High Performance Turbojet Engine Nano-Lubricant

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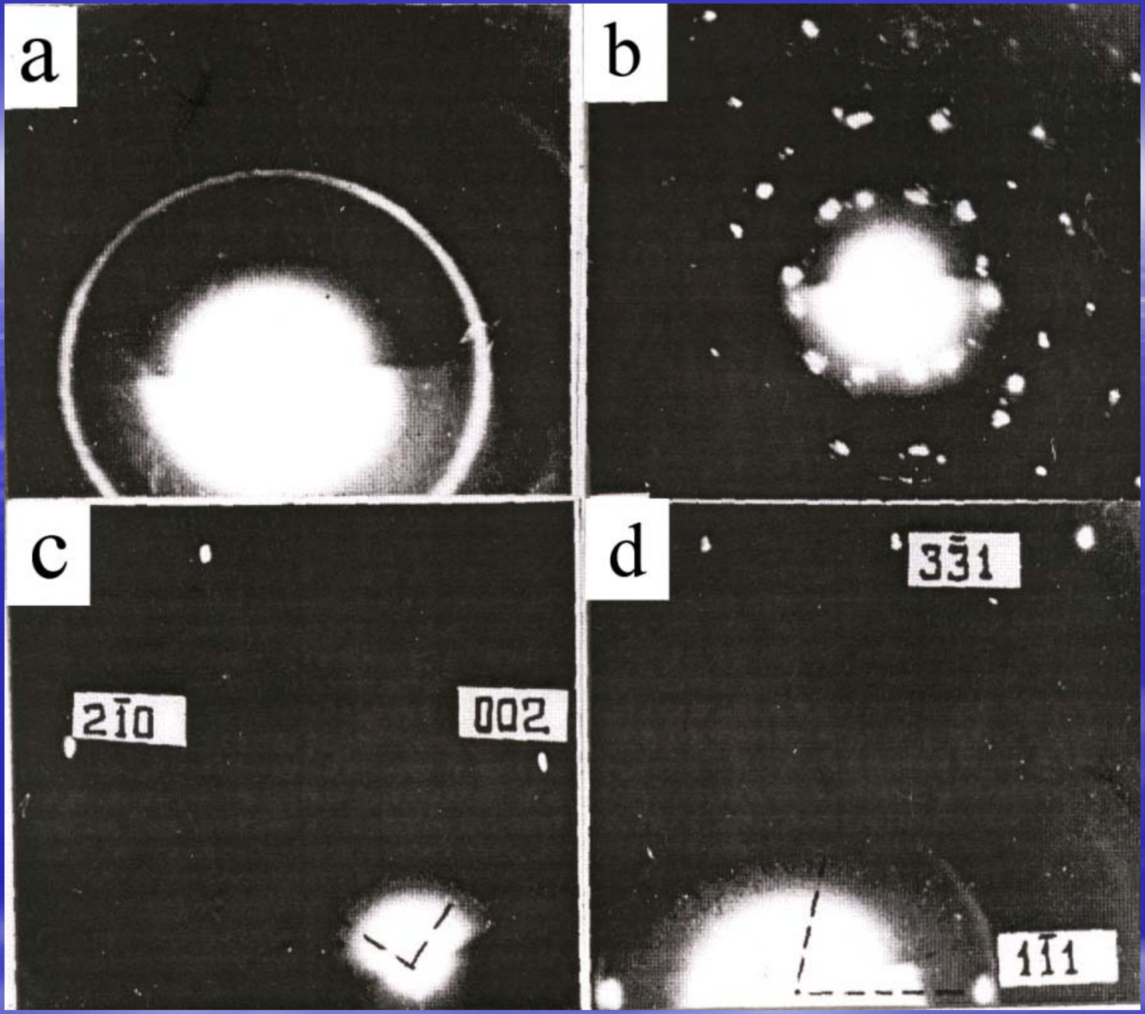
OBJECTIVES

