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BIOFUELS AS PROMISING FUELS

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Abstract: The use of fossil fuels results in global warming and pollution. In comparison with fossil fuels biofuels represent an eco-friendly, biodegradable, sustainable, cost-competitive and promising alternative energy source. They contain high energy content and do not contribute to greenhouse effect. Therefore, using cheap or renewable resources as the feedstock for biofuels production has a great potential in terms of a major contribution to future energy supply. The production and use of biofuels is already well established and a further promotion of these fuels such as lipid biofuels (bioethanol, pure plant oils and biodiesel) and gas biofuels (biomethane, biohydrogen) mainly depends on non-technical issues, such as policies and cost–effectiveness. Biofuels will definitely stay for the foreseeable future and still can continue to provide the earth and the human population with a relatively clean source of energy with several benefits such as economic benefits of providing employment and health benefits of reduced carbon emissions, leading to cleaner air. With increasing sophistication of technology and intense research and development done, one can safely infer that biofuel will become more appealing and applicable for use on a globally commercial level. As such, biofuel is acknowledged as the Earth's future energy source. Until a newer and cleaner energy source is discovered, scientists will definitely persist in researching and enhancing biofuels to make them more cost-effective, while still being environmentally friendly.

Keywords: biofuels, bioethanol, pure plant oils, biodiesel, biomethane, biohydrogen.

1. INTRODUCTION

The demand for crude oil has been continuously increasing since several years ago. The price of crude oil is most frequently a reflection of speculative activities and policies and changes without economic laws. At the same time, the discoveries of new oil fields are rapidly decreasing. New solutions have to be found to guarantee the high standard of daily life in Europe and worldwide. Biofuels are becoming more and more competitive compared to fossil fuels. The development of new technologies for processing and using biofuels is steadily progressing. The use of biofuels features has a number of advantages suitable for achieving energy, environmental, agricultural and trade policies. Global biofuel production and consumption have been increasing annually with a most dramatic rise taking place between 2005 and 2010. Since then biofuel production has grown at a much slower pace. On a global scale, it is difficult to see the trends, because biofuel subsidies change, higher mandatory targets are placed in some countries and the effects of droughts may impact others. However, the overall production appears to be continuing to grow. The world growth in biofuels was only 0.7 percent between 2010 and 2011. However, the North American production increased by 11.4 percent with Canada increasing production by 29 % and the US by 11 percent. South and Central America biofuel production decreased by 9.7 percent and Europe's also decreased by nine percent between 2010 and 2011, while the Asia Pacific region grew by 3.4 percent. In terms of production by region, North America, and in particular the United States, is the world leader in biofuel production followed by South America, which is dominated by Brazil, and then by Europe and the Asia Pacific region, [1].

2. BIOETHANOL

Ethanol can be produced from any biological feedstock that contains appreciable amounts of sugar or materials that can be converted into sugar such as starch or cellulose. As shown in Figure 1, many different feedstock sources can be used for ethanol production. They can be divided into sugary, starchy and cellulosic feedstock [2−5].

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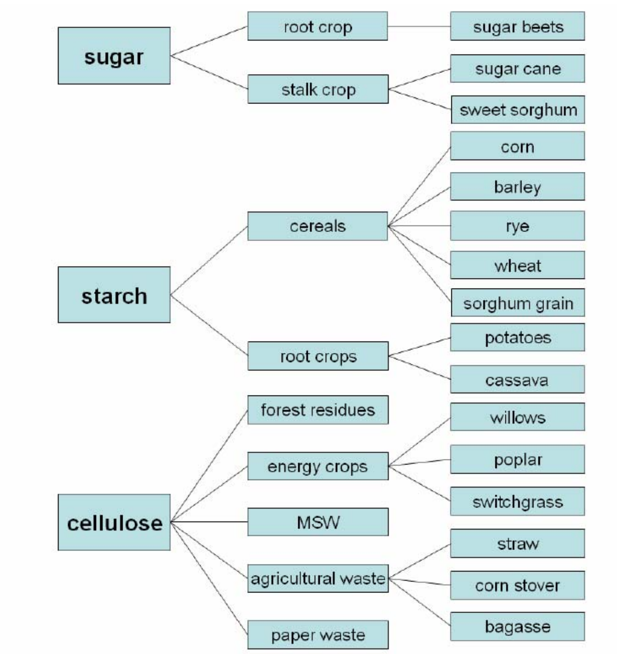

Figure 1. Types of feedstock for ethanol production

Feedstock for ethanol production implies sugar beets and sugar cane which contain high percentages of sugar. Sugars can be easily fermented. Brazil developed a successful fuel ethanol program from sugarcane. In Europe, sugar beets are used for ethanol production. Currently, ethanol imports from Brazil are entering the European fuel market.

