TESTING THE RESISTANCE OF PISTON ENGINE OILS AGAINST MECHANICAL DEGRADATION

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1. Introduction

Piston engine oils contain viscosity improvers, often called viscosity modifiers, that include polymer compounds improving viscosity-temperature characteristics of oils. Oil-soluble polymers with high molecular weight are commonly used as viscosity modifiers.

Long polymer chains of viscosity improvers during lubrication of kinematic pairs (i.e. piston-cylinder) or high velocity flow through gaps (pumps, oil tubings and hoses) are machanically degraded (polymer chains are teared), which results in drop of kinematic viscosity.

Rhelogical properties (viscosity parameters) for engine oils are presented in Table 1.

Table 1 Engine oils viscosity classification (SAE J 300)

SAE viscosity grade	Low temperature viscosity (starting) - mPas, in temperature, ^{0}C max.	Low temperature viscosity - pumping, mPas, in temperature, ^{0}C max.	Kinematic viscosity in temperature 100^{0}C, mm^2/s		HT/HS viscosity w temperature 150^{0}C, mPas, min.
			min.	max.	
0W	6200 in -35	60000 in -40	3.8	-	-
5W	6600 in -30	60000 in -35	3.8	-	-
10W	7000 in -25	60000 in -30	4.1	-	-
15W	7000 in -20	60000 in -25	5.6	-	-
20W	9500 in -15	60000 in -20	5.6	-	-
25W	13000 in -10	60000 in -15	9.3	-	-
20	-	-	5.6	<9.3	2.6
30	-	-	9.3	<12.5	2.9
40	-	-	12.5	<16.3	2.9 (for 0W-40, 5W-40 and 10W-40)
40	-	-	12.5	<16.3	3.7 (for 15W-40, 20W-40, 25W-40 and 40)
50	-	-	16.3	<21.9	3.7
60	-	-	21.9	<26.1	3.7

It is assumed, that engine oil kinematic viscosity change as a result of mechanical degradation can not lead to change of oil viscosity grade according to SAE J 300, i.e. SAE 40 engine oil viscosity in 100^{0}C after polymer additive shear should be not less than 12.5 mm^2/s.

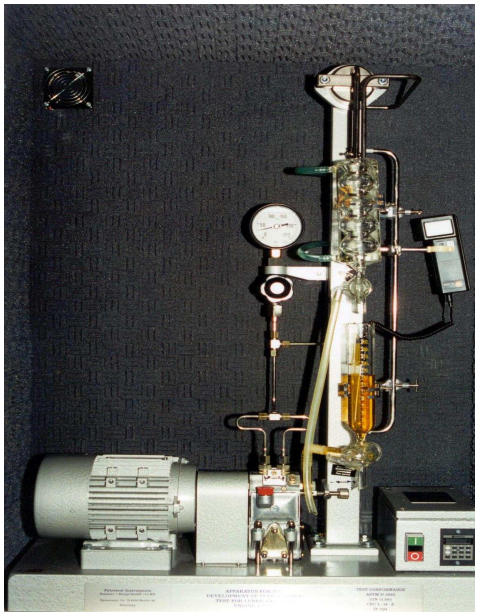
2. Research methodology

Following three methods are commonly used to evaluate mechanical degradation of oils:

- testing with „pump-injector" rig (method applied in research described below);
- testing with „pump-gap" rig (method commonly used in the United States);
- testing with ultrasonic apparatus (method cancelled, used for jet engines oils).

Dla olejów silnikowych w badaniu z wykorzystaniem aparatu „pompa wtryskiwacz" (patrz fot. 1) wykonuje się 30 cykli ścinania a następnie wykonuje się badanie lepkości kinematycznej w temperaturze 100^0C (patrz fot. 2).

For engine oils, during pump-injector rig test (fig. 1) 30 shear cycles must be carried out, and then kinematic viscosity in 100°C is measured.



