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MIXED BIODIESEL FUEL FOR DIESEL ENGINES

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СУМІШЕВІ БІОДИЗЕЛЬНІ ПАЛИВА ДЛЯ ДИЗЕЛІВ

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СМЕСЕВЫЕ БИОДИЗЕЛЬНЫЕ ТОПЛИВА ДЛЯ ДИЗЕЛЕЙ

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Introduction

From the point of view of the mechanical energy when minimum fuel consumption, diesel is the most effective. Due to its fuel-economic features diesels have been most widely used as the power-plant.

The increased level of the nitrogen oxides NO_x emission and hard bodies emission into the environment is the disadvantage of diesels in comparison to the petrol engines. The above-mentioned negative features of the diesels stipulate carrying out the activities aimed to the reduction of the concentration of the nitrogen oxides NO_x and hard bodies in the exhausted gases (EG) while the existing level of fuel efficiency remains and, if possible – increases.

Consumption of the fuels of the renewal sources of energy – vegetal fuels of the first is one of the ways of solving the problem of widening the energetic base for the diesel and for partial solving of the ecological problems. These are the vegetal oils and biodiesel fuel (BdF).

The most widely used in Europe fuel, produced from the plant raw material, is the rape oil and the products of its processing, especially the complex methyl esters of fatty acid of the rape oil (methyl esters of the rape oil). The part of the physicochemical features of the above-mentioned fuels accords with the similar features of the regular diesel fuel (DF) and the part of them doesn't, which has to be noticed and the activities that have to deal with the preparation of the BdF should be carried out.

The explicit feature of the vegetal fuels is that they contain oxygen (nearly 12%), which leads to decrease of the heating value. Containing the oxygen also decreases the temperature of their heating and improves the ecological features. During the studying of the work of the diesel, when methyl esters of the rape oil (MERO) were used as the fuel, the reduce EG smoke and the concentration of the unburned combustibles. Meantime the increase of the fuel consumption per hour and the concentration of the nitrogen oxides NO_x [1].

The fuel combustion in diesel happens in diffusion flow, where the most intense fuel combustion is developed in stoichiometric zone, which is one of the peculiarities of the fuel combustion in diesel ($\delta=1$). If the combustion temperature is maximal, the intense production of the nitrogen oxides NO_x is the result. They are known to be one of the main ingredients of the EG of the diesel, their part in the total drawn to CO emission index may be approximately 90% [2].

The ecological features of the work of the diesel are dependent on such physicochemical features of the fuels as density and kinematic viscosity. Density determines the quantity of energy, that is given in the combustion chamber, as in the high pressure rotary plunger pumps the big dosage of fuel is processing.

Kinematic viscosity determines the internal friction of the fuel flow. The main factor of the viscosity influence on the cycle fuel deliver are the fuel leakages through the gaps of the precision couples

of the fuel delivery equipment. The higher the meaning of density and viscosity, the bigger the drops during the dispension, the maximum range of the fuel flow is increased.

While trying to consumer the alternative fuels for the automobiles that are being used, it is necessary to consider the difference of some physical-chemical features first, such as the kinematic viscosity and density.

The aim of the research

To determine the ecological, economic and energetic properties of the work of diesel while consuming the two-component and three-component BdF.

Materials and methods

Considering that one of the main disadvantages of MERO is the energy, that is demanded for its consumption, is not a lot less than the lower heating value of MERO, so from the point of view of the energetic and economic efficiency, on this stage of development of the technology of consumption of MERO the more rational will be its use as of mixture with the regular DF.

Considering all the above-mentioned, for more rational use of BdF while preparing them the physical-chemical features have to be provided (such as kinematic viscosity, density) as such of the regular DF, by means of adding the components with lower kinematic value to the BdF.

The addition of the components with lower meanings of the kinematic viscosity allows to gradually decrease this property. Kerosene may be one of such components. Its adding in the quantity of 20% gradually influences the other physical-chemical properties of the mixed fuel [3]. In the Table 1 the values of kinematic viscosity for various mixed fuels are shown.

