

**A Biodiesel Primer:**  
*Market & Public Policy Developments,  
Quality, Standards & Handling*

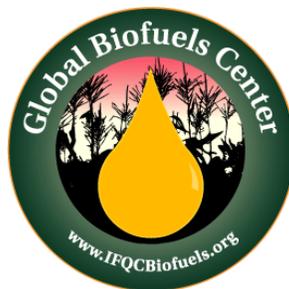
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*and*

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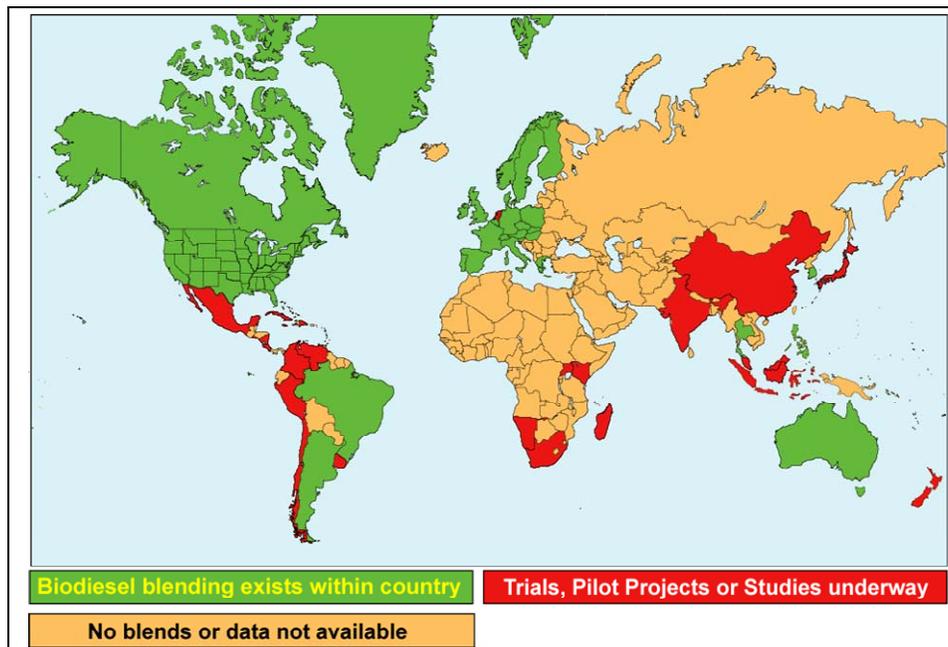
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## A. Introduction

When it comes to biodiesel, we are living in exciting times! Never before has the production and use of biodiesel captivated the interest of such a diverse range of groups, including governments around the world; biodiesel producers; auto and engine manufacturers; methanol producers; petroleum refiners; and the end users themselves to name but a few. The enthusiasm and interest in producing and using biodiesel is not limited to the United States; in fact, many countries around the world have developed or are in the process of developing biodiesel programs. Notably, many European countries have been producing and using biodiesel since the early 1990s. The figure below shows countries that are currently using biodiesel:

**Figure 1. Worldwide Use of Biodiesel, 2006**



Source: IFQC's Global Biofuels Center, November 2006.

There are many reasons, or “drivers,” behind the worldwide enthusiasm for biodiesel fuel because it viewed as:

- A mechanism for reducing dependence on imported oil and extending diesel fuel supplies. This is a major issue for many countries that are “net importers” of crude oil and/or fuel supplies.
- A more environmentally friendly alternative to diesel.
- An alternative to reduce greenhouse gas (GHG) emissions such as CO<sub>2</sub>, as well as carbon monoxide (CO), particulate matter (PM) and hydrocarbon (HC) emissions. For example, this is a major driver for the countries of Europe, which are subject to the Kyoto Protocol and thus required to reduce GHG emissions.
- Able to be used in existing diesel engines with proper care and attention.
- Compatible with the existing fuel distribution infrastructure.
- Able to help stimulate agricultural markets and reduce poverty in rural areas by providing jobs for the poor. In fact, this is the primary reason Brazil has opted to develop and

implement a national biodiesel program – to help develop the agricultural sector in the north of Brazil and provide jobs for millions of the landless poor.

