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BIOFUELS -A Safer Substitute

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Abstract - **Biofuels are liquid fuels produced from biomass such as sugar cane, grains, agricultural residues, algae and household waste. They are typically used to replace gasoline and diesel in transportation". It is an important source of alternative energy in these days. Biofuel is the fact that multiple interests are at play for all the stake-holders and manufacturer present in the development. The farmers who are interested in an increased market for their products and increased prices, the ethanol industry in an increased ethanol demand, the food industry in low commodity prices, the oil industry interested in protecting their dominance on the energy market, the politicians interested in the next election, and so forth. This paper provides insights into the complexity of biofuels based on the best available scientific literature. We also hope it can contribute to an informed discussion on present scenario.**

Keyword: Biofuel, Energy, Ethanol, Environment, Pollution, Technology

1. INTRODUCTION

Biofuels are liquid fuels produced from biomass such as sugar cane, grains, agricultural residues, algae and household waste. They are typically used to replace gasoline and diesel in transportation. One of the advantages of biofuels is that they are the only existing liquid alternative to fossil fuels. As such they can be used in today's vehicles without modification when mixed with gasoline or diesel, or in flex fuel vehicles in high concentrations. Biomass can also be used to produce electricity. Biofuels is a general term used for different types of fuel, produced from many different feedstock using a variety of production processes. These can be divided into two categories: ethanol replacing gasoline and biodiesel replacing diesel. These fuels can again be divided into conventional and advanced.

2. LITERATURE REVIEW

Brazil is the world's second largest producer of ethanol fuel, and until 2010, the world's largest exporter. Together, Brazil and the United States lead the industrial production of ethanol fuel, accounting together for 87.8 percent of the world's production in 2010 and 87.1 percent in 2011. In 2011 Brazil produced 21.1 billion liters (5.57 billion U.S. liquid gallons), representing 24.9 percent of the world's total ethanol used as fuel.
Brazil is considered to have the world's first sustainable biofuels economy and the biofuel industry leader,[1] a policy model for other countries; and its sugarcane ethanol "*the most successful alternative fuel to date.*"[2] However, some authors consider that the successful Brazilian ethanol model is sustainable only in Brazil due to its advanced agri-industrial technology and its enormous amount of arable land available;[2] while according to other authors it is a solution only for some countries in the tropical zone of Latin America, the Caribbean, and Africa. Brazil has ethanol fuel available throughout the country.
Simon et al had analyzed Cellulosic biomass ethanol fuel program is based on the most efficient agricultural technology for sugarcane cultivation in the world,[3] uses modern equipment and cheap sugar cane as feedstock, where as Taheipour et al have analyzed Biofuels, Policy Options, and Their Implications: Analyses Using Partial and General Equilibrium Approaches.[4] In 2010, Tyner et al had done comparison of the US and EU approaches to stimulating biofuels[5]. Research had been carried out by Taheripour et al on "Biofuels and their By-Products: Global Economic and Environmental Implications.

3. ENERGY RESOURCES

The Technology is Ready

While conventional ethanol has been produced for years, advanced bioethanol is currently being deployed in China, Europe, Brazil and the U.S. The major barrier preventing large–scale deployment is financing and political uncertainty. Bringing advanced biofuels to market takes a partnership, where the private sector provides the

innovation and the capital to develop it - and the public sector provides consistent policy support to grow it and capital support in the initial phase

The challenge: Produce more

Producing food for a large world population puts pressure on the environment because large amounts of agricultural land is needed to grow crops and large amounts of fertilizer and pesticides are needed to ensure the yields. The world population is growing to reach 9.5 billion people in 2050 and the pressure on the environment will keep growing unless we find ways to produce more crops with less land, fertilizer and pesticide consumption.

Part of the solution

Novozymes has a range of biological solutions for agriculture which can help increasing yields of crops with the less fertilizers and conventional pesticides. Crop enhancement: Balanced phosphate and nitrogen nutrition is necessary for maximizing yields in agriculture. Novozymes' microbial products enhance crops' phosphate up-take and nitrogen fixation and help farmers increasing yields. Other products which are derived from plants and microorganisms enhance the crop's nutritional capabilities to improve plant growth, increase stress tolerance, and improve yields. Crop protection: Novozymes biocontrol products are based on microorganisms and naturally occurring fungus to provide powerful control against insects, disease, and weed pests.

Less in, more out, smaller footprint

Novozymes' solutions help grow heartier, healthier crops increasing food supply and improving the environment. For example, Novozymes' Jumpstart helps farmers increase crop yields using less fertilizer – that's less material that individual farmers have to buy, transport, store and spread, and less runoff into streams and waterways.