Corn, wheat, barley, rye and other cereals are typical feedstocks containing starch in their kernels. Starch can relatively easily be converted into sugar and then into ethanol. In the USA and Europe, ethanol is manufactured mainly from maize and grain. At the moment substantial capacities for the manufacture of ethanol are being created in Germany. Other starchy crops that can also be used for bioethanol production are sorghum grains, cassava and potatoes. Recent research includes bioethanol production from potatoes and waste potatoes from food industry, [6−7].

2.1. Bioethanol Production

Ethanol, also known as „ethyl alcohol" or „grade alcohol", is a flammable, colorless chemical compound, one of the alcohols that are most often found in alcoholic beverages.

Generally, ethanol can be produced either synthetically from petrochemical feedstock (petroleum) or by microbial fermentation which is applicable to bioethanol production. The process of production of fuel bioethanol from biomass can be broken down as follows:

− *Feedstock production*: harvesting, reception, storage
− *Physical pretreatment*: milling
− *Saccarification*: conversion of starch and cellulose into sugar
− *Chemical treatment*: dilution of the sugars with water and addition of yeast or other organisms
− *Fermentation*: production of ethanol in solution with water along with waste and by-products
− *Distillation*: separation of ethanol
− *Dehydration*: removal of the remaining water by molecular sieves (anhydrous ethanol)
− *Co-product preparation*: Drying of the alcohol free stillage (mash) for high-value animal feed.

2.2. Properties of Bioethanol

Ethanol has many favorable properties. For example, the octane number of ethanol is higher than the octane number of conventional petrol. The octane number influences the antiknocking property of the fuel. A high octane number stands for an antiknocking fuel. Knocking describes uncontrolled combustion which puts heavy mechanical and thermal loads on the engine. On the other hand, the energy yield of ethanol is about one third lower than petrol. One liter of ethanol substitutes only about 0.65 liters of petrol. This is due to the different caloric values of petrol and ethanol. The energy content of petrol is 32.45 MJ/L and 21.17 MJ/L for ethanol.

Another property of ethanol is its low vapor pressure. When stored as pure fuel (or even as an E85 blend), it has a lower vapor pressure than gasoline, and thus will have fewer evaporative emissions. In colder climates, the low vapor pressure of pure ethanol can cause cold start problems. Therefore in cold climates ethanol is blended with gasoline (E85). In contrast, lower-level blends of ethanol in gasoline tend to raise the vapor pressure of the base gasoline to which ethanol is added. When ethanol is blended up to about 40 percent with gasoline, the two fuels combined have higher evaporative emissions than either of it [6,8].

Different blends of ethanol and petrol have different properties. Depending on the situation and the desired fuel, ethanol is therefore blended with gasoline at any ratio. Common ethanol blends are E5, E10, E20, E25, E70, E85, E95, and E100, which contain 5%, 10%, 20%, 25%, 70%, 85%, 95%, and 100% ethanol, respectively. Also, other varying quantities are possible. In the European Union, the so-called flexible-fuel vehicles (FFV) are currently entering the market. They can run with an ethanol proportion of any mixture up to 85 %.

Ethanol is also increasingly used as an oxygenate additive for standard petrol, as a replacement for methyl tertiary butyl ether (MTBE). MTBE is usually mixed with petrol as an additive to improve the octane number. Because MTBE has toxic properties and is responsible for considerable groundwater and soil contamination, MTBE is more and more frequently replaced by ETBE (ethyl tertiary butyl ether). ETBE is produced from bioethanol and may be mixed in maximum quantities of 15 percent with petrol, [9].

