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Subdepartment of Internal Combustion Engines

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REPORT

on Research Work

Experimental Study of Suprotec Compound Influence on Technico-Economical, Environmental and Lifetime Characteristics of a Spark Ignition Engine

Theme Code / Work No. 200301901

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О Т Ч Е Т

о научно-исследовательской работе

Экспериментальное исследование влияния препарата «Супротек» на технико-экономические, экологические и ресурсные показатели двигателя с искровым зажиганием

Шифр темы / № работы 200301901

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Scope of Works

1. Purpose of Work

The purpose of this work is experimental study of influence of the SUPROTEC lubrication compound on the principal performance characteristics of an Otto engine: effective power, fuel consumption, exhaust gas toxicity, as well as the wear rate of the principal friction joints in the process of long-term 150-hour bench motor tests.

The work was performed using the equipment and calculation and experiment procedure of internal combustion engine workflows developed at the subdepartment of internal combustion engines of the Saint Petersburg State Polytechnical University.

2. Object of Studies

A VAZ-2108 high-speed carburetor vehicle engine (4Ch 7.6/7.1) made by the Volga Automobile Plant was chosen as the object of studies.

3. Description of the Test Bench and Measuring Apparatus

The motor tests of the VAZ-2108 engine were carried out at a test bench of the internal combustion engines laboratory of the Subdepartment of Internal Combustion Engines of the SPbSTU. The description of the test bench and the apparatus used was included in the previous report.

4. Test Program

Acceding to the Procedure of Accelerated Tribological Bench Tests accepted as a basis for carrying out independent expert assessment, the test program included:

- Carrying out the engine overhaul including its comprehensive measurement and troubleshooting;
- assembly of the engine, installing the engine on the test bench, connecting the engine to the load device, installing a complex of measuring instruments;
- a short-term engine run in until stabilization of parameters before the start of the tests (3 engine hours);
- measuring the basic characteristics of the engine: external speed performance and performance under load at n= 2000. 3000 rpm including measurement of the principal engine performance parameters;
- measuring the engine friction power at open and closed throttle by dry cranking it on the test bench;
- measuring the cylinder-piston group compression and gas tightness indicators;

- the first treatment of the engine by Suprotec compound (according to its manufacturer's procedure), running it for 10 engine hours in a fixed mode (n=2500 rpm, Me=50 Nm) (an analog of 1000 km drive), measuring the resulting engine characteristics after the first treatment;
- a change of oil and oil filters, filling fresh oil, the second treatment of the engine by Suprotec compound, running it in a fixed mode for 70 engine hours (an analog of 7000 km drive), measuring the resulting engine characteristics after the second treatment;
- the third treatment of the engine by Suprotec compound (according to its manufacturer's procedure), running it for 70 motor hours in a fixed mode (n=2500 rpm, Me=50 Nm) (an analog of 7000 km drive), measuring the resulting engine characteristics after the third treatment;
- measuring the mechanical power loss by dry cranking the engine on the test bench;
- measuring the engine cylinder-piston group compression and gas tightness parameters;
- removing the engine from the test bench, disassembly and troubleshooting.
- analysis of the test results, preparation of a report.

The efficiency of the compounds is assessed by the following parameters:

- measuring the cylinder compression value and its evenness between cylinders;
- the maximum power and the maximum torque values in absolute figures and inn percentage terms;
- specific fuel consumption values in absolute figures and in percentage terms under the specified atmospheric conditions;
- change of exhaust gas toxicity (CO, NO and CH content) before and after the engine treatment;
- change in the engine effective efficiency value before and after its treatment;
- change in wear rates of the principal friction unit components (piston rings, bearing shells) after treating the engine as compared to the analogous parameters of a reference engine.

5. SUPROTEC Compound Test Results

The tests were performed in strict conformity with the program cited above.

Lukoil 10W40 lubrication oil and Slavneft A-92 gasoline were used during the test. Gasoline for all the tests was purchased in a single lot at the start of the tests.

The results obtained in the process of engine parameters check measurements are presented below, in Tables 1-3.

The following designations were used hereinafter in the tables:

n - engine crankshaft rotation frequency;

Me - effective torque;

Ne - effective power;

Gt - hourly fuel consumption

ge - specific fuel consumption,

ηe - effective efficiency;

ηm - mechanical efficiency;

α - air excess coefficient (measured by gas analyzer readings);

Tex - exhaust gas temperature;

CO - carbon oxide content in the engine exhaust gas;

CO_2 - carbon dioxide content in the engine exhaust gas;

NO - nitrogen oxide content in the engine exhaust gas;

CH - residual hydrocarbons content in the engine exhaust gas.

