

Katowice, 10.07.2019r.

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### **Abstract of PhD dissertation entitled**

## **„Studies on the impact of compression-ignition engines with alternative fuels and analysis of their reaction on performance parameters of the selected means of transport”**

In the doctoral dissertation, there are discussed the issues concerning powering of engines with self-ignition with the mixtures of diesel oil and fatty acid methyl esters with simultaneous changes of the fuel injection controller's settings (increased dose of fuel and air supercharging).

The purpose of the study there is the development of a method and construction of a model of assessment of the impact of the addition of fatty acid methyl esters to the diesel oil on the selected values of performance parameters of the means of transport and establishment of the optimum setting of the fuel injection controller of a drive unit powered with the analysed mixtures due to the properties of the performance parameters of that unit.

Taking the above purpose of the studies' conducting into account, the main research problem has been formulated: what impact there have the fatty acid methyl esters added to the diesel oil on the performance parameters of the drive unit of a means of transport?

In order to verify the above research problem, the following thesis has been formulated: development of the method and construction of the model of assessment of the impact of the addition of fatty acid methyl esters to the diesel oil, testing of which shall make it possible to establish the optimum values of the operating parameters of a drive unit of a means of transport, what shall make it possible to take up rational decisions concerning the effective and ecological control of their operation.

This dissertation consists of ten chapters, which starts with introduction comprising the general information on the discussed issue and location of the research problem in the discipline.

In the second chapter there is presented analysis of the present state of the art. Within the scope of the discussed issue, which comprises: review construction and operation solutions of the drive units of the means of transport, review of fuels used for powering of the

engines with self-ignition, review of the legal acts, criteria of assessment of the performance parameters of the means of transport powered with plant oil, description of the plant oil's production technology and of its derivatives. The chapter ends with identification of the state of the art within the scope of the discussed issues.

The chapter three entitled The issues of the doctoral dissertation includes substantiation of purposefulness of conducting the studies within the scope of the realized topic, the research thesis, the research problems, the purpose of the study, presentation of the object and the subject matter of the studies and also the scope of the works.

In the chapter number four, there are described the programmed of the studies divided by stages, in which there is presented the characteristics of the subject matter of the studies and the research material is described. In that chapter there are also presented the methods and tools used during the studies. There has been described the first stage of the studies, which concerned the measurement of the physio-chemical properties of the mixtures of the diesel oil and of the fatty acid methyl esters. There has been presented the course of the power parameters' measurement of the mixtures with the use of the calorimeter, viscosity with the use of the rotational viscometer and the cetane index set with the motor method of fuel rating. One by one there have been discussed the methods and tools used during the second stage of the studies, which were used on the load chassis dynamometer. Based on the analysis of the literature, for the tests there were designated ten performance parameters such as: power, turning moment, emission of noise generated by the engine, solid particles included in combustion gases and toxic combustion gases' components: carbon oxide, carbon dioxide, oxygen, hydrocarbons, nitrogen oxide and the excess air's coefficient. In the chapter there have also been described the applied proportions of the diesel oil and the fatty acids methyl esters' mixtures, which had been selected based on the conducted test studies. Due to that, for conducting of the detailed measurements of the performance parameters at different settings of the fuel injection controller, there were selected the mixtures of the diesel oil and the fatty acid methyl esters in proportions 10%, 30% and 50% and 50% with an additive improving the lubricating and viscosity properties of the tested fuel. There have been assessed the changes introduced in the fuel injection controller's settings of a tested drive unit of a means of transport, which consisted in the increase of the dose of fuel and the increase of the air supercharging. Moreover in that chapter there have been discussed: the course of the measurement of the power and the turning moment performed on the load chassis dynamometer, examination of the volume of toxic components in combustion gases with the use of the combustion gases analyser MGT-5, measurement of the solid particles included in

the combustion gases with the analyzer MPM-4 and measurement of the noise emission determined with the use of a sound level meter.

The chapter number five covers the modes of proceeding at individual stages and description of the tools used for construction of the mathematical model.

The chapter number six includes the assessment and analysis of the results. For these purposes, there have been determined the assessment criteria of the condition of the tested performance parameters and the studied mixtures, and a model has been constructed, in which all the tested values of the parameters reflect the condition of the means of transport powered with the mixtures of the diesel oil and the fatty acid methyl esters. The assessment has been considered with the application of the AHP method and the elements of the fuzzy logic. The obtained results of the assessment made it possible to set the individual components of the state vector. Also the statistical analysis of the results of the studies has been presented in this chapter. The results of the studies conducted on the chassis dynamometer, analysed from the point of comparison of the values of the performance parameters for individual fuel mixtures have showed the decrease of power and of the turning moment for the mixture III and the increase for the mixture IV and V. During the tests there was noticed the decrease of noise emission generated by the drive unit. In case of the solid particles' measurement, their smallest number was recorded for the mixture V. During the conducted studies there was observed the increase of the level of nitrogen oxides and of the air excess coefficient, which increased proportionally to the increasing share of the fatty acid methyl esters in the diesel oil.

In the chapter number seven, the developed model has been verified with application of the method of the average fuzzy diagrams. This analysis makes it possible to verify the form of the constructed model and determining only the parameters which were sensitive to the introduced changes in fuel mixtures and settings of the fuel injection controller of the final form of the assessment vector.

The chapter number eight includes the structure of the computer simulation's algorithm. The constructed algorithm made it possible to assess the impact of the change of the values of individual performance parameters taking into account the type of the applied mixture. In the next chapter there have been presented the directions of the further studies, which shall concern optimization of the tests' results in order to select the least sensitive fuel mixture.

The dissertation ends with the chapter including the summary and the conclusions. Based on the obtained results of the empirical studies it may be found, that the purpose of the study has been realized and the presented thesis - proved.