BIOFUELS

What are Biofuels?

Biofuels are any fuels derived from biological organisms. The term "biofuels" is a broad term including solid energy sources such as wood and coal which may be used for heating and cooking, as well as liquid resources such as bioethanol and biodiesel which are used as alternatives to petroleum-derived gasoline or diesel in motorized vehicles.

Why Biofuels?

There are a number of pressing incentives for the using biofuels as an alternative to gasoline or diesel. Oil stocks around the world are limited and cannot be replenished, and therefore there is a need to find a renewable resource to meet the ever-increasing demand for fuel supplies all over the world. Furthermore, emissions of pollutants and greenhouse gases by vehicles using conventional fuels is an ever-urgent concern – bioethanol and biodiesel produce fewer toxic emissions and greenhouse gases than conventional fuels.[1] Over the entire production and usage life-cycle of biofuels, the impact on greenhouse gas levels is further reduced as carbon dioxide produced by their combustion is countered by the consumption of carbon dioxide by the plants from which biofuels are produced.[1,2] Currently, biofuel contributes to two percent of transportation fuels used in the USA.[3,4] Ninety-nine percent of such biofuels is bioethanol, amounting to 3.4 billion gallons,[1] while the remainder is biodiesel. The U.S. Department of Energy has set goals to replace 30 percent of the liquid petroleum transportation fuel with biofuels by 2025.[3]

Sources of Biofuels

Biodiesel is derived primarily from soybeans,[2] while bioethanol is derived mostly from starch from corn in the US or sugar cane in Brazil.[3] However, there is an increasing move towards using other sources for bioethanol, such as corn stovers (dried leaves and stalks), switchgrass and low-cost agricultural and municipal-waste products.[5, 6] These alternative raw materials contain higher levels of cellulose and hemicellulose, which are broken down into sugars and then fermented to produce bioethanol.[5] Although the actual process of digesting cellulose and hemicellulose into sugars is more difficult than breaking down corn starch, with advances in technology and chemistry, cellulosic materials are considered to have greater long-term potential as bioethanol sources due to their overall lower growth costs in land, water, fertilizer, pesticides and other production costs,[6,7] as well as greater reductions in greenhouse gas emissions.[1]

Biofuel Challenges

The use of biofuels as a replacement for conventional gasoline and petroleum is very promising. However, several factors currently make biofuels a nonviable option as a mainstream source of transportation fuels. Two of the most important challenges for biofuel production are meeting consumer demand and economic incentive. Currently the yield of bioethanol and biodiesel is relatively low – dedicating all current U.S. corn and soybean crops to biofuels would only fulfill 12 percent and 6 percent of demand in the U.S. for gasoline and diesel respectively.[2] Furthermore, current production costs for biofuels are not cost-competitive with conventional petroleum-based fuels. There are also concerns that using land and crops for biofuel production

may affect the supply of food from agriculture.[2,8] These are all issues related to production levels and process efficiency, and many scientists are working to address these challenges.

In addition to finding alternative biofuel sources, plant geneticists are working to increase the efficiency of plant photosynthesis[3] and improve growth on less fertile land.[6] This will enable plants to grow faster, allowing more frequent harvesting and greater yields. Plant scientists are also exploring ways to make cellulose easier to break down into sugars for fermentation. The breakdown of cellulose is also a focus for process engineers who are working to develop cost-effective biological, physical and chemical pretreatment methods which may make this process more efficient.[3] It has been suggested that with suitable technological advances and responsible farming, biofuels could supply about 30 percent of global demand for transportation fuels without affecting food production.[4] Further development of suitable methods and infrastructure for harvesting, storing and transporting large quantities of crops will also assist the efficiency of biofuel production.[9]

Useful Resources and Further Information

- U.S. Department of Energy: www1.eere.energy.gov/biomass/
- U.S. Department of Energy, Alternative Fuels Data Center: www.eere.energy.gov/afdc/
- National Biodiesel Board: www.biodiesel.org
- National Renewable Energy Laboratory: www.nrel.gov/biomass/
- U.S. Department of Agriculture, National Agricultural Library: http://ttic.nal.usda.gov/nal_display/index.php?info_center=6&tax_level=1&tax_subject=318
- The Bioenergy Home Page: http://calvin.biotech.wisc.edu/jeffries/

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