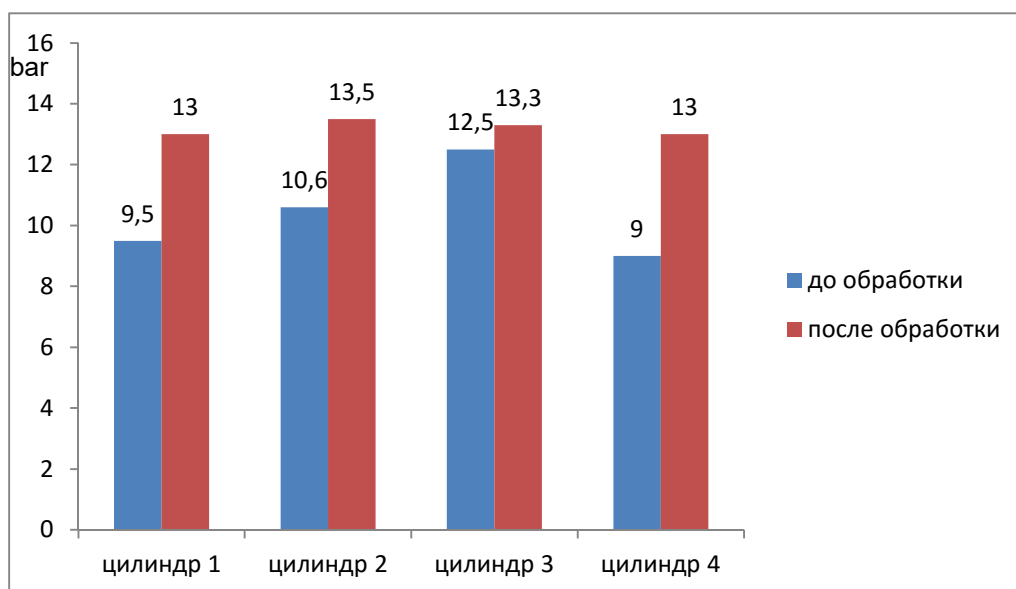
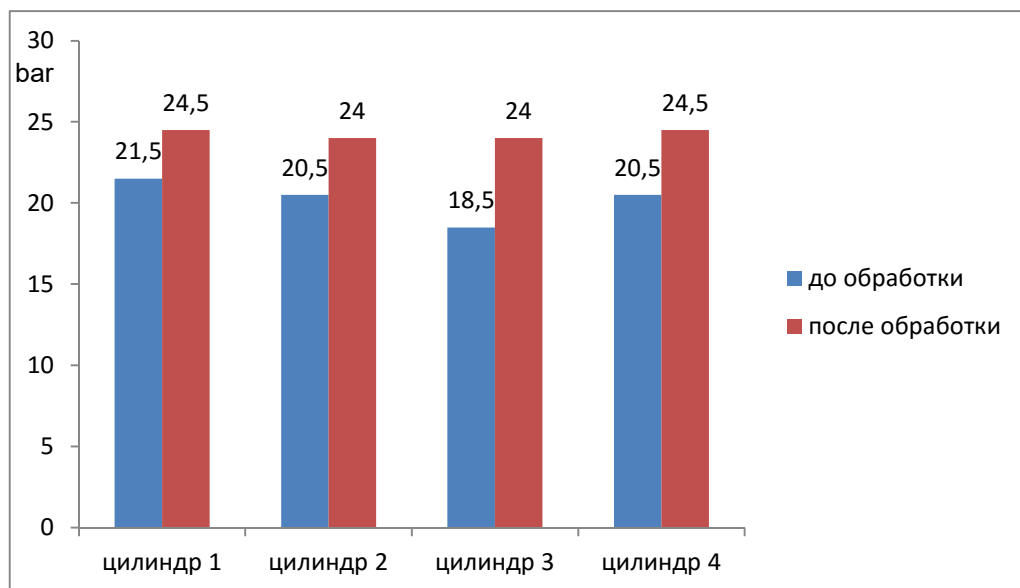


Fig. 2 Average compression values in the cylinders of the Daewoo Lanos engine before and after application of XADO Maximum 1 Stage.

