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BALTTRIB' 2009

At the recent Fifth International Scientific Conference BALTTRIB' 2009, held in Kaunas, Lithuania, 19-21 November 2009 a series of interesting papers, from a lubrication point of view, were presented.

One presentation in particular caught my eye and should be of interest to LUBE Magazine readers. Who knows what novel additives may come of these scientific works?

For completeness, I list below an outline of the papers, presented under the Lubrication and lubricants proceedings: -

Lubrication and lubricants

Numerical and experimental evaluation of lubricant film thickness and contact pressure in ehl contact of dented surfaces
M. Vaverka, J.Šesták, M.Vrbka, I. Křupka, M.Hartl
Institute of Machine and Industrial Design, University of Technology Brno, Czech Republic.

Effects of zddp and chlorinated paraffins on Lubricant film in twist compression tribotest
*S. J. Asadauskas *, G. Bikulčius *, T. G. McClure **, J. R. Mieczkowski ***, G. Biresaw *****
* Dept. of Material Science and Corrosion Research, Institute of Chemistry, Vilnius, Lithuania.
** TribSys LLC, Valparaiso, Indiana, USA *** Fuchs Lubricants Co., Harvey, Illinois, USA.
**** Agricultural Research Service, US Dept. of Agriculture, Peoria, Illinois, USA.

Lubricity And Surface Properties Of Selected Imidazolium Based Ionic Liquids
T.J.Kaldonski, T.Kaldonski**
Department of Tribology, Surface Engineering and Logistics of Maintenance Fluids,
Military University of Technology, Poland.

Testing of lubricant films, coated on steel surface, in electrolytic cell
A. Grigucevičien, S. Asadauskas, E. Moroz, D. Bražinskien
Tribology Group, Institute of Chemistry, Vilnius, Lithuania.

Filterless fine scale separation in lubrication circuits of cold rolling mills
T. Reichardt, S. Eickenberg**, O. Junk***, R. Imkamp*****
* VDEh-Betriebsforschungsinstitut GmbH, Sohnstr. 65, 40237 Düsseldorf, Germany.
** Cymatec GmbH, Freiheitsstrasse 155b, 42853 Remscheid, Germany.
*** ThyssenKrupp Nirosta GmbH, Hildener Strasse 80, 40597 Düsseldorf, Germany.
****C.D. Wälzholz GmbH, Breddestrasse 45, 58840 Plettenberg, Germany.

Thermal aspects on the rheology of lubricating greases
A.V.Radulescu
Department of Machine Elements and Tribology, University POLITEHNICA Bucharest, Romania.

Study of tribological properties of lubricating composites
A. Pogosian, W. Saroyan*, C. Boniatian**
*State Engineering University of Armenia, Armenia

Analysis of tribotechnical characteristics of engine oils boundary lubricating layers
A. A. Dyuzhev, S. V. Korotkevich**, N. F. Solovej*, O. V. Kholodilov****
*Head Specialized Design Office for grain and forage harvesting machinery, Gomel, Belarus.
**Gomelenergo, Belarus.
***Belorussian state university of transport, Department of nondestructive testing and technical
diagnostics, Gomel, Belarus.

Non-destructive method for assessing thin oil films
H. Cesiulis, N. Tsyntsaru***
*Vilnius University, Dept. Phys. Chem., Naugarduko 24, Vilnius, Lithuania.
** Institute of Applied Physics ASM, Akademiei str. 5, Chisinau, Moldova.

The effect of some additives on the tribological properties and modification of metallic surfaces during the sliding friction
V.Agafii, V.Parshutin
The Institute of Applied Physics of the Academy of Sciences of Moldova, Moldova.

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Study of Tribological properties of lubricating composites

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Abstract: Aiming to create new antifriction and antiscoring additives a number of lubricating composites have been worked out on the base of industrial oils and halogen containing organic additives. The tribological properties of lubricating composites have been studied and the antifriction, antiscroring and antiwear mechanisms have been revealed.

