DOI: 10.7251/JTTTP1701005DJ
UDC: 662.756.3:551.588

ORIGINAL SCIENTIFIC PAPER

The possibilities of using biodiesel in service of reducing the urban air pollution

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Received: April 10, 2017
Accepted: October 18, 2017

Abstract: Using renewable energy is in line with the global strategy of sustainable development. The use of biofuels in transport contributes to increasing security of supply and reducing dependence of the transport sector on oil, reducing the share of greenhouse gas emissions from road transport and sustainable development of urban areas. The advantage of biodiesel in comparison to other alternative fuels can be seen in use in existing vehicles without or with minor modification of existing motors, depending on the concentration of biofuels in combination with fossil fuels. This paper discusses the possibilities of reducing the air pollution by using biodiesel, pollutants arising as a result of combustion of fuel in internal combustion engines, as well as the possibility of using waste cooking oil to produce biodiesel. The presented results show the reduction of air pollution using biodiesel as an alternative fuel, as well as the possibilities of solving the problem of wasting edible oil by using it for biodiesel production.

Key words: biodiesel, air pollution, edible oil.

INTRODUCTION

The viability of the environment considers that degree of the emitted pollutants does not exceed the capabilities of the air, the water and the soil to absorb and adapt them. At the same time, it entails constant preservation of the biological diversity, human health as well as the quality of the air, the water and the soil which are sufficient for life and the well-being of the man according to standards. [1]

The air pollution happens due to the emissions of gassy and solid materials, it often occurs as the result of human activity but also by the emissions from the natural resources. The air pollution happens when concentration of the certain substances (pollutants) reaches toxic amounts i.e. it starts to have negative effects on human health, flora and fauna. [2]

The ideas on the manners of reducing carbon-dioxide emissions into the atmosphere, have resulted in the use of bio and other renewable fuels. European Parliament Directive on Climate Change and Energy has the aim to ensure the reduction of the emissions of the gasses with the greenhouse effect by at least 20%, improvement of energy efficiency by 20% and the use of the renewable energy by 20% of the overall energy consumption in EU until 2020.

INTERNAL COMBUSTION ENGINES AS AIR POLLUTANTS

The internal combustion engines are the major sources of certain pollutants into the air. As the sources of the air pollution they are present in the road vehicles, airplanes, ships, agricultural and construction machines, static engines, electric power turbines. They pollute by emissions of carbon-monoxide with 73%, 56% of carbon-dioxide and with 50% of total NaOH emission into the atmosphere.

ROAD TRAFFIC AS THE SOURCE OF POLLUTION

The road traffic presents significant source of pollutants in the most of the countries. Although the introduction of the new standards has reduced the emissions from the car engines, the road traffic has still been the biggest source of carbon-monoxide and non-methane hydrocarbon and altogether with energy sources has been the biggest sources of nitrogen oxide; and with households it has been the biggest emitter of the smoke and soot.

Road traffic is the biggest cause of pollution in the urban areas. About 60% of total air pollutants in urban areas come from the internal combustion engines.

The emission of the air pollutants while burning in the internal combustion engines depends on many factors of which the most important ones are the following: the quality and type of the fuel, type of the motor, the driving conditions and heavy load of the vehicle (table 1.)

Table 1. The emission of the product of the combustion of fuel and diesel engine

	CO	Hydrocarbon	NO	SO_2	Solid particles
	%	ppm	ppm	ppm	g/m^3
Diesel engine	0,1	300	4000	200	0,5
Fuel engine	10,0	1000	4000	60	0,01

The combustion is a complex set of physical and chemical processes which, besides numerous thermal effects, are followed by the vibrational, sound, light and other phenomena. The time of the fuel mixture combustion is limited by the engine work cycle and other phenomena and lasts for a few milliseconds.

The real combustion processes are always incomplete. The main reason is that the air gets into the combustion process and makes one fifth, while nitrogen holds the biggest percentage. The second reason is that the fuels are mixture of different carbon-hydrogen so their combination and recombination is happening all the time during the combustion process. The third reason is that those fuel mixtures in the chamber are undefined in respect to make-up, and physical and chemical conditions that are undefined by the space and time (sometimes they are suitable for complete and sometimes for incomplete combustion).

