

**LOW-TEMPERATURE GREASES FOR DRIVES OF THE DISCONNECTING
DEVICES WORKING IN THE CONDITIONS OF A FRIGID CLIMATE**

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Abstract

Being based on positive experience of use of additives to oils and greases from synthetic diamond ultradisperse powders, the way of application of powders from natural technical diamonds as an additive to standard low-grade lubricants that allows to lower coefficients of a friction of rest and sliding, at extreme temperatures of the North more than twice is offered, thus increasing to 50 % wear resistance of rubbing surfaces, thereby to solve a problem low-temperature lubricant materials for frigid climate conditions.

Key words: low-temperature greases, submicropowders, natural technical diamonds, operational reliability, wear resistance

1. INTRODUCTION

Thanks to a complex of unique physical and chemical properties, natural diamonds find today wide application in the newest high technology branches of technics, for example, as heat-conducting paths, in the semi-conductor technics, in iatrotechnics, abrasive and even greasing materials. Application of diamonds in electronics opens wide prospects in working out and the creation of devices of new generation which does not have analogs, capable to work in extreme conditions, and their application as an additive to standard low-grade greasings is reduced by coefficients of a friction of rest and sliding, at extreme temperatures of the North, more than twice, thus increasing to 50 % wear resistance of rubbing surfaces, i.e. motor potential.

2. THE PROBLEM CONDITION

2.1. Greasing material – a constructional element of knot of a friction

Application of separators, short-contacts and solid-short oil switches in the simplified schemes opened PY the Far North is accompanied by frequent failures because of refusals of drives of these devices at critical temperatures. The reason consists in absence of cold-resistant greasings, and applied TIATIM's greasings don't give desirable results though on technical conditions of manufacturers they are calculated on work at temperatures to a minus 50°C. For this reason operation of devices is conducted without greasing owing to what knots and mechanisms of engines and designs are exposed to the strengthened deterioration, there are breakages, failures. The same situation develops and in other industries, especially in mining where the majority of engines and mechanisms works in the open air at temperatures a minus 50°C and more low. The durability and reliability of work of devices, engines and mechanisms can't be considered in a separation from operational characteristics of lubricant oils and additives. The greasing material is necessary for considering as the integral element of a design of engines and mechanisms. The durability of the last can be increased by 50% and more thanks to increase of frost resistance and quality of greasing materials and additives to them.

Base engine oils and plastic greasings because of sharp increase in viscosity lead to decrease in wear resistance of mechanisms, to increase in time of operation of devices of automatics and protection, to the raised fuel consumption. Repair and restoration before time of the worn out details, knots and mechanisms demand additional expenses. Especially rigid requirements are shown to reliable work of the equipment and mechanisms of the power supplying enterprises. Switching-off because of failures on power objects lead to enormous losses. Therefore lubricants, being a constructional element of knot of a friction, along with other factors define its durability and reliability.

2.2. Application of additives for increase of wear resistance of knots of a friction

For the purpose of improvement of performance data of the greasing materials working at low temperatures, domestic and foreign manufacturers are developed and introduced a number of additives to engine oils which provide their all-weather suitability. In particular, rate of deterioration of the rubbing pair concerns such additives - from 2 to 10 times a thin-dispersed powder from synthetic diamonds (ASh) which addition in oils even in small quantities (0,05+0,5 %) reduces friction factor in sliding bearings in 1,5 ... 1,8 times, and. The volume temperature in a zone of knot of a friction decreases also, maximum loads increase by friction knot from 1,5 to 7 times. Because of selective adsorption viscosity of oil, at the same time discontinuity decreases and destruction of an oil film ("a dry friction") comes at higher speeds of relative sliding. It provides the best противозадирные properties of oils and allows to apply successfully them in high-precision metalcutting machine tools, including – leading western firms. Thus the oil expense in comparison with domestic marks twice decreases.

