ANALYSIS OF THE HARDENING PROCESS OF AUTOMOBILE ENGINES AFTER REPAIR

Ilkhomjon Kasimov

Associate Professor of the Department of Automotive Engineering and Transport, PhD Andijan State Technical Institute,

Tel.: +99897 272 07 37

E-mail: ikosimov1970.andmi@gmail.com

Annotation. This article analyzes the process of post-repair engine hardening, the results of many studies on the topic, and the influence of other factors on the service life of an engine that has undergone major repairs. Methods and technological solutions for engine hardening were also considered and then analyzed.

Keywords*:* engine, overhaul, hardening, crankshaft, test bench, grinding, idle, resource.

Аннотация. В данной статье анализируется процесс обкатки двигателя после ремонта, результаты многочисленных исследований по данной теме, влияние других факторов на ресурс двигателя после капитального ремонта. Также рассмотрены и проанализированы методы и технологические решения обкатки двигателя.

Ключевые слова: двигатель, капитальный ремонт, обкатка, коленчатый вал, испытательный стенд, шлифовка, холостой ход, ресурс.

Annotatsiya. Ushbu maqolada ta’mirdan keyingi dvigatelni chiniqtirish jarayoni, mavzuga oid ko‘plab tadqiqotlar natijalari, kapital ta’mirdan chiqqan dvigatelning resursiga boshqa omillarning ta’siri tahlil qilingan. Shuningdek, dvigatelni chiniqtirish usullari va texnologik yechimlari ko’rib chiqilib so‘ngra tahlil qilingan.

Kalit so‘zlar*:* dvigatel, kapital ta’mir, chiniqtirish, tirsakli val, sinov stendidagi, silliqlash, salt xarakat, resurs.

Introduction

Research is being conducted worldwide aimed at developing new scientific and technical solutions for resource-saving technologies and technical means for the repair of automobile engines. In this direction, research on the production of basic parts of automobile engines, the creation of new methods and technologies that allow increasing their service life, is a priority. In this regard, special attention is paid to the use of high-quality spare parts at all stages of automobile engine repair, ensuring high quality of work when performing technological operations, as well as saving energy and resources, refining the engine, which is the final repair operation, and polishing friction paired parts [1].

In our republic, along with the development of the automotive industry, large-scale measures are being implemented and certain results are being achieved for the efficient operation of cars used in the national economy, their maintenance

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and high-quality repair of parts, the use of friction structures that allow for effective smoothing of working surface roughness, and the development of energy- and resource-saving equipment and technologies. The New Uzbekistan Development Strategy for 2022-2026 defines important tasks, including "Reducing losses in industrial sectors and increasing the efficiency of resource use." In the implementation of these tasks, including technological modernization of working bodies, reducing operating costs and reducing their cost by bringing the resource of working bodies to the level of the resource of working bodies produced by leading world enterprises, is of great importance [2]. Engine running-in, running-in. Owners who have used a car for many years become so accustomed to it that they don't want to buy a new, more functional, and modern car. They study the strengths and weaknesses of their car so well that they prefer to continue repairing it, investing in major repairs, since they have invested so much effort in maintaining its beautiful condition[3].

The most expensive and labor-intensive work is the overhaul of the engine. It is performed by the most experienced masters, who also give advice and recommendations for further operation. For reliable operation and long service life of the power unit, special attention should be paid to hardening.

METHODOLOGY

Our main methodology is experimentation. First, the engines were repaired, and then special technologies were used for their hardening. During the hardening process, the engine's temperature, vibration, and other performance indicators were regularly recorded [4]. These data were analyzed, and the state after repair and operational efficiency were assessed.

In addition, the study of scientific literature provided the necessary theoretical base for the research. International and national standards, scientific articles, and manuals on the repair and hardening of automobile engines were comprehensively analyzed. This, in turn, made the experimental results more accurate and reliable.

The observation method also played an important role in the research. After the repair, constant monitoring of the engine operation was established by specialists. The operating temperature, oil quality, and other technical indicators of each engine were regularly recorded, which made it possible to constantly monitor their performance [5].

Also, using the comparative analysis methodology, the differences between post-repair hardened engines and new, not yet used engines were studied. As a result of this analysis, the effectiveness of the repair and hardening technology was determined.

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Statistical methods were widely used in the research. The indicators obtained based on the results of the experiment were processed using mathematical modeling, correlation and regression analysis, and the reliability of the results was assessed. This process helped to identify the most important factors in engine running-in [6].

The engines selected for the experiment belonged to different models and manufacturers, each of which had its own specific technical characteristics. This ensured the comprehensiveness and generalization of the research results. Each engine was first inspected and the initial parameters were measured. Then, repair and hardening work was carried out, and the results were recorded in detail at each stage [7].

The equipment used in the process was modern, allowing for high-precision measurements. For example, dynamometers were used to measure power, and highly sensitive sensors were used to determine temperature and vibration. Also, the composition of exhaust gases from the engine was regularly monitored, which provided additional data on reducing the impact of the engine on the environment.

To ensure the reliability and validity of the research, all processes were repeated several times. The results of the experiment were constantly checked and confirmed by specialists. This indicates the stability of the obtained data and their reliance on accurate results.

DISCUSSION AND RESULTS. Friction surfaces, such as crankshafts, bearings, cylinders, and piston rings, are machined, polished, and lubricated to the highest accuracy class, but the friction force between new parts remains high. At the initial stage of operation, this leads to significant depreciation. To minimize this depreciation, smooth adjustment is necessary.



Figure 1. Engine hardening process after repair

Analysis of the results of numerous studies on this topic clearly shows that inadequate hardening, incomplete compliance with regulatory requirements reduce the engine's service life by more than 25%.

