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NEW ECOFUEL FOR DIESEL ENGINES

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Abstract

The World is strongly dependent on crude oil for its transport needs. In order to diminish this dependence, we need to introduce clean, CO_2-efficient, secure and affordable transportation fuels. The current production of liquid biofuels in the EU25 is less than 1% of the market. Recent assessments have concluded that the 2010 targets, 18 Mtoe used in the transport sector, are unlikely to be achieved. There can be three basic possibilities of accomplishing this target: i) the use of alcohols (first of all ethanol) and their mixing with petrol; ii) the use of fatty acids esters (methyl or ethyl) of vegetable oils and their mixing with diesel fuel, iii) the use of synthetic hydrocarbons of the synthetic gas coming from biomass resources and eventually their mixing with other "classical" hydrocarbons.

This paper presents a new way of utilizing alcohols as fuels for a diesel engine. It is proposed to use heavy alcohols as a mix with vegetable oils and conventional diesel fuel. It is presented another way to use alcohols. Namely the use of heavy alcohols as a solvent for vegetable oil (called the biomix or BM) and after the obtainment of the density which would be similar to diesel fuel, mixing the biomix with diesel fuel to obtain biomixdiesel (BMD). This solution will be shown for example with butanol as heavy alcohol, rape oil as vegetable oil and conventional diesel fuel. The investigations are carried out with a simple diesel engine on the engine test bed. Main parameters of engine (power output, torque, specific fuel consumption) and the main exhaust gas components (in this case CO, NO_x, PM) were investigated. There were better results achieved than one expected. Contrary to existing experiences, the maximum of power output and the torque of engine is higher in the whole range of the rotatory speed of the engine crankshaft when the engine biomixdiesel (BMD) is reinforced. The addition of the biomix component to fuel influences the specific fuel consumption. Generally with the larger part of the biomix component the specific fuel consumption grows. Because the power of engine also grows up one should expect that in exploitation the specific fuel consumption should not increase. It is very important that this fuel could be used to reinforce old, existing now and the future diesel engines.

It's worth paying attention that the presented solution in which a virgin vegetable oil (contrary to today's situation in which as a fuel ingredient we have only fatty esters) is an ingredient for fuel.

The production of butanol is known (from biomass and in other way with electrolysis of ethanol). The possibility to get butanol from ethanol gives a very good perspective for the use of ethanol from today's overproduction and moreover without the essential change of infrastructure.

All this leads to the conclusion that fulfilling the expected requirements of European Union regarding the biofuels is fully possible.The introduction of new fuel needs carrying out of a lot of complicated investigations, but chosen direction may be interesting.

Keywords: *diesel engine, butanol, biofuel, ecofuel*

Introduction

The World is strongly dependent on crude oil for its transport needs. In order to diminish this dependence, we need to introduce clean, CO_2-efficient, secure and affordable transportation fuels. The current production of liquid biofuels in the EU25 is less than 1% of the market. Recent assessments have concluded that the 2010 targets, 18 Mtonnes used in the transport sector, are unlikely to be achieved.

There can be three basic possibilities of accomplishing this target: i) use of alcohols (first of all ethanol) and their mixing with petrol; ii) the use of fatty acids esters (methyl or ethyl) of vegetable oils and their mixing with diesel fuel, iii) the use of synthetic hydrocarbons of the synthetic gas coming from biomass resources and eventually their mixing with other "classical" hydrocarbons.

It is known that today in EU we have an overproduction of ethanol. Together we have an overproduction of petrol. We need more and more fuels for diesel engines. Also in the nearest future, thanks to increasing of engine efficiency, the situation will be not change.

This paper presents a novel way of using alcohols as fuels for a diesel engine. Namely it shows the use of heavy alcohols as a solvent for vegetable oil (this mixture is called the biomix or BM) and after the obtainment the density by biomix which would be similar to the density of diesel fuel, mixing the biomix (BM) with diesel fuel (D) to obtain biomixdiesel (BMD).

This solution will be shown for example with butanol as heavy alcohol, rape oil as vegetable oil and conventional diesel fuel.

Investigations

The technology of butanol production is known. There are three separated ways to use.

- Directly
  - Conventional

    Traditionally, the production of fermentation products such as Bioethanol has relied on feedstock's that are rich in either sugars (cane or beet) or starch which is easily broken down into sugars (wheat, corn or rice). The future is in new plants the working with another art of microorganisms like thermophiles.
  - TMO technology process

    TMO's technology platform is based on a select group of ***t**hermophilic **m**icro-**o**rganisms* (*Thermophiles*). The optimal feedstock for bioconversions would be waste biomass (e.g. straw, wood chips and paper pulp effluent) and crops specially grown for their high biomass production rate (kenaf, miscanthus and short rotation woody crops). Such sources can be described as "cellulosic biomass" for their high cellulose and hemicellulose content.
- Indirectly – from ethanol

  Electrolysis. The electrolysis is an old process, but with develops a fuel cell and new art of solar cell the electrolysis process may by develop to the new process of butanol production from ethanol. The elektrolyse is going from chemical eqation;

$$2C_2H_5OH + 2C_2H_5OH \rightarrow 2C_4H_9OH + 2H_2 + O_2$$

The properties of butanol and its comparison to the light alcohols and conventional engine fuels are as following.