Today in oil development are continuous ethers – neutralization products carbon acids spirits at which the maintenance of atoms of carbon fluctuates from 4 to 22 and this oil basis *esters* is called. Unlike the usual oil which molecule a simple hydrocarbonic chain, at ester molecules is polarized and the electronic density is displaced to atom of oxygen of the carbon group, thus negatively ionized atom of oxygen always will take root into a crystal lattice of metals. As surfaces of any metals and alloys consist of positively ionized and neutral atoms metal will be always covered by very strong film of greasing, thus durability of an oil film reaches durabilities of natural diamond, and additive application to standard oils of all levels and other industrial oils is extended in a wide spectrum of application in engines, transmissions, manual and automatic transmissions, in hydraulic systems and so on.

It is known that at long operation of oils there is their aging to steady decrease in viscosity. It is connected by that long molecules of oil all time are used up in rubbing steams and decay under thermal influence. It also is at the bottom of loss of working viscosity. Additive addition to standard oils strengthens their structure, creating a strong uncreasable thermostable oil film, having excluded direct metal contact in rubbing steams at high loadings.

Such action of ultradisperse diamond powders is caused by new technology of their reception at which crystals accept the spherical form. These microscopic particles work in oil, as balls in the rock bearing. It is necessary to notice that machine and motor oils not a unique scope of an ultradisperse diamond powder. Application ASh in plastic greasings has shown that in comparison with traditional greasings, such as solidol, TSIATIM, litol, etc., leads to increase of wear resistance of knots of a friction in 1,2 ... 1,3 times, anti-friction on 6 ... 20%, and also to decrease in depth of damages in 1,5 ... 3 times and temperatures in a contact zone on 16 ... 19%.

In practice firm additives to oils successfully apply only at very small sizes of their particles that allows to stabilize their suspension on the basis of oils. It is recommended to use powders with possible narrower fractional structure that it is possible greater quantity of particles, dividing rubbing surfaces, perceived loading, reducing thereby specific pressure. In the conditions of a friction the film strongly connected with a surface is formed. The film prevents direct contact of microledges of roughnesses of rubbing metals, especially in the conditions of shock loadings.

Being based on positive experience of use of additives to oils and greasings from synthetic diamond ultradisperse powders, it is offered to apply to the same purposes powders from natural technical diamonds. It will allow to solve a problem low-temperature greasing materials for conditions of a frigid climate on the basis of one of natural resources Republics Sakha (Yakutia).

2.3. Structure of microparticles of natural diamond

Fractions with the size of particles *a smaller 1 micron*, about histograms of distribution of particles corresponding to the central part in the sizes, represent grains under the form close to synthetic diamonds (ovals).

Diamond submikropowders, unlike usual low-dispersed powders-fillers are not a filler, and a structureform material.

Microparticles of diamonds have difficult structure: a kernel from classical cubic diamond and a carbon cover round a kernel. This cover consisting from sp^2 - the hybridized atoms of carbon, is non-uniform on degree of orderliness of structural fragments. The blanket including atoms of carbon, is sated by a wide spectrum of various functional groups. Thus not diamond components of microparticles of diamonds are not impurity, and the organic components of a product substantially defining a complex of its specific properties.

In conformity with sequence of distribution in total amount of crystals of diamond quasihomogeneous ontogenesis areas are named: central (fig. 1a), intermediate – *b* and peripheral – *c*.

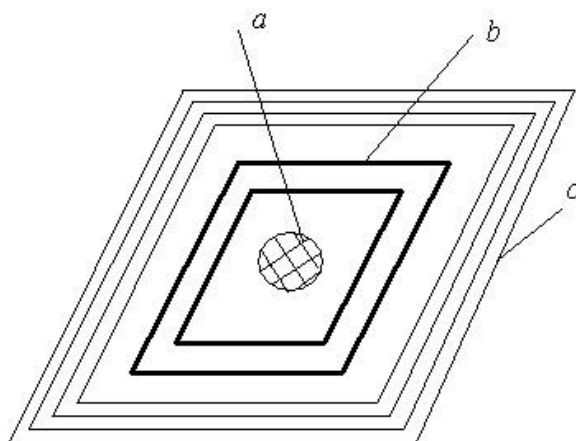


Fig. 1. Sequence of volume distribution quasihomogeneous ontogenesis areas in diamond crystals (the general tendency).