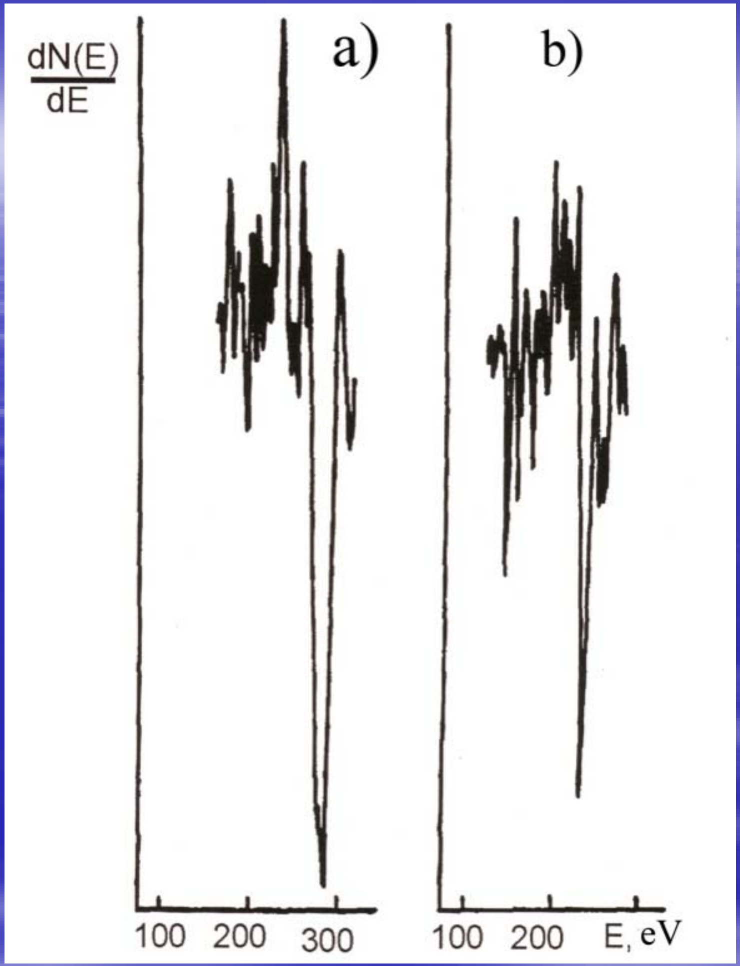
- To develop a high performance nano-lubricant
- A comparative SEM, TEM and Auger-spectroscopic studies of structure of friction surfaces lubricated using different commercially available lubricants and newly developed nano-lubricant