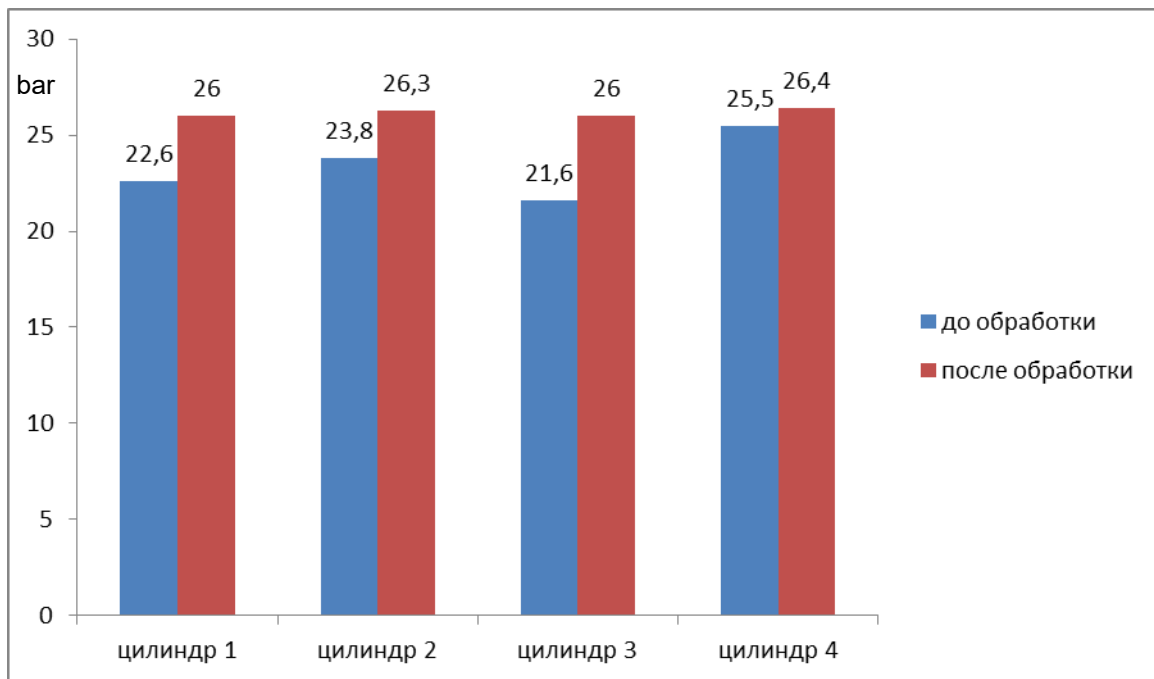
До обработки – Before the application

После обработки – After the application  
Цилиндр 1, 2, 3, 4 – Cylinder 1, 2, 3, 4



До обработки – Before the application  
После обработки – After the application  
Цилиндр 1, 2, 3, 4 – Cylinder 1, 2, 3, 4

Fig. 3 C Average compression values in the cylinders of the Karsan - Peugeot J 9 engine before and after application of XADO Maximum 1 Stage.



До обработки – Before the application

После обработки – After the application

Цилиндр 1, 2, 3, 4 – Cylinder 1, 2, 3, 4

Fig. 4 Average compression values in the cylinders of the Toyota Hi-Ace engine before and after application of XADO Maximum 1 Stage.

## Restorative and protective properties

Application of XADO Maximum 1 Stage had a positive impact on the geometry of working surfaces of the parts of cylinder-piston and crank group of the engine.

The results of measuring geometrical size of diameters of working surfaces of cylinders and crankpins of the engine crankshaft are presented in tables 1, 2 and 3.