Table 1. - The values of the kinematic viscosity of the mixed fuels

	Regular DF	Kerosene TS-1	MERO	90 % DF + 10 % MERO	80 % DF + 20 %MERO	70%DF+ 30%MERO	85 % DF + 10 % MERO + 5 % TS–1	67,5 % DF + 20 % MERO + 12,5 % TS – 1	52 % DF + 30 % MERO + 18 % TS – 1
Kinematic viscosity at 20°C, mm^2/s	3,92	1,51	10,24	4,14	4,58	4,89	3,94	3,92	3,93

It is obvious from the values, shown in the Table 1 that while preparing the mixed BdF, adding of the kerosene TS-1 (the quantity of the adding has been determined by calculative-experimental means for each mixture) basically doesn't lead to the alteration of the values of the viscosity in comparison with the regular DF.

Results and discussion

While feeding of diesel with mixed fuels with 10-, 20% MERO in the mixture with regular DF (further two-component mixed fuel) the hour emission of fuel has increased, so have the values of the spinning moment in the area of full loads, concentration of the nitrogen oxides in the EG.

The effective output factor has decreased in comparison with the work of diesel on the regular DF (Fig. 1.1).

While using the same mixed fuels, but adding 5- , 12,5- , 18% of kerosene TS-1, relevantly for 10-, 20-, 30% two-components mixed fuels (further three-component BdF) the hour fuel combustion practically didn't increase in comparison with the regular DF. The increase of effective output factors took place, but the concentration of the nitrogen oxides NO_x were lower, than while working on the regular DF and two-component BdF . The concentration of the incomplete combustion products CO, C_mH_n also of the smoke of N as while feeding with the two-component and three-component BdF has reduced in comparison with the regular DF.

According to the results of the research carried out (Fig. 1.1) it can be concluded that the hour consumption of two-component BdF more than 3- and 6% relevantly with 10-, 20 % of MERO in the mixture. While using of the three-component BdF the maximum increase of the hour consumption not more than 1,5-2,5% upon the whole under-load area.

