THE BENCH TEST OF EFFECT OF THE MODIFIED LUBRICANTS TO THE POWERPLANT PERFORMANCE

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Abstract. Today there are four-stroke piston internal combustion engines wide use in the general aviation. Different types of oil are used to improve the characteristics of these engines by reducing of friction in the cylinders. This paper is devoted to method of increasing of engine performance by using of tribological additives "Komol" that should reduce the friction coefficient.

The ground tests of additives effectiveness were made during this research. The conversion Subaru EJ-25 engine, which been dismantled from the "Shmel" plane and installed on the specialized bench, was used for this research. The loading of the engine was made by changing the pitch angle of the propeller blades at intervals of 3 degrees.

Research was carried out in two stages: the engine is running on the normal oil and the engine is running on the modified oil after two hours operating time.

The parameters of torque and acoustic were controlled during the test by using the strain gauge and sound lever meter.

The measurement results showed an improvement of the powerplant performance. The average power increasing was about 8.5% after additives using. The decreasing tendency in mechanical noise hasn't been determined during the test because sound of periodical processes increased very high.

Our research showed the real efficiency of the oil additives to improve the performance of aircrafts

Keywords. Tibological additives, Reducing of friction, Powerplant performance.

1 Introduction

Today there is four-stroke piston internal combustion engines (ICE) wide use in the general aviation. The work of the ICE is accompanied by huge evolution of heat because of high temperature of working gases and significant contact stresses in the friction parts. Parts of the engine which are forming the friction pairs are lubricated and cooled to provide the work of the engine. Products of the mechanical wear are washed out via gaps between friction parts. Different types of oil are used to improve the characteristics of these engines by reducing of friction in the cylinders. This paper is devoted to method of increasing of engine performance by using of tribological additives "Komol" that should reduce the friction coefficient.

1.1 About first object of testing

Bench tests of the effect of modification of motor oil were carried out at the power-plant on the base of conversion engine Subaru EJ-25 with a water cooling system. Tested engine was demounted from the plane "Shmel'" of Russian production (figure 1) after the 410 hours operating time on board. Conversion engines Subaru EJ-25 is used in the automotive engineering and converted for aviation purposes by replacing the control unit and the transmission. They are used in a several planes and helicopters, such as Dinali H2S, AeroCopter AK1-3 and others.

Figure 1: The plane "Shmel’" that operating on the conversion engine Subaru EJ-25 which used for research.

2 Measuring equipment

Specialized test bench was used to determine the characteristics of the engine. This bench imitates work of the aircraft engine on take-off mode. The test bench (figure 2) consists of metal frame, fuel tank, engine mounting system, testing engine, cooling system and control panel with set of standard devices for the control of engine parameters [3]. The loading of the engine was made by changing the pitch angle of the propeller blades at intervals of 3 degrees.

Figure 2: Test bench for testing the performance of engines applied in aviation.

There is flange between the engine’s gearbox and the propeller. Power of the engine is determined by deformation of shaft of this flange [2]. Measurement of torque is carried out by strain gauge transducer which transmits a signal wirelessly [1,4].

In addition to torque measurement, the noise production research was conducted within the research. Microphone for recording of acoustic parameters was deployed on the side of the engine.

3 Research methodology

The bench tests were conducted in order to identify and assess the impact of the engine oil modification on the power-plant performance.

This test was carried out in two stages:

- The engine is running on the normal oil
- The engine is running on the modified oil after two hours operating time.

As mentioned earlier the changing of propeller’s blade pitch angle was done in intervals of 3°. Zero position of pitch angle of the blade corresponds to minimum pitch angle in the operating range. Maximum range of changes pitch angle of the blade is 15°.

An example of the torque measurement of the engine from one of the experiments is shown on the figure 3.

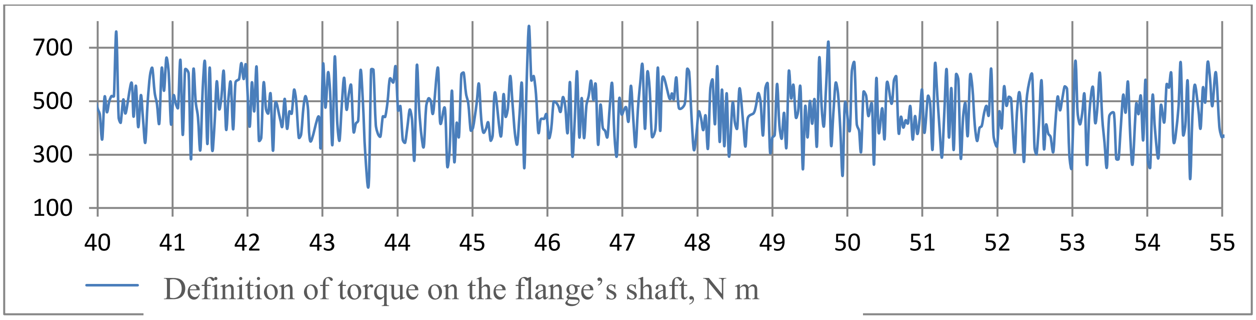

Figure 3 – An example of recording of the torque measurement of the engine from the case of measurements with pitch angle of the blade of 0° with using of modified oil.