External Speed Characteristic.
Suprotec

Reference Condition

n, rpm	Me, Nm	Ne, kW	Gt, kg/h	ge, kg/kWh	ηe	ηm	α	Pm, bar	Tex, °C	CO, %	CH, ppm	NO, ppm	CO_2. %
1500	77.86	12.23	3.99	0.327	0.251	0.852	0.901	2.45	422	5.332	145	1011	10.90
2000	84.94	17.79	5.81	0.327	0.250	0.854	0.894	2.90	486	6.045	142	661	10.06
2500	95.05	24.88	8.05	0.323	0.253	0.852	0.874	3.10	520	7.243	157	511	9.62
3000	99.10	31.13	10.07	0.323	0.253	0.846	0.865	3.40	584	7.482	165	674	10.01
3500	100.1	36.69	10.97	0.299	0.274	0.830	0.879	3.65	615	5.874	134	1250	11.21
4000	95.05	39.82	11.99	0.301	0.272	0.798	0.895	3.70	685	3.856	108	1742	12.15

After the First Treatment

n, rpm	Me, Nm	Ne, kW	Gt, kg/h	ge, kg/kWh	ηe	ηm	α	Pm, bar	Tex, °C	CO, %	CH, ppm	NO, ppm	CO_2. %
1500	79.14	12.43	4.19	0.337	0.243	0.868	0.898	2.40	428	5.102	132	1045	10.76
2000	86.15	18.04	5.80	0.321	0.255	0.869	0.891	2.90	495	6.011	132	656	10.36
2500	96.17	25.18	7.99	0.317	0.258	0.869	0.875	3.15	531	7.120	149	543	9.54
3000	99.17	31.16	10.12	0.325	0.252	0.861	0.861	3.45	594	7.346	154	650	10.12
3500	100.2	36.72	11.17	0.304	0.269	0.841	0.884	3.70	635	5.546	112	1364	11.11
4000	96.17	40.28	12.11	0.301	0.272	0.810	0.901	3.80	697	3.666	101	1837	12.01

After the Second Treatment

n, rpm	Me, Nm	Ne, kW	Gt, kg/h	ge, kg/kWh	ηe	ηm	α	Pm, bar	Tex, °C	CO, %	CH, ppm	NO, ppm	CO_2. %
1500	81.05	12.73	4.09	0.322	0.254	0.881	0.900	2.45	435	5.004	128	1097	10.84
2000	88.06	18.44	5.78	0.313	0.261	0.880	0.894	2.95	504	5.894	136	625	10.44
2500	98.06	25.67	8.00	0.312	0.263	0.883	0.878	3.25	540	7.045	143	565	9.40
3000	100.7	31.65	10.24	0.324	0.253	0.870	0.870	3.50	611	7.450	158	631	10.21
3500	101.1	37.04	11.03	0.298	0.275	0.849	0.884	3.65	649	5.410	110	1410	11.15
4000	99.07	41.50	12.25	0.295	0.277	0.818	0.896	3.85	704	3.410	98	1885	12.40

External Speed Characteristic. Suprotec (Continued)													
Resulting Condition (after Three Treatments)													
n, rpm	**Me, Nm**	**Ne, kW**	**Gt, kg/h**	**ge, kg/kWh**	**ηe**	**ηm**	**α**	**Pm, bar**	**Tex, °C**	**CO, %**	**CH, ppm**	**NO, ppm**	**CO_2. %**
1500	82.05	12.98	4.12	0.320	0.256	0.882	0.894	2.40	438	5.254	131	1101	10.65
2000	89.06	18.65	5.80	0.311	0.263	0.881	0.888	2.90	510	5.995	142	601	10.40
2500	98.73	25.85	8.03	0.311	0.263	0.888	0.875	3.30	547	7.147	147	541	9.40
3000	101.4	31.86	10.38	0.326	0.251	0.875	0.871	3.60	620	7.521	151	610	10.10
3500	101.1	37.04	11.10	0.300	0.273	0.849	0.878	3.75	661	5.560	108	1485	11.10
4000	99.07	41.50	12.19	0.294	0.278	0.822	0.899	3.85	710	3.250	95	1991	12.42

Table 1. External speed characteristics of a VAZ-2108 engine at various stages of treatment by Suprotec compound

