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Estimation of adsorption properties of ethers as an anti-wear additive

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Abstract
Adsorption properties of some ethers of sulphur-containing acids were studied, dependences of electronic work function of a metal and dependence on functional groups were determined

Keywords: Adsorption energy, contact potential difference, metal, dithiocarbamate, xanthogenates, additives

1. Introduction
Information on such surface characteristics like electron density distribution near the surface, energy of adsorption, electronic work function from the surface allows explaining the essence of revealed surface phenomena in adsorption systems and forecasting their new properties. One of the most advanced methods of estimating the effectiveness of adsorption process, in particular, adsorptive properties of the studied compounds is based on the change of electronic work function from the surface of a metal after its modification with adsorption compounds. This change in turn leads to the change of contact potential difference (ΔCPD) between working electrode, processed compound and electrode. Variation value of electronic work function from the surface of a metal ΔCPD depends on both amount of adsorption compound and electron-donor-acceptor properties of separate functional groups and structure as a whole. Correspondingly, absorbability of substances on a metal can be estimated by the change of ΔCPD.

2. Result and discussion
The aim of the present work is to study the adsorption properties of ethers of thiophosphoric (TPh), xanthogenic and dithiocarbanic acids of different structure (table 1, compound 1-7).

Table 1

Compound	Name
1	S – Benzoyl-O.O-diisopropyldithiophosphate
2	S – (Benzoyloxymethyl) – O.O- diisopropyldithiophosphate
3	S – (Acetoxymethyl) – O.O- diisopropyldithiophosphate
4	S – (Methoxycarbonylmethyl) – O.O- diisopropyldithiophosphate
5	S – (Benzoyloxymethyl) –O-isopropylxanthogenate
6	S – (Methoxycarbonylmethyl)-O-isopropylxanthogenate
7	S – (methoxycarbonylmethyl)N,N-diethyldithiocarbamate

To determine ΔCPD we used the known method (2). The results of researches are presented in the figure. As it is seen, the studied ethers DTPh, XG- and DTC acids are electron-donor, i.e. the transition of electrons from their adsorption molecule to a metal is accompanied with the decrease of electronic work function. The influence of functional groups of the studied compounds on their adsorption properties can be detected. Ethers of DTPh acids have the highest absorbability, ethers of DTC acids have the least absorbability, but ethers of XG acids have an intermediate position.
The structure of compounds influences on ΔCPD. Absorbability of compounds with carbonyloxy groups (compound 3) is higher than similar compounds with oxycarbonyl group

(compound 4). Unlike compound 2 the compound 1 has the worst adsorption properties. In the row of ethers of DTPh acids the compound 3 has the highest adsorption properties. ΔCPD is reduced with the increase in contact period of a metal with the compounds from 5 to 30 minutes. As the figure shows different times are required for the formation of a firm boundary film on the surfaces of metals with various compounds:

Dithiophosphates (curves 2,4) are adsorbed instantly, sulfur-containing compounds (curves 5, 6, 7) – in time.

Numbers of curves conform to numbers of compounds in table 1. For detection of a bond between adsorption and anti-wear properties we determined the indications of abrasion of the compounds on four-ball wear machine by GOST 9490-75 (table 2).

It follows from compared data of figure and table 2 that there is a definite dependence between these properties: high absorbability of the compound can be evidence of its high anti-wear properties, though direct relation is not always observed.

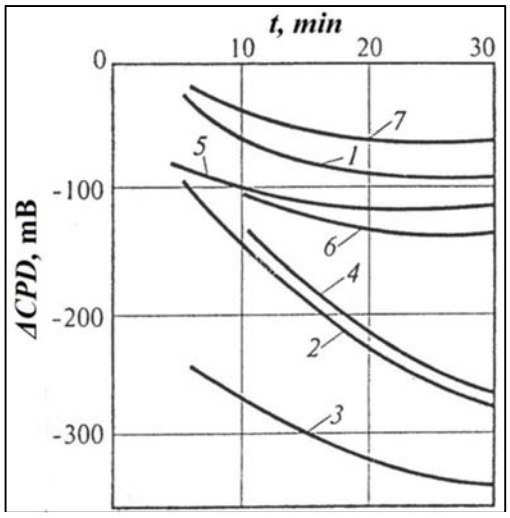

Fig: Dependence of change of contact potential difference ΔCPD on contact period *t* of a metal with the compound.

Table 2

Compound (see table 1)	Wear scar diameter, mm	Compound (see table 1)	Wear scar diameter, mm
Ethers of DTPh acids		Ethers of XG acids	
1	0.66	5	0.7
2	0.4	6	0.75
3	0.39	Ethers of DTC acids	
4	0.53	7	0.82

3. Conclusion

Adsorption properties were studied by contact potential difference method. When ΔCPD value of studied compounds increases wear scar diameter of their solutions in oil is decreases.

4. References

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