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INTENSITY OF WEARING DETAILS OF ICE WHEN OPERATING IN MOTOR OIL WITHOUT AND WITH ANTIMICROBIAL ADDITIVES AND THEIR ANALYSIS

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Abstract

The presence of solid contaminants, in engine lubricating oil, impacts negatively on the performance of the engine and increase fuel consumption.

All types of machines and parts get worn out due to continuous usage and working. Decent maintenance and everyday checks are mandatory to ensure that the machines work for a longer time. During the operation of the machinery, wear occurs whenever there is interaction between moving surfaces, which causes the formation of wear particles from the moving parts resulting in their continual degradation. Wear is an unavoidable phenomena of surface contact between engine parts. Proper use of additives with FLM and adding additional filters can increase life time of ICE friction pairs and other parts.

Keywords: Quality, friction pairs, motor oil, oil films, wear, ICE, antimicrobial additives.

ИНТЕНСИВНОСТЬ ИЗНАШИВАНИЯ ДЕТАЛЕЙ ДВС ПРИ ЭКСПЛУАТАЦИИ В МОТОРНОМ МАСЛЕ БЕЗ И С АНТИМИКРОБНЫМИ ПРИСАДКАМИ И ИХ АНАЛИЗ

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Аннотация

Наличие твердых примесей в смазочном масле двигателя, негативно влияют на производительность двигателя и увеличивают расход топлива.

Все типы машин и деталей изнашиваются из-за постоянного использования и работы. Своевременное техническое обслуживание и ежедневные проверки являются обязательными для обеспечения того, чтобы машины работали дольше. Во время работы машины, износ происходит всякий раз, когда происходит взаимодействие между движущимися поверхностями, которое вызывает образование частиц износа от движущихся частей, что приводит к их постоянному разрушению. Износ является неизбежным явлением поверхностного контакта между частями двигателя. Правильное использование присадок с ТСМ и добавление дополнительных фильтров может увеличить срок службы пар трения ДВС и других деталей.

Ключевые слова: Качество, пары трения, моторное масло, масляные пленки, износ, ДВС, антимикробные присадки.

The performance of parts, interfaces (friction pairs), and components of internal combustion engines (ICE) during operation depends on various factors: the design, technology (quality) of production and the quality of fuel-lubricants (FLM).

If the extensive literature is devoted to the design of machine parts and machinery, as well as engineering technology, then the quality assurance of FLM and lubrication of the working surfaces of parts and friction pairs are left almost in the shade.

As a result of this, there is often an underestimation of the influence of the quality of motor oils (MO) on the performance and durability of the engine and of the machine as a whole.

The inability to properly select and assign MO for a specific case of operation, as well as to formulate requirements for the development of the desired grade MO.

As known, the MO in the period of operation perform several complex functions.

First of all, like all lubricants, they reduce energy costs for overcoming friction and reduce wear on the rubbing surfaces of parts, removing heat from the heating parts, protect them from corrosion, they clean the surfaces of accumulated pollution products both organic (various carbonaceous substances) and minerals (quartzite, alumina, mineral salts).

An important function of MO is the need for sealing mates (cylinder - ring, piston - ring, etc...).

Despite the significant difference in the performance properties of different MO, the requirements with which they must meet are the same.

Motor oils must:

- in all modes of operation of the ICE, smoothly flow to the friction surfaces;

- to ensure the least wear parts of the ICE and the cost of power to overcome friction;

- during long-term operation of the internal combustion engine, to be resistant to the action of high temperature and to form the smallest possible amount of carbon deposits and varnishes, as well as low-temperature deposits (sludge) on the walls of the oil receiver, oil pipes, crankcase;

- protect surfaces of ICE parts from corrosive damage;

- have an optimal fractional composition, providing minimal consumption for waste;

- possess high stability, maintain operational properties during transportation and long-term storage.

Regardless of the working process, power density and structural features of the internal combustion engine (carburetor or diesel) MO work in the most severe and adverse conditions compared with other lubricants.

So, in the CPG zone (cylinder-piston group), the temperature reaches such values at which oxidation and thermal decomposition of a thin oil film on the working surfaces of parts, intensive evaporation and burnout of a part of MO occur.