- a* – the central region;
- b* – intermediate area;
- c* – peripheral area of diamond.

Let's consider characteristic distinctions of areas.

The central region – represents the small site generated about the genetic center of a crystal at a stage of its origin. *For crystal morphology the central region* infringement ideal octahedrony facets, *occurrence of roundish and cubic surfaces is characteristic*. As a rule, this area contains the raised quantity of dispositions and other structural defects, effectively disseminating X-rays and causing a high double refraction. The last often forms a geometrical pattern «tatami». In the central region are raised a yellow, green, flavovirent or orange photoluminescence. The luminescence can and not be observed. The reason is luminescence suppression by structural defects. In spectra of infra-red absorption is absent or system B2 is a little intensive.

The short characteristic of three quasihomogeneous ontogenesis areas is resulted in table 1.

Pyramids of increase of cubic sides in sectorial octahedrons and dodecahedrons diamond possess all listed signs of the central region.

In them the raised quantity of dispositions and other structural defects, a flavovirent photoluminescence, low activity of IR-system B2 is observed. For this reason of a pyramid $\langle 100 \rangle_a$ are carried to the central region.

The intermediate area most boldly shows the properties attributed to natural diamonds as a whole is an internal zonalno-sectorial structure, a high structurally-abnormal double refraction, a blue photoluminescence. The intermediate area is non-uniform and contains the growth zones, different morphology and physical properties. Optical characteristics of separate zones of intermediate area change in a wide range: one zones are opaque, others are transparent, the third possess intermediate value of optical density; in crossed polyroids it is observed re-layer zones with a high and low double refraction; in one zones the blue luminescence is observed, others don't luminesce. Zones with a low double refraction are transparent to $\lambda \leq 225$ nanometers (type II_a), the luminescence isn't raised in them. In spectra of IR-absorption of intermediate area system B2 is intensive.

Table 1

Properties	Area		
	The central	The intermediate	The peripheral
Morphology	Roundish, an octahedron, a cube, a pyramid $\langle 100 \rangle_a$	an roughly-lamellar octahedron, an acute-costal octahedron, pyramids $\langle 111 \rangle_2$	an acute-costal octahedron
Perfection of crystal structure	imperfect, fibrous, dispositions	rather made	the made
Double refraction	very high	alternation of zones with a high and low double refraction	low or is absent
Absorption UF-light	$\lambda < 225$ nanometers N9 $\lambda < 260 - 300$ nanometers	$\lambda < 280$ nanometers N3	$\lambda < 300$ nanometers A
Absorption IR-light	$K_{B1}, K_A = K_{B2} = 0$, $K_A \approx K_{B1} \gg K_{B2}$ system 3107	$K_A \approx K_{B1} \approx K_{B2}$	$K_A > K_{B1} \gg K_{B2}$
Photoluminescence	green, flavovirent, yellow, orange	blue	it is not raised
Selective etching	strong, continuous	strong on borders of zones and growth pyramids	very weak

The peripheral area possesses a low double refraction, doesn't find out abnormal dispersion of X-rays, the photoluminescence isn't raised in it. All these signs specify in high perfection of crystal structure and homogeneity of this area, not broken by presence at it of high concentration of defects And. These defects shift UF-transparency border in a long-wave part of a spectrum to 300 ... 320 nanometers and cause occurrence of intensive system And IR-light absorption.

Volume parities of the central, intermediate and peripheral areas change from the sample to the sample. In smoothly-side acute-costal octahedrons with plastinchato-step sides – roughly-lamellar octahedrons – and in dodecahedrons diamond of type I_a or I_a+III are available the central and

intermediate areas without the peripheral. And, at last, diamonds cubic gabitus and quasihomogeneous crystals of physical type II_a or III have only the central region.