Load Characteristic, n=2000 rpm.
Suprotec

Reference Condition

Mode No.	Me, Nm	Ne, kW	Gt, kg/h	ge, kg/kWh	ηe	ηm	α	Pm, bar	Tex, °C	CO, %	CH, ppm	NO, ppm	CO_2, %
1	19.76	4.14	1.89	0.456	0.180	0.529	1.204	3.10	315	0.099	54	1539	11.54
2	40.18	8.42	2.63	0.313	0.262	0.708	1.189	3.10	345	0.075	78	2524	11.58
3	59.28	12.42	3.39	0.273	0.299	0.791	1.154	3.00	396	0.068	76	3157	11.65
4	78.39	16.42	4.58	0.279	0.293	0842	1.065	3.00	415	0.754	91	2326	12.41
5	82.99	17.38	5.70	0.328	0.249	0.851	0.894	2.90	486	6.045	142	661	10.06

After the First Treatment by the Compound

Mode No.	Me, Nm	Ne, kW	Gt, kg/h	ge, kg/kWh	ηe	ηm	α	Pm, bar	Tex, °C	CO, %	CH, ppm	NO, ppm	CO_2, %
1	20.97	4.39	1.87	0.425	0.192	0.565	1.200	3.15	324	0.092	51	1555	11.64
2	40.28	8.44	2.57	0.305	0.268	0.726	1.180	3.15	356	0.071	72	2466	11.62
3	60.59	12.69	3.35	0.264	0.310	0.810	1.150	3.10	402	0.062	77	3247	11.69
4	79.23	16.59	4.56	0.275	0.298	0.856	1.062	3.00	450	0.714	88	2356	12.41
5	85.89	17.99	5.68	0.316	0.259	0.869	0.891	2.90	495	6.011	132	656	10.36

After the Second Treatment by the Compound

Mode No.	Me, Nm	Ne, kW	Gt, kg/h	ge, kg/kWh	ηe	ηm	α	Pm, bar	Tex, °C	CO, %	CH, ppm	NO, ppm	CO_2, %
1	20.39	4.27	1.81	0.425	0.193	0.573	1.199	3.20	329	0.084	48	1610	1.81
2	40.78	8.54	2.48	0.290	0.282	0.741	1.185	3.15	364	0.068	65	2511	11.71
3	60.01	12.57	3.21	0.256	0.320	0.818	1.146	3.10	410	0.060	71	3450	11.80
4	79.58	16.67	4.52	0.271	0.302	0.865	1.045	3.05	455	0.701	82	2460	12.48
5	87.53	18.33	5.67	0.309	0.265	0.879	0.894	2.95	504	5.894	136	625	10.44

Load Characteristic, n=2000 rpm.
Suprotec (Continued)

Resulting Condition (after the Third Treatment by the Compound)

Mode No.	Me, Nm	Ne, kW	Gt, kg/h	ge, kg/kWh	ηe	ηm	α	Pm, bar	Tex, °C	CO, %	CH, ppm	NO, ppm	CO2. %
1	20.00	4.19	1.80	0.429	0.191	0.573	1.201	3.25	334	0.082	47	1624	11.84
2	39.68	8.31	2.39	0.288	0.284	0.738	1.187	3.15	381	0.064	66	2594	11.80
3	59.52	12.47	3.20	0.257	0.319	0.818	1.149	3.10	415	0.060	72	3510	11.80
4	80.02	16.76	4.56	0.272	0.301	0.866	1.051	3.00	469	0.714	80	2412	12.40
5	88.28	18.49	5.68	0.307	0.266	0.880	0.888	2.90	510	5.995	142	601	10.40

Table 2. Load characteristics of a VAZ-2108 engine at various stages of treatment by Suprotec compound, n=2000 rpm

Load Characteristic, n=3000 rpm.
Suprotec

Reference Condition

Mode No.	Me, Nm	Ne, kW	Gt, kg/h	ge, kg/kWh	ηe	ηm	α	Pm, bar	Tex, °C	CO, %	CH, ppm	NO, ppm	CO_2, %
1	19.82	6.23	2.62	0.421	0.194	0.487	1.114	3.60	482	0.122	46	2192	12.54
2	38.97	12.24	3.85	0.315	0.260	0.659	1.110	3.60	502	0.091	52	3566	12.50
3	58.78	18.47	4.87	0.264	0.310	0.751	1.080	3.50	543	0.115	59	3995	12.65
4	79.26	24.90	6.54	0.263	0.311	0.809	1.015	3.45	562	0.601	78	2970	13.11
5	97.09	30.50	9.87	0.324	0.253	0.844	0.865	3.40	584	7.482	165	674	10.01