Introduction

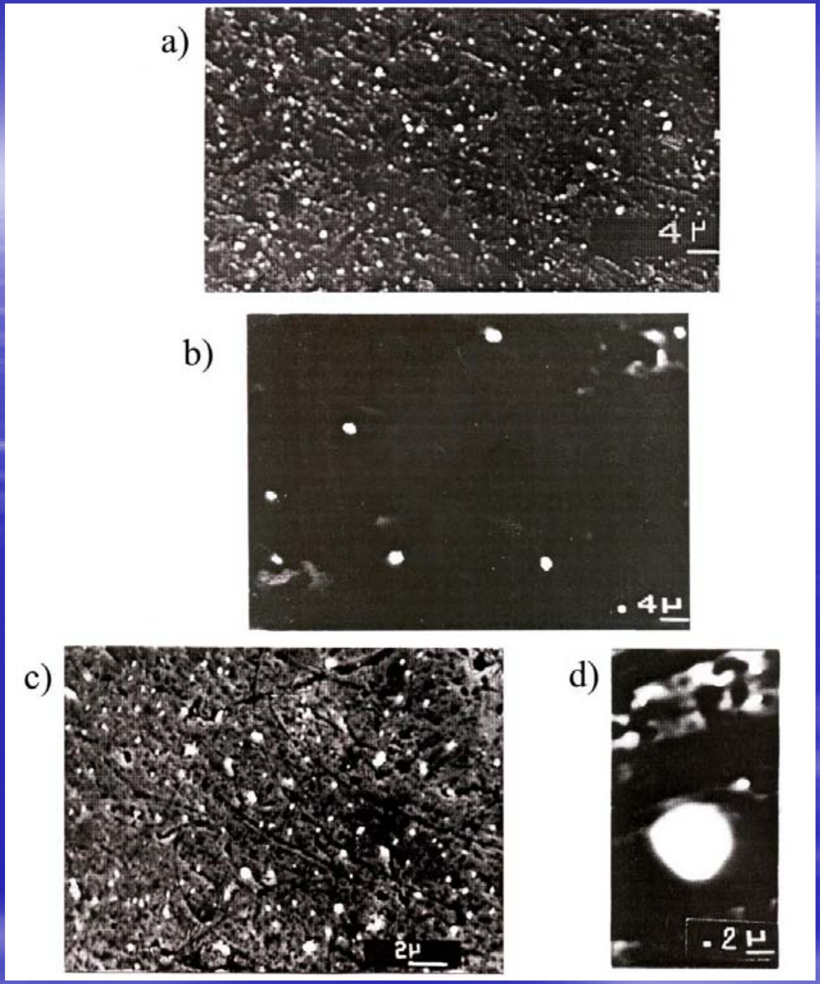
- The superfine amorphous carbon materials are of the great interest, as an additive for the vehicle transmission oil. It is defined that, the superfine amorphous carbon additives (SACA) are capable to develop the second structure films during friction process of two counter-faces, and the films possess the required functional features
- The investigation of structural condition of friction surfaces allowed us to determine the development of the hetero-phase thin film structure at wear of metals in the SACA environment. The mentioned structure consisted of amorphous carbon, hexagonal (lonsdaleite) and cubic diamonds. These phases are depressively arranged in the form of regular graphite-carbon cells and the grid of the tribo-synthesized diamonds. The dimensions of their inherent cells and that of the grid depend on wear conditions and have sizes, in the range of 0,01 -1mm



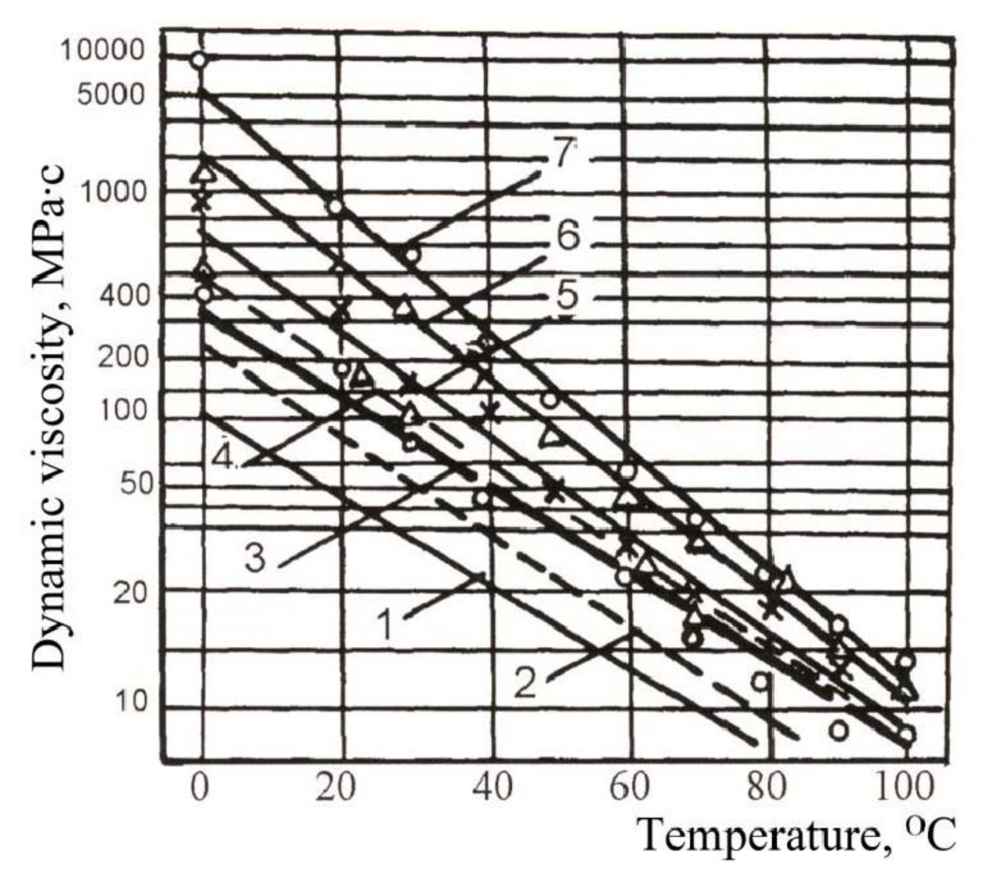
The electron-diffraction patterns obtained from the friction surface: a – amorphous carbon; b –graphite, c –lonsdaleite, axis of the zone; d –diamond, axis on zone