THE POSSIBILITIES OF REDUCING THE AIR POLLUTION

The reduction of pollutants emission into the air in the internal combustion engine can be achieved by:

- Increasing the quality of the used fuel,
- Optimization of the work process in the engine,
- Additional processing of the exhaust gasses,
- Using the alternative/ substitute fuels.

The use of the alternate fuels for motor vehicles represents realistically one of the possible ways of cutting down the pollutant emission from the exhaust gasses of the vehicles. The use of alternative fuels may result in the reduction of dependence on conventional fuels, derived from the oil whose reserves are limited. The part of alternative fuel is renewable, so this is why the issue of the choice of the appropriate fuel can be observed in the big picture.

The most important ones are: gas fuels, alcohol fuels and biodiesel.

The Liquefied Petroleum Gas (LPG) and Compressed Natural Gas (CNG) are used as alternative gas fuels. The use of the natural gas instead of conventional fuel cuts down the carbon monoxide, NaOH and solid particles emissions, it also reduces carcinogenic effects of the exhaust gasses and their influence to create smog *Alcohols* as alternative fuels are used in the mixture with the oil fuels. The most frequently used ones are: methanol, ethanol, isopropyl alcohol, secondary butyl alcohol and tertian butyl alcohol.

Weak lubrication of alcohol, low octane numbers and great hygroscopicity and corrosivity make the use of alcohol in diesel fuels difficult.

BIODIESEL AS ALTERNATIVE FUEL

Biodiesel is a mixture of Fatty Acid Methyl Ester which has standardized quality. Biodiesel - the name itself indicates the fuel derived from bio-material, first of all oil, but also from the animal fat as well as the oil and fat used for the cooking. [3].

Biodiesel is non-toxic, it is biologically renewable and degradable. It is produced by the reaction of transesterification of the plant oils (triglycerides). By transesterification of the vegetable oils, in the presence of catalyst triglycerides, it reacts with alcohol producing the mixture of Alice Ester Fatty Acids and glycerol's.

Transesterification is affected by multiple factors, such are: catalyst, the molar relation between reacting fluids, temperature, the pureness of reaction fluids and the make- up of the free fatty acids.

THE EFFECTS OF THE USE OF BIODIESEL ON THE ENVIRONMENT

A significant move has been made toward the improvement of the air quality in the most polluted urban areas in the past two decades. Using biodiesel as substitute to fossil fuels foresees further improvement of the air quality regardless of whether the fuels are used in the conventional engines with internal combustion or in the new, cleaner automobile technologies.

Using the biodiesel, instead of the fossil fuels, results in the significant reduction in emission of the gasses with the effect of the green house. The quantification of these effects to the environment is being conducted by the measuring of the net emissions during the complete chain of production and consumption. The water pollution is linked to the oil products and the oil spills which results in the contamination of the underground waters from the reservoirs and the outflow of the spilt fuel. Biodiesel, unlike the fossil fuel, quickly biodegrades, and does not represent hazard to waterways and underground waters. Biodiesel spill does not represent hazard to the environment [4].

The main advantage in the use of biodiesel as renewable fuel is the significant reduction in the carbon-dioxide emission. The emission of the sulphur oxides, suspended particles and carbon-monoxide is reduced. The advantages and the disadvantages depend on mixture used as well as the work of the engine. .

Table 2. shows the comparison of biodiesel emission (B 20-mixture 20% biodiesel 80% fossil diesel fuel and B 100-pure 100% biodiesel).

Table 2. The comparison of the emissions of the exhaust biodiesel gasses

Reduction in the emission in comparison with diesel fuel	Pollutant					
	NO_x	Solid particles	Carbon-Hydrate	CO	CO_2	Sulphur
B 20	+2	-10	-15	-11	-15	-20
B 100	+10	-50	-65	-52	-80	-100

Researches and comparisons were conducted on pure diesel, pure biodiesel (mark B100) and diesel fuel mixture and biodiesel in ratio 80:20 (mark B 20).

