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ROAD AND CLIMATIC OPERATING CONDITIONS AND WEAR OF ENGINE PARTS

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ABSTRACT
The article presents the results of work on a qualitative assessment of the degree of influence of various causes on the wear of parts of automobile engines operating in conditions of high temperature and dusty air in the Central Asian zone. Based on the analysis, specific conclusions and proposals are offered to improve the durability of cars by using an effective system for protecting engines from mechanical (dust) particles of contaminants that enter them along with air, fuel and oil [1].

Keywords: Car, engine, motor oil, road climatic conditions, wear, abrasive, corrosive, mechanical, road dust [2].

INTRODUCTION
The operation of automobile vehicles in various operating conditions, especially in quarries where there is increased dust in the air, causes increased wear of their parts and mechanisms, and with increasing wear of vehicle parts, fuel consumption and other operating materials increase, and frequent failures and breakdowns occur [3].

Worn parts of the steering and brake system impair vehicle controllability, reducing driving safety. Wear of parts, assemblies and mechanisms causes a change in the original dimensions of parts and their geometric shape, which subsequently leads to a significant increase in the gaps between rubbing parts, the appearance of noise, knocking and vibration [4].

The largest number of malfunctions and failures in components and mechanisms occurs as a result of the natural process of wear of parts. An increase in the gap in mating parts is allowed up to a certain limit, which is different for different matings and depends on their design and purpose. When the mechanism operates with a gap exceeding the permissible limit, the wear of parts increases rapidly and can lead to a significant increase in fuel consumption and operating materials, to a strong emission of toxic substances that pollute the atmosphere and to a decrease in the efficiency of the vehicle [5].

When designing cars and their engines, as a rule, they are designed to operate in moderate climate conditions, although various natural and climatic conditions, especially extreme ones, have a significant impact on the reliability and durability of engines [6].

Due to the fact that the climatic conditions of European zones are moderate, we believe that the influence of such operating conditions on the wear process of machine parts is minimal

compared to other extreme cases. When operating vehicles in temperate climatic zones, the wear of parts is mainly influenced by technical factors of maintenance and repair [7].
Due to the fact that engine parts are subject to the greatest friction and wear, and 43% of all costs for car spare parts fall on the engine, in order to reduce the large amount of work, we consider it advisable to further consider the essence and degree of influence of climatic conditions on the rate of wear parts in relation to the engine [8].
There are the following main types of wear of engine parts: abrasion and scuffing of rubbing surfaces. Under normal engine operating conditions, wear occurs mainly on cylinder liners, piston rings, liners and bearings. The nature of abrasion can be: mechanical, corrosive and abrasive. Under normal operating conditions, it is the wear of parts that determines the service life of the engine. The table presents the components of the general operational wear of automobile engine cylinders for the temperate climate zone and the Far North [9].
Components of the general wear of cylinders of automobile engines in operation (in percent).

Table 1. Operational wear of automobile engine cylinders for temperate climate zones and the Far North

Components of general wear	Temperate climate zone				Far North
	ZIL-130	ZMZ-53	YaMZ-236	YaMZ-238	YaMZ -238*
General operational	100	100	100	100	100
From normal warm mode	15,1-32,1	15,8-30,8	19,8-29,7	19,3-29,0	15,3-22,9
From reduced thermal conditions	5,0-10,7	5,3-10,3	4,2-6,3	4,1-6,1	33,6-50,4
From inter-shift starts	10,9-23,4	2,4-4,7	8,412,7	8,9-13,3	15,9-23,9
from dust entering the engine	33,8-68,9	54,3-76,5	51,3-67,7	51,6-67,5	2,8-35,2

* When transporting ore.
** Including uninstalled engine operating modes in terms of speed and load.

Engine operation in the Far North during the cold season is considered extremely difficult. Extremely low ambient temperatures can cause a drop in power and increased fuel consumption, cylinder jamming, etc [10].
When the temperature of the coolant decreases from 800 C to 600 C, wear of parts increases by 30%, and when it drops to 400 C, by 140% [4]. In this case, the wear of parts is corrosive in nature and with a decrease in the temperature of the coolant of the cooling system, the amount of this type of wear increases greatly.
The change in the wear rate of engine cylinders at low temperatures is caused by the following reasons: the presence of semi-dry friction between the cylinder walls and the piston rings; corrosion destruction of surface layers of metals [11].

Reduced thermal conditions, including cold starts, unsteady conditions, increased load and speed conditions, as well as the severity of the operating process have different effects on the wear rate of engine parts. However, in normal operation, the wear of parts of the cylinder-piston group is most influenced by abrasive dust that enters the engine from the ambient air in various ways [12].

High and dry ambient temperatures contribute to the appearance of detonation combustion in the engine, which is also one of the reasons for the increased wear rate of the cylinder, piston rings and piston. It is known that with severe detonation the engine overheats, which can result in molecular-mechanical wear, burnout and breakage of the compression rings and piston grooves.

High heat with inefficient operation of the cooling system leads to overheating of the engine, as a result of which engine power drops and specific consumption increases [13].

The climate in Central Asia is sharply continental: summers are long and very hot, and winters are short and cold. During the day, the absolute maximum air temperature in the shade reaches + 450 C, +470 C, sometimes +500 C and more, and at night it drops to +50...100 C.

In mountainous regions, after intense heat (40-470 C), a car passing through mountain passes finds itself in conditions where the air temperature is 0-10 C, i.e. a sharp temperature drop is 40-46 0 C. At mountain altitudes, air density and pressure decrease by 18.5% and 21.5%, respectively (at an altitude of 2000 m above sea level) [14].