- Any hydrocarbon fuel that is produced from organic matter (living or once living material) in a short period of time (days, weeks, or even months) is considered a Biofuel.
- A **biofuel** is a fuel that contains energy from geologically recent carbon fixation. These fuels are produced from living organisms.
- These fuels are made by a biomass conversion (biomass refers to recently living organisms, most often referring to plants or plant-derived materials). This biomass can be converted to convenient energy containing substances in three different ways: thermal conversion, chemical conversion, and biochemical conversion.

4. BIOFUELS: Bioethanol, Biodiesel, Biomass, Biodiesel From Jatropha, Algae Biofuels, Bio-Refineries

4.1 There are four chief Biofuels categories:

The 1st generation of biofuels comes from sugar, starch & vegetable fats that are solely dependent on food-crops. It also can be sourced through animal fats.

4.2 Biofuels are often broken into two generations.

- 1st generation biofuels are also called conventional biofuels. They are made from things like sugar, starch, or vegetable oil. Note that these are all food products. Any biofuel made from a feedstock that can also be consumed as a human food is considered a first generation biofuel.
- 2nd generation biofuels are produced from sustainable feedstock. No second generation biofuel is also a food crop, though certain food products can become second generation fuels when they are no longer useful for consumption. Second generation biofuels are often called "advanced biofuels."

4.3 The First Generation

'First-generation' or conventional biofuels are made from sugar, starch, or vegetable oil.

4.4 Second-generation (advanced) biofuels

- Second-generation biofuels are produced from sustainable feedstock. Sustainability of a feedstock is defined, among others, by availability of the feedstock, impact on GHG emissions, and impact on biodiversity and land use.
- Many second-generation biofuels are under development such as Cellulosic ethanol, Algae fuel, biohydrogen, biomethanol, DMF, BioDME, Fischer-Tropsch diesel, biohydrogen diesel, mixed alcohols and wood diesel.

4.5 Positives of Biofuels

- The energy content of biodiesel is about 90% that of petroleum diesel.
- The energy content of ethanol is about 50% that of gasoline.
- The energy content of butanol is about 80% that of gasoline.
- Biofuels burn cleaner than fossil fuels, resulting in fewer emissions of greenhouse gases, particulate emissions, and substances that cause acid rain such as sulfur.
- Biodiesel is sulfur free.
- Biodiesel has fewer polycyclic aromatic hydrocarbons, which have been linked to cancer.
- Additionally, biofuels are biodegradable, so if they do spill, less harm is done compared to when fossil fuels spill