The values of the potential reduction in the individual pollutant emission using the biodiesel were [4]:

- Carbon-monoxide (CO_2)–each ton of fossil diesel fuel emits about 2,8 t of CO_2 into the atmosphere. Specific make up of carbon in one ton of biodiesel is smaller so the emission of CO_2 is about 2,4 t. Regarding the fact, that the plants absorb carbon-dioxide during the photosynthesis process; using the biodiesel the net emission of carbon-dioxide is almost zero.
- Sulphur-Oxides (SO2) – when fossil diesel fuel burns, sulphur is emitted into the atmosphere in the form of sulphur-dioxide contributing the emergence of the acidic rains. Biodiesel contains sulphur in traces. The European Union promotes the use of fossil diesel fuel containing sulphur under 50 ppm.
- Nitrogen-Oxides (NO_x) – emission of the nitrogen oxides from biodiesel can be increased or decreased in relation to the fossil fuel emission, depending on the type of engine and additional process of the exhaust gasses. Nitrogen-oxide emission from pure diesel is being increased by 10% comparing to fossil fuels.
- Carbon-Monoxide (CO) – biodiesel contains oxides, improving combustion process and reducing the carbon-monoxides emission for about 48% in comparison with fossil diesel fuels.
- Solid particles – inhaling suspended and solid particles is a serious problem and represents hazard for the human health. By using biodiesel, the solid particles emission from the exhaust gasses is by 47% lower than it is with fossil fuels.
- Unburnt hydro-carbons – The unburnt hydrocarbons emission in the exhaust gasses while using bio-diesel is approximately 67% lower than it is in the fossil diesel fuel.
- B100 reduces the risk of cancer by 94% and B20 by 27%.

THE RAW MATERIAL FOR THE BIODIESEL PRODUCTION

The basic raw material for the production of biodiesel are: vegetable and animal oils and fats or the waste oils or fats used for the alcohol and food preparation.

Biodiesel production uses catalyst, acid and demineralized water as auxiliary material.

Fats and oils are materials of vegetable and animal origin composed of Glycerol-Ester and fatty acids, the so-called triglycerides and non-glyceride components. The raw materials for the oil and fat production represent renewable sources and enable production of the series of products for technical and food purpose.

Under the influence of the high temperature during the exploitation, the *edible oil* produces carcinogenic polycyclic aromats whose technical decomposition on the hot surfaces creates extremely toxic and dangerous products.

The waste oils used for the preparation of food can be used as the raw material for biodiesel production. The used oil is often thicker, because of the hydrogenation, and contains vegetable and animal fats from prepared food. The advantage of the waste oil is that it is an available waste product. The intensive examinations on the possibilities of biodiesel production from the waste cooking oils, food processing, city waste and animal lard are being conducted.

Using the waste edible oils as raw material for the biodiesel production achieves the following:

- Gaining the ecological fuel,
- Resolving the waste oils problem and
- Gaining the useful by- product- glycerol.

CONCLUSION

The examinations have shown significant reduction in the solid particles, carbon-dioxide, carbon-monoxide, sulphur-dioxide and hydrocarbon into the atmosphere using B20 and B100 fuels compared with the conventional diesel fuels.

The use of biodiesel increases the nitrogen-oxide (NaOH) emissions which can be disregarded in comparison with the reduction of the emissions of pollutants listed above. The reduction of the nitrogen-oxide emission can be achieved by the additional processing of the exhaust gasses.

Using biodiesel as alternative fuel, besides positive influence in respect of the reduction of the exhaust gasses emissions, has the advantage of biodiesel being a renewable source of energy. Methyl esters and alcohol are derived from the raw materials of vegetable origin, and the combustion products like carbon-dioxide (CO2) and water (H2O) are used in the photosynthesis process by plants.

The use of waste edible oils as material for the biodiesel production should be encouraged through the selective collection of waste edible oils.

The possibilities of biodiesel production are limited, and the expected use in the near future is questionable. The main problem is in the low efficiency of production plants and engines which should use biodiesel.

REFERENCES

[1] Đukić, V. *The Basic Principles For The Environment Protection*, Pan-European University, APEIRON, Banja Luka, 2009.

[2] Đukić, V., Jakupović, E. The Season›s Influence To The Occurence Of The Children›s Asthamic Attacs, *III International Conference „Sports Science and Health",* Pan-European University, Apeiron Banja Luka, mart 2013, pp. 124-128.

[3] Todorović, M., Todorović, T. *Biodiesel human efuel,* Šabac, 2007.

[4] Srinvas, V.A. Design Of 100 kg Biodiesel Reactor For All Inedible/Edible Oil, University of Delhi, Delhi, 2008.