As a result, the filling of the cylinders decreases, the mixture becomes richer, incomplete combustion and engine smoking occurs, excessive fuel consumption and intensive wear of parts of the cylinder-piston group occur [15].

Road and atmospheric dust has a significant impact on the wear rate of parts. Air dust content in a significant part of Central Asia reaches 3.5 g/m3, and during strong winds and storms - 17 g/m3, which is more than 10 times higher than air dust content in the temperate zone (0.003...1.42 g/m3) m3). For clarity of presentation, it is enough to say that when the dust content of the air is 0.8-1.2 g/m3, visibility is completely lost [16].

Dust entering the engine causes abrasive wear of its parts. This is explained by the fact that the dust contains quartz, the content of which ranges from 50 to 95%. The hardness of quartz (1000-1200 kg/mm2) is greater than the hardness of structural materials, which is why it causes abrasive wear of engine rubbing parts. Underestimation of this factor when designing and operating an engine can lead to an unjustified increase in the wear rate of parts and a sharp decrease in its reliability [17].

Abrasive particles entering the engine have different effects on the wear of its parts. Abrasive dust entering the engine along with air and fuel causes the greatest wear of the cylinders in the upper part, i.e. in the area where the piston stops at top dead center, the upper compression rings and the piston grooves. Abrasive particles entering the engine along with the oil cause the greatest wear on the crankshaft bearings, cylinders in the middle part, oil scraper rings, piston pins and bushings [18].

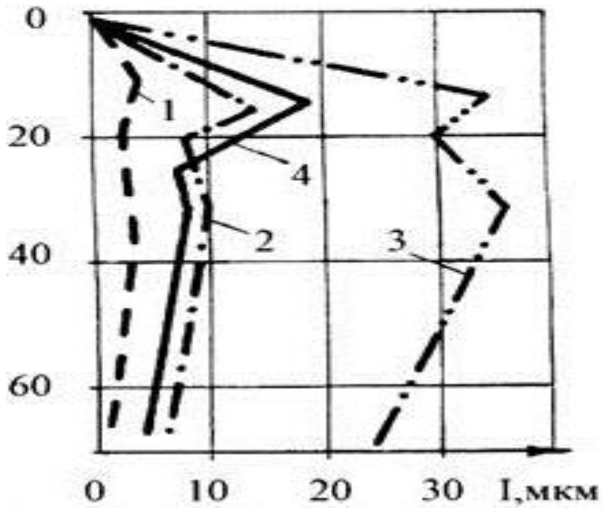

Figure 1. The degree of influence of an abrasive dust particle on the wear process of engine cylinders under various operating conditions [5]:

When the engine is running on gasoline with different contents of mechanical impurities (after 7 thousand km): 1-0%; 2- 13.5 g/t (0.00135%); 3 - the amount of dust entering the engine along with air, fuel and oil 40 g/t (0.004%); 4 - average operational wear .

From Fig. 1 it is clear that with an increase in the amount of dust entering the engine along with air, fuel and oil (line 3), the wear rate of its parts increases and in this case the wear is abrasive in nature. It should be noted that the wear rate of rubbing parts depends on the ratio of the surface hardness of the parts and abrasive particles. The lower the surface hardness of the parts and the higher the hardness of the abrasive, the greater the abrasive wear.

An increase in fuel temperature affects its density and viscosity. A decrease in density and viscosity causes a decrease in the mass supply of fuel to the cylinders and increases the amount of fuel flowing through the gaps in the plunger pairs. In this case, the high temperature of the fuel pump causes semi-dry and dry friction in the plunger pairs and fuel-lubricated parts, which leads to their intensive wear. The listed reasons lead to a decrease in the service life of fuel equipment by 1.5-2 times compared to operation at normal temperatures.

When considering the "part-abrasive particle-part" system, the mutual influence of hardness on the wear resistance of mating parts is noted. It is well known from the practice of operating automobile engines that the use of chromium coating (up to 200 microns) on the working surface of piston rings or increasing the hardness of cylinder liners (hardening their working surface to 40-50 HRC) leads to a simultaneous reduction in wear of both the ring and cylinder liners [ ] especially with leading abrasive wear. At the same time, the authors of the work [ ], in a study of 50 KamAZ-740 diesel engines, established: the largest amount of rubbing (72%) comes from the first piston ring, 20% from the second, and only 8% from the oil scraper ring.

Studies assessing the wear resistance of cylinder liners made of various materials under conditions of predominance of abrasive wear show that wear resistance increases in the following order: liners made of gray cast iron, with a niresist insert, and made of cast iron alloys. These results indicate that hardness is not the only characteristic of the mechanical properties of materials that determines their wear resistance, since the hardness of niresist is even slightly lower (156-197 HB) than that of gray cast iron (180-230 HB).

Thus, the analysis of the influence of various factors on the wear process allows us to draw the following conclusions: the wear of parts of automobile engines is influenced by many factors, such as load and speed operating conditions, which mainly determine the amount of molecular mechanical wear and thermal operating conditions, including periods start-up and warm-up, which determined the amount of corrosion-mechanical wear.
It follows from this that if the engine is insufficiently protected from dust particles, abrasive wear of parts increases sharply and this becomes especially important for vehicles operating in the Central Asian zone, where the atmospheric air is high in temperature and dusty.
We believe that the most accessible and cost-effective way to reduce wear of engine parts is to effectively clean air, fuel and oil and seal all places where dust can enter the engine.

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