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THERMOSTABLE LUBRICATING COMPOSITION BASED ON PENTAERYTHRITOL ESTERS

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A lubricating composition based on pentaerythritol esters was developed; its physicochemical and functional properties satisfy the requirements for aviation oils for gas-turbine engines with an operating temperature of 225°C, and it is as good as the foreign analog.

Synthetic oils made from pentaerythritol esters are of great interest as the base for high-temperature lube oils [1]. The rigorous conditions of use of modern aviation engineering impose heightened requirements for the thermooxidative stability of these oils at high temperatures (above 200°C). This index can be improved with antioxidant additives that combine elevated functional properties with resistance to thermal degradation [2].

We report the results of high-temperature stabilization of pentaerythritol esters by selecting an effective mixture of antioxidant additives [3].

Industrial phenyl-α-naphthylamine – PAN (MRTU 6-09-887 – 68), antiwear tricresyl phosphate – TCP (TU 6-09-4960 – 68), *p, p′*-diisooctylphenylamine – DAT [4], metal deactivator benzotriazole – BTL (TU 14-6-09-1201 – 75), and the experimental antioxidant tri(carbopentoxymethylene)-di[1, 5-bis(4-phenylaminophenoxy]-ethoxysilane – VIP-30 were used as stabilizing additives.

High-temperature stabilization of pentaerythritol ester at a temperature of 225°C was obtained with VIP-30 additive. Several amino groups with a developed conjugation system contained in the additive ensure the maximum

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Table 1

Indexes	Specifications	Oil	
		experimental	Turboil-555
Viscosity, mm^2/sec			
at 100° C	≥3.0	4.96	5.4
at –40°C	≤3000	5874	10 500
Acid number, mg KOH/g	not standardized	0.18	0.32
Flash point (open cup), °C	≥200	243	245
Solid point, °C	≤50	–55	–54
Water, particulate contaminant content	absent	absent	
Thermooxidative stability in volume at 225°C (GOST 23797–79)			
sediment content, %	≤0.15	0.03	0.15
viscosity after oxidation, mm^2/sec			
at –40°C	≤15 000	17 000	26 800
at 100°C	not standardized	7.41	8.75
acid number, mg KOH/g	same	1.25	4.77
deposits of products insoluble in naphtha in reactor, bubbling pipe on plate catalyzers, g/m^2			
ShKh-15		0	0
AK-4		0	0
M-2	–	–2.19	–0.16
Lubricating properties (four-ball friction mill, 20°C, GOST 9490 – 75)			
critical jamming load P_c, N	≥800	1000	900
wear scar diameter, mm	≤0.5	0.35	0.45
Tests in Sh-3 reducing gear unit at 225°C oil temperature going into engagement	passed	passed	no data

stabilizing effect of this additive. This additive is much more effective than the existing antioxidants of the amine type: PAN, DAT, PODPA, etc. [4].

The base for the lubricating composition developed was a mixture of industrial pentaerythritol ester and C_5-C_9 synthetic fatty acids with PES-7 siloxane liquid (MRTU 6-02-276-63). Selection of the components and optimization of the composition of the lubricating composition were refined after a series of tests.

The thermooxidative stability of the composition was assessed by the method of oxidation in bulk (GOST 23797 – 79). The oil samples were oxidized at 225C for 50 h in the presence of copper, steel, and aluminum plates by continuously passing a dry air stream through them at the rate of 170 ml/min. The degree of oxidation was judged by changing the viscosity properties, acid number, sediment formation, and appearance of corrosion on the metal plates.

The lubricating composition developed [5] satisfied the requirements for gas-turbine engines in all indexes of the basic thermooxidative stability and lubricating properties (sediment, 0.1% max; viscosity at – 40°C, 20,000 mm^2/sec max, corrosion ≤ 1 g/m^2), and is slightly more effective than the analogous foreign oil Turboil-555.

The combination of the amine oxidation inhibitors thus provides for synergistic enhancement of their stabilizing effectiveness and the required level of thermooxidative stability of the pentaerythritol ester in conditions of catalytic oxidation at a temperature of 225°C.

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