**Agriculture-Based Biofuels: Production and Uses of Biodiesel, Bioethanol, and Biofuel Blends**

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**Abstract**

The need for alternate fuel sources has been prompted by the depletion of petroleum-derived fuel and environmental concerns. But from the perspective of production capacity and engine compatibility, a total replacement of petroleum-derived fuels with biofuel is not possible. However, a slight switch from diesel to biofuel can delay the depletion of petroleum supplies and slow the drastic climate change brought on by emissions from automobiles. The two main factors influencing global biofuel development, which has the potential to boost the agro-industry are energy security and climate change. However, there are further challenges with the use of biofuels, such as the long-term compatibility of vehicle engines and issues with food security resulting from the manufacturing of biofuel from food-grade oil-seeds. After discussing all of the benefits and drawbacks of biodiesel, it is clear that the best way to make money off of it is to use an engine designed specifically for it. By adopting flexible-fuel vehicles (FFV), which have a specialised engine for both ethanol and gasoline, Brazil successfully increased their bioethanol commercialization. This chapter includes information on biofuels, biodiesel, and a summary of several biofuel processing methods.

 **Keywords:** Biofuel, Flexible fuel vehicle,

**Introduction**

Liquid biofuels are biologically derived renewable energy sources. They differ from fossil liquid fuels, which are likewise derived from living things but are non-renewable. Transport fuels, such as biodiesel and bioethanol, are liquid biofuels. These liquid fuels are produced by processing agricultural products.Agricultural products are typically used to extract liquid biofuel. Major sources of environmentally beneficial fuel are rapeseed, sunflower, linseed, palm, and soybean. These are the main raw materials used to make commercial biodiesel. Carbon emissions from liquid biofuels are either zero or negative. By becoming "carbon neutral," a fuel's carbon emissions are compensated by new plant growth.

Bioethanol is an alcohol produced mostly from sugar and starch crops by fermenting the sugar components of plant materials.Although ethanol can be used as a fuel for cars in its pure form, it is typically added to gasoline to raise octane and reduce emissions from moving vehicles.Moreover, biodiesel can be used as a vehicle fuel in its pure form, it is typically added to diesel to lower emissions of hydrocarbons, carbon monoxide, and particulates from diesel-powered vehicles. The most popular type of biofuel is biodiesel, which is made from oils or fats through a process called trans-esterification.

**First generation biofuels:**

Using standard technologies, first-generation biofuels are produced from sugar, starch, vegetable oil, or animal fats. First generation biofuels are frequently made from basic feedstocks such seeds or grains, which produce starch that can be fermented into bioethanol, or from sunflower seeds, which can be pressed to produce vegetable oil that may be used to make biodiesel.

Alcohols produced biologically are the most prevalent type of biofuel. Fermentation of sugars originating from wheat, corn, sugar beets, sugar cane, molasses, and any other sugar or starch that can be used to make alcoholic drinks results in the production of alcohol fuels (like potato and fruit waste, etc.). In petrol engines, ethanol can be used in place of gasoline and combined with it in any amount. The majority of current automotive petrol engines can run on mixtures of petroleum/gasoline and bioethanol up to 15%. The fact that ethanol (CH3CH2OH) has a greater octane rating than gasoline is a virtue. Biodiesel is the most common biofuel used world wide.. It is produced from oils or fats using *trans-esterification* and is a liquid similar in composition to fossil diesel. Its chemical name is methyl or ethyl ester.

**Agriculture as a source of Biofuel**

Since biofuel is made up of two major fuel categories—bioethanol and biodiesel,there are two distinct processes for making biofuel from biomass.

**What is Bioethanol ?**

Although it can also be made chemically by reacting ethylene with steam, the fermentation of sugar is the major method of producing bioethanol. Energy crops are the primary source of sugar needed to make ethanol. These energy crops, which include maize, corn, and wheat, are typically grown expressly for energy use.

**How Bioethanol is made:**

The three main processes for producing ethanol on a big scale are Sugar fermentation, Distillation, and Dehydration.

Some crops require the breakdown of carbohydrates like cellulose and starch into sugars before fermentation. Cellulolysis is another name for the hydrolysis of cellulose. Sugar is produced from starch using enzymes.

1. **Sugar Fermentation:**

Sugar is fermented by microorganisms to make ethanol. Currently, only sugars will directly support microbial fermentation. Starch and cellulose, two important plant substances, can theoretically be transformed to sugars for fermentation because they are both composed of sugars.

1. **Distillation**:
Water must be taken out of the ethanol in order for it to be used as fuel. Distillation is used to get rid of most of the water. Due to the creation of low-boiling water-ethanol, the purity is restricted to 95–96%.
2. **Dehydration**:

Currently, a physical absorption procedure using a molecular sieve is the most often employed purification technique. By adding the hydrocarbon benzene, which similarly denatures the ethanol, a different distillation technique is accomplished. The use of calcium oxide as a desiccant is a third technique, which is used widely.