After the First Treatment by the Compound

Mode No.	Me, Nm	Ne, kW	Gt, kg/h	ge, kg/kWh	ηe	ηm	α	Pm, bar	Tex, °C	CO, %	CH, ppm	NO, ppm	CO_2, %
1	20.64	6.48	2.61	0.403	0.203	0.517	1.119	3.65	492	0.119	42	2108	12.50
2	39.95	12.55	3.78	0.301	0.272	0.684	1.108	3.60	511	0.087	45	3596	12.40
3	59.92	18.82	4.76	0.253	0.234	0.773	1.075	3.55	554	0.110	52	4010	12.61
4	79.89	25.10	6.53	0.260	0.314	0.826	1.012	3.50	580	0.611	72	2872	13.17
5	98.87	31.06	9.92	0.319	0.256	0.861	0.861	3.45	594	7.346	154	650	10.12

After the Second Treatment by the Compound

Mode No.	Me, Nm	Ne, kW	Gt, kg/h	ge, kg/kWh	ηe	ηm	α	Pm, bar	Tex, °C	CO, %	CH, ppm	NO, ppm	CO_2, %
1	21.01	6.60	2.55	0.386	0.212	0.534	1.203	3.70	500	0.108	39	2114	12.62
2	40.68	12.78	3.73	0.292	0.280	0.699	1.112	3.65	523	0.081	41	3678	12.42
3	61.02	19.17	4.68	0.244	0.336	0.786	1.069	3.60	560	0.101	50	4112	12.74
4	80.70	25.35	6.63	0.262	0.313	0.836	1.009	3.55	589	0.547	72	2946	13.22
5	100.7	31.64	10.04	0.317	0.258	0.870	0.870	3.50	611	7.450	158	631	10.21

Load Characteristic, n=3000 rpm. Suprotec (Continued)

Resulting Condition (after the Third Treatment by the Compound)

Mode No.	Me, Nm	Ne, kW	Gt, kg/h	ge, kg/kWh	ηe	ηm	α	Pm, bar	Tex, °C	CO, %	CH, ppm	NO, ppm	CO2. %
1	20.23	6.35	2.48	0.391	0.209	0.531	1.200	3.75	504	0.111	36	2190	12.60
2	39.79	12.50	3.65	0.292	0.280	0.700	1.115	3.65	528	0.084	40	3670	12.50
3	60.01	18.85	4.58	0.243	0.337	0.787	1.084	3.65	569	0.104	48	4145	12.70
4	80.57	25.31	6.59	0.260	0.314	0.840	1.015	3.60	600	0.523	70	2900	13.10
5	100.8	31.67	10.17	0.321	0.255	0.874	0.871	3.60	620	7.512	151	610	10.10

Table 3. Load characteristics of a VAZ-2108 engine at various stages of treatment by Suprotec compound, n=3000 rpm

The results of mechanical loss power at various stages of the engine treatment by Suprotec compound are tabulated in Table 4.

Mechanical loss torque, Nm								
Motor rotation frequency, rpm	Initial condition		After the first treatment		After the second treatment		Resulting condition	
	Closed throttle	Opened throttle	Closed throttle	Opened throttle	Closed throttle	Opened throttle	Closed throttle	Opened throttle
300	22.5	22.0	21.5	20.0	20.0	19.0	19.5	19.0
500	21.0	18.5	19.5	16.5	18.5	16.0	18.0	15.5
800	18.5	13.5	17.5	11.5	16.5	11.0	16.0	10.5
1000	17.0	13.0	16.0	11.5	15.0	10.5	15.0	10.0
1500	18.0	13.5	17.0	12.0	15.5	11.0	15.5	11.0
2000	19.5	14.5	18.0	13.0	17.0	12.0	16.5	12.0
2500	21.0	16.5	19.5	14.5	18.0	13.0	17.5	12.5
3000	22.5	18.0	21.0	16.0	20.0	15.0	19.5	14.5
3500	24.5	20.5	22.5	19.0	21.0	18.0	21.0	18.0
4000	26.0	24.0	24.0	22.5	23.0	22.0	23.0	21.5

Table 4. Results of mechanical loss torque (Nm) measurement by dry cranking method.

The results of the engine cylinder-piston group tightness at various stages of the engine treatment by Suprotec compound are tabulated in Tables 5…7.