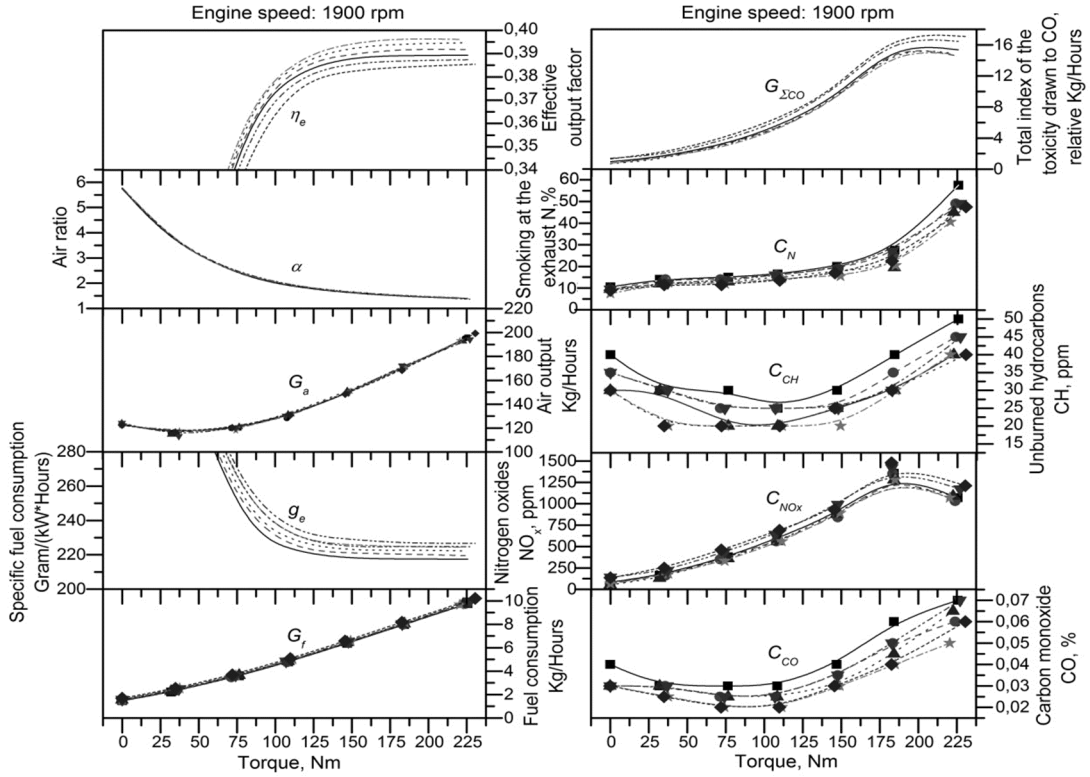

Fig.1.1. The load characteristics of the VAG ASV 1.9Tdi diesel. The fuel economical and energetic properties.

Fig.1.2. The load characteristics of the VAG ASV 1.9Tdi diesel. The ecological properties.

While using the two-component BdF the concentration on the nitrogen oxides NO_x in the EG is increased with the increase of the volume part of MERO in the mixture (Fig. 1.2). As it has been underlined before, the nitrogen oxides NO_x make nearly 90% in the total index of the toxicity of the EG drawn to CO which will lead to its growth, while nitrogen oxides also growing nevertheless the concentration of the products of incomplete combustion CO, $C_mH_n$are decreasing, the smoke of N also (Fig. 1.2). While using the three-component fuels, the decrease of the concentration of nitrogen oxides NO_x takes place. Into the cylinder of the engine less fuel is sprayed in comparison with the consumption of the two-component BdF, which leads to the decrease of the combustion temperature and the process of the creation of nitrogen oxides NO_x and as a result the decrease of the drawn to CO total index of toxicity of EG.

In order to have the ability of determining the most exact level of the emission of the harmful substances with the EG the automobile has to be examined under the conditions that are the most close to the real conditions of exploitation. Contrary to the road tests, the research at the modeling role stage may be carried out in the exact compliance with the pre-set speeds in time without the necessity to take into consideration the real conditions of the movement of the transport flow. Only in such a way the repetitive and comparative research of the automobiles may be carried out.

The program of the research of the conditional movement of automobile at the modeling role stage under the European drive cycle includes the determination and the comparative analysis of the loss of fuel and determination of the mass emissions of the harmful substances (nitrogen oxides NO_x, total hydrocarbon THC, carbon monoxide CO and particulate matter PM) while working on the fuels under the research:

- regular diesel fuel;
- two-component biodiesel fuel containing MERO 20%;
- three-component biodiesel fuel containing MERO 20%.

The analysis of the results of testing the automobile at the modeling role stage under the conditions of modified European drive cycle while working on the regular and mixed biodiesel fuels shows under the engine's functioning on the biodiesel fuels the loss (g/cycle) increases on 4,6% - while functioning of the two-component and on 1.8% while functioning on three-component biodiesel fuel.

The fuels, used during the research have different lower combustion value which is why the evaluation of the quality of the their heat use is stated with the heat expenditure (MJ/cycle) for the

execution of the equivalent work. Under the engine's functioning on two-component biodiesel fuel takes place the increase of the heat expenditure on 2.12% relevant to the heat, that is spent under the work on the regular biodiesel fuel for the execution of the work under the drive cycle.

Table 2. – Mass emission of harmful substance s during the Skoda Octavia 1.9Tdi automobile testing

Emissions of the harmful substances	Fuel		
	Regular DF	2-comp. BdF (MERO 20%)	3-comp. BdF (MERO 20%)
CO, g/km	0,3568	0,2893	0,2808
EURO 2 (CO emissions), g/km	1,0		
CO_2*, g/km	133,26	124,07	118,47
Maximum CO_2 emissions for Skoda Octavia 1.9 Tdi, g/km	135		
$NO_x + THC$, g/km	0,6949	0,7115	0,6404
EURO 2 ($NO_x + THC$ emissions), g/km	0,7		
PM, g/km	0,0421	0,0372	0,0365
EURO 2(PM emissions), g/km	0,08		

* CO_2 non toxic substance.