4.6 Biofuels Cycle : Fig.3 presents life cycle of biofuels.

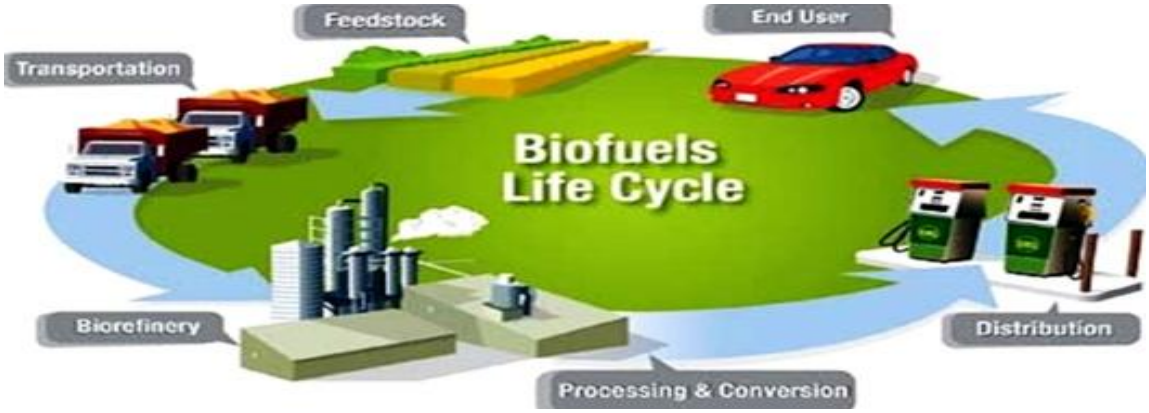

Fig.3: Biofuels Life Cycle

4.7 Biorefinery Concept: Fig.4 present the concept of bio-refinery concept.[3]

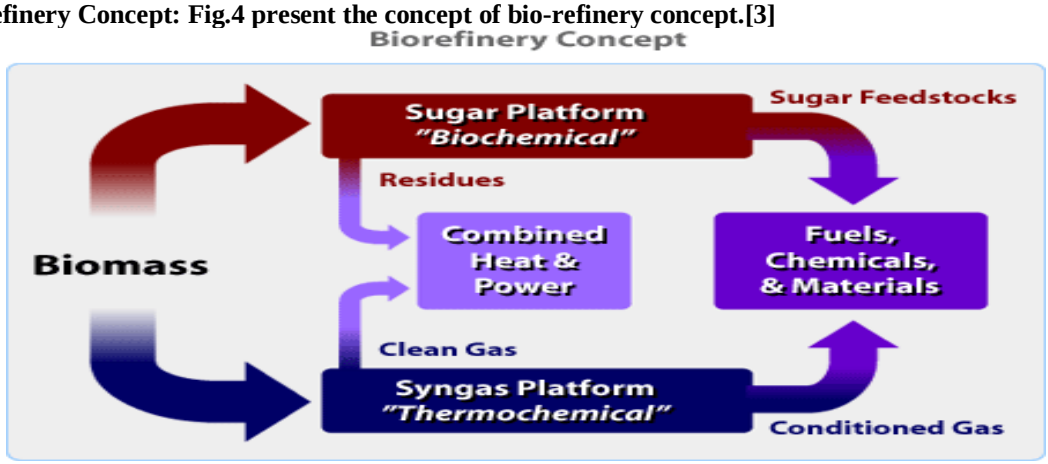

Fig. 4: Biorefinery Concept

4.8 A Brief Study *:Ethanol Biofuels*

- Bioethanol is an alcohol made by fermentation, mostly from carbohydrates produced in sugar or starch crops such as corn or sugarcane.
- Corn ethanol is ethanol produced from corn that is used as a biomass. Corn ethanol is produced by means of ethanol fermentation and distillation.
- Corn ethanol is mainly used as an oxygenate in gasoline to produce a low-level blend. To a lesser extent, it is used as fuel for E85 flex-fuel vehicles.
- Corn is the main feedstock used for producing ethanol fuel in the United States.

4.9 Production Methods

- Broadly, there are two main types of corn ethanol production:

i) *Dry milling process* - It is an enzymatic/biological process in which yeast is used for conversion of sugar(carbohydrate) into ethanol & CO2.

ii) *Wet milling process* – It is a chemical process in which sulphuric acid along with water is added that separates the grain into many components. This slurry is then mechanically processed to segregate the corn germ. The oil is obtained as bi-product. The remaining components of fiber, gluten and starch are segregated out using screen, hydroclonic and centrifugal separators. Out of these components, the corn starch and remaining water are fermented to form ethanol through a process similar to dry-milling.

4.10 Environmental view

- Ethanol produced today results in fewer greenhouse gas (GHG) emissions than gasoline and is fully biodegradable, unlike some fuel additives.
- Ethanol blended fuels currently in the market – whether E10 or E85 – meet stringent tailpipe emission standards.
- Ethanol readily biodegrades without harm to the environment, and is a safe, high-performance replacement for fuel additives.