Table 1 Measurements of the cylinder diameters at height of 20 mm

	Diameter of operating part of the cylinder, mm.							
	I cylinder		II cylinder		III cylinder		IV cylinder	
	Axis A	Axis B	Axis A	Axis B	Axis A	Axis B	Axis A	Axis B
Before application and run of 203,591 km	76.59	76.62	76.57	76.6	76.53	76.58	76.61	76.63
After application and run of 205,905 km	76.52	76.55	76.51	76.51	76.52	76.52	76.52	76.53
After application and run of 314,257 km	76.53	76.55	76.52	76.53	76.52	76.53	76.53	76.54

Table 2 Measurements of the cylinder diameters at height of 50 mm

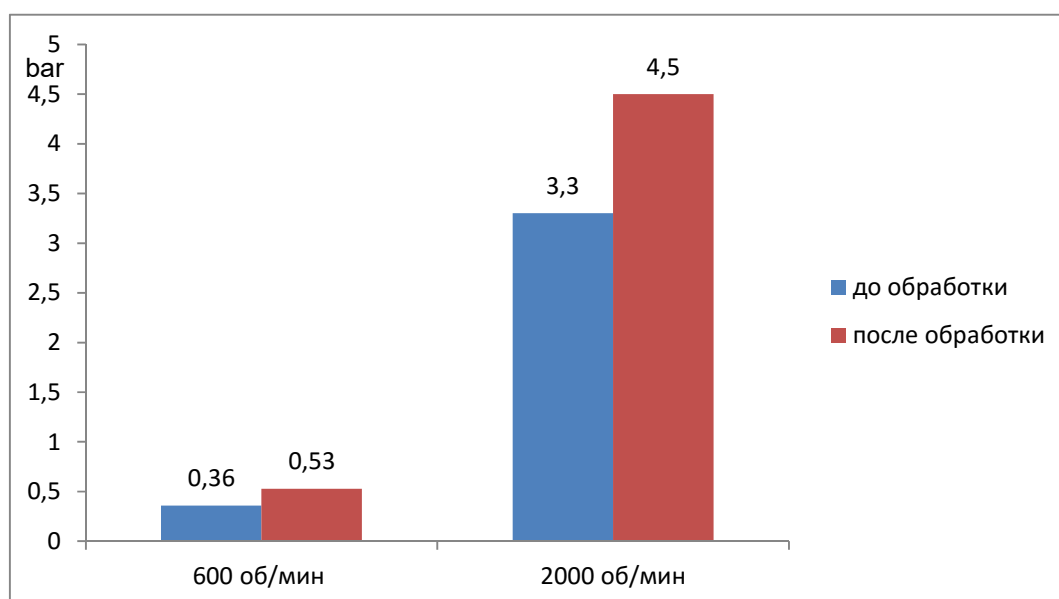
	Diameter of operating part of the cylinder, mm.							
	I cylinder		II cylinder		III cylinder		IV cylinder	
	Axis A	Axis B	Axis A	Axis B	Axis A	Axis B	Axis A	Axis B
Before application and run of 203,591 km	76.53	76.59	76.52	76.56	76.55	76.53	76.54	76.56
After application and run of 205,905 km	76.5	76.53	76.51	76.51	76.51	76.52	76.51	76.53
After application and run of 314,257 km	76.5	76.52	76.51	76.5	76.5	76.51	76.51	76.52

Table 3 Measurements of the diameter of crankpins of the engine crankshaft

Diameter of crankpins of the engine crankshaft, mm.		Before application and run of 203,591 km.	After application and run of 205,905 km	After application and run of 314,257 km
Crankpin I cylinder	Axis C	42.935	42.967	42.965
	Axis D	42.915	42.960	42.958
Crankpin II cylinder	Axis C	42.943	42.974	42.970
	Axis D	42.922	42.970	42.967
Crankpin III cylinder	Axis C	42.939	42.968	42.965
	Axis D	42.928	42.973	42.970
Crankpin III cylinder	Axis C	42.936	42.973	42.970
	Axis D	42.933	42.972	42.969

### 3.2 Pressure in the lubricating system

After application of XADO Maximum 1 Stage the pressure in the engine lubricating system increased by 0.17 bar at idle and by 1.2 bar at 2000 r/min (Fig. 5).