Test stage	Cylinder 1	Cylinder 2	Cylinder 3	Cylinder 4
Before compound treatment	11.3/11.7	9.8/9.5	12.1/12.4	12.2/12.4
After the first treatment	11.8/12.3	10.2/10.5	12.4/12.8	12.5/12.8
After the second treatment	12.1/12.4	10.6/10.9	12.5/12.9	12.7/13.0
Resulting condition	12.1/12.4	10.7/11.0	12.7/13.0	12.9/13.1

Table 5. Compression measurement results, kg/cm$^{2.}$ broken down by cylinders (the numerator: closed throttle, the denominator: opened throttle)

Test stage	Cylinder 1	Cylinder 2	Cylinder 3	Cylinder 4
Before compound treatment	0.840	0.805	0.865	0.870
After the first treatment	0.850	0.835	0.875	0.875
After the second treatment	0.865	0.845	0.880	0.885
Resulting condition	0.870	0.850	0.885	0.885

Table 6. Complete vacuum measurement results (kg/cm^2), broken down by cylinders.

Test stage	Cylinder 1	Cylinder 2	Cylinder 3	Cylinder 4
Before compound treatment	0.360	0.405	0.385	0.375
After the first treatment	0.350	0.385	0.370	0.365
After the second treatment	0.345	0.380	0.355	0.355
Resulting condition	0.335	0.370	0.340	0.335

Table 7. Residual vacuum measurement results (kg/cm^2), broken down by cylinders.

The results of the wear rates of reference weight elements of the reference engine (the results were obtained by averaging the test results of three engines using the same procedure) and an engine that has undergone a full cycle of treatment by Suprotec compound are tabulated in Table 8. The wear rates were determined by accurate weighing of the reference parts. Weighing error: 0.0001 g.

Part	Wear rate, mg/h	
	Before treatment	After treatment
Piston rings		
The first compression ring, cyl. 2	0.45 (+/-12%)	0.30
The second compression ring, cyl. 2	0.76 (+/-12%)	0.45
The first compression ring, cyl. 3	0.46 (+/-12%)	0.28
The second compression ring, cyl. 3	0.74 (+/-12%)	0.51
Crankshaft bearing shells		
Shell 1 (conrod, upper half, cyl. 2)	0.41(+/-15%)	0.18
Shell 2 (conrod, lower half, cyl. 2)	0.32 (+/-15%)	0.17
Shell 3 (main, upper half, support 2)	0.34 (+/-15%)	0.21
Shell 4 (main, lower half, support 2)	0.65 (+/-15%)	0.31
Shell 5 (conrod, upper half, cyl. 3)	0.38 (+/-15%)	0.14
Shell 6 (conrod, lower half, cyl. 3)	0.34 (+/-15%)	0.11
Shell 7 (main, upper half, support 3)	0.34 (+/-15%)	0.09
Shell 8 (main, lower half, support 3)	0.60 (+/-15%)	0.29

Table 9. Results of determination of VAZ-2108 engine reference friction unit components wear rates (based on the averaged three engines test data) and after treatment by Suprotec compound

6. Engine Visual Diagnostics Result

After the tests, the engine was removed from the test bench, disassembled and inspected.

The visual analysis results have not detected any inacceptable defects that might result from the engine treatment by Suprotec compound. Carbon deposition, combustion chamber and piston groove deposits do not exceed the unusual levels (points 1...2).

The results of the engine measurements before and after the tests are tabulated in Appendices 1 and 2.

7. Conclusions on the Results of an Engine Treatment by SUPROTEC Compound

The following conclusions can be made on the basis of the completed work results:

1. The conclusions regarding the positive effect of treatment by Suprotec compound on the technical-economical and environmental parameters of the engine under test obtained earlier were confirmed. The treatment effect values averaged by the principal modes of the universal test cycle are tabulated in Table 10:

Treatment stage	Average effects, % to reference					
	Capacity	Fuel consumption	Effective efficiency	CO	CH	NOx
After the first treatment	1.648	3.712	3.412	8.454	8.131	1.034
After the second treatment	3.663	6.283	6.545	15.862	14.551	-1.371
After the third treatment	4.579	6.526	7.125	14.412	16.120	-4.364

Table 9. Average effects of engine treatment by Suprotec compound in a series of long-term engine bench tests

Deterioration of the parameter is shown in red, their improvement, in green, their change within measurement accuracy, in blue.

Thereby, as a result of all treatments fuel consumption reduction exceeded 6.5. increase in effective power exceeded 4.5%. A certain improvement of exhaust gas toxicity indicators is observed as regards CO and CH components. The change in nitrogen oxides content did not exceed the measurement error limits.

