Basic Biofuels Information Guide

Oklahoma Cooperative Extension Service

OKLAHOMA STATE UNIVERSITY EXTENSION

Biofuels In General

Biofuels of Today—Grain Crops, Oils, and Fats

- **Ethanol:** produced by fermenting sugars derived from starch.
- **Biodiesel:** produced by processing vegetable oils and animal fats.

Biofuels of the Future—Non-Grain Crops

- **Ethanol:** produced by extracting sugars from cellulosic materials.
- **Biodiesel:** produced by extracting oil from algae.
- **Biohydrogen:** produced by extracting hydrogen from biomass feedstock.

Common Biofuel Blends

E100–100% Ethanol.
E85—85% Ethanol, 15% Conventional Gasoline.
E10—10% Ethanol, 90% Conventional Gasoline.

B100—100% Biodiesel.
B20—20% Biodiesel, 80% Conventional Diesel.
B5—5% Biodiesel, 95% Conventional Diesel.

How to Find More Information:

The following websites are good sources of information to learn more about biofuels:

- www.eere.energy.gov
- www.deq.state.ok.us
- www.epa.gov
- www.biodiesel.org
- www.ethanolfacts.com
- www.afdc.energy.gov
- www.energyfuturecoalition.org
- www.nrel.gov
- bioweb.sungrant.org

Biodiesel

A renewable fuel for diesel engines derived from natural oils

Biodiesel Feedstock:

- Vegetable Oil: from soybeans, cottonseed, canola (rape seed), sunflowers, and peanuts.
- Animal-Derived Products: such as tallow, lard, poultry fat, and white and yellow grease.
- Recycled Cooking Oil and Grease: from restaurants and food processing plants.

How It's Made:

"Transesterification" – (1) The raw fat or oil is first filtered and purified to remove any foreign materials and water. (2) It is then neutralized according to its free fatty acid content. (3) Transesterification begins when alcohol and a catalyst is slowly mixed with the oil and then heated. (4) This process produces methyl esters and glycerin, which are separated. (5) Alcohol is distilled from the methyl esters for reuse, and biodiesel is the final product.

Average Biodiesel Emissions Compared to Conventional Diesel

Emission Type	B100	B20
Regulated		
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
Nitrogen Oxide	+10%	±2%
Non-Regulated		
Sulfates	-100%	-20% *

* Estimated from B100 result.
Source: U.S. Environmental Protection Agency.

Biodiesel Properties:

- Biodiesel has virtually no sulfur content.
- Biodiesel is biodegradable.
- Biodiesel provides additional lubricity benefits when blended with conventional diesel.

Ethanol—Starch Based

A renewable fuel for gasoline engines derived from the starch of cereal grains

Starch-Based Ethanol Feedstock:

- Cereal Grains: such as corn, rice, wheat, sorghum, oats, barley, and rye.
- Corn is a more widely used feedstock in the U.S.

	E100	Gasoline
Octane Level	110	84-93
Energy Content (BTU/gal)	76,330-84,530	116,090-124,340
Energy Comparison (% of gasoline energy)	66%	100%

Source: U.S. Department of Energy.

Direct Fermentation of Sugars:

Sugar crops, such as sugarcane, sugar beets, and sweet sorghum, can be pressed to extract a "fermentable juice." This juice can be taken directly into the fermentation and distillation process to produce ethanol.

How It's Made (Two Methods):

1. **"Dry Milling"**— (1) Grains are ground into a coarse flour. (2) Starch within the flour is converted to sugar with a treatment of amylase. (3) The sugar is then fermented with the use of ethanol-tolerant strains of cultured yeast. (4) Ethanol is then separated from the "mash" through the distillation process.
2. **"Wet Milling"**— (1) Grains are soaked in hot water to separate proteins and starch. (2) The grain is then coarsely ground and the germ is separated. (3) The remains are then finely ground and the fiber is separated. (4) The remaining starch and gluten are separated by hydrocyclones. (5) The starch is then processed to produce sugar, syrup, and sweeteners, or it can be used to produce ethanol.