The Methanol Institute and the IFQC's Global Biofuels Center have put together this brief paper to provide the reader with a better understanding of what biodiesel is and how it is produced; the role that methanol plays in the production of biodiesel; public policy initiatives that have been undertaken around the world to promote biodiesel production and use; the importance of assuring quality in biodiesel; warranty issues for diesel engines and vehicles; and, the safe handling of biodiesel and methanol.

## **B. What Is Biodiesel?**

Biodiesel is a clean-burning diesel replacement fuel that can be used in compression-ignition (CI) engines, and which is manufactured from the following renewable, non-petroleum-based sources:

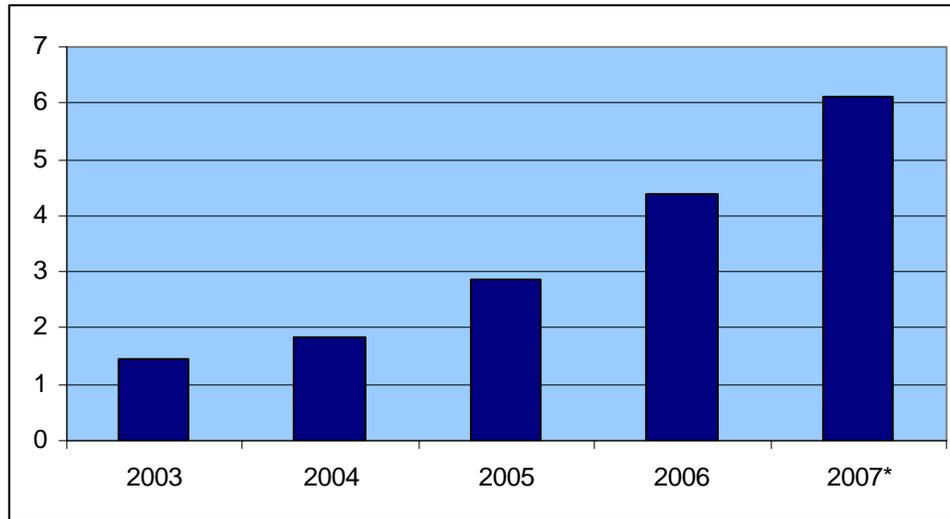
- Virgin vegetable oils such as soy, mustard, canola, rapeseed and palm oils;
- Animal fats such as poultry offal, tallow, and fish oils; and
- Used cooking oils and trap grease from restaurants.

Biodiesel is produced in pure form (100% biodiesel or B100), but is usually blended with diesel at low levels, between 2% (B2) to 20% (B20) in the U.S., but at higher levels in other parts of the world, particularly in Europe, where higher-level blends up to B100 are used. Blends of biodiesel higher than B5 require special handling and fuel management as well as vehicle equipment modifications such as the use of heaters and changing seals/gaskets that come in contact with fuel, according to the National Renewable Energy Laboratory (NREL). The level of care needed depends on the engine and vehicle manufacturer.

Experiments with biodiesel actually date back to the 1850s, even before the CI engine was invented by Rudolf Diesel. Diesel's first engine was powered by peanut oil, and he stated in a 1912 speech that, "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 petroleum and the coal-tar products of the present time." Diesel engine manufacturers altered their engines in the 1920s to accommodate the lower thickness, or viscosity, of petroleum-based diesel as compared with vegetable oils and that, combined with diesel's lower cost, effectively ended (at least temporarily) the concept of using renewable vegetable oils for diesel engines.

Though farmers around the world continued to use vegetable oils to power their equipment and machinery, biodiesel's real "revival" began in the 1990s in Europe as commercial plants opened in France, Germany, the Czech Republic, Sweden and Austria. European countries today, particularly Germany, remain the largest producers and users of biodiesel, as the following graph shows:

**Figure 2. EU Biodiesel Production, 2003-2007  
(in million metric tons)**



*Compiled by Global Biofuels Center citing United States Department of Agriculture data, July 2006.  
\*Denotes estimated production.*

While biodiesel production in the EU commenced with small-scale facilities producing less than 10,000 metric tons per annum (mtpa), the expansion in the market and the involvement of multinational organizations (some with backward integration into oilseed crushing) has resulted in plant size increasing significantly, first through 100,000 mtpa and now to 250,000 mtpa and beyond.

