Biofuels- the power from plants

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Abstract

In this paper I try to review five fundamental groups of biofuels which are used as a power source for mechanical engines. However engines could be use as a propulsion in cars or other machines and as a current source when engines cooperate with generators.
The basics biofuels which belong to the fundamental group are: rapeoil, biodiesel, biomethanol, methan from biogas and synthetic biofuel. I present calorificvalue of these kind of biofuels and compare to earthfuels.
In Europe the leader of production biofueals is Germany. On the basic of this country I present how the biofuel industry deweloped in the last ten years and what kind of benefits is possible to gain. I describe also political and law conditions which influece by using biofuels.
Finally, I pay attention to the most important result of using biofuels which is influence to environment, because producing and burning biofuels take a part in the same carbon dioxide cycle.

Keywords: biofuels, biodiesel, biomethanol, rapeoil, fuels from biomass

I. INTRODUCTION

At present we have an awareness that the sources of fossil energy are becoming lower. In order to stop the disadvantageous phenomenon of decreasing raw fuels and changing climate, we need to start using gradually a new sources of renewable energy. Renewable energy was common used till the 18th century from that supplies as wind and wood. After the industrialisation changes and impoves people started used fossil sources of energy. In the 19th century the renewable sources of energy were comletely replaced by coal, oil and earth gas. These changes were as a consequence of huge industrial growing which reqired a more efficient and high calorific value sources of energy than wood or wind energy. Today result is that 90% of energy which we use becomes from fossil resources. Using and burning coal, oil and earth gas influences very incovenient on climate and environment because producing energy from raw fossil fuels releases great size of carbon dioxide into atmosphere in short time, which results in greenhouse effect. On possible solution to decreas greenhouse effect is becoming greater of using fuels, which producing and burning take part in the same dioxide cycle. These kind of fuels are producing from plants and generaly are divided in two groups such as: biomass and biofuels. Biomass characterises as raw kind of fuels for example wood, straw or pellets, which are generally burned in furnace in order to produce heat.
Whereas biofuels describe as kind of fuels which are producing from raw biomass such as corn or plants wastes in enrichment process. To biofuels group belong: rapeoil, biodiesel, biomethanol, biomethanol and synthetic biofuel. The bigest advantage of biofuels, compare to biomass, is high level of calorific value sometimes similar to fossil fuels. Current life standarts require from people high mobility, which influences on using some kinds means of transport such as cars, trucks or others. The common feature of propulsion machines is converting one form energy (for example chemical) to mechanical, which occur in internal combustion engines. In order to acces satisfactory efficient and working opportunities, are used fuels whch have clorific value on level about 40 MJ/kg such as diesel, petrol or liquid petrol gas. These kind of fuels can be replaced only by biofuels, because the calorific value level is comparable and they can be adapt by modern engines developments.
Biofuels are also easy to storage and management, which means that new technoloy, high investment and infrastructure are not necessary for using biofuels. For these reason in Germany in 2005 the share of biofuels was around 3.6 % of total fuel consumption. The large part of these biofuels is biodiesel.

In the future for become greater the producing of biofuels, larger areas have to be cultivated than now. Interesting is also aspect how is the impact increasing cultivated areas for energy on restrict food production. Whereas the productivity of agriculture has risen constantly and the trend will maintain in the future. For example in Germany the share of freed land for non food production has increased [1]. In 2005 over one million hectares were cultivated for energy production from rapeseed, rye and wheat. Specialist predicted that till 2030 the area for energy production will approach to four million hectares.
The predictions also shows that in Germany the biofuels share of total fuel supply in 2020 can achieve 25%.

II. BIODIESEL

The most widespread of biofuels is biodiesel, because it is adapted to the diesel engines. For example in Germany biodiesel contributes around 18 million tons per year to the fuel consumption [1]. From 2004 the mineral oil corporation add biodiesel to original diesel by 5 %, which allows to carry out technical requirements for vehicle owners.

TABLE I
BIODIESEL BASIC INFORMATIONS [1]

Raw materials:	Rapeseed or other vegetable oils
Annual yield per hectare	1550 l/ha
Fuel equivalent	1l biodiesel substitutes 0.9 l of diesel
Market price	0.75-0.90 EUR/l
CO_2 reduction	Approx. 70 %
Technical information	Biodiesel in pure form: manufacturer's approval required; mixtures up to 5 % without refitting the engine

From chemistry point of view biodiesel is a vegetable oil's methyl ester or fatty acid methyl. Biodiesel production behaves by ester intercharge of vegetable oil. For this reaction the methanol is required and mixed in a ratio o 1:9. In temperature of 50 to 80ºC a catalyst is added in quantity around 0.5 to 1 %. The nature of reaction which occures , the vegetable oil molecule composed of glicerine and three fatty acid chains is broke down. The fatty acids combine with the methanol to form biodiesel. Glicerine is produced and later used in many fields such as pharmaceutical or food industry.