Note: ATF regulations require that ethanol be denatured with gasoline and is therefore unfit for human consumption.

Ethanol—Cellulosic Based

A renewable fuel for gasoline engines derived from cellulosic materials

Average Ethanol Blend Emissions Compared to Conventional Gasoline

Emission Type	E85
Regulated	
Carbon Monoxide	-40%
Particulate Matter	-20%
Nitrogen Oxide	-10%
Non-Regulated	
Sulfates	-80%

Source: Oklahoma Department of Environmental Quality.

Flex Fueled Vehicles (FFV)

Flex Fueled Vehicles are vehicles capable of operating on ethanol blends up to 85% (E85). It is common for FFV owners to not realize they have this type of vehicle. Therefore, it is important for car owners to check their owner's manual, visit with a car dealer, or check the vehicle's fuel filler door to determine if they are driving a FFV.

Cellulosic-Based Ethanol Feedstock:

- Agricultural Residues and Forestry Wastes: such as corn stalks, wheat straw, and woodchips.
- Dedicated Energy Crops: such as switch-grass and miscanthus.

How It's Made (Two Methods):

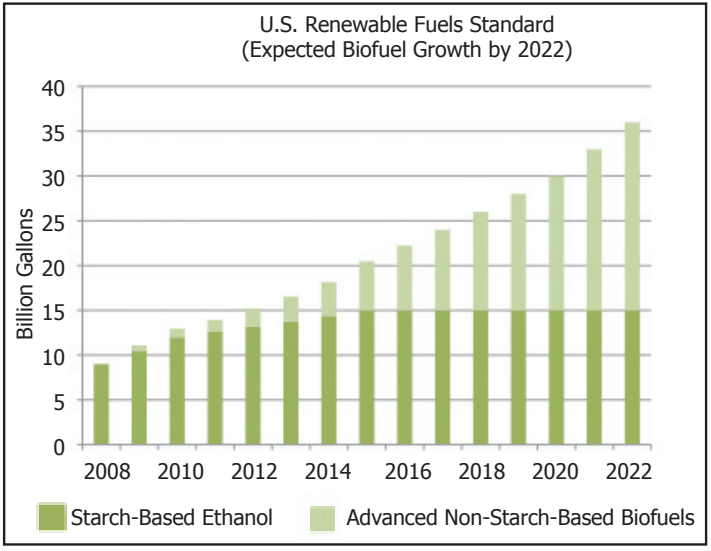
1. **"Cellulolysis"**— (1) Feedstock enters a "pretreatment" phase that prepares it for hydrolysis. (2) It is then broken down by a series of several enzymes into sugars through cellulose hydrolysis (cellulolysis). (3) The mixture then enters a microbial fermentation process to produce ethanol.
2. **"Gasification"** or **"Syngas Fermentation"**— (1) Feedstock is heated in the absence of oxygen. (2) Carbon monoxide, carbon dioxide, and hydrogen are produced, captured, and transported into a fermenter. (3) A special microorganism ingests these gases and produces ethanol. (4) The ethanol is then separated from the mixture through a distillation process.

Renewable Fuels Standard (RFS)

36 Billion Gallons of Biofuel in 2022

The Energy Independence and Security Act of 2007 amended the original RFS set by the Energy Policy Act of 2005 such that:

- RFS levels set for 2012 were increased from 7.5 billion gallons to 15.2 billion gallons; this more than doubles the original standard level.
- RFS levels started at 9 billion gallons in 2008 and will increase to 36 billion gallons in 2022.
  - 15 billion gallons from starch-based ethanol.
  - 21 billion gallons from additional sources such as biodiesel, cellulosic-based ethanol, and other advanced non-starch-based biofuels.
- Starting in 2016, starch-based ethanol production will be capped at 15 billion gallons per year.



Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Robert E. Whitson, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources and has been prepared and distributed at a cost of $2,750 for 30,000 copies. 0309 GH.