Biofuel-Next Generation Cost Effective Fuel-A Review

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Abstract: *Biofuels are a renewable energy source, made from organic matter or wastes, that can play a valuable role in reducing carbon dioxide emissions. Biofuels are one of the largest sources of renewable energy in use today. In the transport sector, they are blended with existing fuels such as gasoline and diesel. In the future, they can be particularly important to help decarbonise the aviation, marine and heavy-duty road transport sectors. Many in the energy industry view biofuel as vitally important to future energy production because of its clean and renewable properties. Ironically, most of the major oil companies are investing millions of dollars in advanced biofuel research. America's largest oil company, ExxonMobil, says they are funding a broad portfolio of biofuels research programs including ongoing efforts on algae as well as programs on converting alternative, non-food-based biomass feedstocks, i.e., cellulosic biomass, to advanced biofuels. They warn, however, that fundamental technology improvements and scientific breakthroughs are still necessary in both biomass optimization and the processing of biomass into viable fuels.*

Energy is essential for the economic development of the world and depends on the fossil fuels that are limited in availability and are associated with environmental pollution of air, water, soil etc. Microalgae make use sunlight and CO2 for their growth and give higher oil productivity more than terrestrial oil seed crops. Biodiesel, as substitute of diesel, can be produced from edible, non-edible and animal fats. Owing to significant advantages over terrestrial oil seed crops, microalgae, is seen as a future third generation source of oil that can be converted into biodiesel. The present paper discusses that the availability of microalgal species, their advantages, oil productivity, land requirement & economics of biodiesel production. The Indian R&D status on various aspects of microalgal biodiesel is also given.

Keywords: *Biofuels, Energy, Biodiesel, Microalgae*

1. Introduction

1.1 Biofuels

Biofuels can be produced from organic matter, or biomass, such as corn or sugar, vegetable oils or waste feedstocks. As biofuels emit less carbon dioxide (CO_2) than conventional fuels they can be blended with existing fuels as an effective way of reducing CO_2 emissions in the transport sector. The use of biofuels have grown over the past decade, driven largely by the introduction of new energy policies in Europe, the USA and Brazil that call for more renewable, lower-carbon fuels for transport. Today biofuels represent around 3% of road transport fuels in use around the world. Biofuel, any fuel that is derived from biomass that is, plant or algae material or animal waste. Since such feedstock material can be replenished readily, biofuel is considered to be a source of renewable energy, unlike fossil fuelssuch as petroleum, coal, and natural gas.

Biofuel is commonly advocated as a cost-effective and environmentally benign alternative to petroleum and other fossil fuels, particularly within the context of rising petroleum prices and increased concern over the contributions made by fossil fuels to global warming. Many critics express concerns about the scope of the expansion of certain biofuels because of the economic and environmental costs associated with the refining process and the potential removal of vast areas of arable land from food production.

Biofuel is a type of energy source derived from renewable plant and animal materials. Examples of biofuels include ethanol (often made from corn in the United States and sugarcane in Brazil), biodiesel (vegetable oils and liquid animal fats), green diesel (derived from algae and other plant sources) and biogas (methane derived from animal manure and other digested organic material). Biofuels are most useful in liquid or gas form because they are easier to transport, deliver and burn cleanly.

1.2. Bioenergy

Bioenergy is energy derived from biofuels. Biofuels are fuels produced directly or indirectly from organic material biomass including plant materials and animal waste. Overall, bioenergy covers approximately 10% of the total world energy demand. Traditional unprocessed biomass such as fuel wood, charcoal and animal dung accounts for most of this and represents the main source of energy for a large number of people in developing countries who use it mainly for cooking and heating.

1.3. Worldwide production of biofuel

Current world oil demand amounts to about 4000 Million tonnes of oil equivalent (Mtoe) while the production of liquid biofuels amounts to 36 Mtoe representing less than 1% of this world demand. Around 85% of the liquid biofuels are currently produced in the form of bioethanol with the main producers being Brazil and the USA. Biodiesel production is essentially concentrated in the European Union. Large-scale production of biofuels from crops requires large land areas to grow them, which generates increasing competition for natural resources, notably land and water. Crop yields per hectare vary widely depending on the type of crop, the country and the production system.

