INFLUENCE OF FUEL TYPE ON WORKING PARAMETERS OF TESTING COMBUSTION MICRO-ENGINE

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Abstract

The choice of appropriate additives to alternative type of fuels determines the basic problem related with diversification of fuels used to the internal-combustion engines. The research micro engine with swept volume of 165 mm^3 and the rotational speed reaching 25000 rpm was fuelled with various liquid fuels of the methyl and ethyl alcohol base. To the alcohol, additives were added with various percentage compositions, such like castor oil and nitro methane. In the fuel system the mixer of fuel with air was applied, that permitted on supply with the liquid fuel, but the composition of the fuel-air mixture was controlled with the quantity of supplied air. Registered was the graph of compression pressure in mini combustion chamber, the maximum power and shaft output torque was measured with the different composition fuels supplied to engine. Research proved that not only alcohol type applied as fuel, but above all percentage participation of additives to the fuels influenced most on the micro engine work parameters. For the same type of alcohol, but with the different additives, the maximum power and the maximum torque differed significantly. For the micro engine of this type, the best fuel was based on the methyl alcohol and has composition of 60% methanol as fuel, 15% nitro methane (CH3NO2) as fuel additive and 25% of lubricant - castor oil. Article presents the design of the power shaft output micro engine, tested fuels, exemplary graphs of compression pressures in mini chamber on the prototype of a miniature power shaft engine, graphs of the rotary torque and of the engine power of supplied with various fuels.

Keywords: *combustion engines, reciprocating engines, micro power generator, micro engine, alternative fuels*

1. Introduction

Development of internal-combustion engines, the application of which brought gigantic progress in world economy, is above all, directed on the solution of the three problems, like: the compliance with even sharper and sharper demands of exhaust emissions and elimination of threats for natural environment, the decrease of the fuel consumption, therefore lowering emission of carbon dioxide and protection of natural Earth resources, diversification of used fuels. The sources of crude oil are faster and faster utilized and the discovery of new crude oil sources do not equalize already extracted crude oil quantities. The strategy of world economy development requires broader and broader application of alternative fuels, among which, one can mention: the gas fuel compressed natural gas (CNG) and liquid natural gas (LNG), propane - butane (LPG), compressed hydrogen (CH2) and liquid hydrogen (LH2), gases produced in the water-waste plants and on the waste dumping grounds containing principally methane, mine gases obtained with the coal and crude oil extraction, rising gases as a result of the biomass gasification), liquid fuel (alcohols - principally methanol and ethanol, vegetable and animal oils and esters of them, synthetic fuel, the mixture of classical liquid hydro carbonaceous fuels with the alcohols and other fuels of vegetable and animal origin addition), fuel or the sources of renewable energy (solar power, the wind energy, nuclear energy). In the article the influence of fuel parameters on performance of a miniature research engine is submitted. The three types of liquid fuels on the base of methyl and ethyl alcohols with the castor oil and nitro methane additives were applied in tests.

2. The conditions of investigations

The research subject was the miniature propeller shaft engine with sweep capacity of about 165 mm^3 and the rotational speed approaching 25 000 rpm, elements of which are shown on Fig. 1. Combustion chamber had the shape of the truncated rotary cone with 3 mm upper diameter and 6 mm bottom diameter.

