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RESTORATION OF PAIRS FRICTION OF THE ENGINE DURING CONTINUOUS OPERATION

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Abstract: *Some results of laboratory tribotechnical and operational tests of various additives (the repair-operational preparations), including created with uses nanotechnology are presented, are presented the concept of technical service of engines without their disassembly.*

1. INTRODUCTION

Result of long-term researches of scientists-tribologists, in a huge degree of the Russian scientific school, there was that fact, that friction now is represented not only as a destructive natural phenomenon. It can be realized in the certain conditions, as creative process that has allowed to develop new, earlier not known methods of technical service of machines, including restoration of units and units of technics without their disassembly and during continuous operation [1-2].

Owing to works of the Russian scientists and experts has arisen and successfully the independent scientific and technical direction – "technical service of machines and mechanisms without their disassembly" which the complex of the technical and technological actions directed on carrying out some operations of maintenance service and repair of units and mechanisms without carrying out of operations of their disassembly is meant develops. It can include operations green run, diagnostics, preventive maintenance, autochemical tuning, clearing and restoration both separate rubbing connections and units, and machines and mechanisms as a whole [2-3].

On componental structure, physical and chemical processes of their interaction with rubbing surfaces, to properties of received coverings (protective films), and also to the mechanism of functioning during the further operation all should be divided repair-regenerative preparations into three basic groups: metal-plating compositions (remetallisants); polymeric preparations; geomodifiers. Layered additives, conditioners of metal are conditionally carried to reducers by criterion of increase of technical and economic parameters of the processed technics, and also nanopreparations (Figure 1).

In conditions of lack of financial assets at the majority of the population, the certain deficiency of accessible lubricants is the problem of maintenance in an efficient condition practically all domestic and second-hand import technics can be to some extent possible due to application of special repair-operational preparations and technologies not folding service, including on the basis of nanotechnology [2-3].

Nanotechnology has allowed to create such chemical structures which are programmed on removal of pollution and protection of rubbing surfaces, and also on their self-restoration [3-4].

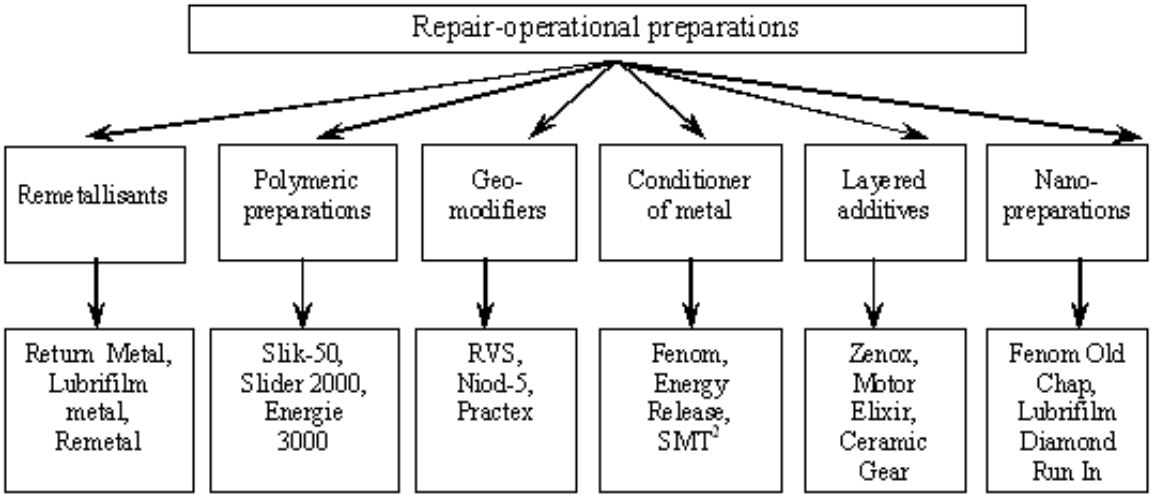

Figure 1. Classification of repair-regenerative preparations

Preparations differ on ways of application (introduction in rubbing connections). The majority of structures enter into oils, fuel or plastic greasings. Some of them submit through the power supply system (the inlet pipeline) in the form of aerosols and additives to fuel mixes (so-called “special treatment”). There are preparations which move directly in a zone of friction, for example, in cylinders of the engine, a nave of a wheel, etc.

In classical understanding process of restoration of a detail, connection or the machine as a whole means carrying out of the technical and technological actions directed on change or their geometrical sizes up to nominal either repair, or restoration of working capacity up to normative parameters. However to spend repair work it is meaningful even in the event that the problem of only partial performance of these requirements is put.

2. EXPERIMENTAL

Comparative laboratory tribotechnical tests were spent on research complex AE-5M. The most known additives of the various mechanism of action were tested: the synthetic conditioner of metal Fenom, metal-plating organic additive Renom Engine, the reconditioner of metal Old Chap, the geomodifier GTM and the new reducer developed by authors − Return Metal.