До обработки – Before the application

После обработки – After the application

600 rpm

2000 rpm

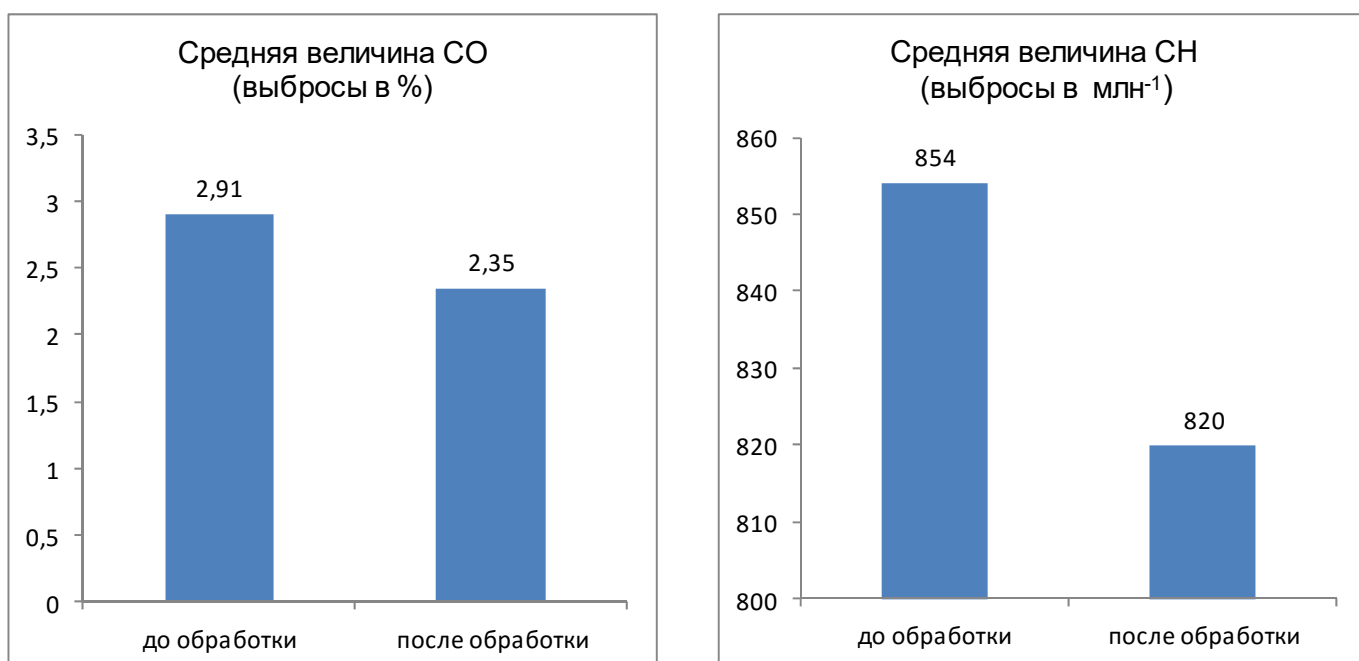


Fig. 5 Pressure in the engine lubricating system of Toyota Hi-Ace car before and after application of XADO Maximum 1 Stage.

### Exhaust toxicity

Application of XADO Maximum 1 Stage resulted in positive changes as to carbon monoxide and hydrocarbon emissions for a VAZ-21099 gasoline engine (Fig. 6), and smoke for a diesel engine.

For VAZ-21099 the average value of carbon monoxide emission decreased by 18.97%, the average value of hydrocarbon emission decreased by 9.6%, from 854  $\text{mln}^{-1}$  to 820  $\text{mln}^{-1}$ , respectively.



