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CREATION OF NEW OIL COMPOSITIONS BASED ON COMPLEX ESTERS OF CYCLIC AND ALIPHATIC NEOPOLYOLS AND ALKYL BENZENE CARBOHYDROGEN OILS

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Mixed esters of 2,2,5,5-tetramethylolcyclopentanol and 2,2,6,6-tetramethylolcyclohexanol mixed with pentaerythritol were synthesized with caproic acid, new oil compositions with the addition of 5-20% mixed esters to alkylbenzene oils were prepared and studied. It was found that the addition of mixed esters significantly improves the performance of alkylbenzene hydrocarbon oils: the viscosity index increases by 4-29 units, the flash point increases by 17-70°C, and the freezing point decreases by 2-16°C. Significant improvements have also been observed in the thermoxidation stability of alkylbenzene oils.

Keywords: *mixed esters of neopolyols, alkylbenzene hydrocarbon oils, operational properties of oils, structure-property dependence on oils*

Novadays, the rapid development of technology puts increasing demands on lubricants. Thus, these oils must be able to operate at temperatures above 225°C, as well as meet the requirements of viscosity-temperature indicators at low and high temperatures. It should be noted that the analysis of scientific, technical and patent literature of the last 10 years shows that synthesis of required aviation oils, as well as special fluids with high thermal stability is almost non-existent[1-2].

One of the most economically and theoretically effective ways to generate high-quality lubricants is to create new oil compositions [3].

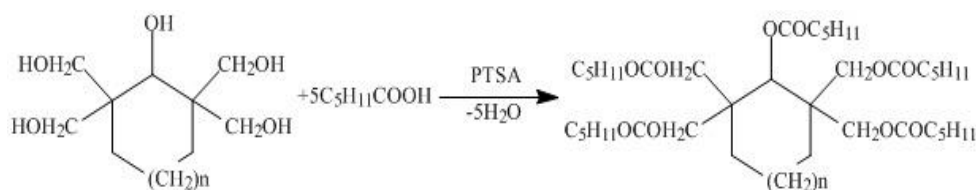
From this point of view, in order to improve the quality of alkylbenzene (AB) type hydrocarbon oils, the complex esters of a mixture of cyclic neopolyols - 2,2,5,5-tetramethylolcyclopentanol (TMCP) and 2,2,6,6-tetramethylolcyclohexanol (TMCH) with pentaerythritol (PET) were synthesized with monocarbon acids and their

compositions with the addition of 5-20% to AB oils were prepared and studied. The choice of a mixture of these esters for supplements is based on such a theoretical, scientific principles that since the esters of cyclic neopolyols have high thermal and thermooxidation stability and the PET esters have satisfactory viscosity and temperature, the esters based on them will contain all these properties [4].

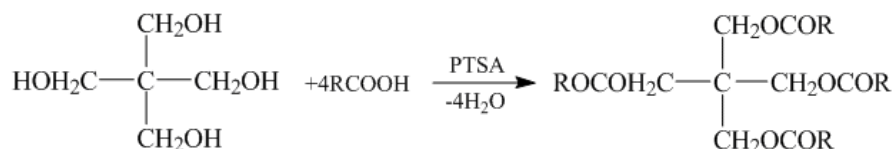
For this purpose, esters of a mixture of TMCH and TMCP with PET in a ratio of 1: 1 with caproic acid were obtained, their oil compositions with the addition of 5-20% to hydrocarbon oils were prepared, their properties were studied.

Experimental part

The esterification reaction of a mixture of cyclic neopolyols with PET can be schematically shown as follows:



where, $n=0;1$, $R = -\text{C}_5\text{H}_{11}$



Paratoluene sulfuric acid (PTSA) in the amount of 1% of the total mixture was used as a catalyst.

Synthesis of esters is carried out as follows: TMCP and TMCH are mixed separately with PET in a ratio of 1:1, caproic acid, 1% PTSA of an alcohol-acid mixture, 50 ml of toluene are added and the mixture is heated until complete separation of the reaction water. The esterification is purified according to a known method [5], finally the ester mixture is individually vacuumed.