The plating preparation-reducer Return Metal represents the neutralized mix of fat acids, nanocomplexes of copper, iron, nickel and some other components.

Constructional and lubricants of real pairs friction "cranked shaft the bearing" (an aluminium alloy− steel) and "the cylinder − ring" (steel − grey pig -iron) Were investigated. As base tests of the same constructional materials for pure engine oil M-8-B (SAE 15W/30) are accepted. Duration of tests has made 180 minutes.

Modes of laboratory tribotechnical tests were set approached to real operating conditions of investigated connections: pressure in a zone of friction was established p = 10 MPa, speed of sliding v = 6,4 km/s, submission of a lubricant in a zone of contact Q = 0,085 ml/s.

The relief of a surface was looked through and fixed in raster electronic microscope Stereoscan-360 of firm Cambridge Instrument at various increases in the same sites in several places for revealing uniformity on a surface of friction.

Samples were weighed on analytical weights VLA-200 to within 0,0001 g. Temperature of samples was registered by the thermoelectric converter, and the moment of friction the special gauge established by the machine of friction. Physical and chemical researches were spent with use of AES-spectrometer PHI-590/550 of firm Perkin Elmer in the Scientific research institute of the general physics it. F.V. Lukin. After application of a reducer AES-spectra were removed from investigated sites for detection of copper in superficial layers with consecutive removal (bombardment by argon) top layers up to 0,1 microns on depth.

Application of repair-operational preparations is defined by a technical condition of the car. Thus necessity of this or that influence is estimated on the basis of results of technical diagnostics. By results of diagnosing are appointed or preventive preparations of "soft" action, or the preparations providing more intensive influence on rubbing connections and units of the car.

It is necessary to note, that sometimes necessity of application repair-operational is caused also by a number of others compelled, for example, participation in competitions, run or any other supernumerary tests.

With use of repair-operational preparations and technologies of restoration without disassembly there is an opportunity of practically full elimination of parametrical refusals, and also a plenty obvious.

3. RESULTS

Authors experimentally receive cyclic dependence of intensity of wear process of connection on concentration of a metal-plating complex. Analyzing experimental results, it is offered to describe studied process by the analytical formula of fading fluctuations. Received dependence is initial for a choice of the theoretical equation of fading f fluctuations:

$$Y = Y_o + A[\exp(-ax)]\sin(\omega_o x + \varphi), \quad (1)$$

where Y = I – intensity of wear process of connection, mg; x = C a weight share of a plating additive in engine oil, %; Y_o – shift of a zero line of fluctuations; A – initial amplitude of fluctuations; a – factor of attenuation of fluctuations; ω_o – about circular frequency of fluctuations; φ – a phase of the beginning of fluctuations.

Additional theoretical and experimental researches on studying process Have been lead , not only wear process of pair friction, but also the conditions of its possible restoration.

Dependence (figure 2) wear processes-restorations of pair friction «a cranked shaft – the bearing» (I, mg) from a weight share of a reducer Return Metal (C, %), described by the equation (2) and allowing to predict conditions of presence of regenerative effect in the given connection.

$$y = 2{,}3[\exp(-0{,}7x)]\sin(3{,}05x - 4{,}8). \qquad (2)$$

It is established, that at a weight share of reducer Return Metal 1; 3 and partially 5 % the regenerative effect consisting formation on surfaces of friction of protective copper servovit-films, defined weight (figure 2) and Auger spectroscopy (AES) methods is possible.

In the work for the first time theoretical factors of the equation describing process of wear process-restoration of given connection at use of metal-plating reducer Return Metal are by certain and experimentally proved $Y_o = 0$; $A = 2{,}3$; $a = (-0{,}7)$; $\omega_o = 3{,}05$; $\varphi = (-4{,}8)$.