Tab.1. The properties of different fluids

Fuel	Energy density	Heat of vaporization	Kinematic viscosity at 20°C
Diesel	38.6 MJ/l	0,47 MJ/kg	>3 cSt
Gasoline	32.0 MJ/l	0.36 MJ/kg	0.4–0.8 cSt
Butanol	29.2 MJ/l	0.43 MJ/kg	3.64 cSt
Ethanol	19.6 MJ/l	0.92 MJ/kg	1.52 cSt
Methanol	16.0 MJ/l	1.20 MJ/kg	0.64 cSt

It is interesting that the butanol is similar in the energetically properties to the petrol. The solvent properties of butanol for solving heavy hydrocarbons (such diesel fuels) are very good. The mix is homogenous (both fluids don’t separate after several months). This is in contrary to the ethanol, which doesn’t solve the diesel fuel. It is important that the butanol practically doesn’t solve water (contrary to the ethanol which solves water in any proportion).

There were prepared three mixtures for investigation.

In the first step the rape oil (vegetable oil) is mixed with butanol from which we have the mixture, the density of which would be similar to the density of diesel fuel. This mixture is called as a BM (Bio Mix). In the second step this fuel (BM) was mixed with conventional diesel fuel (EN 590) to obtain biomixdiesel (BMD). These fluids were mixed in the following proportions.

- biomix (BM) 10 % v/v, diesel fuel (D) 90 % v/v, called as 10BMD,
- biomix (BM) 20 % v/v, diesel fuel (D) 80 % v/v, called as 20BMD,
- biomix (BM) 50 % v/v, diesel fuel (D) 50 % v/v, called as 50BMD.

All above mixtures are very homogeneous. It is impossible to see any phases (contrary to, for example, the mix of rape methyl ester with conventional diesel fuel).

The engine investigations are carried out with a simple diesel engine on the engine test bed.

Main parameters of engine (power output, torque, specific fuel consumption) and the main exhaust gas component (in this case CO, NO_x, PM) will be evaluated.

The investigation results are given in the following figures.

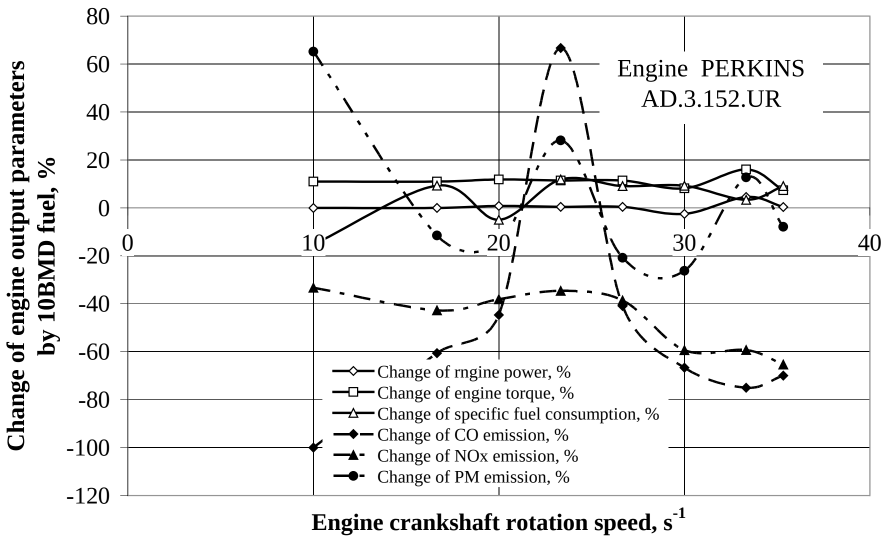

Fig. 1. The change of engine output parameters as a dependant factor of crankshaft rotation speed of the PERKINS AD.3.152.UR engine supplied with 10BMD.

The additive of 10% „bio” phase to the mineral diesel fuel leads to the remarkable increase of engine torque by unchangeable specific fuel consumption. Consequently the emission of NO_x decreases by 30% to 60%. At the same time emissions of CO and PM decrease, too.

Likewise the parameters change by supplying the engine with 20BMD.