2.3. Bioethanol Emissions

One of the major drivers of biofuel promotion worldwide is the concern about the climate change and the potential of biofuels to reduce greenhouse gas emissions (GHG emissions). However, the GHG balance for bioethanol is highly variable and includes emissions of cultivation, transport, conversion process and distribution. Further, the GHG reduction potential depends on type of feedstock, agricultural practices, site productivity, conversion technology, [8,10].

3. LIPID BIOFUELS

There are many options for utilizing different feedstock types for pure plant oil (PPO) and biodiesel production. Besides dedicated oilseed crops such as rapeseed and soybean, also microalgae, animal fats and waste oil provide viable feedstock opportunities for fuel production. However, the latter feedstock types are not yet used on a large scale today, [10,11]. Figure 2 shows some examples for lipid feedstock sources. They can be sub-divided into palm fruits, algae, seeds and waste oil. Although the productivity of palm fruits is one of the highest, the most common feedstock sources for PPO and biodiesel production are seeds from various plants. These include seeds from ricinus, sunflower, peanut, sorghum, rapeseed and jatropha, [12,13].

The choice for a dedicated feedstock is predetermined by agricultural, geographical and climatic conditions. But another thing to be considered is that different feedstock types are characterized by different properties. For instance, the oil saturation and the fatty acid content of different oilseed species considerably vary. Biodiesel from highly saturated oils is characterized by superior oxidative stability and high cetane number, but performs poorly at low temperatures. Therefore, pure plant oil (PPO) with a high degree of saturation is more suitable as feedstock in warmer climates, [14,15].

For PPO and biodiesel production, oilseed crops provide the primary feedstock. Of the major oilseeds cultivated today, soybean production is by far the world's largest, followed by rapeseed and cottonseed, [13]. The dominant feedstock used in PPO and biodiesel, however, is rapeseed which is cultivated mainly in Europe. Nearly 85 % of biodiesel production is made from rapeseed, followed by sunflower seed oil, soybean oil and palm oil, [15].

The first process step of biofuel production is the oil extraction which can be done by several methods. The oil extraction of the feedstock is the first process step of both PPO and biodiesel processing. Regarding the scale of production and the infrastructure, there are two fundamental production process types for vegetable oils:

− Industrial: centralized production by refining in large industrial plants,

− Small scale pressing: decentralized cold pressing directly on farms or in cooperatives.

The common way in oil extraction is the treatment of feedstock in centralized industrial large scale plants. First, the feedstock has to be pretreated. After oil extraction, the next step is the refining process, [16]. The refining process is an important treatment of creating PPO and of preparing vegetable oil for the transesterification process of biodiesel. It is important in order to remove undesirable substances, such as phosphatides, free fatty acids, waxes, tocopherols and colorants. These substances can alter oil storage life and hamper further processing. During this first refining step, the oil mass (4 to 8 %) and the solvent contents are reduced. Since the refining process depends on the vegetable oil quality, the refining steps depend on the feedstock source. Some alternatives of refining also exist while some refining steps are merging. Nevertheless, a simplified process chart is shown in Figure 3, [17].

