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FERMENTED ETHANOL AS A COMPONENT OF THE RAPE-SEED OIL BASED DIESEL FUEL

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Introduction

The increased utilisation the biofuels, especially for diesel engines, was registered in the last ten years. Rape-seed oil is the most extended in the Czech Republic. The use of raw vegetable is not possible in the conventional diesel engines due to the oil attributes. High viscosity means problems with fuel injection, problems with crankcase lubricant polymerization, etc. Only a special engine construction – for example Elsbett motor – can directly use raw vegetable oil [ELSBETT 1996].

Another way of vegetable oil utilization is blending of rape-seed methyl ester (RME) with petrol diesel fuel. This fuel mixture contains 30–36% of rape-seed methyl ester. This fuel mixture is called „biodiesel of the II. generation" and fullfils all ecological and engine requirements, such as emission reduction and biological decomposition.

Special attention should be paid to the emissions. The performance with biodiesel (30% of rape-seed methyl ester and 70% of the light fraction of petrol diesel) showed reduction of emissions of carbon monoxide, sulphates and particular matter [POLÁK 1999]. The paper presents the practical results of the performance with the biodiesel and their mixtures with different quantity of fermented ethanol. The ZETOR trademark Czech agricultural tractor and the AVIA trademark Czech truck engines were used in the experiments.

Materials and methods

The testing was carried out with an unmodified AVIA 712.18 truck engine and an unmodified ZETOR 7701 tractor engine according to thirteen-points homologation test method EHK R49 (ČSN EN ISO 8178-4).

Engine tuning parameters like injection pressure, angle of pre-injection, etc. correspond to manufacturer basic adjustment. All parameters are calculated for standard atmospheric conditions [KŘEPELKA et al. 1996]. The total emission amount is calculated by means of balance coefficient, according to EHK R49.

Biofuel NATURDIESEL, according to the Czech standard ČSN 65 6508, served as a basis for fuel blends and as a comparison fuel. Before the experiment, detailed fuel analyses were done. Based on elemental analysis of fuel samples, it is possible to determine theoretical heat value of blended fuels. Other important parameters like density, viscosity, distillation curve, etc. were also done.

The fuel blends were evaluated from the point of view of fuel properties. The results are as follows: basic fuel NATURDIESEL (0% of alcohol) fully corresponds to the ČSN 65 6508, RME content corresponds to the respective law (it means more than 30%). Also, the (C.F.P.P. – cold filter plugging point), physical and chemical properties are in standard limits as well. It can be said, that NATURDIESEL fullfils the first rate biofuel.

However, increased content of alcohol means decreasing heat value (heat value of alcohol is only 27 332 kJ/kg), lower temperature at the begining of distillation and higher water content. Properties in low temperatures (mainly C.F.P.P.) are within limits.

Engine output and operation parameters

Reduced engine output: Both engines showed, that there are no significant differences in engine output between the biofuels with various shares of alcohol, i.e. engine output is nearly constant in depending of alcohol content.
Specific fuel consumption: Only a light increase of specific fuel consumption of fuel blends with higher concentration of alcohol was observed. The reason the this is the lower heat value and lower viscosity of the fuel with alcohol.
Exhaust gases temperature: There is a slight decrease in temperatures at higher alcohol concentration, due to the high evaporative heat of alcohol, which takes off the heat from combustion space.

Emission parameters

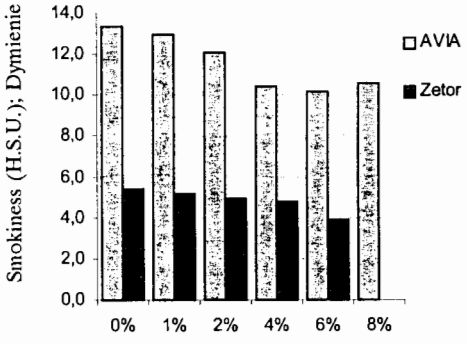
Smokiness: With regard to the high distribution of data, it is not possible to exactly assess the course of this parameter. But, generally, it can be said, that quantity of the smokiness decreases with increased content of alcohol in fuel blend, due to the lower viscosity and consequently to the better fuel spraying. Amount of Zetor smokiness is about half lower than in AVIA, because the temperature in combustion space is higher and combustion is better.
CO emissions: CO is a poisonous gas arising from the imperfect burning of carbon contained in the fuel. Primary cause of the existence is the lack of it's oxygen in burned mixture. Another cause is low reaction velocity of elementary oxidation processes, in which the CO is the primary product of this reaction.

There is little increase of CO emissions depeding on increasing content of alcohol in both cases. Generally, the amount of CO in Zetor fluel gases is about 2 times higher than in AVIA.

HC emissions: The unburned hydrocarbons arise under similar conditions as CO. Besides the negative influence on the environment, it also means the loss of energy. Due to the oxidation of these hydrocarbons it should be possible to enhance the heat brought to the combustion cycle.

Both engines showed increasing amount of unburned hydrocarbons at increasing concentration of alcohol in fuel blend. It could be explained by cooling of combustion space due to the high evaporation heat of alcohol.

