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Introduction to biofuels

Biofuels are liquid or gaseous fuels produced from biomass that are generally high in sugar (such as sugarcane, sugarbeet, sweet sorghum), starch (such as corn and cassava) or oils (such as soybeans, rapeseed, coconut, sunflowers, and palms). The two most commonly used biofuels are ethanol and biodiesel.

Biofuels are mostly used as a transport fuel. Global production of biofuels has been growing steadily over the last decade from 16 billion litres in 2000 to around 110 billion litres in 2013. Biofuels provide around 3.5% of total road transport fuel globally. Higher shares are achieved in certain countries, like Brazil, where biofuels provide around 25% of road transport fuel demand today. Ethanol based fuel gels can be used for cooking.

A biofuel in any type of fuel in which the energy derived from the process of biological carbon fixation. Biological carbon fixation occurs in living organisms. The biggest difference between a biofuel and a fossil fuel is the time period over which the fixation occurs. In a biofuel, fixation occurs in months or years. In a fossil fuel, fixation occurs over thousands or millions of years. Additionally, fossil fuels are made entirely of hydrogen and carbon atoms while biofuels contain carbon, hydrogen, and oxygen. These are just a few of the interesting facts regarding biofuels, but many more follow.

History of Biofuels

- Biofuels are nothing new. In fact, they've been around as long as cars have. Henry Ford originally designed the Model T to run on ethanol. And people have been running diesel engines on vegetable oil much longer than they have been running diesel engines on petroleum-based diesel fuel.
- Rudolf Diesel, inventor of the diesel engine, originally designed it to run on vegetable oil. In fact, one of his early demonstrations, at the World Exhibition in Paris in 1897, had a diesel engine running on peanut oil.

- Petroleum based fuel originally won out over biofuel because of cost. The table is slowly turning though as fossil fuels become more expensive.
- During World War II, the demand for biofuel increased once again as fossil fuels became less abundant.
- Biofuel surged in popularity during the energy crisis of the 1970s.
- The most recent surge in biofuel popularity occurred in the 1990s in response to tougher emissions standards and increasing demands for enhanced fuel economy.

Classification of Biofuel Sources

Classification According to Food and Agricultural Organization (FAO)[3].

Table 2: Classification of Biofuel sources by different characteristics

		woody biomass	herbaceous biomass	biomass from fruits and seeds	others (including mixtures)
		WOODFUELS	AGROFUELS		
Energy crop	direct	- energy forest trees - energy plantation trees	- energy grass - energy whole cereal crops	- energy grain	
By-products*	direct	- thinning by-products - logging by-products	crop production by-products:		- animal by-products - horticultural by-products - landscape management by-products
			- straw	- stones, shells, husks	
	indirect	- wood processing industry by-pro-ducts - black liquor	- fibre crop processing by-products	- food processing industry by-products	- biosludge - slaughterhouse by-products
End use materials	recovered	- used wood	- used fibre products	- used products of fruits and seeds	MUNICIPAL BY-PRODUCTS - kitchen waste - sewage sludge

FAO Classification Biofuel sources

Classification According to Generations

Biofuels are generally classified as first, second and third generations:

First-generation biofuels are made from sugar, starch, vegetable oil, or animal fats using conventional technology. These are generally produced from grains high in sugar or starch fermented into bioethanol; or seeds that which are pressed into vegetable oil used in biodiesel. Common first-generation biofuels include vegetable oils, biodiesel, bioalcohols, biogas, solid biofuels, syngas.

Second-generation biofuels are produced from non-food crops, such as cellulosic biofuels and waste biomass (stalks of wheat and corn, and wood). Common second-generation biofuels include vegetable oils, biodiesel, bioalcohols, biogas, solid biofuels, and syngas. Research continues on second-generation biofuels including biohydrogen, biomethanol, DMF, Bio-DME, Fischer-Tropsch diesel, biohydrogen diesel, mixed alcohols and wood diesel.

Third-generation biofuels are produced from extracting oil of algae – sometimes referred to as “oilgae”. Its production is supposed to be low cost and high-yielding – giving up to nearly 30 times the energy per unit area as can be realized from current, conventional ‘first-generation’ biofuel feedstocks.