Currently, ethanol production from sugar cane and sugar beet produces the highest yields per hectare. In its World Energy Outlook 2006, the IEA projected an increase in the share of the world's fertile land used to grow plants for liquid biofuel production from 1% in 2004 to around 4% in 2030, assuming favourable government policies and reasonable technical development. Using conventional biofuel technologies, this land use would allow 5% of transport fuel demand to be met. If second-generation biofuel technologies were available, this could rise to 10%.This illustrates that biofuels can only be expected to displace fossil fuels for transport to a very limited extent. Nevertheless, they have a significant effect on global agriculture and agricultural markets because of the large volumes of feedstocks and land areas needed for their production.

1.4. Liquid biodiesel for transport

The most widely used liquid biofuels for transport are ethanol and biodiesel. Ethanol is a type of alcohol that can be produced using any feedstock containing significant amounts of sugar, such as sugar cane or sugar beet, or starch, such as maize and wheat. Sugar can be directly fermented to alcohol, while starch first needs to be converted to sugar. The fermentation process is similar to that used to make wine or beer, and pure ethanol is obtained by distillation. The main producers are Brazil and the USA.

Ethanol can be blended with petrol or burned in nearly pure form in slightly modified spark-ignition engines. A litre of ethanol contains approximately two thirds of the energy provided by a litre of petrol. However, when mixed with petrol, it improves the combustion performance and lowers the emissions of carbon monoxide and sulphur oxide. Biodiesel is produced, mainly in the European Union, by combining vegetable oil or animal fat with an alcohol. Biodiesel can be blended with traditional diesel fuel or burned in its pure form in compression ignition engines.

2. Types of biofuels

2.1. Biogas

Biogas is methane produced by the process of anaerobic digestion of organic material by anaerobes. It can be produced either from biodegradable waste materials or by the use of energy crops fed into anaerobic digesters to supplement gas yields. The solid byproduct, digestate, can be used as a biofuel or a fertilizer.

2.2.Syngas

Syngas, a mixture of carbon monoxide, hydrogen and other hydrocarbons, is produced by partial combustion of biomass, that is, combustion with an amount of oxygen that is not sufficient to convert the biomass completely to carbon dioxide and water. Before partial combustion, the biomass is dried, and sometimes pyrolysed. The resulting gas mixture, syngas, is more efficient than direct combustion of the original biofuel; more of the energy contained in the fuel is extracted. Syngas may be burned directly in internal combustion engines, turbines or high-temperature fuel cells.

2.3. Ethanol

Biologically produced alcohols, most commonly ethanol, and less commonly propanol and butanol, are produced by the action of microorganisms and enzymes through the fermentation of sugars or starches (easiest), or cellulose (which is more difficult). Biobutanol (also called biogasoline) is often claimed to provide a direct replacement for gasoline, because it can be used directly in a gasoline engine.

Ethanol fuel is the most common biofuel worldwide, particularly in Brazil. Alcohol fuels are produced by fermentation of sugars derived from wheat, corn, sugar beets, sugar cane, molasses and any sugar or starch from which alcoholic beverages such as whiskey, can be made (such as potato and fruit waste, etc.). The ethanol production methods used are enzyme digestion (to release sugars from stored starches), fermentation of the sugars, distillation and drying. The distillation process requires significant energy input for heat (sometimes unsustainable natural gas fossil fuel, but cellulosic biomass such as bagasse, the waste left after sugar cane is pressed to extract its juice, is the most common fuel in Brazil, while pellets, wood chips and also waste heat are more common in Europe) Waste steam fuels ethanol factory, where waste heat from the factories also is used in the district heating grid. Ethanol can be used in petrol engines as a replacement for gasoline; it can be mixed with gasoline to any percentage.