Discussion of the results

Some physico-chemical properties of esters are performed in Table 1.

As can be seen from the table, the ester mixture are compounds with a high molecular weight (1226-1238) boiling under 215-275 °C/2 mmHg pressure.

The structure of esters was confirmed by IR and NMR spectroscopy, as well as the determination of molecular weight, acid and ester numbers.

In order to improve the quality of alkylbenzene-based lubricants produced in the industry, compositions with the addition of 5-20% esters of cyclic neopolyols mixed with PET were made and studied.

Alkylbenzene lubricants are compounds obtained by the alkylation of benzene with a tetramer of propylene. The process takes place under the conditions of benzene:olefin ratio 7,5:1, temperature 60°C, reaction time 50 minutes and normal atmosphere. The yield of alkylbenzene is 98% of the theoretical yield [6].

Table 2 illustrates the viscosity-temperature characteristics of the mixed esters of cyclic neopolyols and pentaerythritol with caproic acid and alkylbenzene.

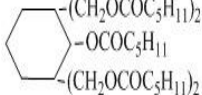
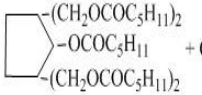
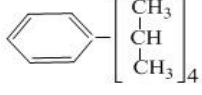
Table 1

Some physico-chemical properties of mixed esters

№	Esters	Yield,% mas.	Boiling point at °C/2 mmHg	Average molecular weight
I	TMCH+PET	63	215-275	1238
II	TMCP+PET	68	220-235	1226

Table 2

Viscosity-temperature properties

Mixed esters of TMCH and TMCP and the composition of the AB	Viscosity, mm ² /s, at tem. °C		Viscosity index	Temperature, °C	
	100 ⁰ C	40 ⁰ C		flash point	freezing point
 Ester I	10,48	39,13	135	318	-56
 Ester II	9,20	38,01	140	330	-60
 Alkylbenzene	12,39	52,23	126,2	223	-46

As can be seen from the chart table, the viscosity-temperature of mixed esters are much higher than those of alkylbenzene oils.

Table 3 shows the viscosity-temperature properties of compositions based on alkylbenzene oils and mixed esters. As can be seen from the table, the properties of alkylbenzene type lubricants improve with the addition of mixed esters: viscosity index increases from 126 units to 155 units, flash point increases from 223⁰C to 293⁰C, and freezing point decreases from -46⁰C to -58⁰C. The highest value occurs with the addition of 20% of ester II (viscosity index 155 units, flash point 293⁰C, freezing point -58⁰C), which is explained by the presence of synergistic effect in the process. On the other hand, the presence of cyclopentane in ester II has a positive effect on all indicators [7-8].

Table 3

Viscosity-temperature properties of compositions

№	Compositions		Viscosity, mm ² /s		Viscosity index	Temperature, °C	
			100 ⁰ C	40 ⁰ C		flash point	freezing point
1	Efir I : AB	5:95	12,20	50,19	130	240	-48
2	Efir I : AB	10:90	12,10	50,02	132	258	-50
3	Efir I : AB	20:80	12,05	49,03	140	275	-52
4	Efir II : AB	5:95	12,00	49,70	134	250	-50
5	Efir II : AB	10:90	11,93	49,50	137	269	-53
6	Efir II : AB	20:80	11,80	48,74	155	293	-58

Thermoxidation stability (TOS) of prepared oil compositions is given in Table 4 (GOST 23797-79).