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Fig 2. Key factors affecting engine life

Other factors also affect the life of an engine that has undergone major repairs, including:

• equipment used, assembly conditions; even a maintenance center equipped with the most modern equipment cannot compete with a car manufacturing plant; in many parameters, the quality of assembly and control is significantly lower than that of the plant; if the assembly is carried out by the foreman in his garage, with only a set of keys and without control equipment, the engine life will be less than that of the plant;

• the quality of the assembly, the lubricants used; craftsmen recommend installing the best spare parts (piston, ring, bearing), regardless of their cost, using modern, expensive, and additive oils;

• the condition of parts not replaced during repair; this condition is directly related to the vehicle's mileage; due to natural wear and tear, their technical parameters do not correspond to the parameters of new parts.

Poor quality hardening can lead to a number of problems: difficulties in starting the engine, engine overheating, increased fuel consumption, and non-compliance with environmental standards. The desire to save on spare parts, rolling costs, especially in cases of major repairs for the purpose of selling the car, leads to a significant reduction in resources.

Engine hardening methods. Grinding of new parts inside an engine that has undergone major repairs is carried out by several methods:

1. Cold hardening - using stands with control tools and the possibility of changing operating modes;
2. Cold hardening without a stand, using available means;

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3. Direct heat hardening;
4. Smoothing with a conventional method (spraying).

Characteristics of cold hardening on a test bench This grinding option is the best; it provides complete control over the process and allows changing operating modes. The main part of the stand is a body in the form of two guides, in which an electric motor, several sensors, measuring instruments, and control mechanisms are installed. The crankshaft is connected to the electric motor shaft by means of a cardan; other units in the rotary motion transmission circuit can be gearboxes, reducers. The rotational speed of the drive motor shaft is controlled using an angular rotation sensor or tachometer. All operating modes are determined by a computer program that takes into account the sensor readings.

The duration of the start-up stage depends on the type of engine, the volume of work performed, and the replaced parts. Grinding of the components of the cylindrical-piston group takes an average of 2-3 hours. The process involves breaks, visual control checks, and increased work time after each stop [5,6].

As a result of training, the following indicators should be achieved:

• stable crankshaft speed in idle mode (not more than 600 rpm);
• the engine should not stop on its own and should accelerate smoothly and without a decrease when the fuel supply increases.

Operating a cold engine on a machine requires the use of complex equipment and tools, and there may be only a few service stations.

Cold grinding without using a stand

The engine is installed in the car, the cooling system and fuel supply are connected, and the previously removed suspension additives are returned to their place. They are filled with oil and cooling water, but do not start the engine. The machine is connected to the towing gear, switched to the 3rd gear, and so on, initially slowly, with pauses, and then faster for 2-3 hours.

The rotation of the wheels is transmitted to the crankshaft, so smoothing occurs. This method is popular among those who repair engines in the conditions of a motorist workshop, but specialists are skeptical of it.

Skilled car service specialists make a house-building device for cold hardening: instructions, an electric motor, a transmission system, but without expensive control and management devices. This is not a full-fledged factory stand, but even such an outdated device for cold grinding gives good results.

Methods of engine hot running-in.

The technology of this method is quite simple; it does not require a service station, test stands, or other additional equipment. During the process, the quality of assembly, the tightness of the lubrication and cooling systems are checked. With

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the help of this method, the roughness in the dimensions of the installed parts is partially leveled. The sequence of actions is:

• starting the engine; the crankshaft must rotate at a minimum speed;

• after the first start, start the engine for 1-3 minutes, stop it, and check that the fuel, oil, and cooling water do not leak;

• after cooling, start the engine, increasing the idle time;

• gradually and periodically increase the crankshaft speed to half the maximum speed during subsequent starts; The duration of the process is not clearly defined; craftsmen determine it based on their own experience and opinions.

During idle operation, the temperature sensor shows a sharp increase when it stops working, you need to turn off the unit, wait for it to cool down, check the liquid level in the radiator, and identify other causes of overheating. After completing the hardening process, the levels of technical fluids and compression are measured again, the compression and tightness of joints are checked, valve openings and ignition system parameters are checked.

Hardening under normal conditions

This method is used for partial disassembly of the engine without removing it from the vehicle, replacing some parts: crankshafts, chains, valve handles. After assembly, they begin to drive, maintaining low speed and maintaining speed from high rotations. After covering a distance of 500 km, the running period can be considered complete. After major repairs, it is necessary to cover a distance of at least 2000 km in a gentle mode.

If the piston rings need to be replaced without polishing the liners, an improved smooth mode is required, while maintaining the old pistons and strengthening the conserved mode. This involves smooth starting from the parking lot, limiting speeds to 60 km/h, low gear, and the use of high-quality fuel. In this case, it is necessary to cover 4000 km.

Engine oil change during running-in

Professionals recommend using high-quality oil intended only for a specific engine type and operating conditions. The conversion frequency is:

• after covering the first 500 km;

• after 1000 km - second replacement;

• after covering the next 1500 km - the third replacement;

• fourth replacement - after covering another 2000 km.

After a short period of major repairs, replacing engine oil may seem excessive, but it is justified. The more thoroughly the commissioning process is carried out in accordance with all recommendations, the longer the service life of the power unit.

CONCLUSION

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Upon completion of repair work, specialists recommend operating the vehicle in "careful mode": do not drive long distances immediately, move at low speeds, and do not overload the engine. Failure to comply with these rules significantly reduces the service life of the engine, although this does not lead to its immediate failure. Based on the recommendations of experienced masters, the article describes how to harden the engine in the best possible way.

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