Applying diamond as an additive to greasing materials us *the central region* of its structure interests, allowing to receive fractions *ovals* forms.

Diamond possesses high firmness to grating. Its wear resistance in relation to corundum, exceeds this indicator in 90 times, and other abrasive materials – in hundreds and even thousand times. The comparative characteristic of physicomechanical properties of diamond with other firm materials shows its conclusive advantages and only the synthesized chemical compound – cubic nitride of a pine forest is artificial – can compete to diamond. Therefore application diamond submicropowders as an additive to standard greasings not only reduces friction factor, but also taking root into microroughnesses of surfaces of pairs a friction increase their wear resistance to 50 %.

Introduction submicropowders from natural technical diamonds in greasings, for example, on a basis ethyleneglicoles or fluororganic opens real possibility of reception low-temperature greasings for engines, mechanisms and the devices working in the conditions of the Far North.

2.4. A method of increase of wear resistance of lubricants

As it is known, antiwear action of lubricants is based on formation by them on rubbing surfaces of the protective films, capable to reduce a friction and deterioration. Researches of influence of a thickness of films, formed mineral oil of an oil origin without additives on intensity of wear process of rubbing surfaces in the conditions of various modes of operation have shown that in operational conditions of a film, formed oils and additives, have a thickness from 0,5 to 20 microns. High specific pressure in a zone of frictional contact cause sharp increase of viscosity of oil, than and bearing ability of a film is provided. However decrease in speed of sliding, increase in loading or application of oil with low viscosity can and to lead in the presence of a film to direct contact of microedges of roughnesses owing to reduction of its thickness. It is established that the quantity of products of deterioration and degree of their dispersion sharply decreases at a specific thickness of a film $\lambda > 2$. Specific thickness of a film λ - this relation of a thickness of a film h , formed oil and an additive between rubbing surfaces, to the sum of root-mean-square values of heights of microedges of roughnesses on these surfaces s (fig. 2), that is:

$$\lambda = \frac{h}{\sqrt{\sigma_1^2 + \sigma_2^2}}.$$

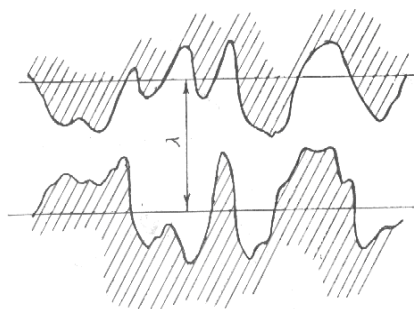


Fig. 2. The scheme of definition of a specific thickness of a film λ , formed oil with an additive in conditions of elastohydrodynamic mode.

On fig. 3 showed influence of a specific thickness of a film λ on character of a mode of greasing is shown. It is obvious that at $\lambda < 1$ (the area C) is created the maximum contact interaction of microedges at which antiwear properties of the films formed by an additive at chemical modifying of metals of surfaces of a friction are shown. In area "A" when $\lambda > 4$ and in area "B" ($\lambda > 2$) direct contact interaction of microedges of roughnesses is excluded and there should be no an adhesive wear process.

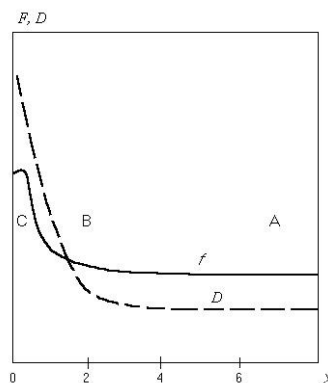


Fig. 3. Influence of a specific thickness λ on friction F and on deterioration D .

2.5. Laboratory researches of standard greasings with additives from natural diamonds

We develop technology of application in greasings of micropowders of natural technical diamonds. Samples of investigated lubricants prepared on a basis low-temperature plastic oil greasings TSIATIM, LITA, PGS.