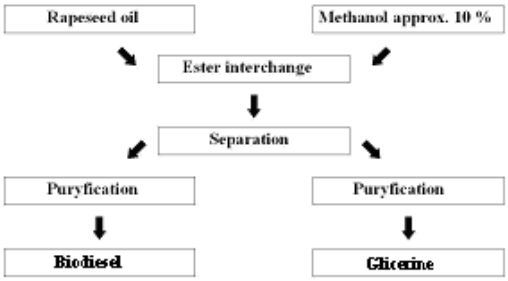

Figure 1. Ester interchange of rapeseed oil to create biodiesel [1]

Using the biodiesel to the engine is depended on viscosity and ignition properties, which are similar to fossil diesel. By adding some components the ability of using in winter is possible witout difficult to minus 20ºC. Important is also the lubrication effect which is higher than fossil fuels. Consunption of biodiesel is 5 % more then diesel because the yiel energy is lower.

The requirements necessary for the fuel quality are defined in the Europe standard DIN EN 14214.

III. BIOETHANOL

Biodiesel and vegetable oil are useful by diesel engines but bioethanol can replace petrol. Bioethanol can be mixed with petrol from mieral oil manufactures in share up to 5 %. For use more share of bioethanol the vehicles should be adapted.

Ethanol is produced by fermenting the sugar included in plants. The sugar stach and cellulose-bearing occur mainly in wheat, rye, maize and sugar beet. In the future by developement of well-fitted enzymatic processes also the wood, and straw could be fermented.

TABLE II
BIOETHANOL BASIC INFORMATIONS [1]

Raw materials:	Grain, sugar
Annual yield per hectare	2560 l/ha
Fuel equivalent	1l biodiesel substitutes 0.66 l of petrol
Market price	0.50-0.60 EUR/l
CO_2 reduction	30- 70 %
Technical information	Can be mixed with fuel by up to 5 %

The raw plants which included sugar are fermented by yeast and enzymes to ethanol. When plants containe the starch, that first the starch is converted into sugar by enzymes. From fermentation proces the by-product which occures in large quantities can be used latter as fodder for the biogas plants.

Properties of ethanol improve the quality of petrol, because the alcohol has a higher octane value than petrol. When the octane value is higher , it means the better antiknocking property. But the disadvantage of bioethanol compare to pertrol is calorific value, which is one third lower than conventional petrol. After mixing ethanol increase the vapour pressure of fuel.

Since 2005 in Germany many series vehicles are available to run with ethanol proportion up to 85 %, which is called flexible-fuels.

Mixing ethanol with petrol is restricted by petrol fuel standard DIN EN 228 permits mixing of up to 5 % of ethanol with petrol. For example when the 5 % by volume of all petrol fuels were to be replaced by ethanol, this would be around 1.3 million tons per year.

IV BIOMETHANE

Biomethane is called as a biogas, which is for example gained in agricultural facilities, in general by the fermentation of maize silage or manure. To produce biogas can be used many kinds of organic substrate. Farms, which basen on cattle or pigs husbandry, can use animal excrement, as a main material for anaerobic fermentation. On the othre hand there are a lot of farms where only plants are used for energy production. In this kind of farms they exploid mew renewable materials as crops, grass,

maize, sunflawers and others. To increas biogas production and to utilize non-agricultural but organic wastes some biogas factories use the residues from food industry such as vegetable from wholesales, distiller's wasch or grease. The process of residues fermantation provide many benefits, because the dealing cycle of waste food is closed and it is hygienic.

In Germany the substrate, which are used for biogas production are constitute of 48 % animals excrement, 26 % organic waste and 26 % renewable raw materials.

The biogas is end product of fermentation, which is conbustive and it is composed as:

50-75 % methane
25-45 % carbon dioxide
2-7 % water
< 2 % oxygen
< 2 % nitrogen
< 1 % amonia
< 1 % hydrogen sulphide

The content of energy is depended on the methane concentration. For example when a substrate as the fats and starch are used, which are easy to break down in fermented mass, the content of methane is greater. Compare to fossil fuels the calorific value of 1 m^3 of biogas is substitute for 0.6 l of heating oil.

TABLE III
BIOGAS BASIC INFORMATIONS [1]

Raw materials:	Maize and other energy producing plants
Annual yield per hectare	4950 m^3 or 3560 kg
Fuel equivalent	1 kg of methane substitutes 1.4 l of petrol
Market price	-
CO_2 reduction	-
Technical information	Biomethane can be used in natural gas vehicles witout adjustments

In Germany the producing of biogas is around 23-24 billion m^3/year. From agricultural sector provide about 85 % of them. When we compare the amount of biogas to all energy consumption in Germany, it represent only about 3 %.

The bigest disadvantages of gas sources are transport and storage compare to liquid fuels. Methan require more space for storage and their density of energy is lower. For example in natural gas vehicles, the methane is compressed in peculiar pressure tanks, which are instaled and adapted to pressure of 200 bar.