Biodiesel in the EU is largely derived from rapeseed with an 85% market share quoted by Fediol (the European Vegetable Oil Producers and Processors Federation). The remaining feedstocks consist of palm, soybean and sunflower oils together with a limited quantity of waste cooking oils and tallow. This is as a result of the current EN14214 biodiesel specification (discussed in more detail below), which effectively limits the amount of soybean, palm and sunflower oil feedstocks that can be utilized as a blend with rapeseed oil due to the amount of unsaturation present in the fatty acids contained in these oils and the resulting Iodine value.<sup>1</sup>

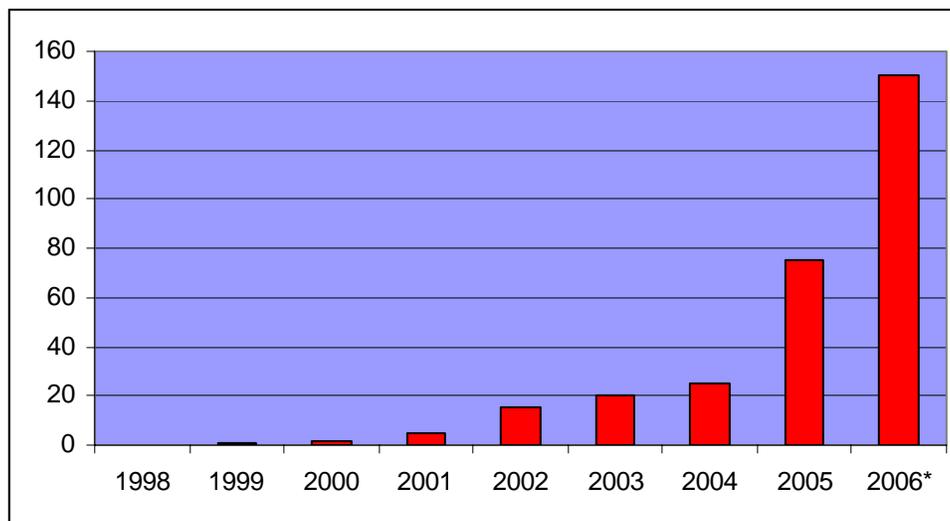
Though rapeseed oil is the current feedstock of choice for the EU biodiesel industry, the resulting competition with the food sector and indeed other traditional applications for the oil, has driven up the price. This, together with the desire of the EU Commission to take a “balanced approach” to biofuel imports expressed in its Biomass Action Plan, is likely to result in a significant increase in the use of alternate feedstocks in coming years. In December 2006, the European Parliament adopted the “Resolution on a Strategy for Biomass and Biofuels”. The main focus during the final plenary vote was the call “to introduce a mandatory and

<sup>1</sup> Iodine value is a measure of total unsaturation within a mixture of fatty materials, regardless of the relative shares of mono-, di-, tri- and polyunsaturated compounds of the biodiesel feedstock. It is expressed in grams of iodine which react with 100 mg of the respective sample. Iodine number is limited to  $\leq$  (gI<sub>2</sub>/100g) in EN14214, as discussed in more detail below. Iodine value is important because engine manufacturers have noted that fuels with high iodine numbers tend to form deposits on injector nozzles, piston rings and piston ring grooves when they are heated. See Martin Mittelbach, Ph.D. and Claudia Remschmidt, Biodiesel: The Comprehensive Handbook 127-128 (Boersedruck Ges.m.bH, Vienna 2<sup>nd</sup> Ed. 2005)

comprehensive certification scheme allowing the sustainable production of biofuels at all stages and applicable to biofuels both produced within, and imported into, the European Union.”

In comparison to Europe, the biodiesel market is still in its infancy in the United States. Consider that 800 million gallons of biodiesel was produced in Europe in 2005, much of it in Germany, but production in the U.S. in 2005 was barely 10% of this. Nevertheless, a combination of the aforementioned drivers, along with incentives provided at the state and federal level (described in more detail below), have created a boom in production and use of biodiesel in a very short period of time. Note that in 1999, biodiesel production was just 500,000 gallons, while in 2005, 75 million gallons were estimated to have been produced, according to the National Biodiesel Board (NBB).<sup>2</sup> The jump in production from 2004 to 2005 alone is striking at 25 million to 75 million gallons. That production is expected to double between the 2005 and 2006 timeframe to approximately 150 million gallons.