Keywords: tribology, additive, lubricant, boundary lubrication

1. INTRODUCTION

In boundary lubrication conditions availability of friction units is determined by interaction of simultaneous process of external layer formation and fracture on friction surface. In case, when before regular fracture boundary layers could to be reformed, friction is going on in normal conditions and determined as normal wear process. In other case it is followed by seizure process and, as a result, by breaking down of friction parts of machines and mechanisms [1]. One of these two active processes is composition of organic composites as additive in lubricant, which contains such active atoms as chlorine, phosphorus, nitrogen, etc. They come to chemical absorption process under temperature influence caused by friction and as a result, formation of protective layer on the surface of metal, which provides improved friction surface conditions.

2. EXPERIMENTAL

The aim of the work is to create additives based on organic combinations, containing halogens, and experimental studies, as well as reveal of their tribological mechanisms. Object of research have been various numbers of atoms containing chlorinated paraffin – C□$H_m h_k$ with general formula, where *n* is carbon, *m* is hydrogen and *k* is number of atoms of halogen in additive molecule. Using new additives in lubricant composites on the base of VM–1 vacuum oil and I-G-A-68 industrial oil are worked out.

Tribological properties of developed lubricants were studied on a four ball Mast-type friction machine using steel ball specimens. Experiments have been made in air at room temperature. Sliding velocity was 0,23 m/s. The steel balls 12,7x10^{-3} m in diameter served as the friction bodies with the surface hardness of HRC 62-65 and roughness of 0,008-0,16µm. Before testing, balls were washed in a solution of ethylene spirit, toluene, and acetone and then dried.

The mean value of the scar diameters D on the three stationary balls pressed for 60 minutes under constant load was considered as a wear characteristic.

3. RESULTS AND DISCUSSION

First of all the general agent of chlorinated paraffin productive wastes of sulfonal (CPS) are used as additive. Paraffin, containing C_{10}-C_{16} compounds, is chosen, where chlorine is 44%. It has been added into VM–1 vacuum oil with 5 weight % amount. Antiwear and antiscroring characteristics of new lubricant composites are given in the table 1, where for comparing it's also given tribological prperties of composite, using similar range of industrial additive of chlorinated paraffin-470 (CP-470).

According to the experiments, using of new additive of 5 weight % in normal loading conditions (up 900 N), wear is reduced for 12% in comparison with basic oil, but seizure capability increases for 2.25 times in compare with VM–1 basic oil and overtops CP–470 for 35%. Antifriction properties of composites, containing sulfonal chlorine productive wastes are given in the figure 1.

Table 1.
Antiwear properties of composites with sulfonal chlorine productive wastes

Axial load *P*, *N*	Wear characteristic D_{min}, mm		
	VM-1	VM-1+5% CP-470	VM-1+5% CPPW
750	0.44	0.42	0.42
900	0.50	0.45	0.44
1200	0.9 (seizure)	0.49	0.49
1350	-	0.52	0.50
1500	-	0.61	0.52
1800	-	0.95 (seizure)	0.58
1950	-	-	0.61
2025	-	-	0.67
2150	-	-	0.93 (seizure)

In case of using CP-470 and sulfonal chlorine productive wastes additive in low loading conditions, coefficient of friction values actually remains on the same level as with basic oil. In case of higher loading conditions of 900 N, coefficient of friction values increased rapidely, but for CPS and sulfonal chlorine productive wastes additive the values growth begins accordingly 1200 N and from 1800 N, which testifies the higher antifriction properties of sulfonal chlorine productive wastes additive.

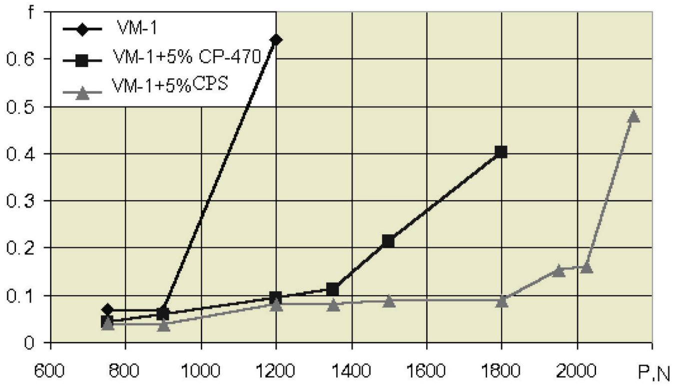


Figure 1. Friction f coefficient dependences upon the axial P load during the experiment of sulfonal chlorine productive wastes

Experimental results assist for creating antiscoring and antifriction additives with structure and composition of chlorinated paraffin basis. Such as 3-4-dichlorobutane–2 (DCB), containing chlorine atoms, and 1-2-dichloroethane (DCE) were investigated. It's structure formulas are given in the table 2. In order to choose the highest rate of additive for composites based on industrial I-G-A-68 oil, 3 compositions, containing 1%, 2% and 5% additives were examined.