Average CO values (emissions in %)  
До обработки – Before the application  
После обработки – After the application

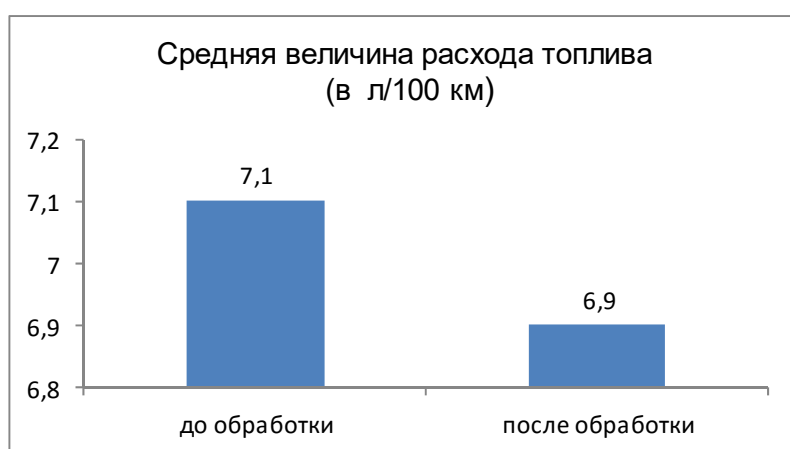
Average CH values (emissions in  $\text{mln}^{-1}$ )  
До обработки – Before the application  
После обработки – After the application

Fig. 6 Comparison of average toxicity values before and after application of XADO Maximum 1 Stage for the gasoline engine of a VAZ-21099

Change of the average value of natural absorption of light from  $2.74 \text{ m}^{-1}$  to  $2.38 \text{ m}^{-1}$  for the diesel engine of a Karsan – Peugeot J 9 corresponds to decrease in smoke by 15.7%.

### 3.3 Fuel consumption

As a result of application of XADO Maximum 1 Stage, decrease of fuel consumption was recorded through comparative analysis (Fig. 7). Change of the average value from 7.1 L/100 km to 6.9 L/100 km corresponds to decrease in fuel consumption by 2.8%.



Average fuel consumption (in l/100 km)

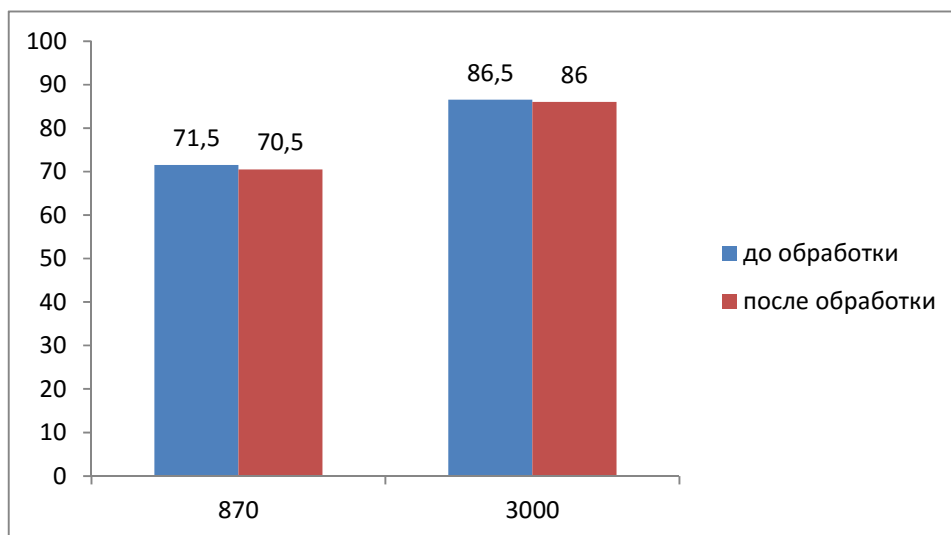
До обработки – Before the application

После обработки – After the application

Fig. 7 Comparison of average values of fuel consumption for a Dacia Logan car before and after application of XADO Maximum 1 Stage.