Biofuel: Ethanol

Ethanol (CH3CH2OH) is an alcohol fuel made from the sugars found in grains such as corn sorghum, barley and in plant products such as potato skins, rice, sugar cane, sugar beets, yard clippings, bark and switchgrass. Ethanol can be produced by a process called gasification. Gasification systems use high temperatures and a low-oxygen environment to convert biomass into synthesis gas, a mixture of hydrogen and carbon monoxide. The synthesis gas, or "syngas," can then be chemically converted into ethanol and other fuels. Ethanol is used in special engine by mixing with petrol and is called Gasohol (70-90% petrol and 10-30% ethanol). Currently, a blend of 10% ethanol and 90% gasoline called E10 is approved for use in all vehicle. E10 was previously called Gasohol.Unknown Object. Ethanol is generally used as a blending agent to increase octane adn cut down carbon monoxide and other smog-causing emissions. Unknown Object

E10 was introduced into the German Market in 2011 following the EU guidelines of enviornmental protectiona and reduce dependency on fossil fuels. However E10 has received a lot of criticism in the market. The high water content in E10 is corrosive on metals ,mostly to aluminium. E 10 is also supposed to increase petrol consumption by 2%. Moroever , there is also a food vs fuel debate where people argue that producing E10 could lead to rising food prices. A counter arguement could be that E10 is eco friendly and reduces our dependence on fossil

fuels.Ethanol may be considered to be carbon-neutral because the plants that are used to make fuel ethanol (such as corn and sugarcane) absorb CO2as they grow and may offset the CO2produced when ethanol is made and burned.

Energy Content 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.
- Most biofuels are at least as energy dense as coal, but produce less carbon dioxide when burned.
- The lower energy content of biofuels means vehicles travel shorter distances on the same amount of fuel. This has to be taken into account when considering emissions.

Air and Water Concerns with Biofuels

- Biofuels burn cleaner than fossil fuels, resulting in fewer tailpipe emissions of greenhouse gases, particulate emissions, and substances that cause acid rain such as sulfur.
- Biofuel production uses anywhere from 2 to 84 times as much water as fossil fuel production. Water use can be mitigated by planting crops that do not require irrigation.
- When the entire life cycle of a biofuel is considered, it may actually generate more greenhouse gases than fossil fuel. The following comparison of various fuel sources by gram of carbon dioxide produced per megajoule of energy produced. Note that the ranges provided for biofuels result from the location in which the feedstock is grown. For instance, sugarcane grown in Brazil as far less impact than sugarcane grown in South Africa.

    - Coal - 112
    - Gasoline - 85
    - Diesel fuel - 86
    - Natural gas - 62
    - Biofuel made from sugar cane 18-107
    - Biofuel made from wheat 58 - 98
    - Biofuel made from corn 49-103

- Biodiesel is sulfur free, but contains nitrates that contribute to acid rain.
- Biodiesel has fewer polycyclic aromatic hydrocarbons, which have been linked to cancer.

Land Use and Biofuels

- The amount of land required to meet the world's energy needs using biofuels is a major concern. Depending on the feedstock, the requirements can be massive. The following numbers reflect the amount of land that would be needed to meet the requirements of just the global aviation industry.

    - Jatropha would need to be planted over 2.7 million square kilometers. That is an area roughly 1/3 the size of Australia.
    - Camelina would require an area of 2 million square kilometers.
    - Algae would need 68,000 square kilometers to meet the needs of the aviation industry. That is an area roughly the size of all of Ireland.
    - The aviation industry accounts for only 13% of all fuel consumption, so the values above would need to be increased 10-fold to encompass global fuel demand.
        - Jatraopha would need to be planted over 27 million square kilometers just to meet all fuel demands. An area that vast would cover all of Russia and the United States and still need a little more room.
        - Algae would require an area of 680,000 square kilometers, or all of France plus some.

- There is not enough land currently in use to meet fuel needs. That means forested areas would need to be cleared. This would release vast amounts of carbon and create a carbon debt that could take centuries to repay.
- The impacts of biofuels on greenhouse gas emissions were originally measured by considering only direct land use changes. When indirect land-use changes were considered, the green house gas savings from biofuels increased as follows (note that negative and positive values are in comparison to current fossil fuels):

- Corn ethanol – From -20% to +93%
- Cellulosic ethanol – From -70% to +50%

Feedstock

- Everything from vegetable oil to coffee grounds to exotic plants like Jatropha can be used to produce biodiesel. As long as the plant produces triglycerides (fats and oils), it can be used to produce biodiesel.
- Bioethanol is produced from things like corn, sugarcane, and the non-edible parts of plants. The latter feedstock leads to the production of cellulosic ethanol.
- Algae can also be used to produce biofuels, including biodiesel. Algae offer a number of unique advantages and some disadvantages.

    - It is easily genetically modified to produce oil or even to produce biofuels directly. There are algae that can directly convert carbon dioxide into things like gasoline, butanol, and diesel fuel.
    - Algae can be grown on marginal land, which means they are less of a threat to the food supply than 1st and 2nd generation biofuels.
    - Some companies have demonstrated that they can produce up to 9,000 gallons of biofuel per acre using specially modified algae.
    - Algae require a great deal of water and fertilizer in order to grow. At this point, the net energy invested into producing biofuel using algae is greater than the amount of energy that can be extracted from the fuel.