4 Results of the measurements

The results of bench tests of power-plant indicate the overall trend of increasing the value of the torque on shaft, frequency of rotation and the power of engine as a result of using the modified engine oil.

After the operating time of 2 hours with a modified engine oil at the equal pitch angle of the propeller blades, there was an increase in frequency of rotation, about 4.1%, the torque - about 6.4% and the power - 10.7%. This increase was observed in the whole range of engine rotation frequency. The results of the measurements are shown in the table 1. The diagram for engine power depending on the rotational speed at the different pitch angle of propeller blades shown on figure 4.

Table 1: The results of measurements of the engine parameters in two cases with using of standard oil and with using of modified oil by “Kamol”additive.

Changing of pitch angle of the blade, °	Average torque of the engine, N m	Rotation frequency, min-1	Power, h.p.	Average torque of the engine, N m	Rotation frequency, min-1	Power, h.p.	Relative increase of torque, %	Relative increase of power, %
15	195,3	4800	133,3	181,3	4617	119,0	7,7	12,0
12	187,4	5260	140,2	176,6	5020	126,1	6,1	11,2
9	178,6	5660	143,8	168,3	5390	129,0	6,1	11,4
6	167,7	6095	145,4	156,8	5900	131,6	7,0	10,5
3	152,3	6660	144,2	144,2	6450	132,3	5,6	9,1
0	140,0	7295	145,2	132,3	7000	131,7	5,8	10,3
	Modified oil (two hours operative time)			Standard oil			**Total**	
							6,4	**10,7**