**Figure 3. U.S. Biodiesel Production, 1999-2006  
(in million gallons)**



Source: Compiled by the Global Biofuels Center citing National Biodiesel Board statistics.  
\*Denotes estimated production.

There are currently 116 production facilities in the U.S. and another 179 that are in the development stages, according to December 2006 estimates from the IFQC Biofuels Center. Many of these facilities produce small quantities of biodiesel (less than 1 million gallons per year), though there are a number of larger plants in the 30 million gallon range currently operating. Moreover, several larger plants in the 35-60 million gallon range are planned and the largest biodiesel plant in the country (85 million gallons) is currently under construction in Velva, North Dakota by agribusiness giant, Archer Daniels Midland (ADM). In Europe, there are more than 120 facilities in operation, with another 120 planned. Many are small plants as well, but there are several large biodiesel production facilities in operation with capacities as large as 90 million gallons (also owned and operated by ADM).

<sup>2</sup> See National Biodiesel Board, Production available at [http://biodiesel.org/pdf\\_files/fuelfactsheets/Production.PDF](http://biodiesel.org/pdf_files/fuelfactsheets/Production.PDF) (last visited Jan. 10, 2007).

### **C. Federal and State Public Policy Initiatives to Spur the Production and Use of Biodiesel in the United States**

Various agencies of the federal government as well as U.S. states have implemented many initiatives that are meant to spur the production and use of biodiesel. At the federal level, the Energy Policy Act of 1992 (EPAAct 1992), the biodiesel tax credit enacted in 2004, the U.S. Department of Agriculture's (USDA) Commodity Corporation Credit (CCC) program, and most recently, the Energy Policy Act of 2005 (EPACT 2005) are the most notable federal public policy programs to encourage biodiesel production and use. At least 31 states have also instituted a number of different initiatives as well.

#### 1. EPAAct 1992

There is no question that the EPAAct program, run by the U.S. Department of Energy (DOE) has had a profound effect on the development of the biodiesel market in the U.S.<sup>3</sup> EPAAct requires government fleet operators to use a certain percentage of alternatively fueled vehicles (AFVs). EPAAct established a goal of replacing 10% of motor fuels with non-petroleum alternatives by 2000 and increasing to 30% by the year 2010. Today, 75% of all federal vehicles purchased are required to have alternative fuel capability to set an example for the private automotive and fuel industries.

Under the Energy Conservation Reauthorization Act of 1998 (which amended Title III of the Energy Policy Act of 1992), vehicle fleets that are required to purchase AFVs (e.g., government fleets) can generate credit toward this requirement by purchasing and using biodiesel in a conventional vehicle. Since there are few cost-effective options for purchasing heavy-duty AFVs, federal and state fleet providers can meet up to 50% of their heavy-duty AFV purchase requirements with biodiesel.

The biodiesel fuel use credit allows fleets to purchase and use 450 gallons of biodiesel in vehicles in excess of 8,500 pounds gross vehicle weight instead of AFVs. Fleets must purchase and use the equivalent of 450 gallons of pure biodiesel in a minimum of a 20% blend to earn one AFV credit. Covered fleets earn 1 vehicle credit for every light-duty vehicle (LDV) AFV they acquire annually beyond their base vehicle acquisition requirements. Credits can be banked or sold. Compliance with the requirements under EPAAct 1992 is the reason why the Defense Department is the largest purchaser of biodiesel in the U.S.

Note that in September 2006, DOE proposed to modify the EPAAct goal of achieving 30% utilization of replacement fuels (calculated by energy content) by 2010, extending the date to 2030. Replacement fuels include ethanol, compressed natural gas (CNG), hydrogen, electricity – and biodiesel. DOE determined based on forecast data supplied by its Energy Information Administration that the 2010 deadline could not be met, and that 2030 is a more realistic target.

Based on the EIA's latest forecast (AEO 2006), replacement fuels currently supply approximately 2.5% of the total motor fuel used in on-road motor vehicles. In one scenario, achieving the 2010 goal would require the U.S. to replace, in the next three years, over 90 million of the 130 million light-duty passenger cars on the road today with alternative fuel vehicles (AFVs) running 100% of the time on alternative fuels – clearly not achievable.