Table 2. Chlorinated paraffin based additives

Name	Chemical formula
3-4-dichlorobutane–2 (DCB)	H H H C – CH = C – C H H Cl Cl
1-2-dichloroethane (DCE)	H H H C – C H Cl Cl

Antifriction properties due to dichlorobutane (3-4-dichlorobutane–2) additive experiments are given in the table 3. In fact of each load case according to increasing of additives amount, wear is also increases and seizure loads also increases from 800 N to 1200 N, which testifies the antiscoring productivity of the current composition. Analyses of antifriction properties (fig.2) show that coefficient of friction values are lower in comparison with basic oil.

Table 3. Antiwear properties of components with dichlorobutane (3-4-dichlorobutane–2) additive

Axial load *P*, N	Wear characteristic D_{min}, mm			
	I-G-A-68	I-G-A-68+1%DCB	I-G-A-68+2%DCB	I-G-A-68+5%DCB
200	0.31	0.32	0.34	0.31
400	0.34	0.39	0.51	0.50
600	0.36	0.37	0.50	0.51
800	0.92 (seizure)	0.45	0.63	0.53
1000	-	1.16 (seizure)	1.32 (seizure)	0.93
1200	-	-	-	1.02 (seizure)

So the usage of DCB as additive in normal loads brings to some increasing of wear, but improves antiscoring and antifriction properties due to amount of additive, which is explained by influencing mechanism of additives containing chlorine. According to it, during friction in some temperature and load conditions, chlorine protective layers appear on the friction surface, which are rather friable and refreshed quickly, but they have relatively low shear strength [2].

Figure 2. Friction f coefficient dependences upon the axial P load during the experiment of DCB additive

In table 4 there are antiwear properties worked up by using 1, 2-dicloretan additive during experiments of composites. The new additive increases basic lubricant loading capacity up to 1.5 times.

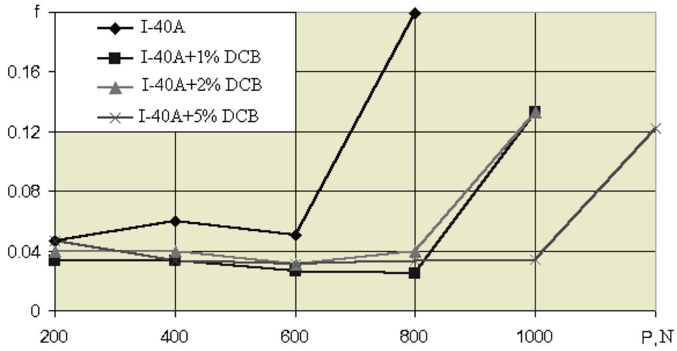


Table 4. Antiwear properties of composites with dicloroetan (1, 2-dicloroetan) additive

Axial load *P*, N	Wear characteristic D_{min}, mm			
	I-G-A-68	I-G-A-68 +1%DCE	I-G-A-68 +2%DCE	I-G-A-68 +5%DCE
200	0.31	0.35	0.33	0.32
400	0.34	0.39	0.36	0.35
600	0.36	0.41	0.39	0.37
800	0.92 (seizure)	0.47	0.50	0.39
1000	-	0.79 (seizure)	0.88 (seizure)	0.48
1200	-	-	-	0.96 (seizure)

Antifriction properties of DCE additive is expressed in figure 3. All lubricating composites have lower values of friction coefficient, and exceed basic oil more than twice with antifriction properties.

