



# Overview of Biodiesel

**Instructor's Manual**

National Alternative Fuels Training Consortium



A Program of  
 West Virginia University

## Lesson 1: Energy and Environmental Concerns

### Petroleum-Based Products

In combination, diesel fuel, heating oil, and gasoline represent about 70 percent of the total product line of recovered and refined petroleum (EIA, 2004). Jet fuel takes up less than 10 percent, and to an even lesser degree, plastics, asphalt, nylon, synthetic rubber, and other chemicals are derived from petroleum (Figure 1-1). These products are just as important as the fuels that power vehicles. According to the Energy Information Administration (EIA), U.S. refinery yields in 2004 were:

- 46.8% Gasoline
- 23.9% Diesel fuel and heating oil
- 19.6% Plastics/others
- 9.7% Jet fuel

### Transportation Modes That Use Petroleum

The main petroleum-consuming sectors in the U.S. consist of transportation, industrial, and residential/commercial, with the transportation sector being the largest consumer of petroleum

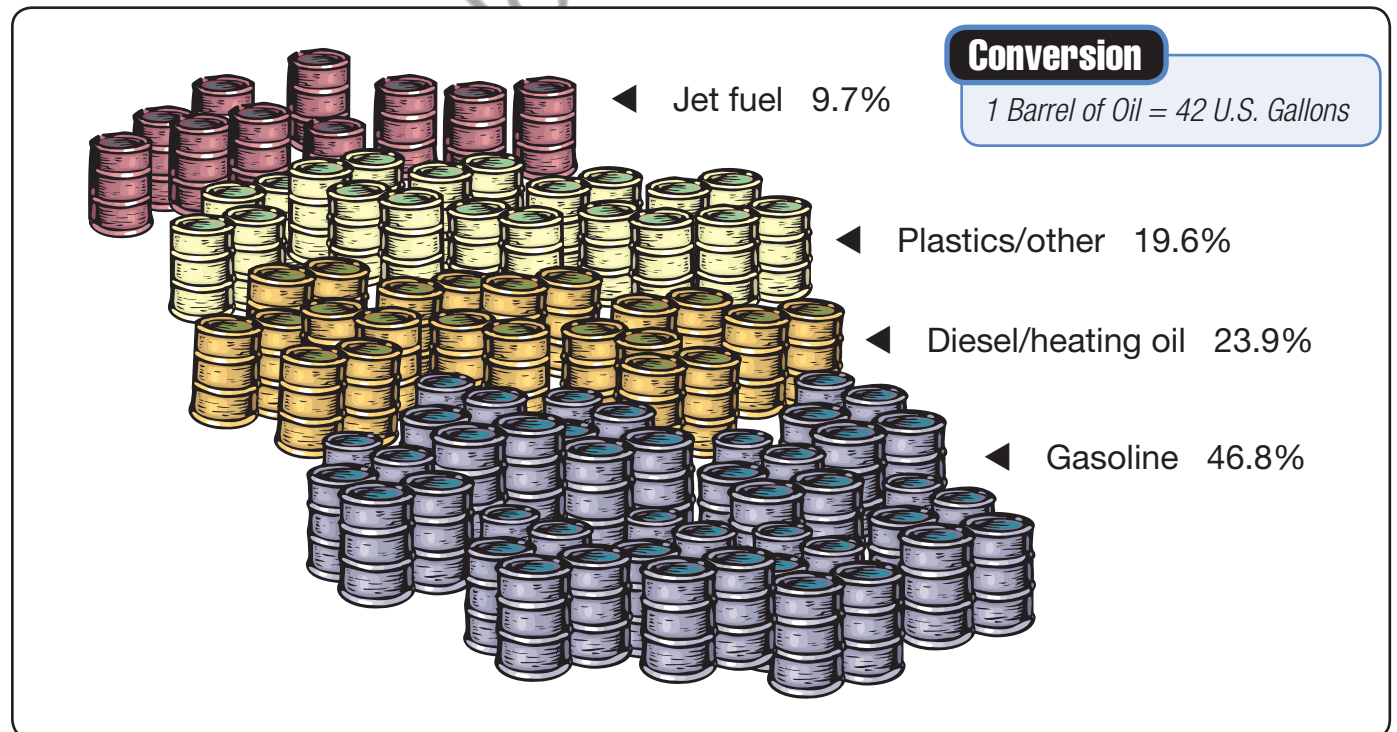


Figure 1-1: Petroleum-based products. Source: EIA (2004).