Table 4

Thermal oxidative stability of compositions

Compositions	Viscosity at 100°C, mm ² /s (after oxidation)	Acid number mgKOH/g	Sediment insoluble in isooctane, % mas.	Corrosion, mg/cm ²		Volatility, % mas.
				AK-4	IIIX-15	
1	14,22	1,30	0,015	0,12	0,80	1,20
2	14,10	1,30	0,013	0,10	0,75	1,15
3	13,90	1,25	0,010	0,07	0,70	1,10
4	13,48	1,10	0,010	0,10	0,90	1,03
5	13,12	1,15	0,006	0,05	0,86	1,00
6	13,15	1,06	0,055	0,03	0,65	0,95
Ester I	14,22	1,20	no sediment	no sediment	no sediment	0,90
Ester II	12,90	1,02	no sediment	no sediment	no sediment	0,80
Alkylbenzene	14,60	1,38	0,03	0,18	0,93	1,40

As can be seen from the table, the acid amount of the compositions is significantly reduced compared to the AB (1,06 mgKOH/g instead of 1,38 mgKOH/g), the insoluble precipitate in isooctane falls from 0,03% mass to 0,005% mass, corrosion decreases from 0,18 mg/cm² to 0,03 mg/cm² at the AK-4 electrode, from 0,93 mg/cm² to 0,65 mg/cm² at the IIIX-15 electrode, evaporation decreases from 1,40% mass to 0,95% mass.

The performance of compositions based on the ester of TMCP mixed with PET is much higher than the performance of esters of TMCH with PET.

As can be seen, the TOS of compositions based on mixed esters is much higher than that of AB industrial oil. [9].

Thus, as a result of the research, it can be noted that the addition of esters of cyclic neopolyols (TMCP and TMCH) with PET to industrial AB oils by 5-20% can significantly improve the viscosity-temperature, thermooxidation stability of these oils and further expand their application [10- 11].

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TSIKLIK VƏ ALİFATİK NEOPOLIOLLARIN MÜRƏKKƏB EFİRLƏRİ VƏ KARBOHİDROGEN YAĞLARI (ALKİLBENZOL) BAZASINDA YENİ YAĞ KOMPOZİSİYALARININ YARADILMASI VƏ TƏDQIQI

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2,2,5,5-tetrametiloltsiklopentanol və 2,2,6,6-tetrametiloltsikloheksanolun pentaeritritlə qarışığının kapron turşusu ilə qarışıq efirləri sintez olunmuş, onların alkilbenzol yağlarına 5-20% əlavəsilə yeni yağ kompozisiyaları hazırlanmış və tədqiq edilmişdir. Müəyyən olunmuşdur ki, qarışıq efirlərin əlavəsi ilə alkilbenzol karbohidrogen yağlarının istismar xassələri xeyli yaxşılaşır: özlülük indeksi 4-29 vahid artır, alışma temperaturu 17-70°C yüksəlir, donma temperaturu isə 2-16°C aşağı düşür. Alkilbenzol yağlarının termooksidləşmə sabitliklərində də nəzərə cərpacaq yaxşılaşma halları müşahidə olunur.

Açar sözlər: neopoliolların qarışıq efirləri, alkilbenzol karbohidrogen yağları, yağların istismar xassələri, yağlarda quruluş-xassə asılılığı

СОЗДАНИЕ И ИССЛЕДОВАНИЕ НОВЫХ МАСЛЯНЫХ КОМПОЗИЦИЙ НА БАЗЕ СЛОЖНЫХ ЭФИРОВ ЦИКЛИЧЕСКИХ И АЛИФАТИЧЕСКИХ НЕОПОЛИОЛОВ И АЛКИЛБЕНЗОЛЬНЫХ УГЛЕВОДОРОДНЫХ МАСЕЛ

M.A. Mamedyarov, G.N. Gurbanov, L.M. Yusifova

Синтезированы смешанные эфиры 2,2,5,5-тетраметилциклопентанола и 2,2,6,6-тетраметилциклогексанола пентаэритритом с капроновой кислотой. Добавлением этих эфиров в количестве 5-20% к алкилбензольным маслам изготовлены и исследованы новые масляные композиции. Найдено, что с добавлением этих эфиров значительно улучшаются эксплуатационные свойства синтезированных масел: повышаются индекс вязкости 4-29 единиц, температура вспышки 17-70°C, понижается температура застывания 2-16°C. А также наблюдается значительное улучшение термоокислительных свойств алкилбензольных смазочных масел.

Ключевые слова: смешанные эфиры неополиолов, алкилбензольные углеводородные масла, эксплуатационные свойства масел, зависимость структуры-свойств масел