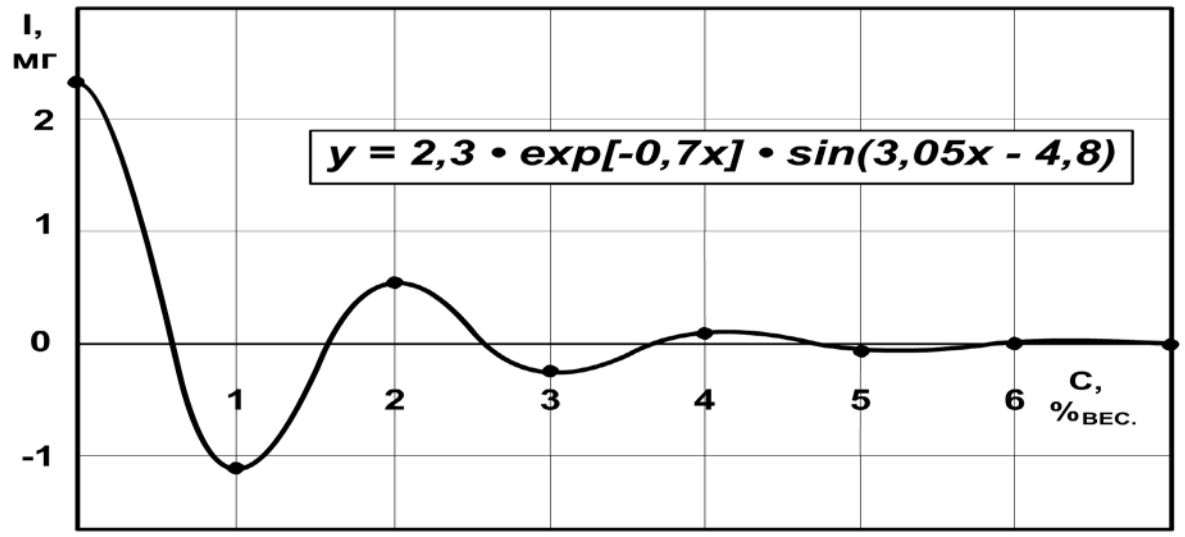

Figure 2 − Dependence of wear process - restoration of pair friction "a cranked shaft - the bearing " (*I*, mg) from a weight share of reducer Return Metal (*C*, %)

Comparative laboratory technical tests of pair friction “the cylinder – a ring” have revealed increase of efficiency from application of preparation Return Metal in comparison with base pure oil: in 12 times on deterioration, in 1,42 times on the moment of friction and on 44 % on temperature in a zone of friction.

Application of preparation Return Metal has provided significant decrease in deterioration of samples; in comparison with Fenom in 11 times; three times in comparison with Old Chap, in 2,5 times with Renom Engine and in 2 times with GTM (Figure 3 left).

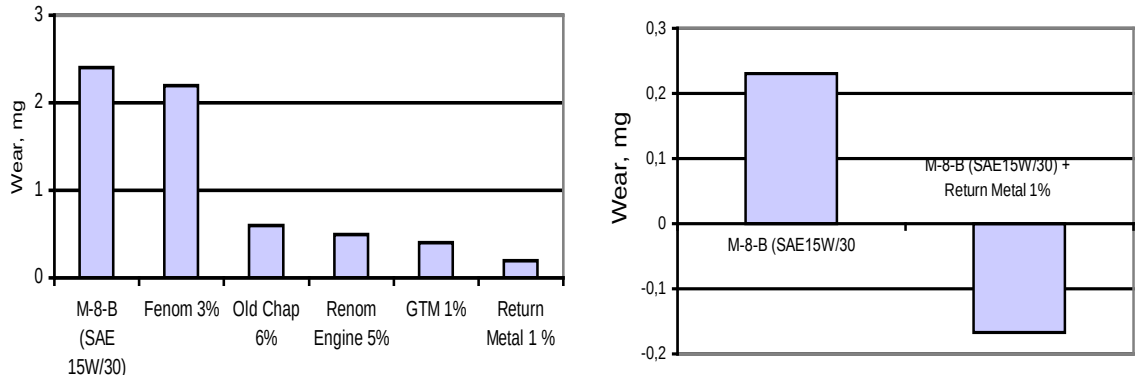

Figure 3. Results of tests of various repair-regenerative preparations

Thus, use of preparation-reducer Return Metal in the given pair friction has provided in comparison with other repair-regenerative preparations decrease in the end of tests of the moment of friction on 6,7…17,7 %, and temperatures in a zone of friction on 10…20 %.

Laboratory tribotechnical tests of pair friction "a cranked shaft - the bearing" (steel 45 - an aluminium alloy AO-20-1) have revealed restoration of aluminium samples on 0,17 mg at application of a weight share of reducer Return Metal of 1 % that confirms results of theoretical researches (figure 3). An explanation of restoring properties of a preparation is formation servovit-film on sites of contact of rubbing pairs.

By results of researches it is established, that surfaces of friction of steel balls after laboratory tribotechnical tests for pure oil at increase in 1000 times (Figure 4a) have obviously expressed centers with occurrence of sites the tease (white spots on a diagonal of figure). The dark sites in the picture (in the left bottom corner) represent the surfaces amazed by micro-corrosion processes. All this specifies insufficient antifrictional and anticorrosive properties of used base oil on the given modes of test [5].

After the test of the given pairs friction for compositions of a lubricant with a plating additive, it is established (Figure 4b), that application of an additive provides improvement of quality of a surface of friction. Apparently, on sites where earlier arose teases, such defects practically are absent. There were only insignificant teases had initially deep defects of metal (a dark spot in the center). Application of a repair-regenerative additive also have allowed to exclude occurrence of corrosion sites.