Fot. 1 Pump-injector rig

Fot. 2 Baths for kinematic viscosity measurements

3. Tests performed

Most of engine oils resistance against mechanical degradation testing results are positive – oil viscosity grade is not changing after 30 shear cycles. Although in case of more shear cycles applied on-going mechanical degradation is observed – oil viscosity is decreasing.

During testing of various oils, the resistance against mechanical degradation was evaluated with „pump-injector" rig, with up to 250 shear cycles, and kinematic viscosity measurements were carried out after specific number of shear cycles. Tests results are presented in Table 2.

Table 2. Tests results for different oils

Oil name/ID	Kinematic viscosity in 100°C, mm²/s. After specific number of shear cycles						
	0	30	50	100	150	200	250
Mineral oil SAE 50	18,0	17,6	17,5	17,5	17,4	17,4	17,4
Mineral oil SAE 20W-50	16,6	15,3	14,4	13,8	13,4	13,4	13,3
Mineral oil SAE 15W-40	14,0	12,5	12,0	11,9	11,7	11,7	11,6
Semi-syntetic oil SAE 10W-40	14,6	12,8	12,6	12,5	12,1	12,0	11,9
Syntetic oil SAE 5W-40	13,4	13,3	13,3	13,2	13,2	13,2	13,2
Syntetic oil SAE 0W-40	12,7	12,5	12,5	12,4	12,2	12,2	12,2

Obtained results are presented graphically on Fig. 1 and 2. For SAE 50 oil with no viscosity improver positive result was obtained, but for multi-season oil SAE 20W-50 viscosity after 250 shear cycles was below limit in SAE J 300 classification. Similar results were obtained for majority of SAE 40 oils.