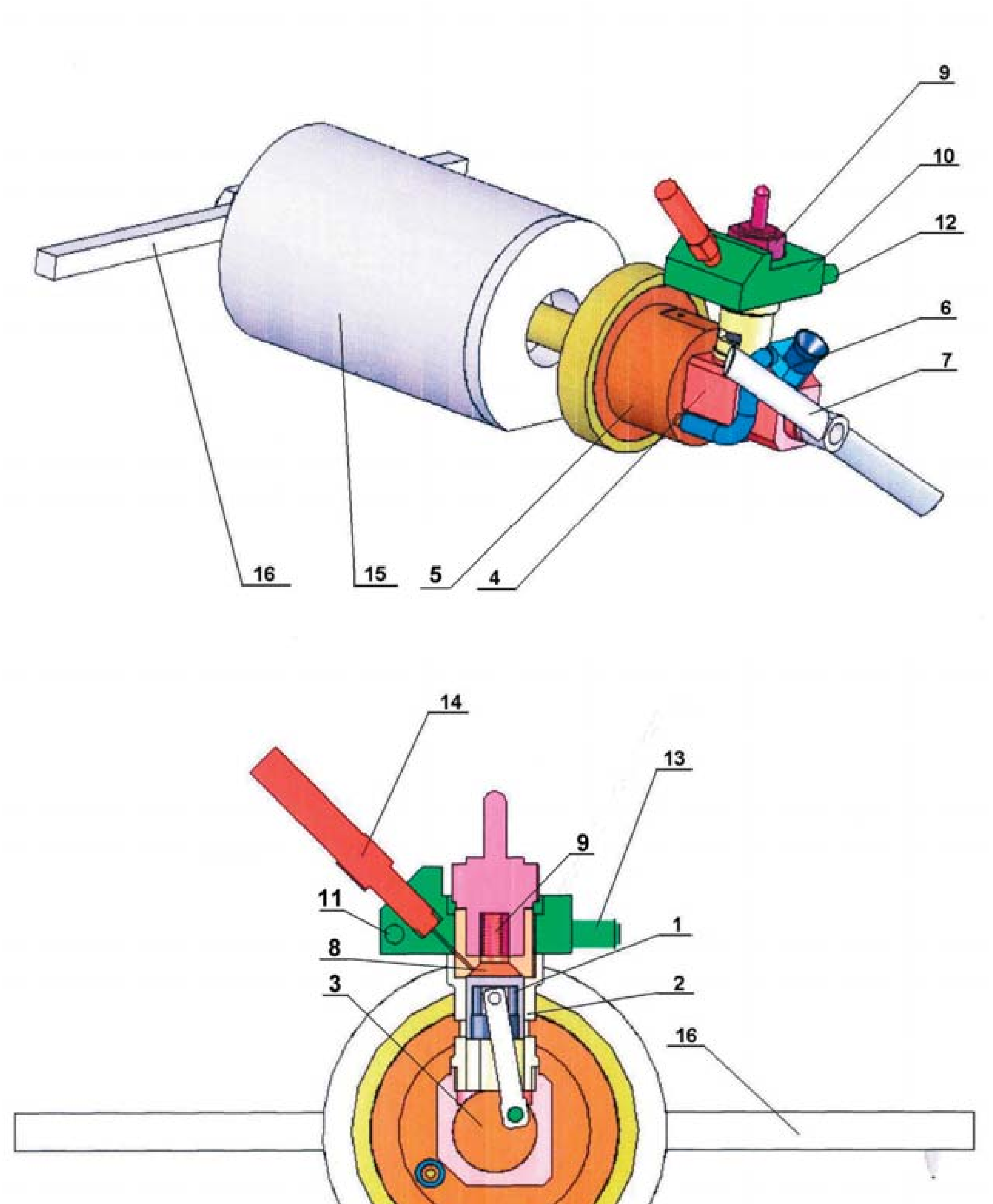

Fig. 1. The view of the miniature propeller shaft engine, together with the miniature brake

The principal micro engine elements are: 1. piston, 2. cylinder, 3.shaft, 4. crankcase, 5. fuel tank, 6. carburettor, 7. starting propeller, 8. combustion chamber with glow plug case, 9. glow plug (catalytic igniter), 10. pressure pickup case with the water cooling system, 11. water channels, 12. cooling water entry, 13. cooling water outlet, 14. pressure pickup - transducer, 15. miniature shaft brake, 16. the shoulder of brake with the torque scale pressing spire.

To investigate the influence of the fuel type on the parameters of the engine performance, the three types of the fuels were used, the voluminous composition of which is submitted in the Tab. 1.

Tab. 1. The voluminous composition of the liquid fuels used in the measurements and investigations of pressure, ignition and combustion in the miniature research engine

Item	Fuel type	Ethanol [%]	Methanol [%]	Castor oil [%]	Nitromethane [%]
1	MN60	–	60	25	15
2	EN60	60	–	25	15
3	M80	–	80	20	-

The investigations were performed on the research test stand consisting of the miniature brake and the engine research prototype. The performance parameters were measured, parameters characterizing miniature engine supplied sequentially with fuels, described in Table 1. In the induction system, the mixer of fuel with air was used, that permitted on the liquid fuel engine supply, and the composition of the fuel-air mixture was regulated with the quantity of admitted air.

On Fig. 2 is presented the exemplary course of the measured pressure values in the combustion chamber during activity of the miniature propeller shaft engine prototype, supplied with fuel designated by the symbol MN60.

The mean indicated pressure values for this fuel are equal to 19 bars.