4.11 Production from sugarcane to Ethanol: Fig.5 shows the production process.[4]

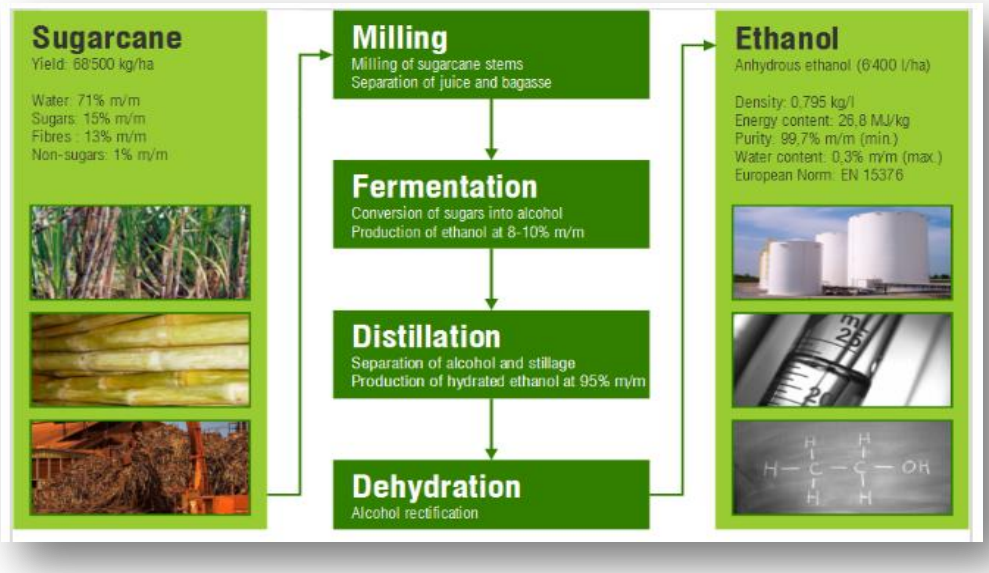

Fig. 5: Production Process

6. BIOETHANOL

Bioethanol is an alcohol made by fermentation, mostly from carbohydrates produced in sugar or starch crops such as corn or sugarcane. Cellulosic biomass, derived from non-food sources such as trees and grasses, is also being developed as a feedstock for ethanol production. The principle fuel used as a petrol substitute is bioethanol. Bioethanol fuel is mainly produced by the sugar or cellulose fermentation process. Ethanol is a high octane fuel and has replaced lead as an octane enhancer in petrol.

Bioethanol Production

- Wheat/Grains/Corn/Sugar-cane can be used to produce ethanol. (Basically, any plants that composed largely of sugars)

Concentrated Acid Hydrolysis

- ~77% of sulfuric acid is added to the dried biomass to a 10% moisture content.
- Acid to be added in the ratio of 1/25 acid :1 biomass under 50°C.

- Dilute the acid to ~30% with water and reheat the mixture at100°C for an hour.
- Gel will be produced and pressed to discharge the acid sugar mixture.

Separate the acid & sugar mixture by using a chromatographic column .

Wet milling process

- corn kernel is soaked in warm water
- proteins broken down
- starch present in the corn is released
  (thus, softening the kernel for the milling process)
- microorganisms, fibre and starch products are produced.

In the distillation process, ethanol is produced.

Dry milling process

- Clean and break down the corn kernel into fine particles
- Sugar solution is produced when the powder mixture (corn germ/starch and fibre) is broken down into sucrose by dilute acid or enzymes.
- Yeast is added to ferment the cooled mixture into ethanol.

Sugar fermentation

- Hydrolysis process breaks down the biomass cellulosic portion into sugar solutions which will then be fermented into ethanol.
- Yeast is added and heated to the solution.
- Invertase acts as a catalyst and convert the sucrose sugars into glucose and fructose. (both *C6H12O6*).

7.1 Bioethanol Properties

- Colourless and clear liquid
- Used to **substitute** petrol fuel for road transport vehicles
- One of the widely used alternative automotive fuel in the world (Brazil & U.S.A are the largest ethanol producers)
- Much more environmentally friendly
- Lower toxicity level
- Octane number

7.2 Fuel Properties

- Octane number of ethanol is higher than petrol
- hence ethanol has better antiknock characteristics
- increases the fuel efficiency of the engine
- oxygen content of ethanol also leads to a higher efficiency, which results in a cleaner combustion process at relatively low temperatures

7.3 Application

- transport fuel to replace gasoline
- fuel for power generation by thermal combustion
- fuel for fuel cells by thermochemical reaction
- fuel in cogeneration systems
- feedstock in the chemicals industry
- Blending of ethanol with a small proportion of a volatile fuel such as gasoline -> more cost effective
- Various mixture of bioethanol with gasoline or diesel fuels
- E5G to E26G (5-26% ethanol, 95-74% gasoline)
- E85G (85% ethanol, 15% gasoline)
- E15D (15% ethanol, 85% diesel)
- E95D (95% ethanol, 5% water, with ignition improver)

8. FUTURE SCOPE FOR DEVELOPMENT

- For bio-ethanol to become more sustainable to replace petrol, production process has to be more efficient

  - Reducing cost of conversion
  - Increasing yields
  - Increase the diversity of crop used
- As microbes are use to convert glucose into sugar which is ferment in bio-ethanol
  - Microbiology and biotechnology will be helpful in the genetic engineering

9. CONCLUSION

- With the increasing demand for fuel and depleting fossil fuel resources, biofuels can act as a perfect substitute for gasoline and diesel in the future.
- Derived from bio sources, these have least environmental effects.
- While biodiesel remains more expensive than regular diesel, consumers need to look beyond the cost per gallon to really gauge the economic benefits. Biodiesel vehicles get 30 percent better fuel economy than gasoline-powered vehicles [Consumer Reports].
- Above all, biofuels can be readily considered as renewable sources of energy.

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