2. The engine treatment by the Suprotec compound resulted in a decrease of friction loss moment that is most noticeable in the low crankshaft rotation frequency range (up to 30...35%). This effect is reduced to 8...12% in the high crankshaft rotation frequency ranges.

3. The cylinder-piston group tightness was improved substantially; this improvement consists in increased compression in all cylinders, increased full vacuum and reduced residual vacuum parameters in the cylinders.

4. The decrease in wear rates of the cylinder-piston group units of an engine treated by Suprotec compound amounted to 30...45%, that of the crankshaft bearings, to 40...80%.

Appendix 1.

Defect List

VAZ-2108 Engine

Suprotec Compound Endurance Tests

Before tests

1. Cylinder block

1.1. Cylinder diameters, bore wear and ovalization

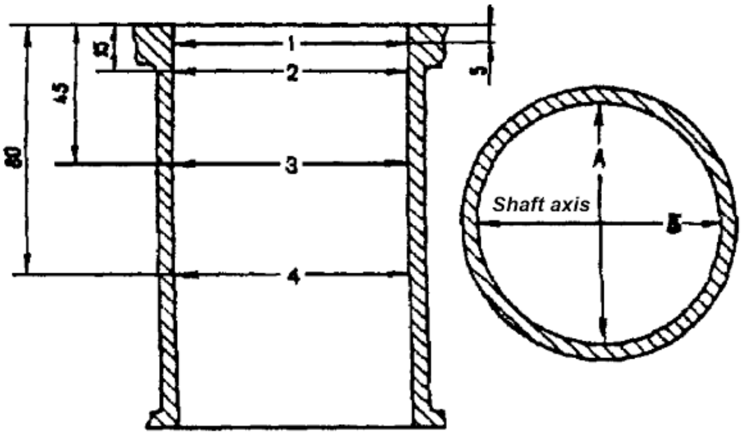

Table 4

Cylinder No. & class	section/ Size	1 (5 mm)	2 (15 mm)	3 (45 mm)	4 (80 mm)	STD
1	A, mm	82.010	82.040	82.030	82.035	82.000
	B, mm	82.000	82.060	82.020	82.020	
2	A, mm	82.030	82.050	82.045	82.040	82.000
	B, mm	82.000	82.020	82.020	82.020	
3	A, mm	82.030	82.045	82.060	82.040	82.000
	B, mm	82.000	82.020	82.020	82.020	
4	A, mm	82.020	82.040	82.040	82.025	82.000
	B, mm	82.000	82.030	82.020	82.025	

Note: 1. Before measurements, the bore gauge is set to the nominal cylinder diameter using a micrometer

2. Pistons and rings

2.1. Maximum skirt size, piston/cylinder gaps

Table 5

Cylinder No.	1	2	3	4
Max, skirt size:	81.967	81.965	81.965	81.965
Gap, mm:	0.068	0.075	0.075	0.060
Norm. gap, allowance:	0.025 ÷ 0.045. [0.15]			

Note: 1. The maximum skirt diameter was measured in the section perpendicular to the piston pin at 51.5 m distance from the piston crown. 2. The gap is calculated as the difference between the cylinder diameter measured by "A" size in the 4th measuring level (see Table 4) and the actual maximum size of the skirt.

2.2. Ring joint expansion gaps

Table 6

Piston No:	1	2	3	4	Norm, mm
Gap in ring 1 (1)	0.680	0.720	0.750	0.810	0.25 ÷ 0.45
Gap in ring 1 (2)	0.860	0.900	0.850	1.000	0.25 ÷ 0.45
All gaps allowance:	[1.0]				

Note: 1. Gaps are measured using a set of feeler gauges after the ring is installed in the top unworn groove of the respective cylinder (section 1-5 mm). 2. The gap is also measured at level 2 - 15 mm away from the joint plane (in the wear zone).

3. Moving Parts and Bearings

3.1. Crankshaft conrod journals, conrod bearings wear

3.1.1. Conrod journal diameters

Table 7

Cylinder No.		1	2	3	4	STD
Size in section 1	A, mm	47.840	47.840	47.840	47.840	46.830÷46.850
	B, mm	47.840	47.845	47.840	47.845	
Average on all measurements		47.840	47.842	47.840	47.842	

Note: 1. Size A - measured in the crank plane, size B - in the one perpendicular to it. 2. Section 1 is located in the central zone of a journal, measurements are taken several times at various points. 3. Allowable wear, ovality, conicity, etc. not more than 0.03 mm.