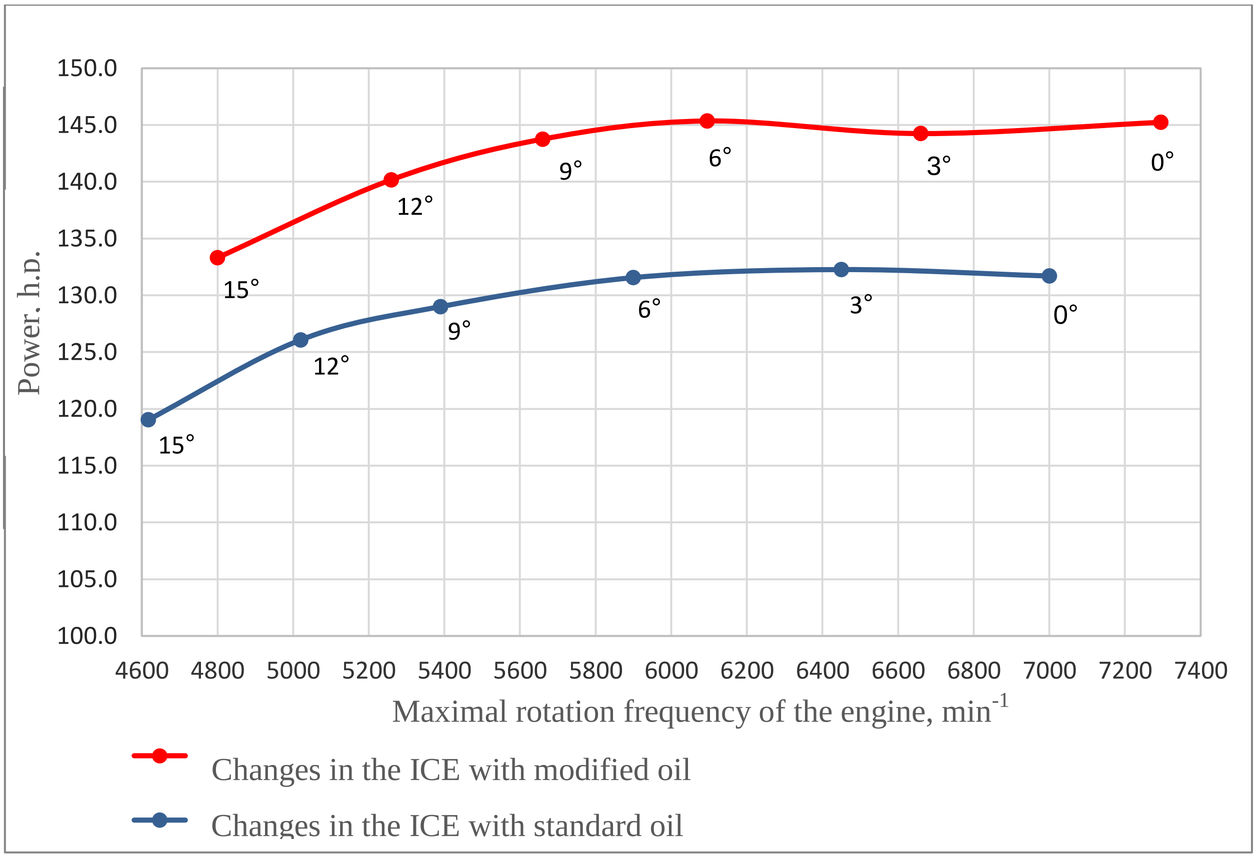

Figure 4: The diagram for engine power depending on the rotational frequency at the different pitch angle of propeller blades, for the base engine oil and after the 2 hours operating time with the modified engine oil.

Approximate functions describing the dependence of the power of rotation frequency were constructed according to the results of measurements [5].

This addiction for the case of using of standard oil looks as

$$P = 1{,}573\cdot 10^{-9}\cdot n^3 - 31604{,}555\cdot 10^{-9}\cdot n^2 + 211000989{,}904\cdot 10^{-9}\cdot n - 336{,}103 \quad (1)$$

Addiction for the case of using of modified oil looks as

$$P = 2{,}404\cdot 10^{-9}\cdot n^3 - 47252{,}830\cdot 10^{-9}\cdot n^2 + 308814304{,}368\cdot 10^{-9}\cdot n - 526{,}303 \quad (2)$$

where P – power of the engine, h.p.;
ω – maximal rotation frequency of the engine, min^{-1}.

The data of recalculation for comparable engine rotational frequency showed that the power increase of about 8.7%. It shown in table 2.

Table 2: Changing of power of the engine at comparable frequencies.

Pitch angle of the blade, °	Rotation frequency of the engine, min^{-1}	Standard oil	Modified oil (two hours operative time)	Relative increase of power, %
		Power of the engine, h.p.	Power of the engine, h.p.	
15	4800	122,494	133,164	8,0
12	5200	127,691	139,8364	8,7
9	5600	130,628	143,3894	8,9
6	6000	131,907	144,745	8,9
3	6400	132,133	144,827	8,8
0	6800	131,911	144,558	8,7
Total				**8,7**

The noise of periodic processes produced by the three-bladed propeller shows significant increase when using the modified engine oil (figure 5). The value of noise level was about 4.4 dB within the equal pitch angles of the propeller blades. The increase is due to the propeller rotation frequency growing.