## Notes

### Lesson 3: The Nature of Lipids – First Stage in Understanding Biodiesel

#### Lesson Introduction:

*In this lesson, it is not necessary to be a chemist to understand how biodiesel is produced or used; however, it is useful to review some of the chemical principles of lipids especially, as they relate to the production process and the quality of the fuel.*

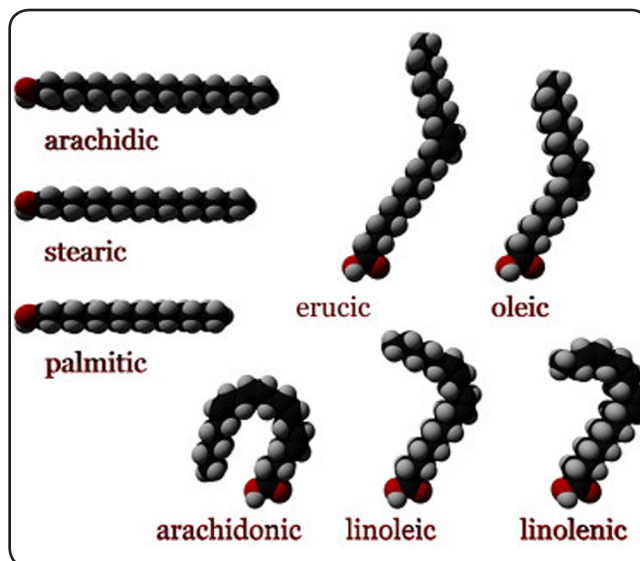
#### Lipids – Plants and Animals

Lipids are oils, fats, steroids, triglycerides, or other compounds that are used by plants and animals to store energy. All living organisms depend on foodstuffs for energy and fall into a particular place in the food chain. Plants produce food internally in a process called photosynthesis, whereas animals are dependent on external sources of food. Plants are harvested and processed into vegetables, oils, and other products. Animals are raised for meat, milk, eggs, and medicine. Lipids found in plants and animals are important for human nutritional needs and industrial purposes. In both cases, lipids are a source of energy. The three building blocks (or chemical elements) of lipids include:

- Carbon (C)
- Hydrogen (H)
- Oxygen (O).

Types of lipids vary due to the proportion of carbon to oxygen or carbon to hydrogen. In this discussion related to biodiesel, focus is paid to a particular type of lipid called triglycerides.

Triglycerides consist of a chain of three (tri-) fatty acids bonded to a molecule of glycerin.



**Figure 1-12:** Structures of saturated and unsaturated fatty acids.  
Source: Wikipedia.

## Notes

### Lesson 4: Sources of Feedstock – Where Biodiesel Comes From

*“The use of vegetable oils for engine fuels may seem insignificant today. But such oils may become in the course of time as important as the petroleum and coal tar products of the present time.”*

–Rudolf Diesel, 1912

#### **Plant and Animal Matter**

Feedstock consists of plant and animal matter not needed for nutritional purposes. It consists of any preliminary product that can be made into a fuel. Feedstock can be a waste product from food preparation, such as yellow grease, or it can be fresh, such as vegetable oil. For this reason, exhaust emissions from biodiesel carries an aroma similar to freshly made French fries or popcorn.

Many types of vegetable sources are suitable for biodiesel production such as soybean, palm, sunflower, peanut, olive, cottonseed, sesame, jojoba, linseed, avocado, and corn (Figure 1-15). Of these oils, energy content comparison (measured in BTUs) per kilocalorie/liter is negligible.