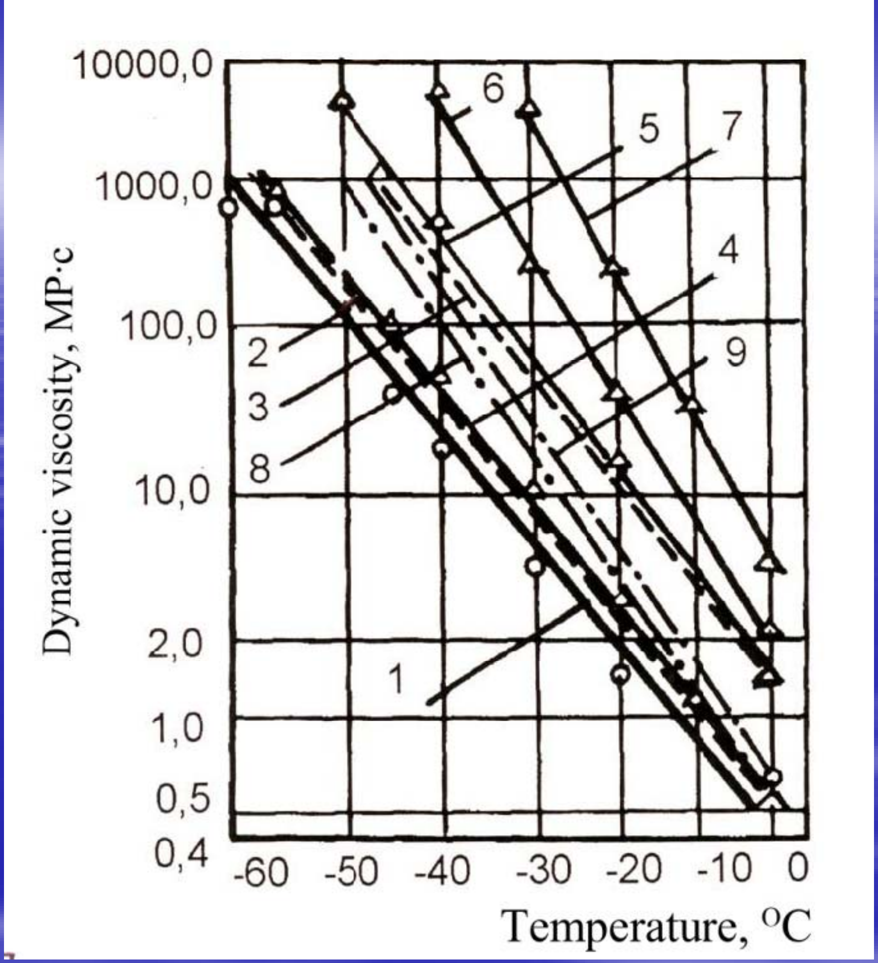
The differential KLL Auger-spectra for the carbon that are commensurate to the natural diamond (a) and the diamond synthesized on the friction surface in the oil environment with SACA