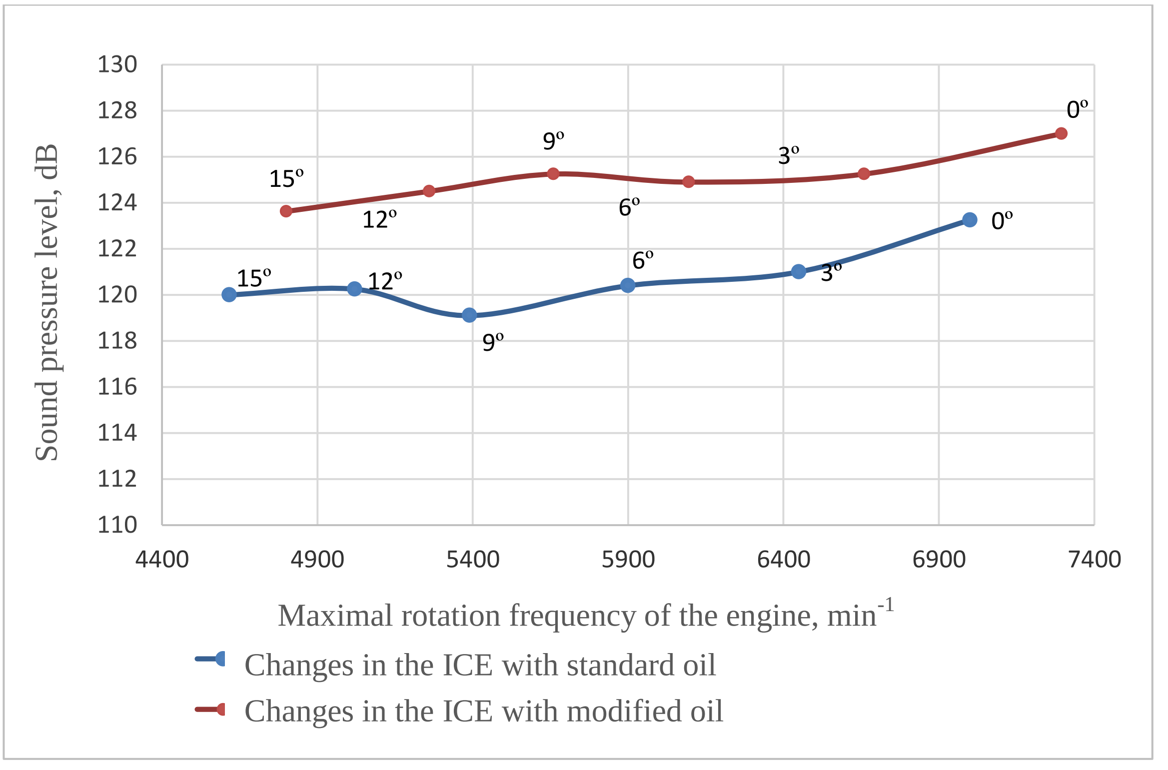

Figure 5: The diagram for the noise level depending on the rotational frequency at the different pitch angle of propeller blades, for the base engine oil condition and after the 2 hours operating time with the modified engine oil.

Besides the experiments with Subaru EJ25 the research of additive influence to engine ASh-62 with an air cooling system which is installed to AN-2 was performed. The results of measurements on the engine ASh-62 (figure 6) have shown that the fuel consumption can be reduced about the 15-20%.

Figure 6: The ground tests of power plant on the flying vehicles.

The engines with an air cooling system operate at higher temperatures. So that the living time of additives in these conditions is shorter. The investigations on improve the stability of additives to the conditions of the engine with an air cooling system are required.

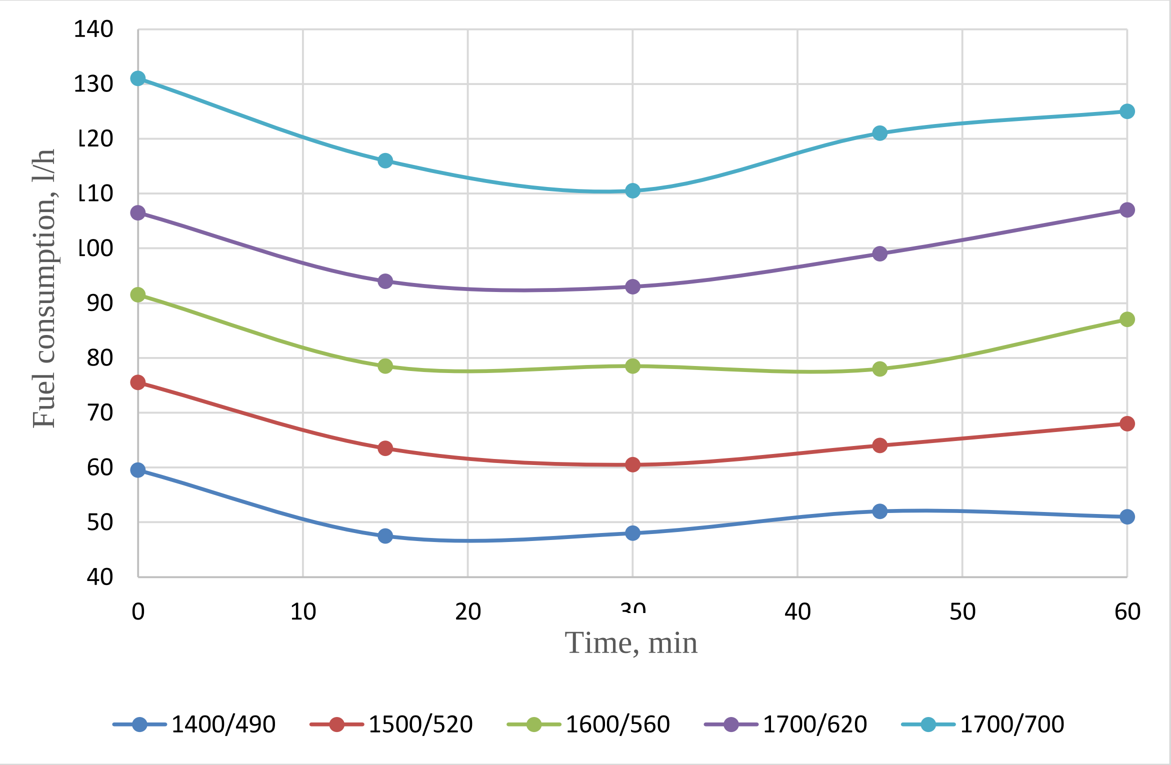

Figure 7: The fuel consumption depending on operating time with a modified engine oil.

5 Conclusion

The results of the bench test measurements of the propeller propulsion system has shown that the modification of engine oil by the additive concentrate allows the increase of the power-plant power up to 10.7% at the equal angles of the blades installation, that's 8.7% at comparable rotation frequencies.

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