2.5.Butanol

(C_4H_9OH) is formed by ABE fermentation (acetone, butanol, ethanol) and experimental modifications of the process show potentially high net energy gains with butanol as the only liquid product. Butanol will produce more energy and allegedly can be burned "straight" in existing gasoline engines (without modification to the engine or car), and is less corrosive and less water-soluble than ethanol, and could be distributed via existing infrastructures. Due Pont and BP are working together to help develop butanol.

3. Indian research and production

Specially bred mustard varieties can produce reasonably high oil yields and are very useful in crop rotation with cereals, and have the added benefit that the meal left over after the oil has been pressed out can act as an effective and biodegradable pesticide. The NFESC, with Santa Barbara-based Biodiesel Industries, is working to develop biofuels technologies for the US navy and military, one of the largest diesel fuel users in the world. A group of Spanish developers working for a company called Ecofasa announced a new biofuel made from trash.

3.1. Ethanol biofuels (bioethanol)

As the primary source of biofuels in North America, many organizations are conducting research in the area of ethanol production. The National Corn-to-Ethanol Research Center (NCERC) is a research division of Southern Illinois University Edwardsville dedicated solely to ethanol-based biofuel research projects. On the federal level, the USDA conducts a large amount of research regarding ethanol production in the United States. Much of this research is targeted toward the effect of ethanol production on domestic food markets. A division of the US Department of Energy, the National Renewable Energy Laboratory (NREL), has also conducted various ethanol research projects, mainly in the area of cellulosic ethanol.

3.2. Jatropha

Several groups in various sectors are conducting research on Jatropha curcas, a poisonous shrub-like tree that produces seeds considered by many to be a viable source of biofuels feedstock oil. Much of this research focuses on improving the overall per acre oil yield of Jatropha through advancements in genetics, soil science, and horticultural practices.

3.3. Fungi

A group at the Russian Academy of Sciences in Moscow, in a 2008 paper, stated they had isolated large amounts of lipids from single-celled fungi and turned it into biofuels in an economically efficient manner. More research on this fungal species, Cunninghamella japonica, and others, is likely to appear in the near future. The recent discovery of a variant of the fungus Gliocladium roseum (later renamed Ascocoryne sarcoides) points toward the production of so-called myco-diesel from cellulose.

3.4. Animal gut bacteria

Microbial gastrointestinal flora in a variety of animals have shown potential for the production of biofuels. Recent research has shown that TU-103, a strain of Clostridium bacteria found in Zebra feces, can convert nearly any form of cellulose into butanol fuel. Microbes in panda waste are being investigated for their use in creating biofuels from bamboo and other plant materials. There has also been substantial research into the technology of using the gut microbiomes of wood-feeding insects for the conversion of lignocellulotic material into biofuel.

Conclusions

Biofuels are currently the only viable replacement to hydrocarbon transportation fuels Because biofuels can be used in existing combustion engines, minimal changes to infrastructure are required for their implementation. This is their most prominent advantage as concerns about the environmental impacts of fossile fuels continue to rise.

While there is some dispute over just how “renewable” biofuels are, it is generally accepted that the crops used to produce them can be replenished much faster than fossil fuels Concerns about biofuels are usually centered around the fact that they are an agricultural product. One key concern about biofuels is that crops grown for fuel production compete with other natural resources, particularly food and water.

First generation biofuels use only edible crops which has led to biofuel crops displacing food sources in some regions. In many regions of the world, subsidies are provided for these crops which only amplifies these issues. In addition, increased agriculture of any form often comes with concerns of deforestation, water and fertilizer use, which all have their own respective environmental and climate impacts

In recent times, microalgae has been found to produce 19,000-57,000 liter compared to 2000-2500 liter of biodiesel per acre from edible & non-edible oils. Apart from biodiesel production, a number of byproducts can also be produced such as food, feeder, fertilizer, antioxidant, polysaccharides, pharmaceuticals, biopolymers etc. which can be utilized by human. Approximately 50,000 microalgae species exist all over the world but all species are not suitable for biodiesel production.

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