3.1.2. Conrod Bearing Diameters

Table 8

Section	Cyl. No. size	1	2	3	4	STD
1	A, mm	47.895	47.887	47.890	47.905	47.900
	B, mm	47.880	47.905	47.910	47.905	
Average on all measurements		47.888	47.896	47.900	47.905	

Note: 1. Sizes A and B are measured using the same procedure as for the crankshaft; however, size B coinciding with the bearing joint is measured in two planes from the joint ±10÷20° away from it, the average value is tabulated. 2. An assembled bearing is measured. Conrod bolt nuts tightening torque: 45÷53 Nm (in two stages). 3. Ovality, conicity and lobing not more than 0.03 mm

3.2. Crankshaft main journals, main bearings wear

3.2.1. Main Journal Diameters

Table 11

Section	Cyl. No. size	1	2	3	4	5	STD
1	A, mm	50.56	50.56	50.55	50.55	50.55	
	B, mm	50.55	50.55	50.55	50.55	50.55	
Average of measurements		50.555	50.555	50.55	50.55	50.55	

Note: The general procedure provisions are the same as for the conrod journals.

3.2.2. Main Bearing Diameters

Table 12

Section	Cyl. No. size	1	2	3	4	5	STD
1	A, mm	50.615	50.620	50.610	50.615	50.59	
	B, mm	50.618	50.605	50.617	50.617	50.61	50.6
Average of measurements		50.617	50.612	50.614	50.616	50.600	

Note: 1. The general procedure provisions are the same as for the conrod journals. 2. The main bearing caps bolt tightening torque is 70÷84 Nm (in two stages).

3.2.3. Main bearing gaps (measured by "A" size / Average)

Table 13

Journal Nos.	1	2	3	4	5	***STD***
Gap, mm:	0.055/ 0.062	0.060/ 0.057	0.060/ 0.064	0.065/ 0.066	0.040/ 0.050	0.026 ÷ 0.073
Allowable gap value, mm						[0.150]

Note: The gap is calculated in the same way as for a conrod bearing.

3.2.4. Main Bearing Shells

Table 14

Cyl. No. shell	***Section***	1	2	3	4	5	STD
Upper half	1	1.945	1.945	1.950	1.955	1.965	
Lower half	1	1.960	1.950	1.950	1.945	1.950	

Note: The general procedure provisions are the same as for the conrod shells.

Appendix 2.

Defect List
VAZ-2108 Engine
Suprotec Compound Endurance Tests
After the tests

4. Cylinder block

4.1. Cylinder diameters, bore wear and ovalization

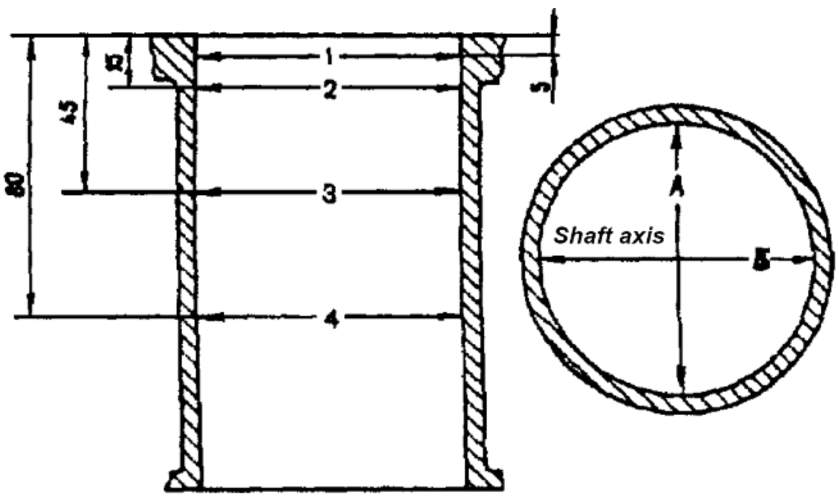

Table 4

Cylinder No. & class	section/ size	1 (5 mm)	2 (15 mm)	3 (45 mm)	4 (80 mm)	STD
1	A, mm	82.025	82.060	82.040	82.040	82.000
	B, mm	82.015	82.060	82.035	82.035	
2	A, mm	82.035	82.055	82.050	82.040	82.000
	B, mm	82.015	82.045	82.025	82.030	
3	A, mm	82.035	82.060	82.055	82.040	82.000
	B, mm	82.015	82.030	82.025	82.025	
4	A, mm	82.030	82.080	82.040	82.030	82.000
	B, mm	82.010	82.035	82.030	82.035	

