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Evaluation of Ethanol-Containing Fuel Supply Control Efficiency in Spark Ignition Engine

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Abstract

The article is devoted to investigation of fuel supply control efficiency in a spark ignition engine equipped with a catalytic converter during use of ethanol-containing fuels with different ethanol content. The study involves determining the efficiency of fuel supply controlling algorithm for the engine, which is powered by conventional petrol and non-adapted for using fuels with high ethanol content. Within the study the following fuels were used: petrol, ethanol and fuel blends with ethanol content varying from 15 to 90%. The efficiency of fuel supply control is evaluated in terms of providing the specified fuel-air mixture composition, fuel consumption and emissions in transient engine operation modes during vehicle motion in the driving cycle.

The data obtained during the engine bench tests using petrol and ethanol-containing fuels were used for evaluation. The data of the engine operation parameters measurements for transient vehicle motion modes under real road conditions are also used. Methods and experimental equipment are described. An original designed test device was used during the vehicle road tests. The device allows controlling the on-board diagnostic system data (OBD-II standard) at certain time intervals and parameters of satellite system of vehicle positioning (GPS standard), transmit this data by wireless communication to the information device on vehicle control panel and store them. For this purpose, the information device has an original author application for processing and storing the received data.

Evaluation of the influence of the fuel supply controlling algorithm on the fuel consumption and emissions during use of different ethanol-containing fuels is carried out on the basis of vehicle performance in the driving cycle mathematical modeling. The description and features of mathematical model of the engine operating process are given. This model takes into account the available fuel supply controlling algorithm and ethanol content in the fuel.

The dependencies of fuel consumption and exhaust gases emissions for the vehicle motion in the driving cycle using the studied fuel compositions, obtained using mathematical modeling, are presented.

Introduction

A problem of improvement motor transport environmental performance under operating conditions can be solved by using ethanol-containing fuel (ECF) [1] due to biological origin of some ECF components, in particular ethanol. Biological origin ethanol is obtained from vegetable feedstock, which consumes carbon dioxide from atmosphere during its life cycle. So, the biological origin ethanol (bioethanol) using as a motor fuel does not break a natural balance of carbon dioxide. This statement is correctly if electrical energy from coal-fired stations is not used for ethanol producing process. Moreover, the life cycle analysis of bioethanol production from waste paper shows that this production method allows to reduce carbon dioxide emissions by almost 80% compared to waste paper processing in landfills [2]. Also, the use of petrol-ethanol mixtures can directly reduce carbon dioxide emissions from motor transport. Studies show that the use of petrol-ethanol mixtures in spark ignition engines leads to significant reduction of carbon dioxide (CO_2) emissions when ethanol content in fuel blends is about 50% or more [3]. However, this significantly increases the mass and volume consumption of blended fuel.

So, bioethanol is considered as full or partial substitute for petroleum fuels. This reduces petroleum fuels demand, and can address fuel availability concerns. The significant effect of ethanol adding on petrol octane number, saturated

fuel consumption and emissions in transient engine modes with different dynamics of engine speed and load. Modeling of fuel consumption and harmful emissions by the vehicle for its motion in the UNECE № 83-05 driving cycle using these fuels was also performed. According to the research results, it was found that use of fuel with ethanol content of more than 50% is not appropriate. It mainly leads to reduction of the engine and vehicle performance. The reasons for reduction are decrease of the fuel heat of combustion and the low adaptation of engine control parameters to the use of ethanol-containing fuels in transient modes. It is possible to improve performance of the vehicle with engine non-adapted to ECF use by changing of the engine control system characteristics. This is planned for the further research.

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Definitions/Abbreviations

OBD - on-board diagnostic
GPS - Global Positioning System
ECF - ethanol-containing fuel
NEDC - New European Driving Cycle
WLTC - Worldwide harmonized Light vehicles Test Cycle
EG - exhaust gas
ECU - electronic control unit
CAN - Controller Area Network
UNECE - United Nations Economic Commission for Europe

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