Factors of a friction of rest (r) are defined and a sliding friction (sf) steam a steel-steel with various cleanliness of processing of a surface, at specific loading 50 g/sm^2 . Factor of a friction of rest was defined on effort moving, sliding friction factor - on effort at uniform movement. Viscosity of greasing and adhesive forces weren't defined.

Cleanliness of a surface:

1 counterbody - 7 class	1 sample - 8 class
2 counterbody - 8 class	2 sample - 9 class.
3 counterbody - 9 class	

Results of tests are resulted on fig. 4 and in table 2,

where: f_r - factor of a friction of rest; f_{sf} - sliding friction factor.

Table 2

Results of tests of standard greasings with additives from natural diamonds

Greasings	Counterbody											
	1-7 class				2-8 class				3-9 class			
	1 оѡп. (8cl)		2 оѡп. (9 cl)		1 оѡп. (8 cl)		2 оѡп. (9 cl)		1 оѡп. (8 cl)		2 оѡп. (9 cl)	
	f_r	$f_{\mathcal{A}}$	f_r	$f_{\mathcal{A}}$	f_r	$f_{\mathcal{A}}$	f_r	$f_{\mathcal{A}}$	f_r	$f_{\mathcal{A}}$	f_r	$f_{\mathcal{A}}$
Dry	0,36	0,3	0,32	0,3	0,37	0,32	0,37	0,31	0,4	0,37	0,39	0,37
TSIATIM	0,22	0,2	0,32	0,2	0,37	0,32	0,37	0,3	0,4	0,37	0,37	0,36
LITA	0,15	0,14	0,13	0,12	0,18	0,16	0,16	0,12	0,15	0,12	0,16	0,13
PGS	0,1	0,08	0,08	0,06	0,08	0,06	0,1	0,05	0,08	0,04	0,08	0,04
TSIATIM +5% 1 mkm	0,18	0,13	0,18	0,12	0,13	0,11	0,13	0,12	0,14	0,11	0,13	0,09
TSIATIM + 5% 40 mkm	0,35	0,3	0,3	0,24	0,28	0,18	0,28	0,19	0,22	0,16	0,24	0,16
LITA +5% 1 mkm	0,19	0,16	0,19	0,14	0,15	0,12	0,15	0,11	0,19	0,15	0,17	0,16
LITA +5% 40 mkm	0,2	0,16	0,19	0,15	0,22	0,17	0,22	0,17	0,44	0,4	0,44	0,38
TSIATIM +2,5% 1 mkm	0,21	0,12	0,21	0,16	0,16	0,13	0,2	0,13	0,18	0,11	0,19	0,11
TSIATIM +2,5% 40 mkm	0,26	0,21	0,22	0,19	0,3	0,15	0,29	0,2	0,23	0,18	0,21	0,14
LITA +2,5% 1 mkm	0,21	0,16	0,2	0,13	0,18	0,15	0,2	0,15	0,16	0,13	0,16	0,11
LITA +2,5% 40 mkm	0,22	0,16	0,21	0,16	0,19	0,15	0,18	0,14	0,16	0,11	0,18	0,11

Apparently from table 2 decrease in factors of a friction most typical for TSIATIM. So, additives in the size about 1 micron at concentration of 2,5 % and 5 % give decrease in factor of a friction in 1,5 ... 2 times. Micropowders in the size about 40 мкм don't give essential decrease in factor of a friction. For oil of LITA of an additive in 1 micron give insignificant decrease f_r, f_{sf} at a combination: a counterbody 8 кл. – the sample 8 кл.

For oil PGS an additive with a size about 40 microns increase friction factors, and at the sizes 1 microns don't cause appreciable effect.