Note: 1. Before measurements, the bore gauge is set to the nominal cylinder diameter using a micrometer

5. Pistons and rings

5.1. Maximum skirt size, piston/cylinder gaps

Table 5

Cylinder No.	1	2	3	4
Max, skirt size:	81.970	81.955	81.960	81.960
Gap, mm:	0.070	0.085	0.080	0.070
Norm. gap, allowance:	0.025 ÷ 0.045. [0.15]			

Note: 1. The maximum skirt diameter was measured in the section perpendicular to the piston pin at 51.5 m distance from the piston crown. 2. The gap is calculated as the difference between the cylinder diameter measured by "A" size in the 4th measuring level (see Table 4) and the actual maximum size of the skirt.

5.2. Ring joint expansion gaps

Table 6

Piston No:	1	2	3	4	Norm, mm
Gap in ring 1 (1)	0.750	0.800	0.800	0.860	0.25 ÷ 0.45
Gap in ring 1 (2)	0.900	0.900	0.900	1.000	0.25 ÷ 0.45
All gaps allowance:	[1.0]				

Note: 1. Gaps are measured using a set of feeler gauges after the ring is installed in the top unworn groove of the respective cylinder (section 1-5 mm). 2. The gap is also measured at level 2 - 15 mm away from the joint plane (in the wear zone).

6. Moving Parts and Bearings

6.1. Crankshaft conrod journals, conrod bearings wear

6.1.1. Conrod journal diameters

Table 7

Cylinder No.		1	2	3	4	STD
Size in section 1	A, mm	47.840	47.840	47.840	47.840	46.830÷46.850
	B, mm	47.845	47.840	47.840	47.840	
Average on all measurements		47.842	47.840	47.840	47.840	

Note: 1. Size A - measured in the crank plane, size B - in the one perpendicular to it. 2. Section 1 is located in the central zone of a journal, measurements are taken several times at various points. 3. Allowable wear, ovality, conicity, etc. not more than 0.03 mm.

6.1.2. Conrod Bearing Diameters

Table 8

Section	Cyl. No. size	1	2	3	4	STD
1	A, mm	47.910	47.920	47.910	47.925	47.900
	B, mm	47.955	47.930	47.920	47.950	
Average on all measurements		47.932	47.925	47.915	47.938	

Note: 1. Sizes A and B are measured using the same procedure as for the crankshaft; however, size B coinciding with the bearing joint is measured in two planes from the joint ±10÷20° away from it, the average value is tabulated. 2. An assembled bearing is measured. Conrod bolt nuts tightening torque: 45÷53 Nm (in two stages). 3. Ovality, conicity and lobing not more than 0.03 mm

6.2. Crankshaft main journals, main bearings wear

6.2.1. Main Journal Diameters

Table 11

Section	Cyl. No. size	1	2	3	4	5	STD
1	A, mm	50.565	50.560	50.555	50.560	50.565	
	B, mm	50.56	50.550	50.550	50.550	50.555	
Average of measurements		50.562	50.555	50.552	50.555	50.555	

Note: The general procedure provisions are the same as for the conrod journals.

6.2.2. Main Bearing Diameters

Table 12

Section	Cyl. No. size	1	2	3	4	5	STD
1	A, mm	50.640	50.630	50.625	50.625	50.615	6
	B, mm	50.640	50.620	50.625	50.635	50.63	
Average of measurements		50.640	50.625	50.625	50.630	50.622	

Note: 1. The general procedure provisions are the same as for the conrod journals. 2. The main bearing caps bolt tightening torque is 70÷84 Nm (in two stages).

6.2.3. Main bearing gaps (measured by "A" size / Average)

Table 13

Journal Nos.	1	2	3	4	5	***STD***
Gap, mm:	0.075/ 0.078	0.070/ 0.070	0.070/ 0.073	0.065/ 0.075	0.060/ 0.067	0.026 ÷ 0.073
Allowable gap value, mm						[0.150]

Note: The gap is calculated in the same way as for a conrod bearing.

6.2.4. Main Bearing Shells

Table 14

Cyl. No. shell	**Section**	1	2	3	4	5	STD
Upper half	1	1.945	1.945	1.955	1.960	1.970	
Lower half	1	1.960	1.950	1.950	1.950	1.950	

Note: The general procedure provisions are the same as for the conrod shells.