* Yeast bacteria, sugar, and water are combined in the customary method of making bioethanol, and the mixture is then allowed to ferment in a warm atmosphere. The mixture gradually transforms into a liquid that contains roughly 15% alcohol. The liquid mash is then distilled and filtered to produce bioethanol, which accounts for around 99.9% of the final product.
* The fermentation process is a chain of chemical processes that turns simple carbohydrates into ethanol. Fermentation happens as a result of the process, which is brought on by yeast or bacteria that consume the sugars. The simplified fermentation reaction can be represented by the following straightforward formula:

**C6H12O6 (glucose) —> 2 CH3CH2OH (Ethanol)+ 2 CO2 (Carbon dioxide)**

* Bioethanol is derived from a variety of sugar and starch-rich crops, which includes grain, corn, sugar cane, and sugar beet. Bio alcohol is alcohol obtained from biological sources, not from petroleum. Examples include methanol and ethanol. Although certain new cars can use BA100, it is often used as a blend of biofuel and petroleum (Bioalcohol 100 percent ).Bio alcohols can help reduce carbon-dioxide emissions and reduce our dependence on foreign oil. One of the biggest challenges is to produce enough crop without having an impact on the food chain.

**Ethanol from starchy feed stock (grains)**

It is far simpler to produce ethanol from cereal grains like barley, wheat, and corn than it is from cellulose.The process includes several steps:

a) Milling of grains

b) Hydrolysis of starch to sugar units

c) Fermentation by yeast

d) Distillation

e) Removal of water from ethanol

* The raw material is ground, and then it is combined with water and enzymes to convert the starch to sugar units. The free sugar can be used by yeast or bacteria and converted to ethanol and carbon dioxide.
* As the concentration of ethanol increases to about 15%, fermentation is reduced, since high alcohol concentration kills the yeast or bacteria.
* The ethanol content is raised by distillation to roughly 95%. The ethanol solution must be dried using various drying agents to a concentration of 99.5 percent ethanol in order to eliminate the remaining water.
* Approximately, 3 kilogram of wheat can be used to make 1 litre of pure ethanol.

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**Ethanol production from sugar cane:**

* Sugarcane, which contains roughly 15% sucrose, makes for one of the simplest and most effective ways to produce ethanol.
* After cutting the cane, the juice is macerated to be removed. The juice is clarified and then condensed by boiling. To create raw ethanol, the concentrated juice is fermented with yeast.
* To obtain anhydrous ethanol, a succession of distillation processes are used, finishing with an extractive distillation using benzene. Approximately 8.73 litres of alcohol per tonne of cane is the typical production of ethanol.
* The process flow chart for production of ethanol from sugarcane.



**Biodiesel**

**How to produce Biodiesel ?**

***Trans-esterification****:* The chemical interaction between oils, sodium hydroxide, and methanol (or ethanol) results in the production of biodiesel and glycerol. For every ten parts of biodiesel, one part of glycerol is created.

When combined with mineral diesel, biodiesel can be utilised in any diesel engine. The majority of automakers only advise using mineral diesel and biodiesel in blends of 15% or less. The design of many modern diesel engines allows them to operate on B100 without requiring any engine modifications.

Biodiesel is also an *oxygenated fuel*, meaning that it contains a reduced amount of carbon and higher hydrogen and oxygen content than fossil diesel. This improves the combustion of fossil diesel and reduces the particulate emissions from un-burnt carbon. Although less desirable oils can be used for this purpose, edible vegetable oil is often not used as fuel. More and more used vegetable oil is being converted into biodiesel. The end result is a straight-chain hydrocarbon with a high cetane content, a low level of aromatics and sulphur, and no oxygen.

**Reaction raw materials**:

1. Oil

2. Methanol (CH3OH) 99%+ pure

3. Potassium hydroxide (must be dry)

**Manufacturing Process**

1. Jatropha oil is filtered to remove any solid particles.
2. Jatropha oil is then heated to remove any water content (optional).
3. Potassium Hydroxide is then throughly mixed in Methanol till it disolves completely to get potassium methoxide.
4. Jatropha oil is heated if required (during winter), and mixed in the potassium methoxide while with agitator running.
5. It is then allowed to settle and glycerine is removed from bottom.
6. BioDiesel fraction is then washed and dried.
7. It is then checked for quality.

KOH and methanol are combined during transesterification to produce potassium methoxide (K+ CH3O-). If you're not careful, this potent molecule with strong polar bonds splits the transfatty acid into soap and glycerine chains (biodiesel) when it's mixed with the oil. Esters are converted to methyl esters. If they were reacted with ethanol instead of methanol, they would become ethyl esters.

**Process in Detail:**

Filter the oil to remove solid particles. Heat the oil to remove any water content and allow cooling. Add the potassium methoxide to the oil and stir the mixture for 50 minutes to an hour. (Dissolve 5 gram of KOH in 1 liter of oil). Warm gently in hot water and stir until all the oil dissolves in the alcohol and the mixture turns clear. The settling takes some time to complete. This will result in three levels, with glycerine at the bottom and biodiesel on top of unreacted oil. The methyl esters are separated from the glycerine during the transesterification process. The transesterification process separates the methyl esters from the glycerine. Glycerin or glycerol is the main by-product of making biodiesel. The glycerine will be approx. 95% pure.