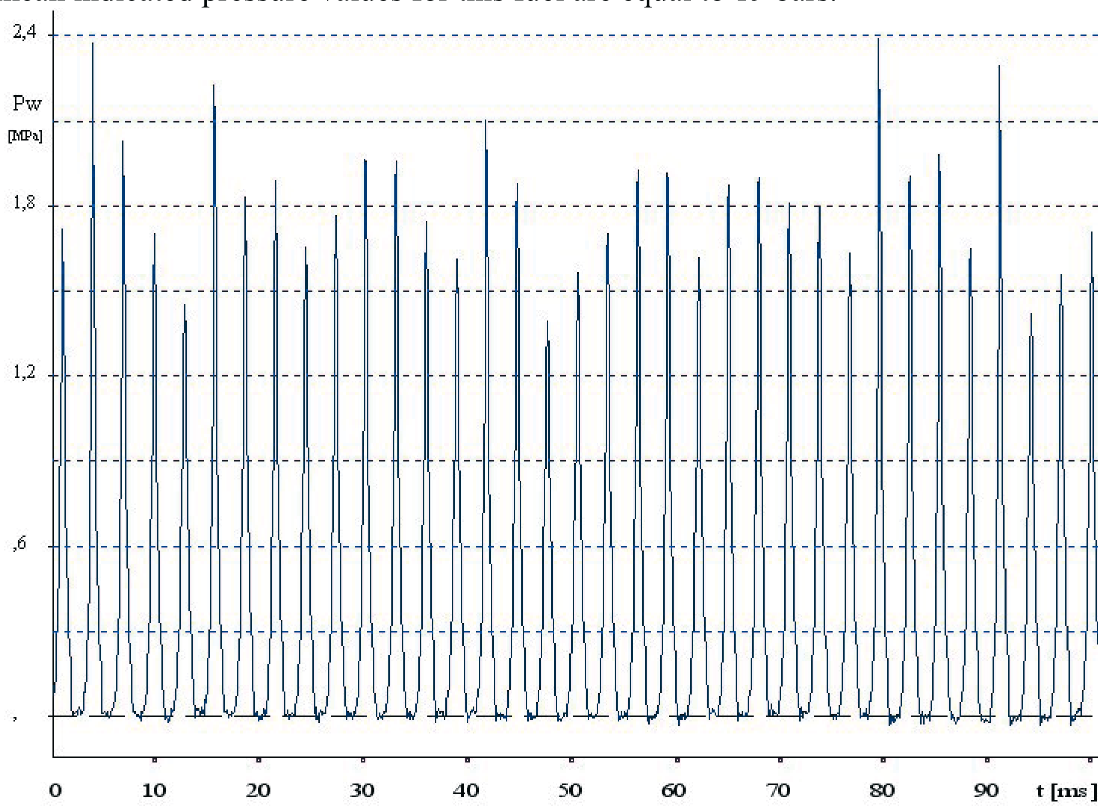

Fig. 2. Exemplary graph of compression pressure in mini combustion chamber on the prototype of a miniature propeller shaft engine supplied with fuel designated by the symbol MN60.

The graph on Fig. 3 represents the course of the measured pressure values in the combustion chamber during the activity of a miniature research engine, supplied with fuel designated by the symbol EN60.

The mean indicated pressure values for this fuel are equal to 16 bars.

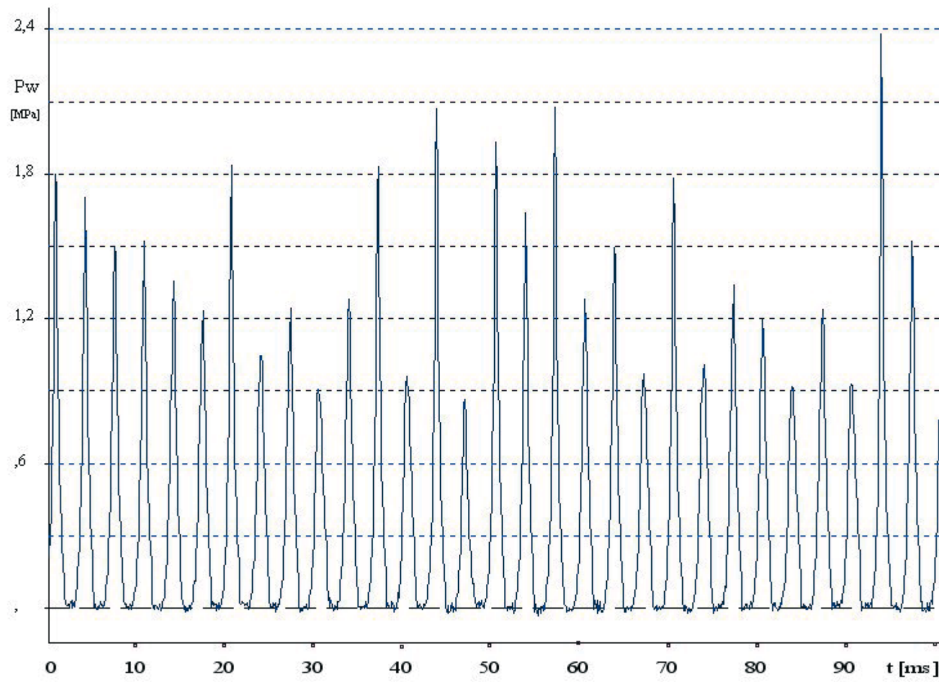

Fig. 3. Exemplary graph of compression pressure in mini combustion chamber on the prototype of a miniature propeller shaft engine supplied with fuel designated by the symbol EN60.