To ensure reliable operation of the internal combustion engine, the MO should have the ability to form strong oil films on the working surfaces of the parts, reducing friction and wear, as well as preventing the formation of high-temperature deposits.

Lubricating efficiency of MO depends on a combination of numerous factors that determine in aggregate - the nature of the influence of MO on friction and wear of lubricated working surfaces of parts and friction pairs of ICE.

One of these factors is the properties of MO (viscosity), including dependence on their changes in the process of ICE operation. Others - on the state and properties of the friction surfaces of parts, including their changes during the operation of the engine. Third - on the nature of the interaction between the components of MO, rubbing surfaces of parts and oxide films covering them. The fourth - on the load speed, temperature and other parameters of the friction mode.

The interaction of these factors is complex, sometimes controversial.

Special studies have established that additional difficulties introduce changes in the lubricity of MO due to its microbiological oxidation.

It has been established that MOs used in modern ICEs, which are operated especially in hot natural conditions, are constantly affected by microorganisms, under the influence of which MOs are unable to perform their functions.

In order to study the effect of changing the properties of MO without and with the addition of antimicrobial additives (alpha-naphthoquinone, ortho-hydroxyquinoline, dichloro-naphthoquinone) on the performance of parts, friction pairs (interfaces), components and mechanisms of ICE. The intensity of their wear, was investigated and determined the concentration of wear products in the samples of spent (past a certain range) of the studied MO by spectral analysis using a photovoltaic system - quantometer MFS - 3.

Sampling MO for analysis, sample preparation and spectral analysis was carried out according to GOST 20759 - 75 (Diesel locomotives. Technical diagnostics and prediction of residual life by the method of spectral analysis of oil. General rules).

Table 1 shows the results of spectral analysis of the concentration of chemical elements that have worked MO as a result of the wear of ICE parts, as the arithmetic average of the three definitions, taking into account 5 ÷ 10% discrepancy.

Table 1. The content of wear products in Motor Oil M-8A (GOST 10541 - 78) with and without additive dichloro-naphthoquinone depending on the mileage of the car [1].

Car mileage, km	The concentration of elements, g/t							
	Al	Fe	Pb	Cu	Cr	Si	Sn	
2 000	00005 / 00004	00014 / 00012	00023 / 00027	00007 / 00005	00028 / 00004	00085 / 00060	00009 / 00004	
4 000	00005 / 00004	00015 / 00013	00030 / 00029	00007 / 00005	00030 / 00004	00070 / 00070	00010 / 00004	
6 000	00006 / 00004	00018 / 00013	00045 / 00032	00007 / 00005	00035 / 00004	00080 / 00080	00013 / 00005	
8 000	00006 / 00003	00020 / 00012	00058 / 00033	00008 / 00004	00035/ 00003	00090 / 00090	00013 / 00004	
10 000	00008 / 00002	00020 / 00010	00070 / 00033	00008 / 00003	00035 / 00003	00100 / 00100	00013 / 00002	
12 000	00008 / 00002	00025 / 00010	00080 / 00022	00009 / 00003	00035 / 00004	00110 / 00120	00014 / 00002	
14 000	00010 / 00002	00030 / 00011	00090 / 00020	00009 / 00003	00040 / 00004	00120 / 00120	00014 / 00002	
16 000	00012 / 00001	00040 / 00012	00095 / 00020	00009 / 00004	00040 / 00005	00120 / 00130	00014 / 00003	
18 000	00013 / 00001	00055 / 00013	00095 / 00020	00009/ 00005	00045/ 00006	00125 / 00140	00014/ 00003	
20 000	00014 / 00001	00060 / 00013	00095 / 00020	00009 / 00005	00050 / 00006	00130 / 00140	00014 / 00003	

Note: in the numerator - MO without antimicrobial additives, in the denominator - MO with the addition of dichloro-naphthoquinone additive.

The change in the concentration of wear products in the tested MO without the addition of antimicrobial additives depending on the mileage of cars in hot operating conditions shows (Table 1) that the content of aluminum, iron, lead, chromium and other wear elements is constantly.