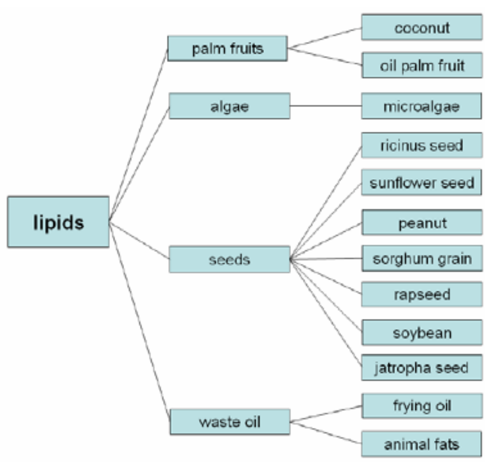

Figure 2. Types and classification of lipid feedstock sources

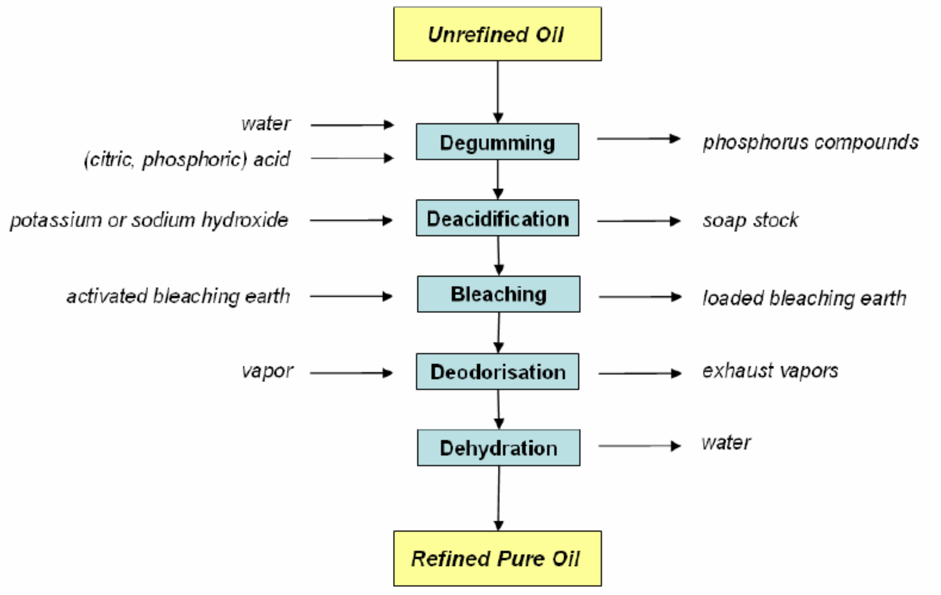

Figure 3. Chemical plant oil refining process

The first purification step of oil refining is the removal of phosphatides, also known as degumming. This is necessary as phosphatides make oil become turbid during storage and as they promote the accumulation of water [11]. Phosphatides can be removed by two different ways: water degumming and acid degumming.

The second refining step is deacidification. It is an important step for edible oils as the development of rancid flavors of free fatty acids (FFA) are prevented.

In the third step bleaching, colorants are removed. This process step enhances storage life of biofuel. Bleaching is mainly conducted by adsorbing substances, such as bleaching earth, silica gel or activated carbon. But also oxygen, ozone, hydrogen peroxide and heat (200°C) can be used for bleaching. In the deodorization step, odorous substances (ketone, aldehyde) are removed by steam distillation.

Finally, a dehydration step has to be conducted, as traces of water may decrease conversion in the transesterification process of biodiesel production. Removal of water is either accomplished by distillation under reduced pressure or by passing a stream of nitrogen through the fatty material, [10,11]. After refining, the plant oil can be directly used as PPO. For the use as biodiesel it has to be transesterificated.

Alcohols methanol and ethanol are mainly used for the transesterification process. Theoretically transesterification can also be processed with higher or secondary alcohols, but the viscosity of the obtained monoesters is higher. Transesterification with methanol, also called methanolysis, is the most commonly method for biodiesel production. Methanol is characterized by its lower prices and its higher reactivity as compared to other alcohols and the resulting product has a viscosity similar to mineral diesel and fulfills the requirements of EN 590. This reaction can happen by heating a mixture of 80–90 percent oil, 10–20 percent methanol, and small amounts of a catalyst. For the reaction it is necessary to mix all ingredients well, as the solubility of methanol in vegetable oil is relatively low. The resulting biodiesel after methanolysis is fatty acid methyl ester (FAME), [13,16].

As methanol is usually a fossil product, the use of bioethanol in an ethanolysis reaction is often discussed as a more environmentally friendly alternative, since it allows the production of entirely renewable fuel. In addition, ethanol is much less toxic and slightly increases the heat contents and cetane numbers of the resulting fuel. But, on the other hand, for ethanolysis much more energy is needed and problems with the separation of the ester and glycerin phases are reported more frequently, [10]. The process energy costs seem to be higher as well. Biodiesel which is produced by ethanolysis is also called fatty acid ethyl ester (FAEE).