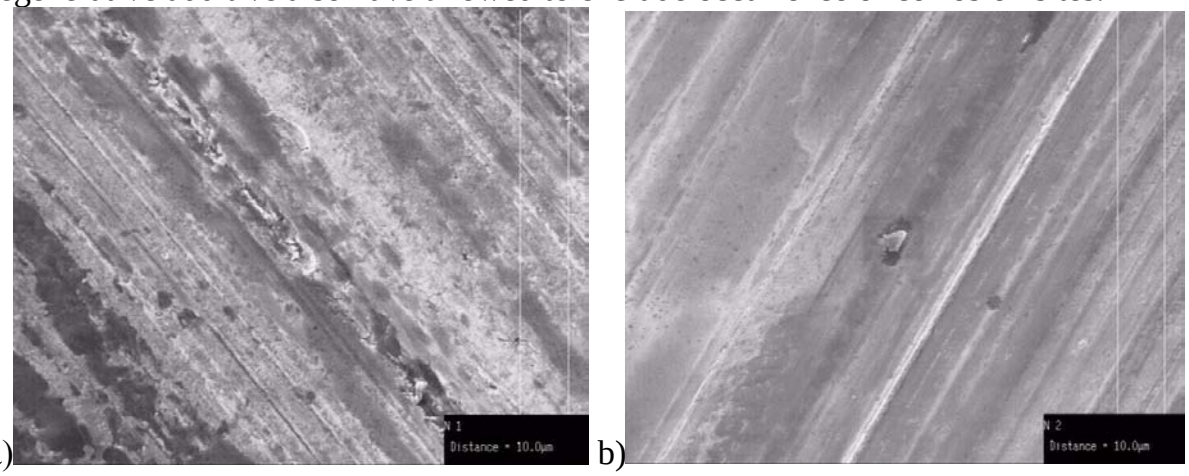

Figure 4. Appearance of steel surfaces of friction after laboratory tribotechnical tests for pure oil (a) and oil with a metal-plating additive (b)

On the basis of physical and chemical researches it is established, that metal-plating preparation Return Metal is capable to restore partially microdefects of rubbing surfaces by means of formation on them copper protective servovit-film, displayed two power splashes in copper on the AES-spectrum of investigated samples of friction.

On the basis of bench tests, it is established, that application of preparation Return Metal has allowed to raise a compression in cylinders of the engine on the average on 19 %, up to average value 0,87 MPa, to lower factor of non-uniformity in 1,73 times and to finish it to normative parameters.

The analysis of the received results of bench tests of engine GAZ-52 has shown, that use of repair-regenerative preparation Return Metal has provided, increase of effective power on 9 %, and decrease in the specific charge of fuel to 9,6 %.

More often it is directly after treatment high-speed characteristics (dispersal, etc.) at once appear better on 10…25. At the further operation restoration of the worn out surfaces of friction and other technical and economic characteristics of the unit proceeds. Technical and economic parameters increase before run 1,5…5 thousand in km, remain almost constant before run nearby 15 thousand in km, and then start to decrease gradually, being partially kept up to 30…50 thousand in km, according to some information - up to 80 thousand in km of run [2-3].

4. CONCLUSION

1. Research of the phenomenon of self-organizing of technical systems in rubbing connections of machines and mechanisms, dissipation energy, is abnormally low friction, Rebinder-effects and "no-wear effect" which are corner stones of synergetrics, have allowed to put forward the concept of technical service of engines without their disassembly of vehicles during continuous operation.

2. Results of tribotechnical tests of metal-plating preparation Return Metal have shown its high efficiency for application as repair-regenerative means for restoration of working capacity of engines of automobile technics.

3. It is necessary to note, that process of formation steady servovit-film long enough and, that the most important, gradual, therefore at tests, and also use of the processed technics can not be observed immediately after improvement of technical and economic characteristics of the machine, but their positive dynamics will be marked.

4. On the basis of operational tests it is established, that Application of metal-plating preparation Return Metal allows to restore a compression in cylinders of the engine up to 50 %, to lower the maintenance CO in the fulfilled gases to 3 times, to save up to 10 % of fuel and engine oil, and also to provide easier start and steady work of the engine.

5. Application of technologies of service of automobile technics without its disassembly allow to raise considerably wear resistance of rubbing connections, it is essential to lower economic expenses at its operation and repair. Operation of automobile technics in real conditions of the motor transportation enterprises of the country, and also responses of many private motorists specify, that their application is

reduced considerably with the general expenses for maintenance of technics in an efficient condition.

6. In connection with the last achievements of science and practice in this area time has come to make change and in definition of concept “Tribology”. Most fully a modern level of studying and development of the given question following definition would be reflecting. Tribology – a science about contact interaction of the mobile connections, covering a complex of questions of their friction, wear process, greasing and itself the organization (restoration).

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