The graph on Fig. 4 represents the course of the measured pressure values in the combustion chamber during the activity of a miniature research engine, supplied with fuel designated by the symbol M80.

The mean indicated pressure values for this fuel are equal to 17 bars.

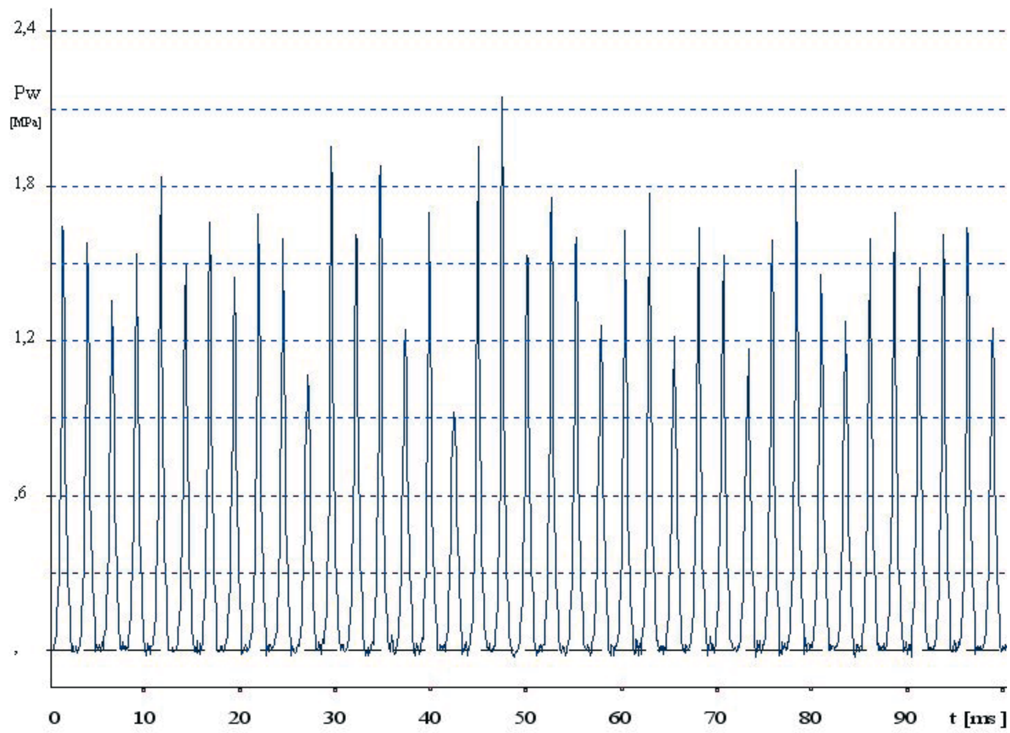

Fig. 4. Exemplary graph of compression pressure in mini combustion chamber on the prototype of a miniature propeller shaft engine supplied with fuel designated by the symbol M80.

During the measurements engine was held on the maximum rotational speed.

From presented above data results, that for this engine, the best is the fuel based on methyl alcohol. This was also confirmed later in investigations of this engine characteristics.

On Fig. 5 the graph presents the course of shaft torque, and on Fig. 6 course of the maximum power of a miniature engine supplied with MN60 fuel.