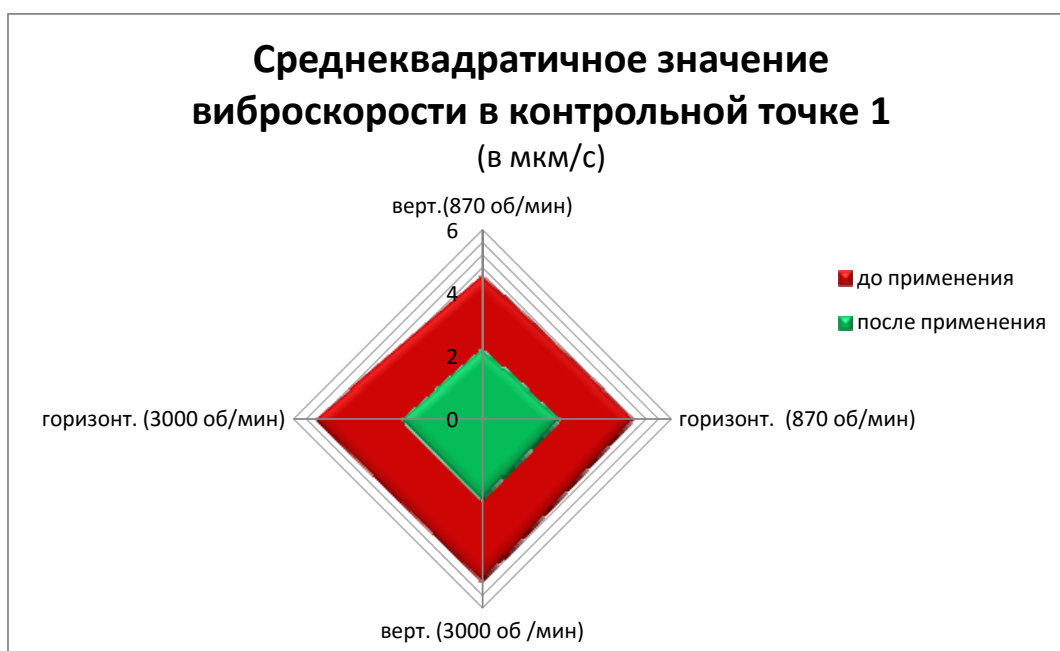
### 3.6 Noise and vibration level of the engine

The engine noise level remained virtually the same after application of XADO Maximum 1 Stage during the whole test period (changes in noise level were observed within the margin of error) (Fig. 8), mean-square values of vibration velocity at reference points of the engine decreased on average by 45%. (Fig. 9 and 10)



До обработки – Before the application  
 После обработки – After the application

Fig. 8 Noise level (dBa) of the engine of a Toyota RAV4 car before and after application of XADO Maximum 1 Stage.



Среднеквадратичное значение виброскорости в контрольной точке 1 (в мкм/с) - Mean-square value of vibration velocity at the reference point 1 (mkm/s)

Vertical (870 rpm)

Vertical (3000 rpm)

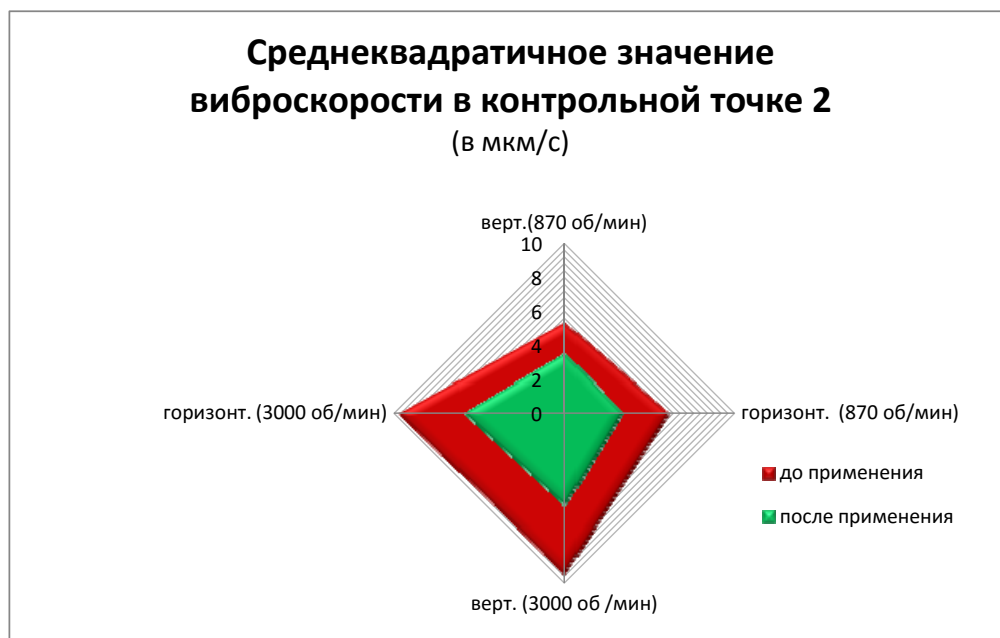
Horizontal (3000 rpm)