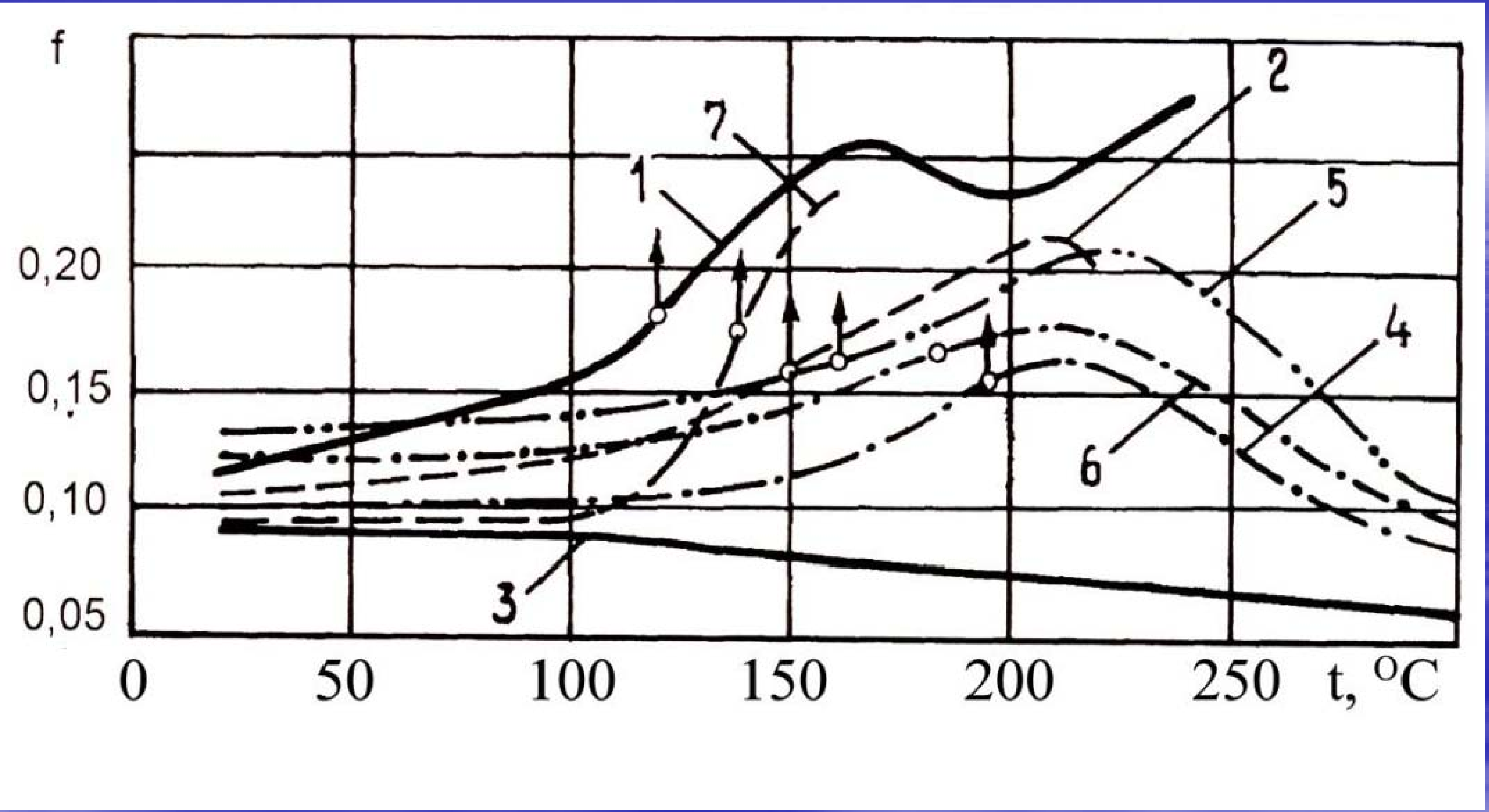
SEM images of the friction surfaces of steel balls worked in the environment of thin oil with SACA in the borderline lubrication condition during the sliding (a, b) and rolling with sliding (c, d). A, b –10 sec; c, d – 3,600 sec