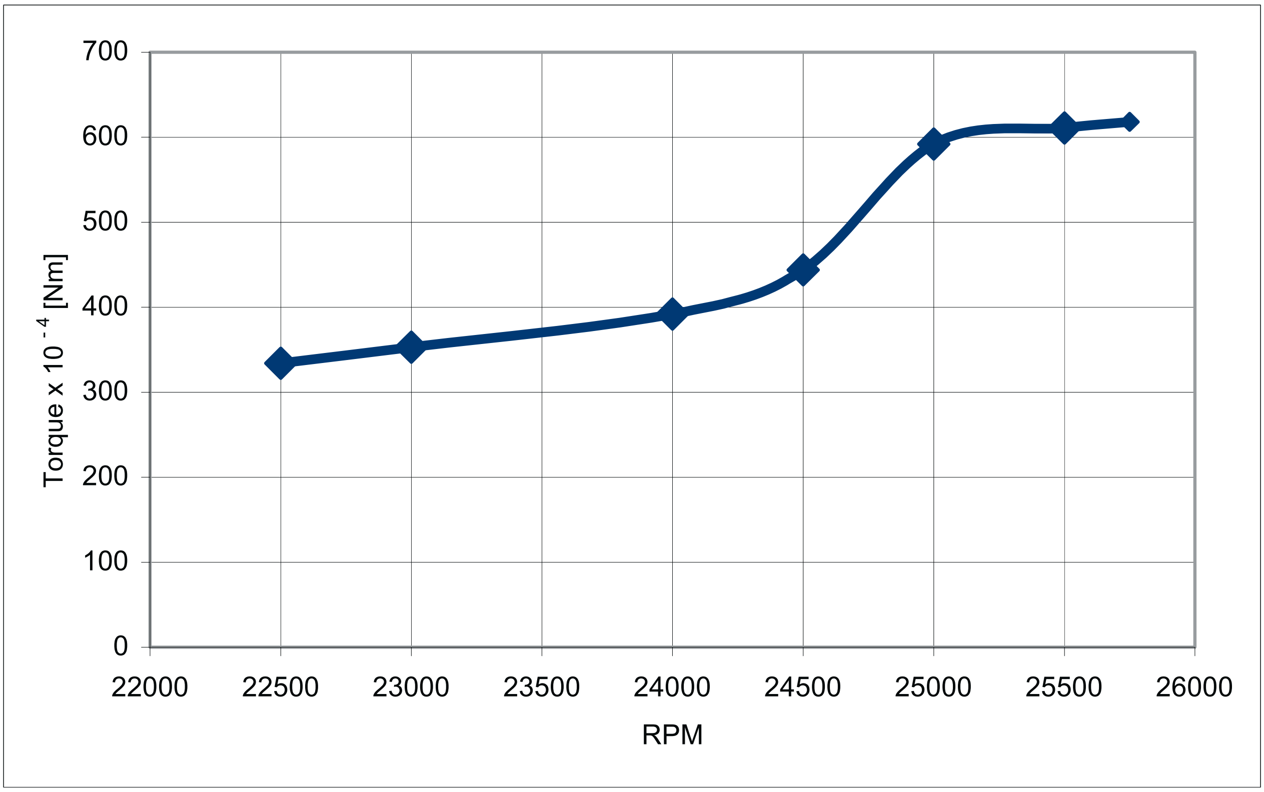

Fig. 5. The graph of output shaft torque for the miniature engine supplied with MN60 fuel

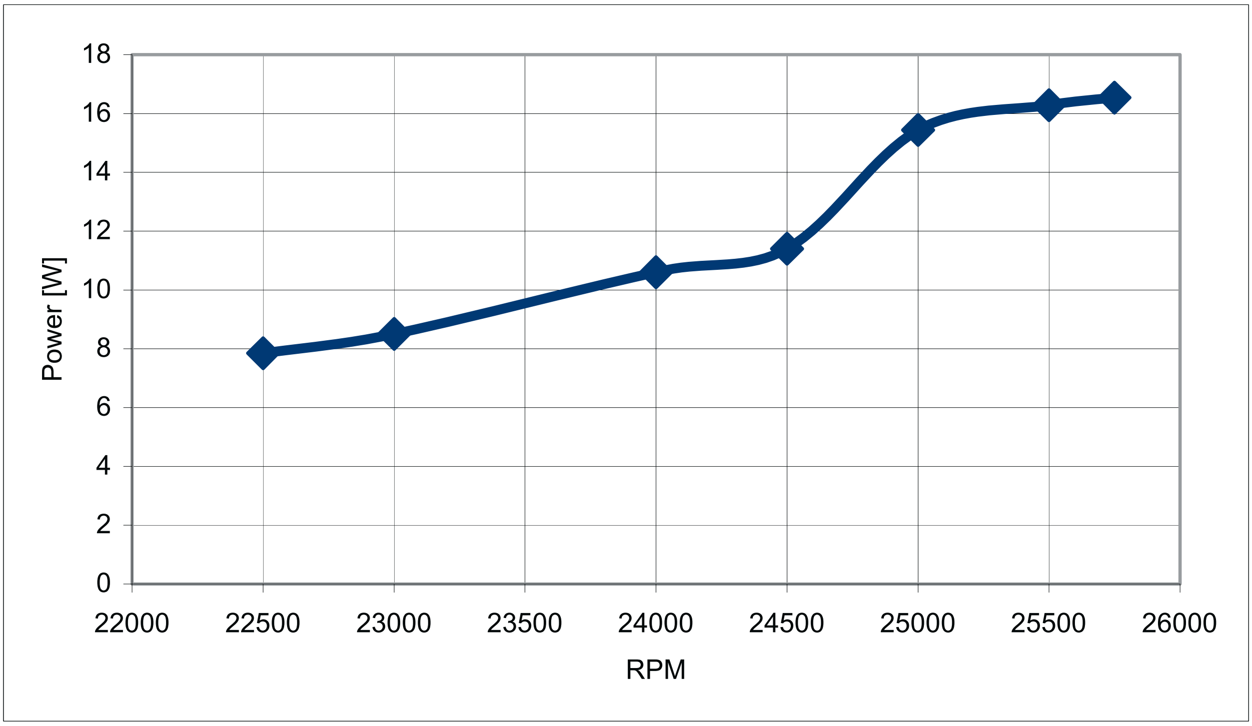

Fig. 6. The graph of the maximum power for the miniature engine supplied with MN60 fuel