During the engine functioning on the three-component biodiesel fuel takes place the inconsequent reduce of the expenditure (on 0,68%) for the execution of the equivalent work.

The mass emissions of the products of incomplete combustion are reduced: total hydrocarbon THC, carbon monoxide CO and particulate matter PM (Table 2). Herewith the mass emissions of the nitrogen oxides NO_x with the EG under the engine's functioning on the two-component fuel (the value of the coefficient of kinematic viscosity of which is some bigger) increase on 5,3% relevant to the mass emissions of the nitrogen oxides NO_x with the EG while functioning on regular DF. The mass emissions of NO_x while working on the three-component biodiesel fuel decrease on 6,2% (the kinematic viscosity of three-component fuels is equal to the kinematic viscosity of the regular DF).

Conclusions

Also, the carried out research has determined that while using the three-component BdF the effective output factors is higher in comparison with the DF and while using the two-component BdF it is lower.

The higher effective output factors of the diesel while feeding with three-component fuel may be explained by higher efficiency of its combustion due to the presence of oxygen in the molecule of MERO while storing the quality properties of the sprinkling and dosage of the fuel, that is delivered to the engine cylinder.

As the result of carried out research of two- and three-component BdF it may be stated, that the use of the three-component BdF gives opportunity to improve the energetic, economic and ecological features of the work of the engine in comparison with the use of the two-component fuels.

The results of the research has identified that the summarized mass emissions of the harmful substances with the EG, modified to CO, under the modified European drive cycle while working on the two-component biodiesel fuel increase on 0,68%, while working on the three-component – reduce on 8,22% in comparison with the regular diesel fuel.

REFERENCES

1. Девянин С.Н. Растительные масла и топлива на их основе для дизельных двигателей / С.Н. Девянин, В.А. Марков, В.Г. Семенов. – Харьков: Новое слово, 2007. – 452 с.

2. ГутаревичЮ.Ф. Екологіяавтомобільноготранспорту: Навч.посібник // Ю.Ф. Гутаревич, Д.В.Зеркалов, А.Г.Говорун[таін.] – К.: Основа, 2002. – 312 с.

3. Колосюк Д.С. Експлуатаційні матеріали: підручник / Д.С. Колосюк, Д.В. Зеркалов.– 2–ге вид. – К.: Арістей, 2005. – 241 с.

ABSTRACT

HovoroonA.G, PavlovskyM.V., KutsyyP.V. Mixed biodiesel fuel for diesel engines

The article goes over the ways of improvement of the ecological properties of automobiles with the modern diesels, that are in exploitation by means of gradual transfer from supplying diesels with regular fuel to supplying with the alternative types of fuels.

The aim of research is broadening of the fuel base of automobile transport while using the alternative types of fuels.

The object of research – the influence of mixed biodiesel fuels on fuel-economy, ecologic and energetic properties of the automobile with engine.

Methods of research – experimental.

The optimization of physical and chemical features of mixed biodiesel fuels is one of the effective ways of reducing the toxicity of exhausted gas and improvement of fuel economy. This can be reached by providing the necessary physical and chemical features of mixed biodiesel fuels as well as by narrowing their limits of verification in other words by adaptation of these fuels to the diesels that are in exploitation.

Consequently the optimization of physical and chemical features of mixed biodiesel fuels allows to improve the efficiency of its use in modern diesels and to reduce the emissions of harmful substances with the exhausted gas.

The results of the article may be used as the recommendations while preparing and using the mixed biodiesel fuels for the automobile transport.

KEY WORDS: DIESEL, ALTERNATIVE FUELS, BIODIESEL FUELS, METHYL ETHER OF RAPE OIL, FUEL ECONOMY, ECOLOGICAL FEATURES.