Although the transesterification process proceeds in the absence of catalysts as well, the reaction is usually conducted by using catalysts due to economic reasons. Non-catalytic reacting too slowly and high energy inputs are required. An advantage of a non catalytic process would be the creation of purer esters and soap-free glycerin. Several types of catalysts can be used: Alkaline material, Acidic material, Transition metal compounds, Silicates, Lipases, [13].

Acidic and alkaline catalysis can be divided between homogeneous and heterogeneous catalysis. Thereby, alkaline catalysis is by far the most commonly used reaction type for biodiesel production. Sodium hydroxide (NaOH) and potassium hydroxide (KOH) are the most common alkaline catalysts, in part because with them, transesterification can happen at a lower temperature, [13].

3.1. Properties and use of lipid biofuels

The molecules of pure plant oil, animal fat and biodiesel vary, depending on the origin of the feedstock type. Nevertheless, PPO and biodiesel must meet certain properties and standards after refining and transesterification, respectively, [11].

The properties of pure plant oil (PPO) largely differ in its properties when they are compared to the properties of fossil diesel. For example the viscosity of PPO is much higher, especially at lower temperatures. It is up to ten times higher than the viscosity of fossil diesel. This property leads to technical challenges in winter running and when cold starting in conventional engines. Since PPO tends to gum up at colder temperatures, it has been difficult to blend it with conventional diesel fuel. However, different types of plant oil have different properties that affect engine performance.

Also, the flashpoint of pure plant oil is significantly higher than that of normal diesel. Additionally, PPO is biodegradable in a short time in soil and waters and e.g. in Germany, it is not classified in any water hazard class.

Because of its specific properties, the refined PPO usually cannot be used in normal diesel engines. In order to run on pure plant oil, diesel engines must either be refitted, which is often done by attaching a mechanism for preheating the oil, or a dedicated engine must be used such as the Elsbett engine.

Generally, the properties of biodiesel and especially its viscosity and ignition properties are similar to the properties of fossil diesel.

Although the energy content per liter of biodiesel is about 5 to 12 % lower than that of diesel fuel, biodiesel has several advantages. For example, the cetane number and lubricating effect of biodiesel, important in avoiding wear to the engine, are significantly higher. Therefore the fuel economy of biodiesel approaches that of diesel. Additionally, the alcohol component of biodiesel contains oxygen, which helps complete the combustion of the fuel. The effects are reduced air pollutants such as particulates, carbon monoxide, and hydrocarbons. Since biodiesel contains practically no sulfur, it can help reducing emissions of sulfur oxides.

Biodiesel is sensitive to cold weather and it may be necessary to add additives to improve low temperature performance, similar to those taken with standard diesel. Another problem is that biodiesel readily oxidizes. Thus, a long-term storage may cause problems, but additives can enhance stability, [12,13].

Biodiesel also has some properties similar to solvents. Therefore, it can attack plastic and rubber components such as seals and fuel lines. This causes problems in vehicles which have not been approved or which are filled with biodiesel for the first time after a long mileage with fossil diesel. In this case biodiesel acts like a detergent additive, loosening and dissolving sediments in storage tanks. Residues of the fossil fuel are released, causing the filter to become blocked. It is therefore advisable to change the fuel filter after several tank fillings with biodiesel.

Conventional diesel engines operate readily with up to 100 % of biodiesel fuel, but using blends above 20 % may require modest costs in order to replace some rubber hoses that are sensitive to the solvency character of biodiesel, [14].

3.2. Emissions of lipid biofuels

Most studies on biodiesel show a net reduction in emissions. For instance, up to 78 % reductions in CO_2 are estimated by using soybeans in the United States, [16,17]. Also the estimates for net GHG emissions reductions from rapeseed-derived biodiesel range from about 40% to 70% when compared to conventional diesel fuel. Besides, many studies show GHG reductions for biodiesel.

There are by far fewer studies on GHG balance of PPO exist. But, as the process step of transesterification is not applied to PPO, some GHG emissions can be saved. On the other hand, the consideration of glycerin, a co-product of biodiesel production, reduces GHG emissions of biodiesel, [16,17]. Biodiesel from rapeseed is generally more favorable in regard of GHG emissions then pure rapeseed oil, since glycerin can be used to substitute technically produced glycerin.

