INCREASING SERVICE LIFE OF MAJOR PARTS OF INTERNAL COMBUSTION ENGINES

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Abstract. The interaction between the cylinder and the piston in the internal combustion engine under various cooling conditions and restoration of geometrical parameters of cylinders are considered. The possibilities of using more economic technologies are also analyzed, with the results of the research presented. To restore the geometric parameters a restoring repair mixture is used, which, together with the oil of a lubrication system, gets into the engine’s friction couples covering them by a ceramic layer.

1. Introduction

The expenditures in automobile transport depend to a great extent on the service life of an internal combustion engine. It should be noted that at design and production stages operational parameters influencing the engine’s service life are not given proper consideration. When the state of operation of an engine is getting worse or any breakdown occurs it results in the reduction of the engine’s service life and the increase of maintenance costs.

Proper state of operation of the cylinder block of an engine and the parts of the cylinder and the piston is particularly important, since it largely determines not only the service life of an engine, but also its efficiency. Mechanical losses, suction, compression and combustion processes as well as the amount of exhaust gases mainly depend on the state of operation of the cylinder and piston parts. The latter is much influenced by the temperature condition of an engine.

2. The effect of operating characteristics of cylinder and piston parts on the service life of an engine

A group of cylinder and piston parts is one of the most important and heavily loaded unit. In most cases, service life of these pieces determines the total engine service life.

The lack of proper interaction between the cylinder and piston parts results in worse performance as well as reduced power and less economic operation of an engine.

A lot of studies prove that about 65 % of power losses due to friction in the engine are associated with the cylinder and piston parts. The state of operation of this group depends on the temperature condition of an engine varying according to the efficiency of cooling. The running parts of cylinder and piston have the inhomogeneous temperature pattern.

The above inhomogeneous pattern is the main cause of inhomogeneous deformation. This deformation alters the gaps between the interconnected parts causing the distortion of their shape and surfaces as well as changing their relative position. The greatest effect of the temperature pattern is observed in the parts making a friction couple. The inhomogeneous deformation changes their geometry, and the altered internal dimensions
do not conform to those specified in their design. In addition, a resulting oval and cone shapes are not proportional to the cylinder height.

This causes difficulties in lubrication as well as increasing the wear and fuel consumption and reducing the engine power.

Therefore, the temperature condition of the parts making a friction couple should be such as to ensure their proper operation with the optimal gap between frictional surfaces.

The gap size influences not only the mechanical efficiency determining the engine power and fuel consumption, but also the intensity of wearing.

Therefore, the need arose to investigate temperature deformations occurring in the cylinders and pistons of the engines in operation, with the aim to increase their service life and efficiency.

3. Investigation of temperature deformations of the cylinder and piston parts

In order to provide proper sealing of the working space of a cylinder as well as ensuring minimum friction and avoiding the seizing of a hot piston, a certain expansion gap $\Delta$ should be maintained between the piston and cylinder walls. It is determined by temperature deformations of the above parts. These deformations vary when an engine is running, being dependent on cooling conditions, which are getting worse due to scale formation in the cooling system.

Taking into account temperature deformations, an optimum gap between the piston and cylinder should be selected. However, this gap is getting larger due to the wearing action on the engine in operation. Therefore, in time it should be reconditioned.

When reconditioning the gap during the repair of an engine, temperature deformations of the piston and cylinder varying in accordance with the altering cooling of a running engine should be determined.

![Fig. 1 A discrete - element model of the piston FIAT 138 A. 5.000](image)

For the theoretical study of temperature deformations of a piston in operating conditions a discrete - element model of a piston of the engine FIAT 138 A. 5.000 has been developed for ANSYS program (see Fig. 1). Solving a thermal conductivity problem,
Cross-sections were measured in the following order: beginning with the first section 10 mm downward from the cylinder top, followed by the others per every 10 mm. Fig. 1 and Fig. 2 show cylinder diameters before and after experimenting.

![Graph showing cylinder diameters before and after treatment](image)

**Fig. 1** Diameters of cylinder 1 in the plane perpendicular to the camshaft axis

![Graph showing cylinder diameters before and after treatment](image)

**Fig. 2** Diameters of cylinder 2 in the plane perpendicular to the camshaft axis

Before measuring of the fuel consumption started, the engine had been in the idle running for about 30 min, with the cooling liquid temperature being 90 – 95 °C. This was aimed at achieving more uniform oil viscosity when measurements were made. Fuel consumption in the idle running of an engine before pouring a repairing – restoring compound and after each treatment is shown in Fig. 3. The reduction of fuel consumption in the idle running of the vehicle may be accounted for by decreased mechanical friction losses.

In order to determine if the compression variation at the end of compression stroke, the cylinder compression was measured after each application of the compound. Compression measurements were made at the oil temperature reaching about 70°C.

The revolutions of the engine during measurement were about 300 ± 20/min. The results of measurements after the third application of the compound are given in Fig. 4.
Fig. 3 Fuel consumption during the idle running of the vehicle after each compound application

Fig. 4 Cylinder compression before and after the compound application

6. Conclusions

1. The experiments reveal that up to 0.02 mm thick ceramic layer has formed on the cylinder walls after the engine had been running about 30 hours, with the repairing - restoring compound poured in it.
2. According to the obtained fuel consumption of the engine in the idle running, friction losses in the engine decreased by about 3.5%.

References
