Biodiesel is a renewable and biodegradable fuel that can be domestically produced and manufactured from vegetable oils, animal fat/tallow, and recycled restaurant grease.

There are a number of feedstock products that can be used to make biodiesel, such as canola, sunflower seeds, palm oil, hemp, jatropha, castor, and algae. The highest potential yield (i.e., 5,000 gal. per acre) of the feedstock is algae. Biodiesel is the only alternative fuel or fuel additive that is registered under Section 211(b) of the Clean Air Act of 1990 and it significantly reduces air pollutants such as carbon monoxide, hydrocarbons, and other particulate matter. Biodiesel fuels have increased in popularity in the United States since the passage of the Energy Policy Act of 1992 and the increased cost of diesel fuel.
Biodiesel is a combination of biologically derived components, typically including restaurant oils, vegetable oil, and/or animal fat, with a varied blend of petroleum diesel. Biodiesel in technical terms is a fuel comprised of mono-alkyl ester of a long chain of fatty acids that meets the American Society of Testing and Materials (ASTM) D6751 standards. Biodiesel that meets the 11 standard specifications of the ASTM D64751 can be run in an unmodified diesel engine, and if registered with the Environmental Protection Agency (EPA), can be legally sold and distributed in the United States. The international equivalent to ASTM D64751 is EN 14214. Biodiesel should not be confused with straight vegetable oil (SVO) systems, because SVOs require significant modifications to a diesel automobile that include a heat tank and a tank for the diesel.

Production

The major ingredients for producing biodiesel include oil, methanol or ethanol, and either lye or potassium hydroxide. Biodiesel is produced by the chemical reaction of a fat with a simple alcohol (methanol or ethanol) in the process of transesterification. Transesterification is a fairly basic organic chemistry reaction where more complex fat and/or oil molecules known as triglycerides break down into simpler fat and/or oil molecules known as monoglycerides and replace one form of alcohol (glycerine) with another (methanol). The rate of the chemical reaction is sped up by the use of a catalyst. In addition to the production of biodiesel, the transesterification reaction also yields a small amount of glycerol. For example, 100 pounds of oil plus 10 pounds of methanol or ethanol will yield approximately 100 pounds of biodiesel and 10 pounds of glycerol. As a result of increased global biodiesel production, there is a surplus of glycerol and little or no market. The color of biodiesel ranges from golden to dark brown with most feedstocks. However, hemp-based biodiesel results in a green-colored fuel.

According to the report “Global Biodiesel Market (2009–2014)” by Markets and Markets in 2009, global biodiesel production was 5.1 billion gal. (worth $8.6 billion), which was a 17.9 percent increase over 2008 production levels. The biodiesel market is expected to grow to $12.6 billion by 2014. Globally, Germany is the largest producer of biodiesel, with 2.8 million tons. One limitation of biodiesel is the feedstocks available to meet the production demands. Moving away from food feedstocks will reduce the cost of biodiesel globally. Specifically, the development of algae and other existing nonfood feedstocks holds the best promise for meeting the increased production demand of biodiesel and reducing the cost. Presently, automobiles account for 70 percent of biodiesel demand. The International Air Transport Association (IATA) estimates that second-generations biodiesel will account for 6 percent of aviation fuel by 2020.

Nonfood Feedstocks for Biodiesel/Bioheat Policy and Production

There have been a number of U.S. federal and state incentive programs seeking to promote biodiesel and alternative fuels, such as the Energy Policy Act of 1992 (Public Law 102-486), which includes provisions for purchasing alternative fuel vehicles at the state and federal level. Another incentive program is the Cellulosic Biofuel Producer Tax Credit. A number of incentive programs expired in December 2011, causing concern among producers and investors. Some states have implemented biodiesel/bioheat programs, such as Vermont, Massachusetts, and Maine, as well as several major cities, such as Baltimore, Boston, and New York. Most of these programs are mandating a certain level (generally a few percent) of biodiesel/bioheat. Even though the science of nonfood feedstock biodiesel is sound, the production levels have been below expectations. For example, the U.S. Department of Energy estimated that cellulosic output would produce a billion gallons of biodiesel by 2018, which is far below the congressional mandate.
of 7 billion gallons. The reasons for the low production levels range from limited financial and governmental policy support to challenges of the production and usability of cellulosic biodiesel.

Advantages and Drawbacks of Biodiesel

There are a number of advantages to using biodiesel. Biodiesel is more viscous than diesel and it is a better lubricant for reducing fuel injection wear. Biodiesel has almost no sulfur emissions, has a higher boiling point, and low vapor pressure. Biodiesel and water do not mix (i.e., are immiscible). Biodiesel vaporizes at a lower temperature (>130 degrees Celsius, >266 degrees Fahrenheit) than diesel (64 degrees Celsius, 147 degrees Fahrenheit) and gasoline (minus 45 degrees Celsius, minus 52 degrees Fahrenheit). There are also a number of different blends of biodiesel, listed as a B followed by the percentage of biodiesel it contains. For example, a B100 blend means that it is 100 percent biodiesel and no diesel fuel. A B2 blend would have 98 percent diesel and 2 percent biodiesel, and a B20 blend would have 20 percent biodiesel. These blends enable biodiesel to be used in various diesel-operated automobiles and equipment, such as diesel-based generators, most marine vessels, and even diesel-operated all-terrain vehicles (ATV). It can also be used for heating oil with a B5 blend.

There are several drawbacks to using biodiesel, which include cold temperature issues (crystals and gelling), water in the fuel, and the breaking down of rubber gaskets and hoses in vehicles built before 1992. Cold temperatures present a couple of problems for biodiesel. In cold temperatures, biodiesel starts to form crystals, and as the temperature decreases, biodiesel begins to gel. Biodiesel gels at different temperatures depending upon the oil used for fuel as well as the mix of esters. For example, soybean-based biodiesel gels at about 32 degrees Fahrenheit, canola at about 14 degrees Fahrenheit (minus 10 degrees Celsius), and animal fat gels at around 61 degrees Fahrenheit (16 degrees Celsius). For comparison, 100 percent nonwinterized diesel fuel starts to cloud at 20 degrees Fahrenheit, with a gel point of 0 degrees Fahrenheit. There are additives that can be used in biodiesel to lower fuel crystallizing and slow down gelling. Another process involves insulating the biodiesel tank, as well as wrapping it in a heating coil. The manufacturing process can result in enough water mixing with biodiesel to lower combustion, clog the fuel system, and produce corrosion.

Bibliography