The most benefits of using biogas compare to petrol and diesel is very low emission of several toxic substances, mainly nitrogen oxides or reactive hydrocarbons, which can be reduced by up 80 %.

Biogas is able to use for runing the motor vehicles. For example in Germany is abour 56 million cars and only 35000 run with natural gas. These cars could use biogas in the future without technical adjustment.

V RAPEOIL

The rapeoil is not only used as raw material for biodiesel production, but can be used originally in specially diesel engines. From wide variety of vegetable oils the rapeoil is most economically cultivated compare to sunflower or soya oil.

Production of rapeoil is divided on two groups: one i s industrial and the second is decentralised.

Decentralized yield of rapeoil is conducted on farm by cold pressing, where the rapeseeds are pressed by mechanical force at maximum of 40°C. After pressing suspended solids are capture by filtration or sedimentation from oil. The press cake contain over than 10 % of oil, which is used later as a fodder. Industrial production is centralized, where the rape seeds are presed at high temperature aroun 80°C and the oil is extracted from cake with solvent. Latter the solvent is separated from the oil by evaporation. Next step is refining process, because the oil still has unpleasant components. The end product is fully refined and has quality as edible oil.

The properties of of rapeoil are specific, which makes it different from diesel and using in combustion engines is possible after refitting. First large differnt is viscosity, which in low temperatures is up to 10 times higher than diesel. High viscosity leads to technical challenges in winter and cold starting in conventional engines, because the flashpoint is significantly higher that in normal diesel. On the other hand the storage and transport of oil is more safety. Rapeoil is not included in any hazard classes according to the Ordinance for Flammable Liquids.

TABLE IV
RAPEOIL BASIC INFORMATIONS [1]

Raw materials:	Rapeseed oil
Annual yield per hectare	1480 l/ha
Fuel equivalent	1 l of rapeseed oil substitutes 0.96 l of diesel
Market price	0.55-0.75 EUR/l
CO_2 reduction	>80 %
Technical information	Engine refit necessary

When the raw rapeoil is required to use as a fuel, the engine should be reffited adapt to the viscosity and combustion properties of the rapeoil. Same refitting bases on the pre-heating system, where the fuel and injection system are heated before starting engine. Other way based on 2-tank system, where engine start with diesel and after required time is changed to rapeoil.

In Germany is about 250 filling stations with rape or vegetable oil. The pure fuel cost is lower than diesel, but the costs for refitting and more frequent oil changes are incurred, from these reasons a driving car with rapeoil fuel becomes economically viable from 100000 kilometers of driving.

VI SYNTHETIC BIOFUELS

The synthetic fuels are new dewelopment and still not available on the market. The raw material for this kind of synthetic fuels is biomass. The idea of synthetic biofuels is becoming the biomass to liquid form, which could be adapted to current engine concepts. The most advantage is that very many different materials, such as biological waste, straw or wood, can be used for production the synthetic biofuels.

The process of manufacture the synthetic fuels from biomas is in two stages. In the first stage, which is called gasification, a synthetic gas is produced in a reactor, where the biomass is placed and broken down in the presence of heat, pressure and oxygen. After first stage the synthetic gas compose mainly of hydrogen, carbon monoxide and carbon dioxide. In the second stage componets are synthesised from this, which is able to be processed to synthetic biofuel end product.

The chemical properties of hydrocarbons in synthetic biofuels allow efficient and complete combustion with low exhaust gas emission. The properties can be influenced by changing parameters during synthesis such as the pressure, temerature and catalysts. Modern fuels and engines could be adapted each other and could be able to fulfil the requirements for the less emission and improving energy efficient.

TABLE V
SYNTHETIC BIOFUELS BASIC INFORMATIONS [1]

Raw materials:	Plants and wood
Annual yield per hectare	4030 l/ha
Fuel equivalent	1 l of synthetic fuel substitutes 0.97 l of diesel
Market price	-
CO_2 reduction	>90 %
Technical information	Can be used in pure form or in mixtures without adjustment of engine

Based on the current knowledge, in the future will be possible to transfer about 50 % of energy contained in vegetable raw materials to synthetic biofuels under optimum conditions. From this reason it can result in large carbon dioxide saving.

VII CONCLUSIONS

In spite of full of promise potencials of biofuels, the combustion engine in combination with fossil diesel and petrol will dominate the transport sector in the future. Propably be not the only strategy to save or replace the fossil fuels. Some of them have immediate effect and other like biodiesel or bioethabol will contribute large amount of fossil fuels. Till 2010 they will share about 5 % of fuels market by mixing with conventional fuels.

From all of biofuels, the synthetic biofuels give the greatest opportunity of potential quantities in the long term, but they will make a contribution after 2010, when them production will be on an industrial scale. Till 2020 their consumption share could increase to 9 %.

The opportunities of biofuels consumption share is depended on tax incentives and promotion of research.

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