4. BIOMETHANE

The raw material for the production of biomethane is biogas, which can be processed from various feedstock sources. For biogas production much more different feedstock sources can be used than for common liquid biofuels. For instance biodiesel can only be made from plant materials containing certain amounts of oil. In contrast, biogas is produced from nearly all types of organic materials including vegetable and animal feedstocks, [18,19]. One main advantage of methane production is the ability to use the so-called "wet biomass" as feedstock source. Wet biomass cannot be used for the production of other biofuels such as pure plant oil, biodiesel or bioethanol. Examples for wet biomass are sewage sludge, manure from dairy and swine farms as well as residues from food processing. They are all characterized by moisture contents of more than 60–70 %.

4.1. Biomethane Production

The production of biomethane includes two steps. First, biogas has to be produced from feedstock sources. Secondly, biogas has to be further processed and cleaned in order to receive biomethane which is suitable for transport applications, [20−22].

Biogas is produced by means of anaerobic digestion. Organic matter is broken down by microbiological activity and in the absence of air. Symbiotic groups of bacteria perform different functions at different stages of the digestion process in order to break down complex organic materials. There are four basic types of microorganisms involved. Hydrolytic bacteria break down complex organic wastes into sugars and amino acids. Fermentative bacteria then convert those products into organic acids. Acidogenic microorganisms convert the acids into hydrogen, carbon dioxide and acetate. Finally, the methanogenic bacteria produce biogas from acetic acid, hydrogen and carbon dioxide, [18, 23].

4.2.Technology applications for biomethane

Gaseous energy sources are far more difficult to store and transport than liquid fuels and require more storage space due to their substantially lower energy density. For transport purposes biomethane must be stored in specially installed pressure tanks at a pressure of 200 bars. However, these fundamental disadvantages are offset by positive combustion properties. In comparison with petrol and diesel, the emission of several toxic substances such as nitrogen oxides and reactive hydrocarbons can be reduced by up to 80 %, [12].

Generally, biomethane can reach the consumer by two routes. One means is to feed it into the existing natural gas network, to which the natural gas filling stations are connected. The difficulty of this are presented by technical barriers, as treatment to reach the quality of natural gas and supply into the natural gas network still pose high requirements. Also, gas in feed must be provided with a stable legal basis. Biogas plant operators therefore currently choose a second route: the construction of decentralized biomethane filling stations directly at biogas plants, [12,24].

Untreated biogas is usually unsuitable for transport applications as its methane content is relatively low (60–70 %). Additionally, untreated biogas typically has high concentrations of contaminants. Therefore biogas is purified and the resulting fuel is biomethane.

Biomethane can be used in engines for all types of vehicles which are suitable for natural gas, since biomethane is very similar to natural gas. The real methane content of both fuels, biomethane and natural gas is above 95%. Also engine performance, drivability, emissions, and maintenance are considered to be equivalent. Moreover, no differentiation in warranty coverage is required as long as the biomethane characteristics fulfill the vehicle manufacturer's requirements, [18,24].

There are two types of GHG emissions that are influenced by the production and utilization of biomethane: methane and carbon dioxide.

Methane itself is a greenhouse gas with a relatively high global warming potential. As for all other biofuels, carbon dioxide emissions have to be considered when evaluating biomethane as transport fuel. Therefore emissions of all life cycle steps of biomethane have to be included. These CO_2 emissions largely depend on feedstock. If biomethane is produced from waste materials such as manure, emissions during feedstock production can be kept minor. This advantage will be abolished if dedicated energy crops are used as feedstock source. However, it can be concluded that the carbon dioxide reduction of biomethane can be 65-85 % when compared to fossil fuels. It largely depends on the choice of the feedstock source.

Biomethane is not toxic to human health. Nevertheless, biomethane is an asphyxiant and may displace oxygen in a workplace atmosphere. Asphyxia may result if the oxygen concentration is reduced to below 18 % by displacement. Since biomethane is mostly produced from wastes, such as manure, it does not have any negative impact on land use and biodiversity, [12,18]. When compared to biodiesel, bioethanol and BtL, biomethane receives the most effective yields per hectare and thus is a very economical way in using agricultural land for energy purposes. Additionally, the use of biomethane has several positive and comfortable side effects to humans. Firstly, due to the impermeability of digesters, far less odors are emitted than if animal manure is collected in open storage facilities. Secondly, vehicles running on biomethane are generally not as noise intensive as other vehicles. This is due to good combustion properties of biogas.