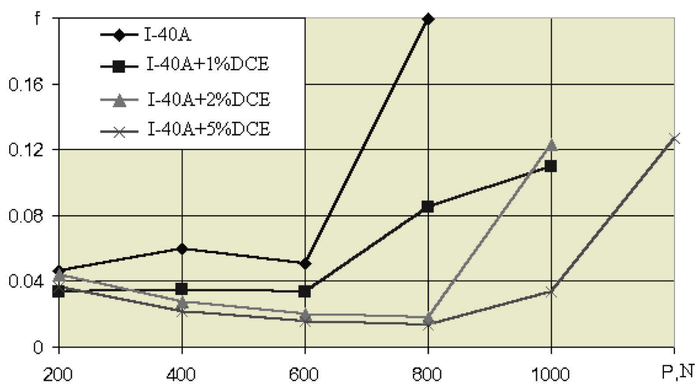
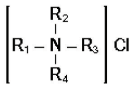


Figure 3. Friction f coefficient dependences upon the axial P load during the experiment of DCE additive

Nitrogen containing cathamin AB-14 (C-AB14), additive was studied with the following formula:



Where- R1 = C2H5, R2 = , R3 = CH3, R4 = C14H28.
The molecule of this additive contains nitrogen and chlorine, but number of chlorine atoms is little, which creates preconditions to follow changes of tribology properties in the process of atoms interaction. Considering additive is added to IG- A-68 basic oil with 1, 2 and 5w % quantity. Values of wear are given in the table 5.

Table 5. Antiwear properties of catamin AB-14 containing composites additive

Axial load P, N	Wear characteristic D_{min}, mm			
	I-G-A-68	I-G-A-68 + 1% C-AB14	I-G-A-68 + 2% C-AB14	I-G-A-68 + 5% C-AB14
200	0.31	0.30	0.29	0.32
400	0.34	0.32	0.31	0.34
600	0.36	0.36	0.35	0.40
800	0.92 (seizure)	0.42	0.43	0.47
1000	-	1.1 (seizure)	0.56	0.58
1200	-	-	1.23 (seizure)	0.64
1400	-	-	-	1.37(seizure)

In case of containing just 1and 2 % additive, composites obtain higher antifriction properties in comparison with oil and seizure load increases appropriately for 25%-50% in accordance with additive amount. But higher component rate (5%) of additive brings to wear increase and then follow the seizure load increase (up 75%). Low component rate (1 and 2%) of additive exceeds anticorrosion action of nitrogen, containing in its molecule [3]. And in case of higher component rate (5%) action of atoms are reduced by accumulated of friction contact chlorine atoms.

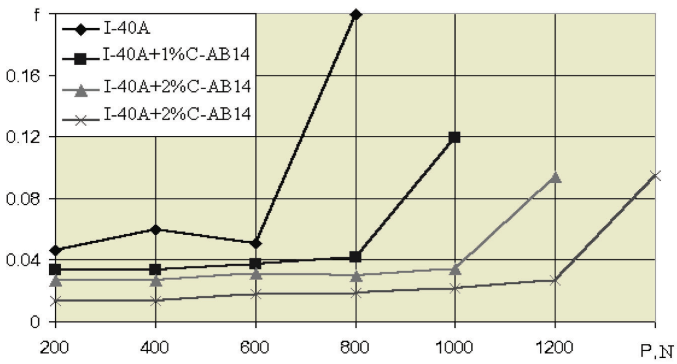


Figure 4. Friction f coefficient dependences upon the axial P load during the experiment of C-AB14 additive.

Antifriction properties analyses of lubricant composites follows that, in comparison with I-G-A-68 industrial oil cathamin AB-14 additive reduces coefficient of friction value on average 50%.In addition it has higher productivity according to increase of additive component rates.

4. CONCLUSIONS

Compositions of cathamin class, in case of simultaneously existence of anticorrosion hydrogen atoms and chloride atoms can perform a good base for working up new lubricant composites, which have high antifriction, antiscoring and antiwear properties, as it’s possible to change R1-R 4 sets which exist in composition molecule.

New lubricant composites are suggested to use in boundary lubrication conditions for running various machines and mechanisms. They are also suggested for restoring and even improving of tribological properties. Investigations give opportunity to choose more productive additives for tribosystems, to exploit in various conditions and also are basis for creating new additives with various components for the high productive lubricants.

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[3] P.S. Belov, R.M. Matveevskii, I.A. Buyanovskiy, A.N. Ermolaeva,V.A. Trofimov,I.A. Fokina, Sulphur nitrogen and oxygen containing compositions lubricating ability in mineral oils. Friction and Wear, 12 (3) 1991, p. 561-563.

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