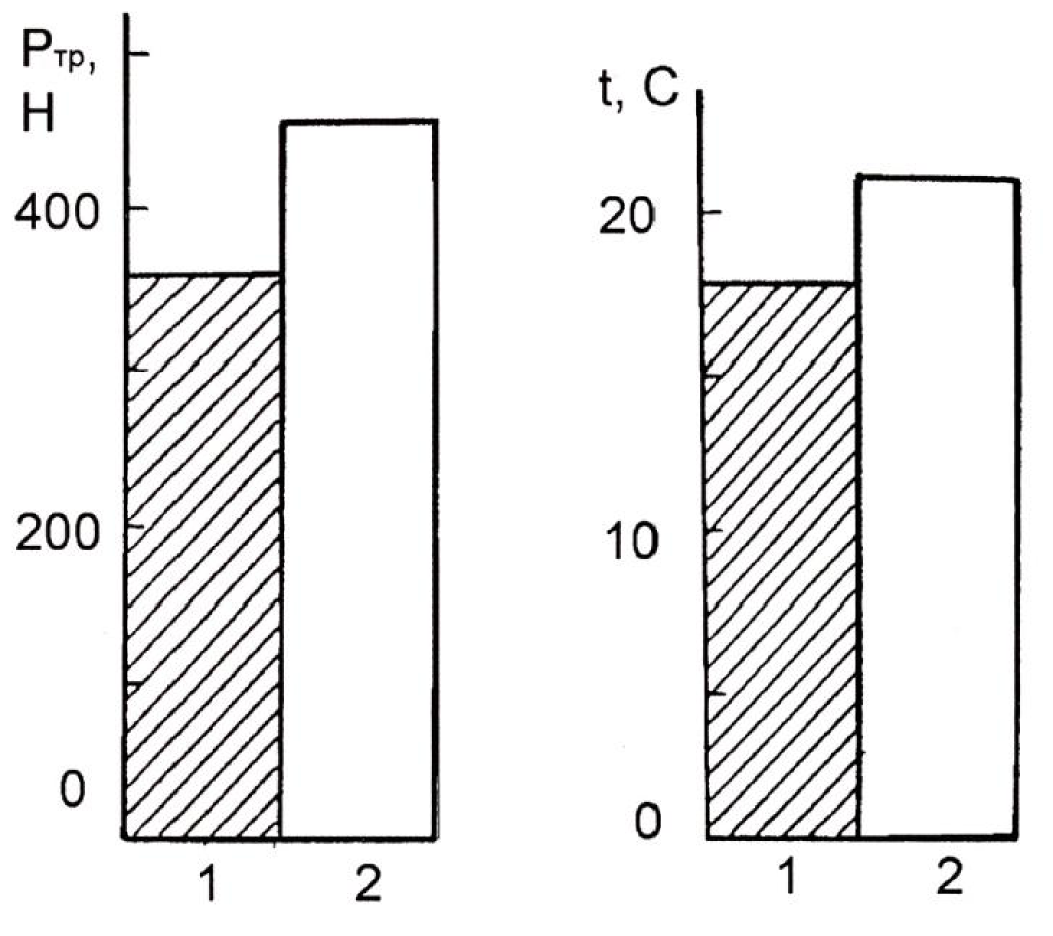
The viscosity-temperature properties of the I-12A oil with the SACA and other commercial transmission oils: 1 –I-12A; 2 –I-12A+17.5% Acor-1; 3 –I-12A+5% SACA+17.5% Acor-1+1%AzNII; 4 –I-12A+5% SACA +20% nigrolL+3%DF-11+1% AzNII; 5 –TCp-10; 6 –TCp-15k; 7 –Tap-15B