Figure 1-15 graphically depicts that of the existing U.S. feedstock supplies (greases, animal fats, other vegetable oils, and soy), there is potential to produce 1.7 billion gallons of biodiesel annually. There is potential for an additional 3.5 billion gallons of biodiesel when other sources are included (such as new animal fats, new vegetable

#### **Oil Extraction:**

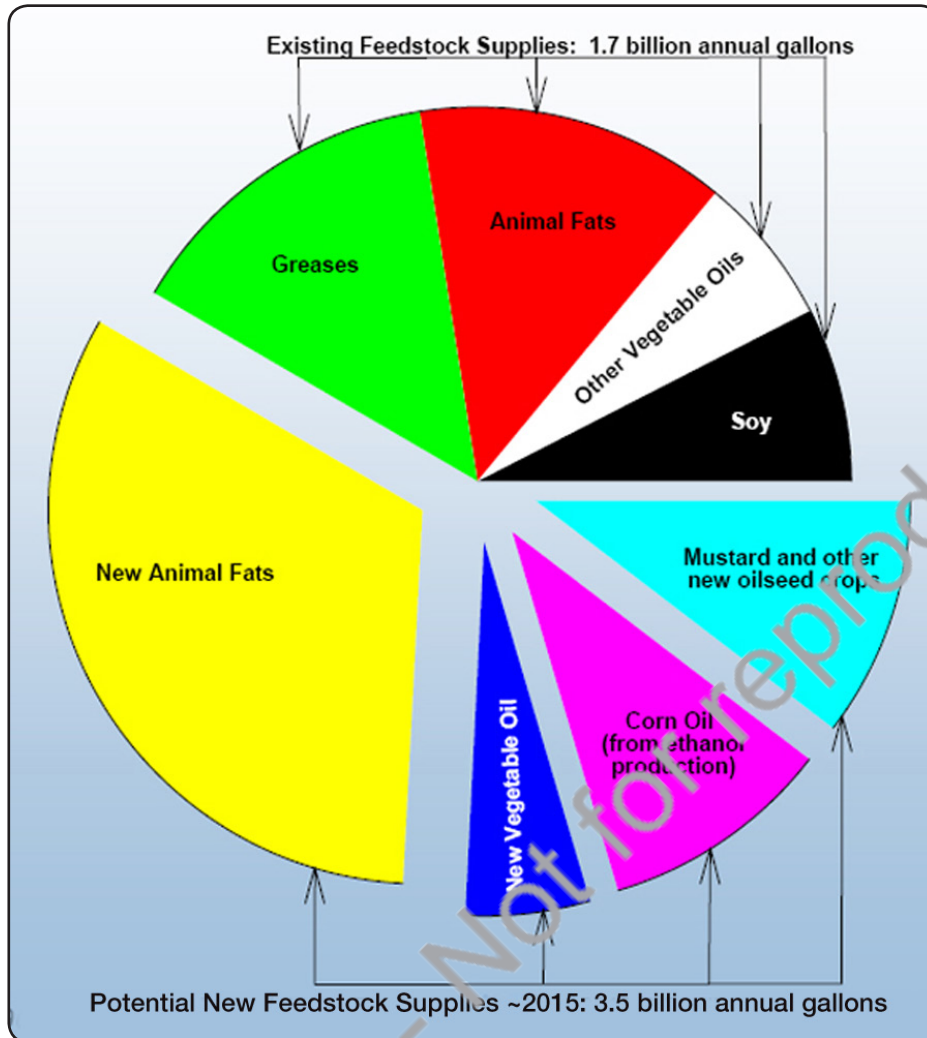
*Triglycerides are derived from the oil in the feedstock, but how is the oil produced? Seeds or beans go through a preparation process where they are first cleaned, dried, dehulled, crushed/flaked, and conditioned. From this point, there are two main methods used for oil extraction:*

- (1) **Solvent Extraction:** This process is favored for the large-scale production of biodiesel and recovers virtually all of the oil from the seed.*
- (2) **Mechanical Extraction (Expeller Extraction):** This is the preferred method for small-scale production of biodiesel and leaves about 5 to 7% of the oil in the meal. This is about one third of the total oil in soybeans.*

# Lesson 4: Sources of Feedstock-Where Biodiesel Comes From

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**Figure 1-15:** U.S. biodiesel feedstock supply.  
Source: National Renewable Energy Laboratory (NREL), 2004.

oil, corn oil, mustard, and other new oil seed crops). When the methods to produce biodiesel are refined, it is expected that U.S. feedstock could produce 10 billion gallons by 2030.

## Lesson Summary

Feedstock refers to any preliminary agriculture product that can be made into a fuel. Triglycerides are the main component in feedstock needed for the manufacturing of biodiesel. Triglycerides are derived from plant and animal products. Triglycerides can be used as a fuel; however, this practice is not recommended. Genuine biodiesel fuel must be developed during a chemical process called transesterification.