On Fig. 7 the graph presents the course of shaft torque, and on Fig. 8 course of the maximum power of a miniature engine supplied with EN60 fuel.

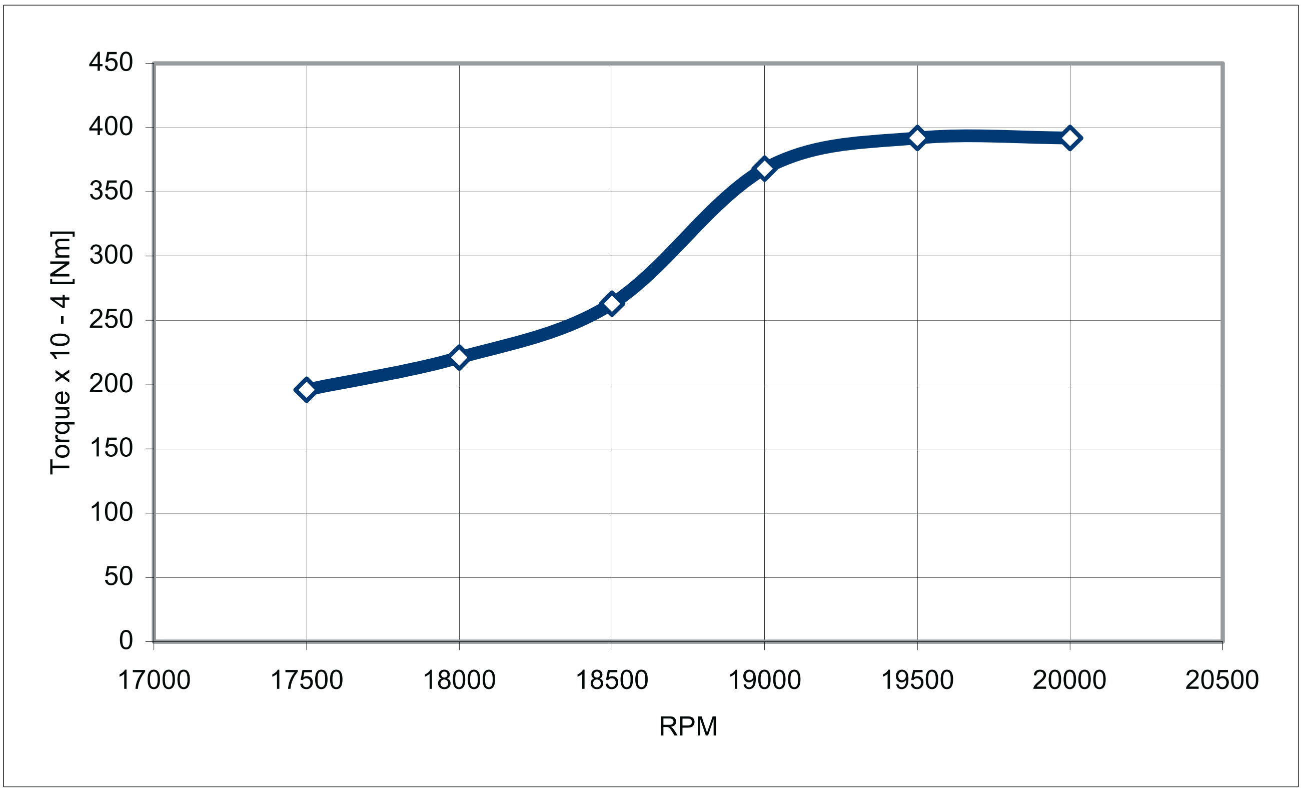

Fig. 7. The graph of output shaft torque for the miniature engine supplied with EN60 fuel