5. BIOHYDROGEN

Hydrogen is a promising alternative to fossil fuel with many social, economic and environmental benefits. H_2 has low emission, represents a cleaner and more sustainable energy system and can substantially contribute in the reduction of GHG emissions. Hydrogen acts as a versatile energy carrier with a potential for extensive use in power generation and in many other applications. H_2 gas is a widely used feedstock for the production of chemicals (ammonia and methanol), in oil refineries for removal of impurities or for upgrading heavier oil fractions into lighter and more valuable products, production of electronic devices, processing steel, desulfurization and reformulation of gasoline in refineries and is also used in the world's space programmes, [26]. Vehicles can be powered with H_2 fuel cells, which are three-times more efficient than a gasoline powered engine, [27]. As of today, in all these areas H_2 utilization is equivalent to 3% of energy consumption, but it is expected to significantly grow in future. More than 50 million tonnes of H_2 are produced annually worldwide with a growth rate of nearly 10% per year. This amount of H_2 could produce 6.5 EJ of energy, equivalent to about 1.5% of world energy consumption. H_2 (99%) is produced from fossil fuels, primarily natural gas, with chemical production and renewable energy sources accounting for the rest. Based on the National Hydrogen Program of the United States, the contribution of H_2 to total energy market will be 8-10 % by 2025, [28].

Although H_2 is the most abundant element in the Universe, it must be produced from other H_2-containing compounds such as fossil fuels, biomass, or water. Conventional physicochemical methods for H_2 production are based on steam reforming of natural gas (methane and other hydrocarbons), partial oxidation of hydrocarbons heavier than naphtha, coal gasification, and pyrolysis or gasification of biomass, which produces a mixture of gases (H_2, CH_4, CO_2, CO and N_2), [29]. All these processes require high temperatures (>850^{o}C), derived from combustion of fossil fuels, thereby being energy intensive and expensive. Among these methods, steam reforming process alone produces nearly 90% of H_2 but it requires more cost for power. Water can be used as renewable resources for H_2 gas production and methods are based on electrolysis, photolysis, thermochemical process, direct thermal decomposition or thermolysis, [30].

Electrolysis of water can be attractive and the cleanest technology for H_2 gas production. However, electricity costs account for 80%. Moreover, to avoid deposits on electrode and corrosion problems, feeding water should be mineralized, which ultimately increases the process cost. Although all these methods, in general, have a potential for effective H_2 production but require a source of energy, which, derived from fossil fuels, usually involve complicated procedures, economically unfeasible and not always environmentally benign.

5.1. Use of biohydrogen

As cited in 'An EU Strategy for Biofuels', „advanced biofuel technologies could also provide a stepping stone to renewably-produced hydrogen, which offers the prospect of virtually emission-free transport. However, hydrogen fuel cells require new engine technology as well as a big investment in plants to produce the hydrogen and a new distribution system. In this context, the sustainability of hydrogen has to be carefully assessed. In particular, energy effective use of hydrogen requires the introduction of fuel cells instead of internal combustion engines and therefore, adds another technology and cost challenge. The implementation of fuel cell vehicles is promising. Hydrogen from renewable sources for fuel cell-driven vehicles might be a long term option, but its introduction will take a long time, needs breakthroughs in technology and cost and will require intermediate steps to enable a gradual growth of both fuel and vehicle availability, [31,32]. The use and logistics of hydrogen becomes a difficult problem, since hydrogen in its gaseous state takes up a very large volume when compared to other fuels. One possible solution is to use ethanol to transport hydrogen, then liberate the hydrogen from its associated carbon in a hydrogen reformer and feed the hydrogen into a fuel cell. Alternatively, some fuel cells (DEFC Direct-ethanol fuel cell) can be directly fed by ethanol or methanol.