РЕФЕРАТ

Говорун А.Г., Павловський М.В., Куций П.В. Сумішеві біодизельні палива для дизелів / Говорун Анатолій Григорович, Павловський Максим Вікторович, Куций Петро Вікторович //

В статті розглянуто напрям поліпшення екологічних показників автомобілів з сучасними дизелями, що перебувають в експлуатації, системним поетапним переходом з живлення дизелів штатним паливом на живлення альтернативними видами палив.

Об'єкт досліджень - вплив сумішевих біодизельних палив на паливно-економічні, екологічні та енергетичні показники автомобіля з дизелем.

Метою досліджень є розширення паливної бази автомобільного транспорту при використанні альтернативних видів палива.

Методи дослідження – експериментально-розрахункові.

Оптимізація фізико-хімічних властивостей сумішевих біодизельних палив є одним із ефективних шляхів зниження токсичності відпрацьованих газів та поліпшення паливної економічності. Це досягається як забезпеченням необхідних фізико-хімічних властивостей сумішевих біодизельних палив, так і звуженням їх меж зміни, тобто адаптацією цих палив до дизелів, що перебувають в експлуатації.

Таким чином, оптимізація фізико-хімічних властивостей сумішевих біодизельних палив дає можливість покращити ефективність його використання в сучасних дизелях, а також зменшити викиди шкідливих речовин з відпрацьованими газами.

Результати статті можуть бути використанні як рекомендації при підготовці та застосуванні сумішевих біодизельних палив для автомобільного транспорту.

КЛЮЧОВІ СЛОВА: ДИЗЕЛЬ, АЛЬТЕРНАТИВНІ ПАЛИВА, БІОДИЗЕЛЬНІ ПАЛИВА, МЕТИЛОВИЙ ЕФІР РІПАКОВОЇ ОЛІЇ, ПАЛИВНА ЕКОНОМІЧНІСТЬ, ЕКОЛОГІЧНІ ПОКАЗНИКИ.

РЕФЕРАТ

Говорун А.Г., Павловский М.В., Коцый П.В. Смесевые биодизельные топлива для дизелей / Говорун Анатолий Григорьевич, Павловский Максим Викторович, Куцый Петр Викторович //

В статье рассмотрены направления улучшения экологических показателей автомобилей с современными дизелями, находящихся в эксплуатации, системным поэтапным переходом с питания дизелей штатным топливом на питание альтернативными видами топлива.

Объект исследований - влияние смесевых биодизельных топлив на топливно-экономические, экологические и энергетические показатели автомобиля с дизелем.

Целью исследований является расширение топливной базы автомобильного транспорта при использовании биодизельных топлив.

Методы исследования - экспериментально-расчетные.

Оптимизация физико-химических свойств смесевых биодизельных топлив является одним из эффективных путей снижения токсичности отработавших газов и улучшения топливной экономичности. Это достигается как обеспечением необходимых физико-химических свойств смесевых биодизельных топлив, так и сужением их границ изменения, т.е. адаптацией этих топлив к дизелям, находящихся в эксплуатации.

Таким образом, оптимизация физико-химических свойств смесевых биодизельных топлив позволяет повысить эффективность их использования в современных дизелях, а также уменьшить выбросы вредных веществ с отработавшими газами.

Результаты статьи могут быть использованы как рекомендации при подготовке и применении смесевых биодизельных топлив для автомобильного транспорта.

КЛЮЧЕВЫЕ СЛОВА: ДИЗЕЛЬ, АЛЬТЕРНАТИВНЫЕ ТОПЛИВА, БИОДИЗЕЛЬНОЕ ТОПЛИВО, МЕТИЛОВЫЙ ЭФИР РАПСОВОГО МАСЛА, ТОПЛИВНАЯ ЭКОНОМИЧНОСТЬ, ЭКОЛОГИЧЕСКИЕ ПОКАЗАТЕЛИ.