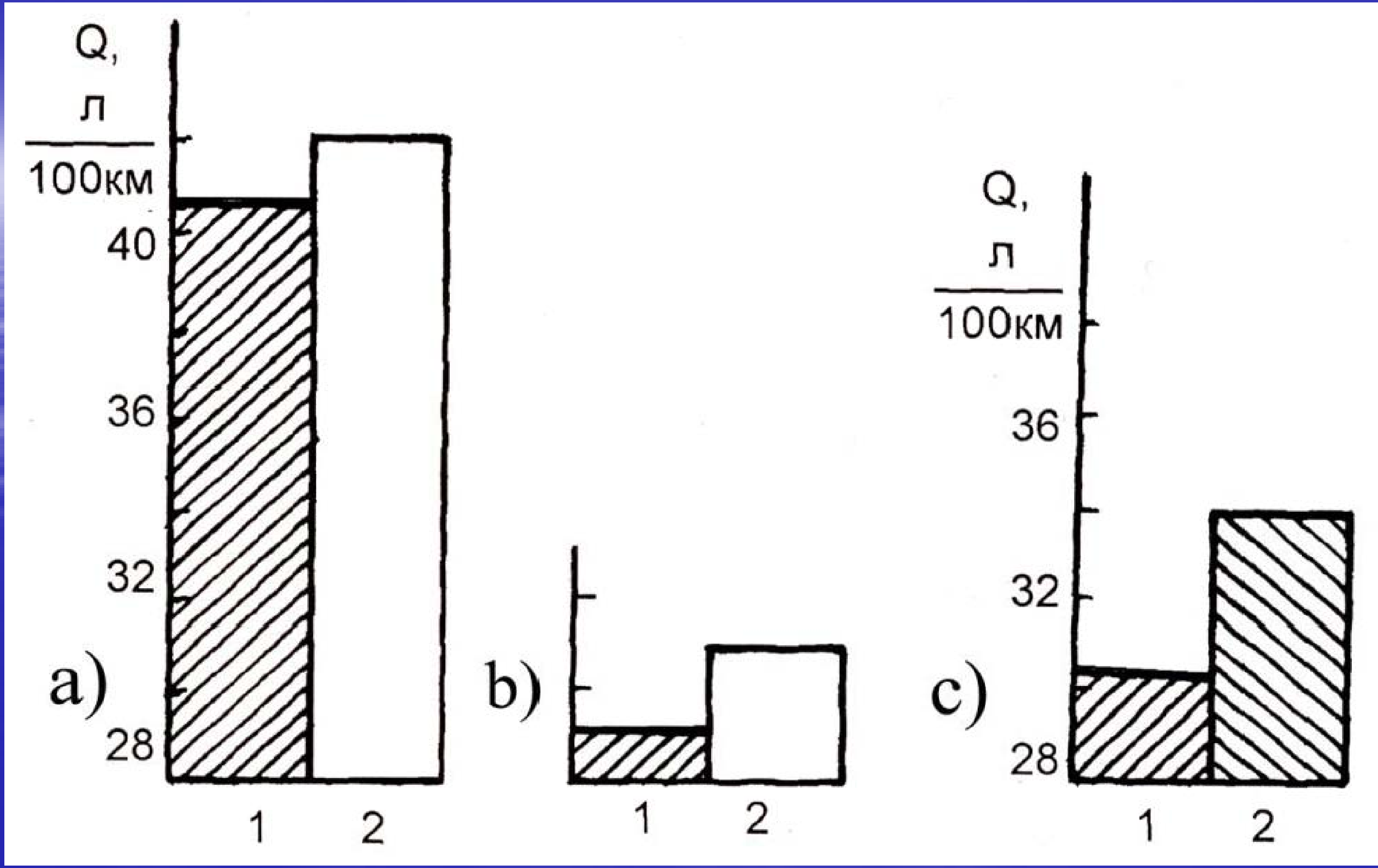
Low-temperature properties of the oils with SACA and other tradable transmission oils: 1 –I-12A+5% SACA+17.5% Acor-1+1%AzNII; 2 and 3 –ACB-5 and I-50Awith 5% SACA+17.5% Acor-1+1%AzNIIrespectively; 4 -TM5-12B; 5 –TCp-10; 6 –TCp-15k; 7 –Tan-15B; 8 –Shell, Shell Spirax Heavy Duty SAE 80; 9 –Esso, EssoCX SAE 80