The change in the concentration of wear products in the tested MO without the addition of antimicrobial additives, depending on the mileage of cars in hot operating conditions, shows (Table 1) that the content of aluminum, iron, lead, chromium and other wear elements is constantly increasing. Which shows the wear of cylinders, bearing shells, piston rings, pistons, respectively.

The results of comparative tests of the intensity of wear of parts of the ICE showed that the concentration of various elements in MO containing antimicrobial additives (0.01 wt.%) was significantly lower compared to the concentration of the same elements in MO product (without antimicrobial additives).

Thus, an increase in the concentration of wear products (2–10 times) during the operation of the internal combustion engine on MO without antimicrobial additives (Table 1) indicates that complex processes of the interaction of MO with the microorganisms' vital processes occur.

At the same time, the normal working process in the internal combustion engine operation is disrupted, and the wear rate of parts begins to increase progressively after 6–8 thousand km of mileage.

Further operation of the internal combustion engine on this MO becomes unprofitable due to a decrease in its technical and economic indicators and the possibility of unexpected failures in the operation of the internal combustion engine.

Research results show that when using MO in ICE with dichloro-naphthoquinone antimicrobial additive, the wear concentration of all elements stabilizes sensitively from 2 thousand km of vehicles (Table 1). Which is an indicator with a good protective property (the concept of «protective property» includes the ability of FLM films to prevent damage to the metal surfaces of parts in friction pairs from electrical corrosion), providing a protective film of working surfaces of parts (friction pairs) of an ICE against oxidation, mechanical impact of abrasive particles and watering, i.e. preservation of their positive properties, which in turn leads to a decrease in the wear rate of the working surfaces of the engine parts.

All this testifies to the need to make certain concentrations of antimicrobial additives in MO, operated (used) in hot climates.

It should be noted that the concentration (quantity) of wear products in MO with antimicrobial additives by the end of the test - 20 thousand km of run - was less (about 2 times) compared to the mileage (10 thousand km) of cars running on the product MO, those. without additive.

For example, comparing the nature of the change in wear rate for iron (which is 80 ÷ 90% of cylinders of the ICE wear indicator) it can be noted that only iron in MO samples with antimicrobial additives is 4-6 times less than in samples with commodity MO, i.e. without antimicrobial additives.

Consequently, the process of wear of parts of ICE to a large extent can be determined by saturation (pollution) MO microorganisms, because due to the deterioration of performance properties (indicators), the protective properties of MO, which intensifies the wear of the working surfaces of parts, the friction pair, the amount available in quite a lot in ICE.

When low molecular weight (microorganisms' waste products) acids appear in MO as a result of its microbiological oxidation, as well as minor concentrations of water in MO, the protective layer of MO undergoes destruction, resulting in intensified wear of working surfaces of parts and the engine friction pairs.

In addition, the presence in the MO of a significant concentration of abrasive particles, especially in the form of quartz (as with and without antimicrobial additives), plays a dominant role in the process of wear of working surfaces of friction pairs of an ICE.

The results of the spectral analysis of MO samples (Table 1) convincingly prove that the fuel, oil and air filter elements installed in the fuel, oil and air systems of internal combustion engines of cars, tractors, road construction, agricultural and other machines are far from the desired indicators cleaning of contamination and protection of numerous parts, engine friction pairs from wear.

Analysis of the results of spectral analysis of MO samples shows that with increasing vehicle mileage, the concentration of fine quartz in MO increases evenly (Table 1).

Table 2 shows the results of studies that convincingly prove the degree of influence of contamination of MO on the rate of wear of a friction pair of ICE.

Table 2. The effect of MO contamination on the rate of wear sleeves and upper piston ring engine [2]

№	The content of mechanical impurities, in %	Particle size, microns	Wear rate, mg/h	
			Radial sleeve	Upper piston ring
1.	0,027	Up to 100	2,1	3,1
2.	0,1	Up to 50	0,35	6,0
3.	0,176	Up to 30	-	8,0

Thus, the use of antimicrobial additives alpha - naphthoquinone, ortho-hydroxyquinoline, dichloro - naphthoquinone in motor oil M-8A at a concentration of 0.01 mass %, contributes to the preservation of their performance properties, an increase in the service life and a concomitant decrease in the wear of working surfaces of parts, and friction of the internal combustion engine during operation in a hot climate.

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