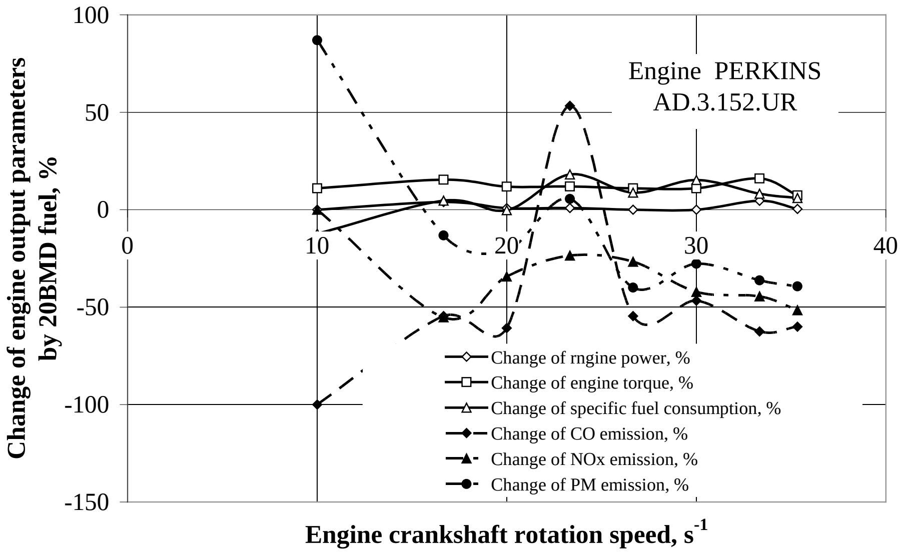

Fig. 2. *The change of engine output parameters as a dependant factor of crankshaft rotation speed of the PERKINS AD.3.152.UR engine supplied with 20BMD.*

Undoubtedly the biggest changes of engine parameters occur with supplying the engine with 50BMD. In this case the maximum of engine power and engine torque increases with the simultaneous increase of specific fuel consumption. Fuel consumption increases only with the higher engine crankshaft speed. The fuel consumption increases by the percentage as the engine torque, but increasing of torque was registered with all engine crankshaft rotation speeds. All the emissions of toxic parts of engine exhaust gases were decreased considerably.

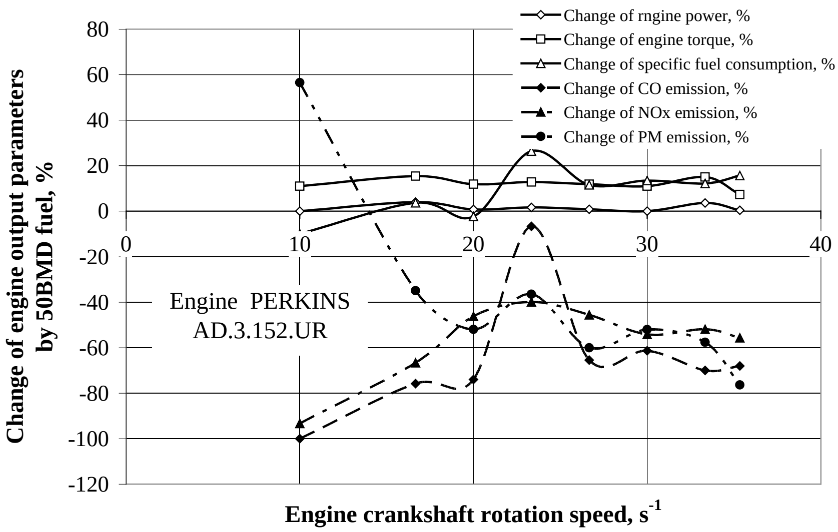

Fig. 3. *The change of engine output parameters as a dependant factor of crankshaft rotation speed of the PERKINS AD.3.152.UR engine supplied with 50BMD.*

The above results were obtained without any change of engine control parameters (the engine control parameters were the same as with supplying the engine with conventional diesel fuel), so without any optimization of control parameters. It appears that after optimization of engine control parameters; the results will be much better.

Conclusions

There have been given the first results of investigations of application of heavy alcohols as an ingredient of diesel fuel. In this case there have been presented the first results of investigations of the mixture of butanol (as heavy alcohol), rape oil (as vegetable oil) and conventional diesel fuel. This mixture was called the biomixdiesel (BMD).

There were better results achieved than one expected. Contrary to existing experiences, the maximum of power output and the torque of engine is higher in the whole range of the rotatory speed of the engine crankshaft when the engine biomixdiesel (BMD) is reinforced. The addition of the component biomix to fuel influences the specific fuel consumption. Generally with the larger part of the biomix component the specific fuel consumption grows. Because the power of engine also grows up one should expect that in exploitation the specific fuel consumption should not increase. It is very important that this fuel could be used to reinforce old, existing now and the future diesel engines.

The production of butanol is known (from biomass and in another way from electrolysis of ethanol). The possibility to get butanol from ethanol gives a very good perspective for the use of ethanol from today's overproduction and moreover without the essential change of infrastructure.

There has also been presented another way to use alcohols (and vegetable oils – without transestrification) as diesel engine fuel.

All this leads to the conclusion that the use of ethanol overproduction and European production of vegetable oils will contribute to fulfilling of the expected requirements of European Union regarding the biofuels.

It is very important that this fuel could be used to reinforce old, existing now and the future diesel engines.

The future works should refer to, first of all, the better adjusting of the engine to fuel (especially engine control parameters) and also fuel to the engine for specific exploitation needs.

Literature

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