The dependence of the boundary friction *f* on the temperature *t* for the following oils: 1 –I-12A; 2 –I-12A+17.5% Acor-1; 3 –I-12A+5% SACA+17.5% Acor-1+1%AzNII; 4 –I-12A+17.5% Acor-1+5% MoS; 5 –I-12A+17.5% Acor-1+5% graphite; 6 –I-12A+17.5% Acor-1+5%PM-100; 7 –I-12A+17.5% Acor-1+3%DF-11



The energy loss in the transmission (P_{fr}) and acceleration time (t) for the vehicle Kama AZ-2E541121 to the speed of 60km/h at the air temperature of minus 25-27^{O}C with the oils: 1 –I-12A with SACA; 2 –TM%-12B



The average fuel consumption (Q) of the vehicle KamazAZ-5320 during the driving in city (a) and at the high way (b) at the temperature minus 3-5^{O}C with the oils: 1 –I-12A with SACA; 2 –Tan-15B; and the vehicle KamazAZ-2E541121 at the air temperature minus 25-36^{O}C (c) with the oils: 1 I-12A with SACA; 2 –Tan-15B

Pitting damaged cogs surfaces of the drive gear (for the 42 experimental hours of final drives' redactor of vehicle KamazAZ-5320 using the stand "Glisson-510")

Oils	Damaged cogs by pitting	
	The intensity, points	Part of the shared cogs, %
"Kolkhida"	Do not exist*	
TAп-15B	1-2	65
TCп-10	1-2	70
TCп-15K	4-6	60
TM5-12B	1	60
TH35901 (USA)	1	60
TH35903 (USA)	1	75
SAE 75W-90 (Sweden)	Do not exist	
SAE 85W-140 (Sweden)	Do not exist	

Conclusions

• A comparative SEM, TEM and Auger-spectroscopic studies of structure of friction surfaces of different objects were conducted. It was find out that the amorphous fine carbon (AFC) additives, obtained, for example, via oxidizing pyrolysisof methane during production of acetylene, improves the resistance to mechanical, chemical and abrasive scuffing and fret. It also provides increase in resistance to contact fatigue (pitting), fretting and corrosion resistance; reduces energy losses caused by external and internal friction, improves a wear-in of sliding surfaces, and the "aftereffect" is achieved

• After tribo-activated conversion of the AFC a specific, secondary, hetero-phase structure was formed on the rubbing surfaces that provides a multifunctional effect of the lubricating oil.

• The obtained results allowed us to developed a method for surface film formation on the rubbing parts of mechanisms made of steel, cast iron and other iron alloys in order to increase the resistance to wear and reduce friction, in particular for heavy-loaded machines. The method implies the wear-in of the parts in the environment of thin oil with the additives composed of nanopowder of amorphous carbon

• The new transmission motor oils could provide increase of the automotives lifetime for 20% and the transmission efficiency at the temperatures below the zero up to -500 ^{o}C

Thank You!