Smokiness – balanced average
Dymienie – średnie zrównoważone



CO emissions – balanced average
Emisja CO – średnie zrównoważone

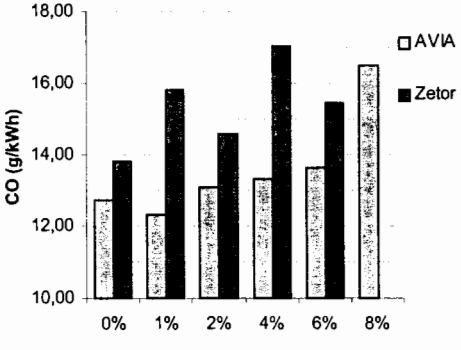
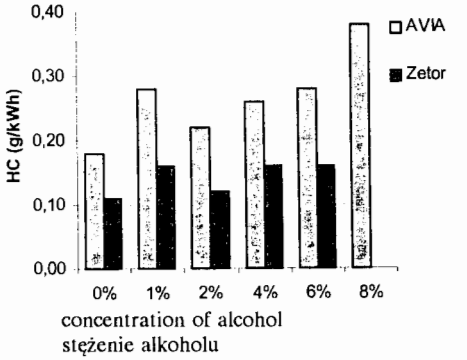


Fig. 1. Total smokiness and CO emission amount
Rys. 1. Ogólne dymienie i emisja CO

No_x emissions: These emissions arise as a product of the airy nitrogen oxidation in combustion space. The oxidation of nitrogen passes under the high temperatures and it is endothermic.

The results of these emissions measurements are very interesting. The significant decrease was observed in the Zetor engine whereas the outstanding decrease in the AVIA engine. However, increased share of alcohol means the increased concentration of NO_x.

HC emissions – balanced average
Emisja HC – średnie zrównoważone



No_x emissions – balanced average
Emisja NO_x – średnie zrównoważone

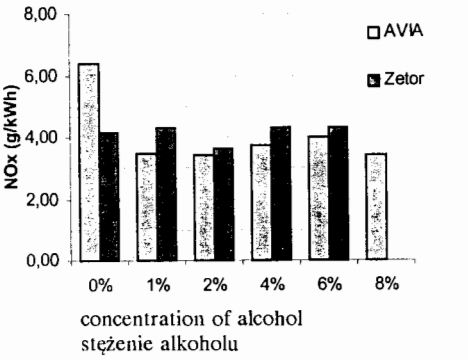


Fig. 2. Total HC and NOx emission amount
Rys. 2. Całkowita emisja HC I NOx

Conclusion

Based on the above mentioned results, it can be said, that the most suitable fuel blend is: biodiesel + 2% addition of fermented bioethanol according to following points. This addition significantly reduces the NO_x emissions. In the AVIA engine the reduction is about 54% in comparison with non additived fuel (0% fuel blend). In the Zetor engine, it is decreased by 88% of its primary value. Even in the case of smokiness, the situation is similarly favourable. The power output parameters are almost constant. No significant increase of fuel consumption was observed. However higher share of unburned hydrocarbons depending on increased alcohol content was observed. In this case, the lower concentration of alcohol is advantageous, which is in accordance to the 2% fuel blend. Higher share of ethanol is not interesting from the point of view of fuel requirement. The price of the fuel blends increases due to the co-solvent addition (of about 10% in case of the fuel blend with 2% of alcohol).

The water contents in ethanol caused, that the alcohol is insoluble in biodiesel. Due to this the addition of the so called co-solvent is necessary. The tercial butanol (TBA) was used in this experiment. However, the price of this components is high and its amount increases the price of biofuel.

In comparison to the commercially available petrol diesel, the total amount of emissions of the fuel blends (especially with small content of alcohol) was lower in all cases, which facilitates the realization of emission limits also in the older types of engines.

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Key words emissions, biodiesel, fuel blend, ethanol

Summary

The paper presents the practical results of the performance with the biodiesel and their mixtures with different quantity of fermented ethanol. The ZETOR trademark Czech agricultural tractor and the AVIA trademark Czech truck engines were used in the experiments.

Based on the results, it can be said that the most suitable fuel blend is: biodiesel + 2% addition of fermented bioethanol according to following points. This addition significantly reduces the NO_x emissions. In the AVIA engine the

reduction is about 54% in comparison with non additived fuel (0% fuel blend). In the Zetor engine, it decreased by 88% of its primary value. Even in the case of smokiness, the situation is similarly favourable. The power output parameters are almost constant. No significant increase of fuel consumption was observed. However higher share of unburned hydrocarbons depending on increased alcohol content was observed.

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BIOETANOL JAKO SKŁADNIK PALIWA (ESTRU) PRODUKOWANEGO NA BAZIE OLEJU RZEPAKOWEGO

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Słowa kluczowe: emisja, biodiesel, mieszanina paliw, etanol

Streszczenie

W artykule przedstawiono praktyczne wyniki stosowania do silników wysokoprężnych biopaliwa (bioetanol), przy różnej zawartości bioetanolu. W badaniach stosowano silniki wysokoprężne produkcji czeskiej ciężarówki AVIA i ciągnika ZETOR. Wyniki wskazują, że najbardziej odpowiednią mieszanką paliw było biopaliwo z 2% dodatkiem etanolu. Dodatek ten znacznie zmniejszał emisję NO_x: w silniku AVIA o około 54%, w porównaniu z paliwem bez dodatków, natomiast w silniku ZETOR spadek wyniósł 88% w stosunku do wartości początkowej. Także w odniesieniu do dymienia zjawisko było podobnie korzystne. Parametry mocy silników były prawie stałe. Nie zaobserwowano znaczącego wzrostu zużycia paliwa, jednak zwiększał się udział nie spalonych węglowodorów w miarę wzrostu zawartości alkoholu.

W porównaniu z dostępnym na rynku olejem napędowym, przy zastosowaniu mieszanek paliwowych (szczególnie przy niskiej zawartości alkoholu), całkowita emisja była niższa we wszystkich przypadkach, co ułatwia spełnienie wymagań dotyczących emisji w silnikach starszych typów.

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