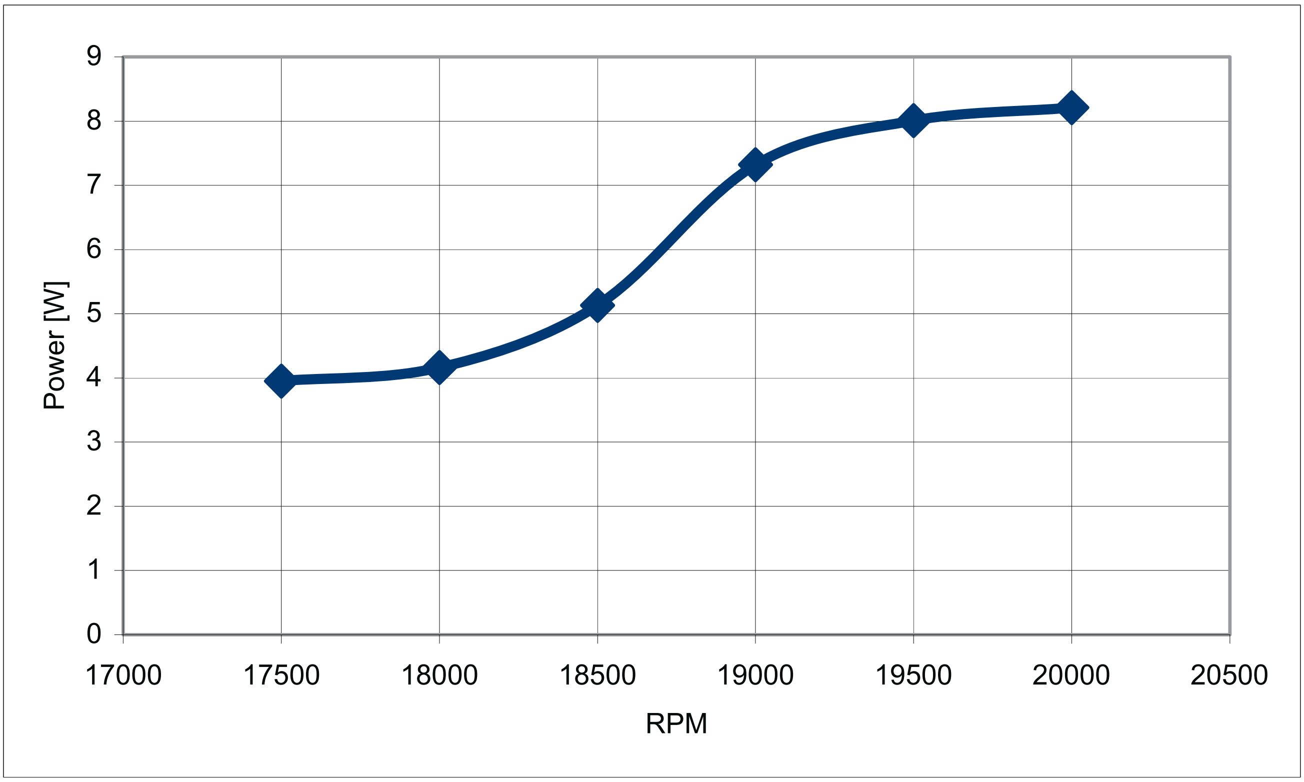

Fig. 8. The graph of the maximum power for the miniature engine supplied with EN60 fuel

On Fig. 9 the graph presents the course of shaft torque, and on Fig. 10 course of the maximum power of a miniature engine supplied with MN60 fuel.