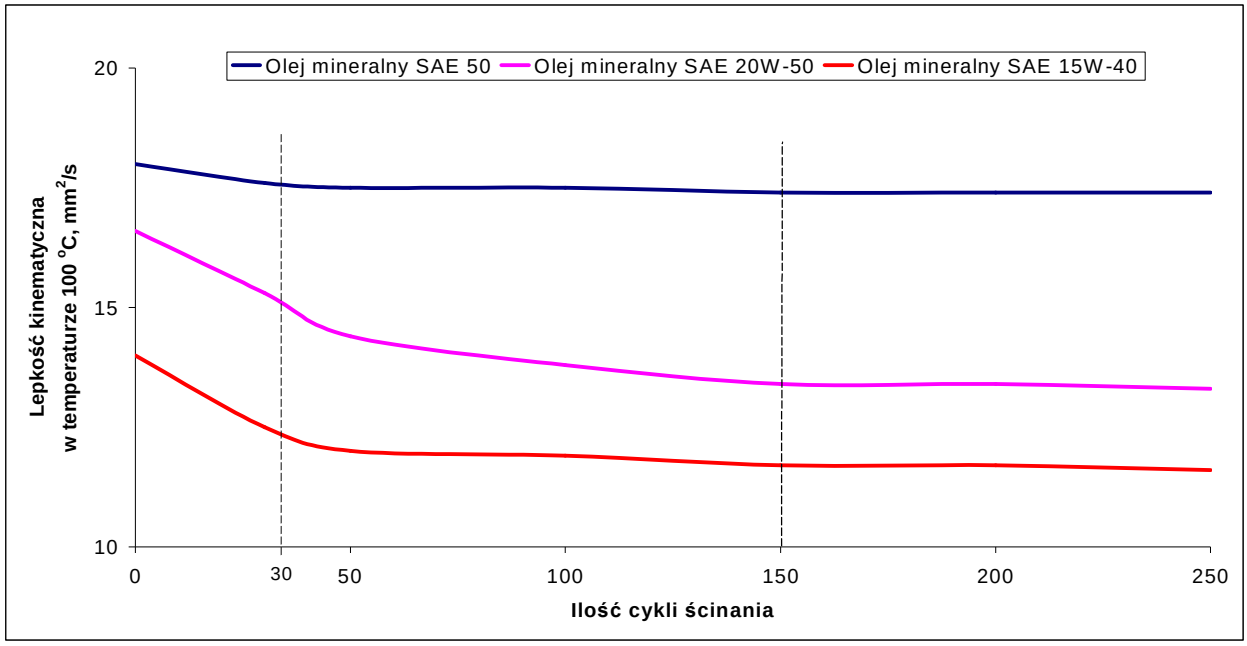


Fig. 1. Shear resistance for selected mineral oils used in piston engines

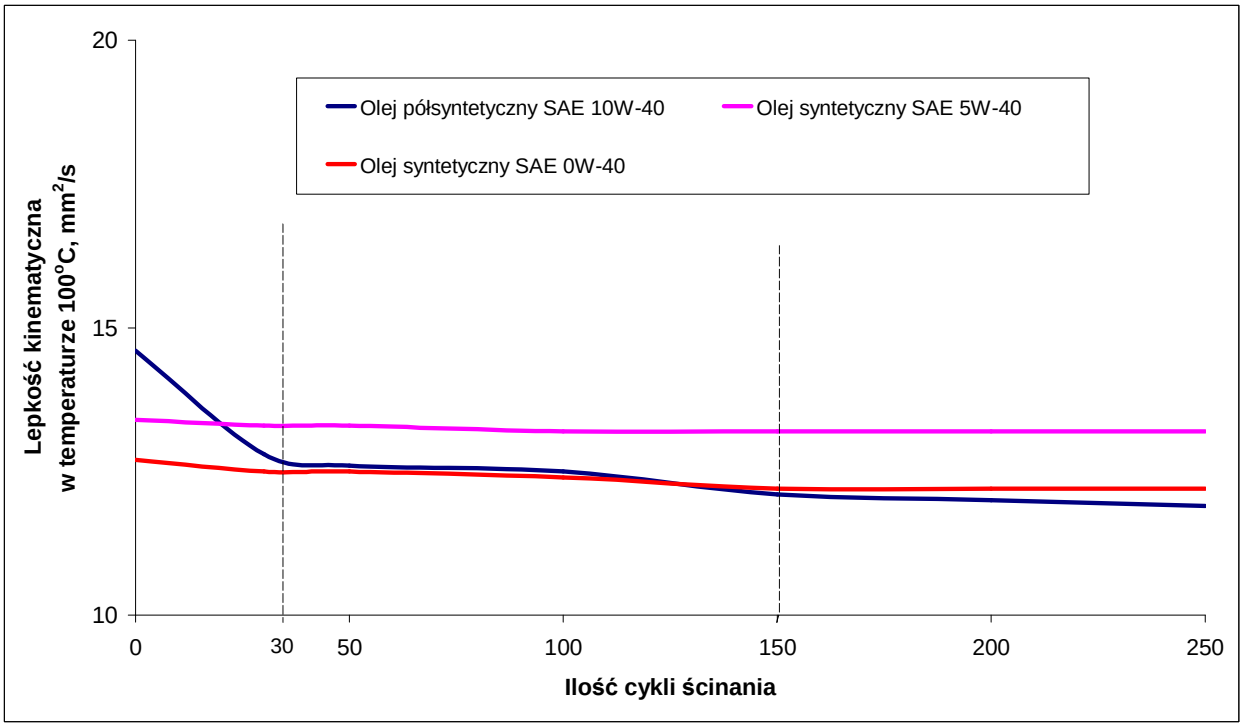


Fig. 2. Shear resistance for selected semi-syntetic and syntetic oils used in piston engines

4. Summary

Obtained results are the basis for consideration of possible changes to methodology of piston engine oils mechanical degradation resistance testing and implementation of i.e. 150 shear cycles.

Presented methodology may be also used during preparation of new technologies for engine oils (removing of unstable viscosity improvers) and for quality verification for piston engine oils.

Literature

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