6. CONCLUSION

Disadvantages of burning fossil fuels are numerous, through air pollution by emitting greenhouse gases such as carbon monoxide, carbon dioxide, nitric oxide, sulphur oxides, methane and particulate matter. This depletes the ozone layer and produces acid rain, causes health hazards due to inhalation of toxic gases, and aquatic hazards through potential oil spills. Greenhouse gases result in global warming and pollution.

Biofuels as a promising alternative for fossil fuels have to be one of the solutions. The use of biofuels has a number of advantages suitable for achieving energy, environmental, agricultural and trade policies. The use of biofuels is closely linked to available and future engine technologies. To replace conventional engine concepts which are based on mineral oil, two alternative strategies are principally pursued at the moment (short and long- term strategy). These concepts mainly differ in the philosophy of the engines. In short term the concept is based on further developments of today's combustion engine and the use of biofuels. This is the most promising approach today. It is efficient and sustainable, as no additional infrastructure and no principally different engine technology is needed.

A long-term approach favors a change to electric engines driven by fuel cells which work without producing emissions during vehicle use. However, numerous technical and economical challenges need to be overcome and only few manufacturers today produce hybrid vehicles (combinations of electric and combustion engines) already available on the market.

A common basic approach of these two concepts is that they will function in the long term only with renewable energy sources. The concepts must also be available at reasonable prices, contribute substantially to the reduction of CO_2 emission and exhibit a high potential as a substitute for conventional fuels.

The promotion of renewable energies is faced by various market barriers. These barriers limit the development of renewables unless special policy measures are enacted, unless no other fossil resources are available or unless the price advantage of renewables highly exceeds that of fossil fuels. In order to promote a fast introduction of biofuels, barriers have to be detected and solutions have to be found.

The production of biofuels is still expensive, markets are immature and beneficial externalities are not accounted (economical barriers).The fuel quality is not yet constant and the conversion technologies for certain biofuels are still immature (e.g. for synthetic biofuels). This is a technical barrier. Depending on the type of biofuel, new or modified infrastructures are needed. Especially, the uses of biohydrogen and biomethane need profound infrastructural changes (infrastructural barriers). Biomass feedstock sources may compete with food supply (ethical barriers). The general public, but also decision makers and politicians are lacking knowledge on biofuels (knowledge barriers). Lobbying groups influence politicians to create or conserve an unfavorable political framework for biofuels (political barriers).

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БИОГОРИВА КАО ОБЕЋАВАЈУЋА ГОРИВА

Сажетак: Употреба фосилних горива има за посљедицу глобално загријавање и онечишћење животне средине. У поређењу са фосилним горивима, биогорива представљају еколошки прихватљив, биоразградив, одржив, у погледу цијене конкурентан и перспективан алтернативни извор енергије. Она имају висок енергетски садржај и не доприносе ефекту стаклене баште. Стога, кориштење јефтиних или обновљивих извора као сировине за производњу биогорива има велики потенцијал у смислу значајног доприноса будућем снабдјевању енергијом.

Производња и кориштење биогорива је већ добро установљено и даља промоција ових горива као што су липидна биогорива (биоетанол, чисто уље из биљака и биодизел) и гас биогорива (биометан, биохидроген) углавном зависи од питања која нису техничке природе, као што су политике и економичност. Биогорива ће дефинитивно наставити да се користе и у догледној будућности и даље за свијет и свјетско становништво представљати релативно чист извор енергије, уз предности као што су оне економске у смислу обезбјеђења нових радних мјеста и здравствених у смислу смањења емисија угљика, што доводи до чистијег ваздуха. Уз све софистициранију технологију и интензивно спровођење истраживања и повећан развој, може се слободно закључити да ће биогориво постати све привлачније за кориштење и налазити све више примјена на глобалном комерцијалном нивоу. Као такво, биогориво је препознато као будући извор енергије за планету Земљу. Све док се не пронађе новији и чистији извор енергије, научници ће дефинитвно устрајати на истраживању и побољшању биогорива како би она постали све економичнија а при томе постала еколошки прихватљива.

Кључне ријечи: биогорива, биоетанол, чиста уља биљака, биодизел, биометан, биохидроген.