Horizontal (870 rpm)

До обработки – Before the application

После обработки – After the application

Fig. 9 Mean-square value of vibration velocity at the reference point 1 of the engine of a Toyota RAV4 car.



Среднеквадратичное значение виброскорости в контрольной точке 2 (в мкм/с) - Mean-square value of vibration velocity at the reference point 2 (mkm/s)

Vertical (870 rpm)

Vertical (3000 rpm)

Horizontal (3000 rpm)

Horizontal (870 rpm)

До обработки – Before the application

После обработки – After the application

Fig. 10 Mean-square value of vibration velocity at the reference point 2 of the engine of a Toyota RAV4 car.

### 3.7 Metal content in the motor oil

Application of XADO Maximum 1 Stage resulted in decreased content of metal products of wear in the motor oil. (tables 4 and 5).

Table 4 Content of metal products of wear in the oil of the gasoline engine of a Chevrolet Aveo car

Run, thousand km	Fe	Al	Cr	Cu	Total metal content, mg/kg
117	30	8	1	4	43
128	12	4	1	1	18
163	9	1	0	2	12
231	6	3	1	0	10
249	8	1	0	2	11

Table 5 Content of metal products of wear in the oil of the diesel engine of a VW Caddy 1,9 TDI car

Run, thousand km	Fe	Al	Cr	Cu	Total metal content, mg/kg
241	21	5	2	4	32
255	10	2	1	2	15
282	8	3	0	2	13
297	8	2	1	1	12
324	5	1	1	2	9
354	6	1	0	1	8

### 3.8 Tribological properties of motor oil

Application of XADO Maximum 1 Stage resulted in improvement of tribological characteristics (wear scar, critical load, welding load) of a motor oil (Table 6, 7).

Table 6 Tribological characteristics of the motor oil in a Chevrolet Lacetti car

Tribological characteristics	$D_{И}$ , mm	$P_K$ , H	$P_{CB}$ , H
New oil	0.34	735	1646
After application, at the end of the oil service life	0.31	784	1744

Table 7 Tribological characteristics of the motor oil in a Volga GAZ 31105 car

Tribological characteristics	$D_{И}$ , mm	$P_K$ , H	$P_{CB}$ , H
New oil	0.36	784	1744
After application, at the end of the oil service life	0.32	823	1842

### **Summary results:**

The conducted analysis of application of XADO Maximum 1 Stage in ten passenger cars affirmed its positive impact on operational characteristics of engines.

Application of XADO Maximum 1 Stage:

1. Increases compression by 16% and decreases its variation in the cylinders from 3.0 to 0.5 bar.

2. Increases (restores) the geometry of worn friction parts of the engine: cylinder by 0.04 mm; crankpins of the engine crankshaft by 0.038 mm. Keeps the restored size by more than 108,000 km of run.

3. Increases the pressure in the lubricating system: by 0.17 bar at idle and by 1.2 bar at 2000 r/min.

4. Decreases the exhaust toxicity: in a gasoline engine — CO by 19,0%, HC by 9,6%; in a diesel engine — smoke by 15.7%.

5. Decreases fuel consumption in operating mode by 2.8%.

6. Decreases the engine vibration values at reference points by 45%.

7. Decreases the total content of metal products of wear in the oil by a factor of 4 and preserves its antiwear properties during 132,000 km of run of a gasoline engine, and during 113,000 km of run of a diesel engine.

8. Improves tribological characteristics of the oil: antiwear by 11.1%, antiwelding by 5.8%.