**Transesterification Reactions:**

The following is a transesterification reaction scheme:

Long carbon chains that are too long to fit in the diagram are represented by R1, R2, and R3 in this illustration.

Typically, triglycerides, which are esters of free fatty acids with the trihydric alcohol glycerol, are used to create animal and plant fats and oils. The base-catalyzed method, which is the most cost-effective way to handle vegetable oils, is used to make almost all biodiesel from vegetable oils.

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**Biodiesel Blends:**

The proportion of biodiesel in any fuel mix is indicated on the label by the "B" factor, which is used for blends of biodiesel and conventional hydrocarbon diesel. Fuel containing 20 percent biodiesel is designated as B20, while 100 percent pure biodiesel is designated as **B100**. Blends of 20 percent biodiesel with 80 percent petroleum hydrocarbon diesel (B20) can generally be used in unmodified diesel engines. In order to prevent maintenance and performance issues, biodiesel can also be utilised in its pure form (B100), however this may require certain engine modifications.

**Applications**

In the majority of contemporary diesel engines, biodiesel can be utilised in pure form (B100) or blended with petroleum fuel at any concentration. Biodiesel will destroy natural rubber gaskets and hoses in automobiles because it differs from petro-diesel in its solvent characteristics. Where petro-diesel has been utilised, biodiesel has been proven to dissolve deposits of residue in the fuel lines. As a result, if a sudden switch to pure biodiesel is made, fuel filters may become clogged with debris. Therefore, it is advised to replace the fuel filters on heaters and engines soon after making the initial transition to a biodiesel blend.

1. **Vehicular use:**

The Jeep "Liberty" with 5% biodiesel blends was issued by Chrysler in 2005, demonstrating at least some acceptance of biodiesel as a legal diesel fuel additive. McDonald's announced in 2007 that it would begin making biodiesel from the used cooking oil left over from its restaurants. Its fleet would be powered by this fuel.

1. **Railway usage:**

The **Virgin Voyager Train,** owned by **Richard Branson**, was converted to run on 80% petro-diesel and only 20% biodiesel, and it is claimed that this will reduce direct emissions by 14%. This train is marketed as the first "biodiesel train" in the world. In 2007, the Royal Train accomplished the first ever trip powered entirely by biodiesel. The Royal Train has successfully run on B100 since 2007. (100 percent biodiesel).

**Conclusion**

Although the Jatropha plant has been touted as a high-yield biodiesel source, yields are very reliant on meteorological and soil factors. The yield is estimated to be between 1.5 and 2 tonnes per hectare each crop at the low end; in more hospitable climates, two or more crops have been produced year. It can coexist with other cash crops and is drought-resistant.

Energy consumption patterns at the moment are neither safe nor environmentally, economically, or socially sustainable. If we don't adjust our routine and source of energy, an impending energy crisis will halt our social and economic development. It is predicted that there will be a severe petroleum fuel scarcity in the near future, which will have negative environmental effects. Therefore, finding a clean alternative fuel is essential. Currently, fusion, wind, solar, and tidal energy are all very promising forms of renewable energy. However, we need a substitute that can readily adjust with the current supply and storing system to meet the rising demand for transport fuel for millions of existing autos, and biofuel is such a contender. because it can be used in internal combustion engines without major modification and is interchangeable with gasoline and diesel. A minor adjustment can provide a thorough answer for adjusting gasoline qualities for engine compatibility. On the other hand, there isn't a modified car patent that uses biodiesel as of yet. It is understandable that multi-functional fuel additives may improve the engine compatibility of biodiesels but will raise their cost after taking into account all the benefits and drawbacks and fuel attributes.

Glossary:

* **Alternative Fuel** a well-known term for "non conventional" transportation  fuels derived from biomass  or natural gas  (propane, compressed natural gas, methanol, etc) (ethanol, methanol).
* **Biodiesel -** An alternative fuel that can be made from any fat or vegetable oil. It can be used in any diesel engine with few or no modifications. Although biodiesel does not contain petroleum, it can be blended with diesel at any level or used in its pure form.
* **Biofuels:** Liquid fuels and blending ingredients made from biomass (plant) feedstocks that are predominantly used for transportation
* **Fossil Fuels:** Fuels (coal, oil, natural gas, etc.) that result from the compression of ancient plant and animal life formed over millions of years.
* **Horsepower:** A unit for measuring the rate of work (or power) equivalent to 33,000 foot-pounds per minute or 746 watts.
* **Kilowatt-hour (kWh):** A unit of energy equal to one kW applied for one hour; running a one kW hair dryer for one hour would dissipate one kWh of electrical energy as heat.
* **Methane:** The most common gas formed in coal mines; a major component of natural gas.
* **Natural Gas:** a fossil fuel that burns cleanly and without smell, colour, or taste. It is typically found in fossil fuel deposits and is utilised as fuel.

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