Supervision by means of an electronic microscope have shown that positive effect strengthening at change of the sizes of diamond particles is caused by that in this case they takes root into a zone of frictional contact more. At contact of firm bodies owing to unequal rigidity there is an introduction of more rigid roughnesses in a surface of less rigid body. Thus deformation of more rigid body is much less, than less rigid, and she can neglect. Therefore, considering influence on process of interaction of firm bodies of a roughness of a surface, it is necessary to consider a roughness of a surface of more rigid body. Distinguish initial and established in the course of a friction (equilibrium) roughnesses of surfaces. The initial is understood as a roughness of a surface of the firm body, received in the course of its processing. The established (equilibrium) roughness is created on surfaces of contacting bodies in the course of a friction and depends on working conditions of frictional knot. Thus, decrease in height of microledges of a surface is reached. It leads to "smoothing" of roughnesses and to improvement of operational properties of lubricant.

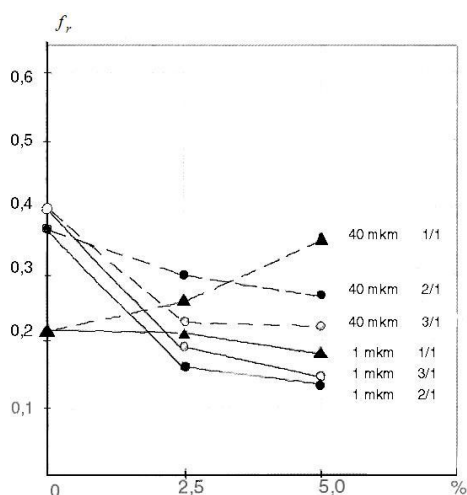


Fig. 4. Change of factor of a friction depending on percentage of additives
and the size of particles of diamonds.

1/1 2/1, 3/1 – in numerator counterbody number, in a denominator number of the sample.

Thus, research standard oil low-temperature greasings with additives from ultradisperse powders (UDP) natural technical diamonds have shown that at extremely low temperatures concentration of additives to greasings within 2,5 ... 5,0 % with the size of grains less than 1 micron reduces factor of a friction of rest and sliding twice, *providing reliable work hinge connections* of drives of an electric equipment and mechanisms in the conditions of the North.

3. A CONDITION AND PROSPECTS OF EXTRACTION OF DIAMONDS AND DEVELOPMENT OF THE DIAMOND INDUSTRY

In Russia of extraction of 99,8 % of diamonds makes AK «Diamonds of Russia-Sakha», from them about 80 % of total amounts it was necessary on a tube "Successful" which delivered the production on the world market about 10 million carat. The volume of production of other tubes – Sytykansky, Ajhal, Anniversary – fluctuates about a half-million carat. Against the general estimated world's reserves of diamonds the share of Russia is rather considerable (more than 30 %) and surpasses in volumes all large diamondiferous regions of the world: the Central Africa (850 million carat), Southern Africa (about 800 million carat), Australia (500 million carat).

In Yakutia to 80 ... 85 % make diamonds of technical application of all volume of extracted diamonds – low-grade, of little use for jewels. Therefore, as already it was told above, they can quite provide requirements of the newest high technology branches of the industries both as an abrasive material, and as additives to standard and again developed lubricants. Thus there will be a possibility of creation of new workplaces which are necessary in an uneasy situation of a world economic crisis. The role of technical diamonds and in electronic industry without which any state in the world today can't develop is invaluable.

The American engineer L. Devis in article «Economic and strategic value of diamonds used in the industry», published in March, 1955 in mountain-industrial and the technical journal of the South African Union so has estimated value of diamond for industrial potential of the USA: «For such modern, technically developed country as the USA, value of technical diamonds can't be overestimated. In the USA 12 million carats of diamonds in cost about 50 million dollars is annually consumed. It has been counted up that if this country has been cut off from sources of supply by diamonds its industrial potential for very short term would fall to half». It is necessary to add that in the fifties last century the USA bought up to 70 % of world extraction of diamonds. Now consumption of technical diamonds in the USA has even more increased, hence, and their value has increased in industrial potential of this country. Therefore Russia possessing huge stocks of such precious raw materials, it is necessary to take advantage of experience of the USA and to make efforts in expansion of scope of application of technical diamonds in the industries one of which are additives to greasings.

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