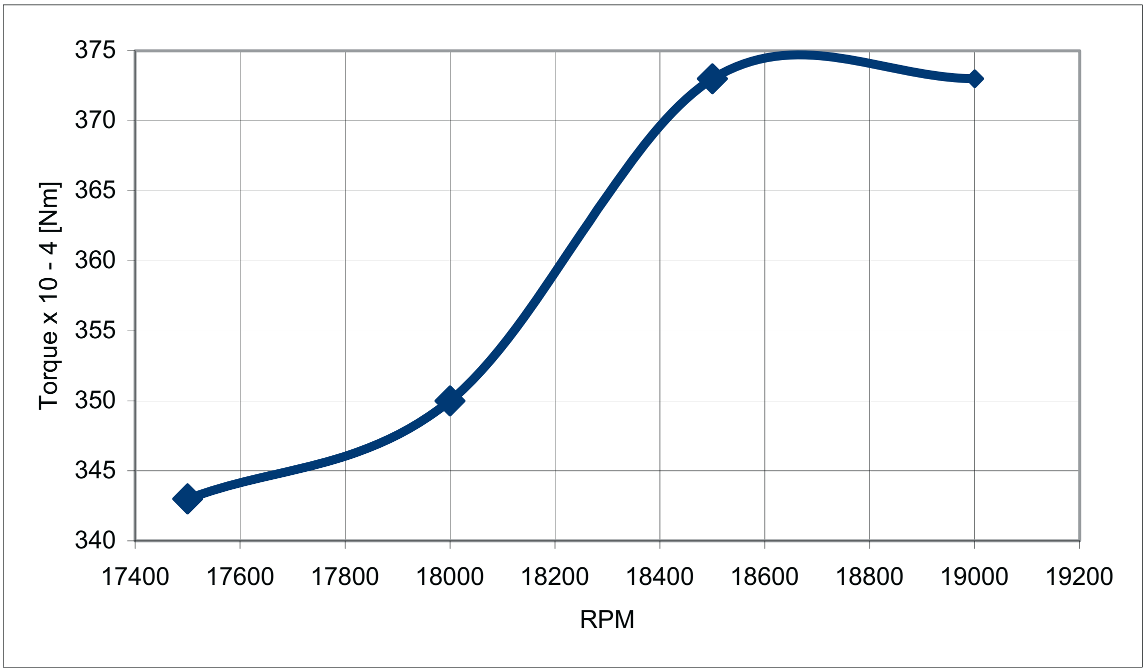

Fig. 9. The graph of output shaft torque for the miniature engine supplied with M80 fuel

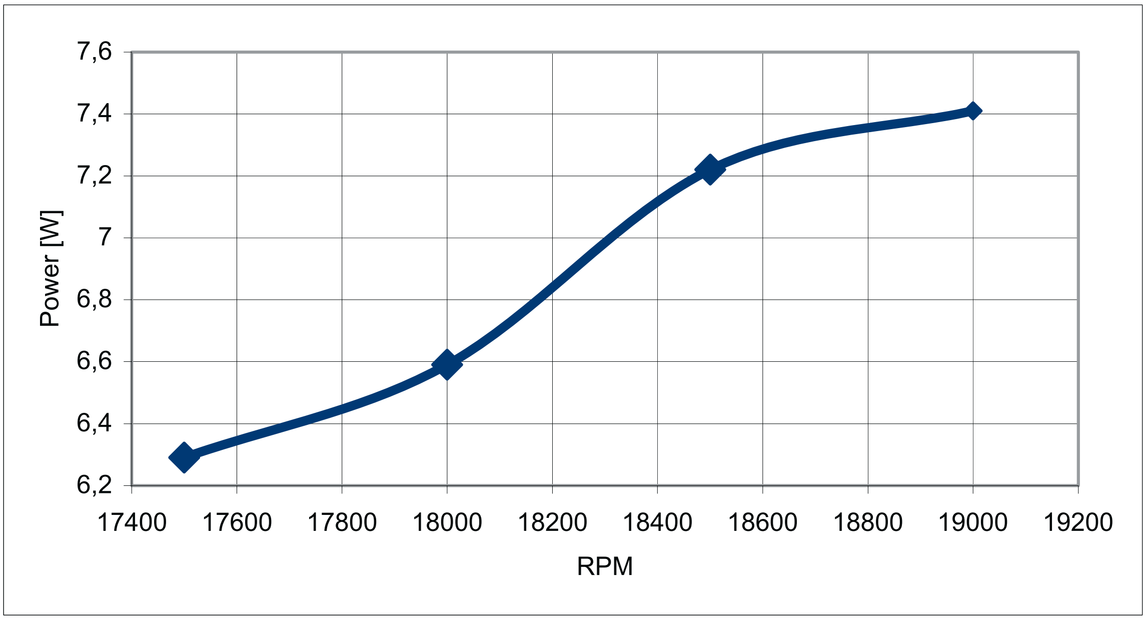

Fig. 10. The graph of the maximum power for the miniature engine supplied with M80 fuel

In the Tab. 2 the juxtaposition of maximum performance of the research miniature engine supplied with liquid fuels ME60, EN60 and M80 is submitted.

3. Conclusions

The measurements of pressure in mini combustion chamber on the working model of the miniature engine proved, that maximum compression and combustion pressures rise up with rotational speed increase. This results from the improvement of relations between chemical reaction time and charge cooling time. From investigations results, that the best fuel for this engine is the fuel based on methyl alcohol.

Table. 2. The juxtaposition of maximum performance of the research miniature engine supplied with liquid fuels ME60, EN60 and M80

Item	Fuel	M/n Gcm/rev^{-1}	N/n W/rev^{-1}
1	MN60	628/25000	16.54/25750
2	EN60	392/20000	8.21/20000
3	M80	392/19000	7.80/19000

The largest torque and the greatest power on the propeller shaft and the steadiest performance research engine obtained on the fuel consisting of 60% methanol alcohol, 25% castor oil and 15% nitro methane. The selection of appropriate additives to the fuel plays the significant role. The engine did not work correctly fuelled with ethyl alcohol without the nitro methane additive. The results of research shows, that fuel ought to be composed for concrete applications, because the performance of engine in real conditions can, and in general strongly runs out from the conditions of the research engines performance.

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