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<sup>3</sup> See U.S. Department of Energy, Energy Efficiency and Renewable Energy Office, *Energy Policy Act (EPAAct)*, <http://www1.eere.energy.gov/vehiclesandfuels/epact/> last updated Feb. 7, 2006

## 2. The Biodiesel Tax Credit

In October 2004, Congress passed a biodiesel tax incentive, structured as a federal excise tax credit, as part of the American Jobs Creation Act (JOBS Act) of 2004. The credit amounts to a penny percentage point of vegetable oil biodiesel blended with petroleum diesel (and one-half penny per cent for recycled oils). Thus, for example, blenders that blend B20 made from soy, canola and other vegetable oils would receive a 20 cent per gallon excise tax credit, while blenders of B5 would receive a 5 cent per gallon tax credit. Biodiesel made from recycled restaurant oils ("yellow grease") would receive half of this credit. For example, B20 blenders would receive a 10 cent per gallon credit; B5 blenders would receive a 2.5 cent per gallon credit.

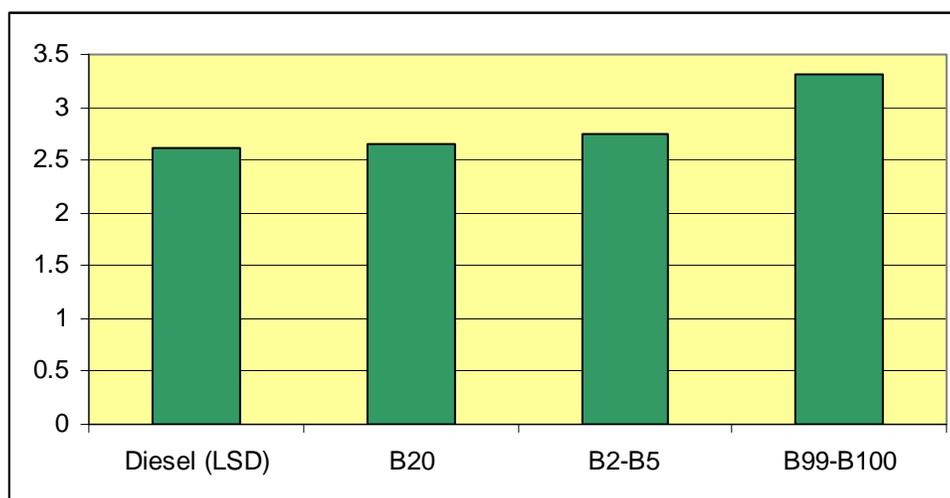
The tax incentive is taken at the blender level, generally meaning petroleum distributors, and passed on to the consumer. It is designed to lower the cost of biodiesel to consumers in both taxable and tax exempt markets. NBB expects that blenders will be driven to pass most of the savings on to consumers out of sheer competition; however some of the tax incentive may be put toward infrastructure costs. The tax credit under the JOBS Act was scheduled to expire at the end of 2006, but was extended in EPACT 2005 to the end of 2008. There were many proposals in Congress in 2006 to extend the tax credit to the end of the decade or to make it permanent, and the Global Biofuels Center expects these proposals to be renewed in the 110<sup>th</sup> Congress. In fact, on the opening day of Congress, Representatives Earl Pomeroy (D-North Dakota) and Kenny Hulshof (R-Missouri), introduced the Renewable Fuels and Energy Independence Promotion Act, which would make the federal excise tax credit for biodiesel permanent.

The current tax incentive is meant to lower the cost of biodiesel bringing it closer in line to the cost of diesel. According to DOE, this actually began to occur toward the end of 2005 as biodiesel prices for low-level blends were reported to be about the same as for regular diesel, and B20 blends are about 10 cents more per gallon than regular diesel.<sup>4</sup> B99/B100 blends (essentially pure biodiesel) were reported to have a cost of more than 50 cents per gallon more than regular. The graphics below further illustrates the point, comparing diesel prices to B20, B2-5 and B99-100.

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<sup>4</sup> See U.S. Department of Energy, *Alternative Fuel Price Report*, September 2005.

**Figure 4. Comparison of Low-Sulfur Diesel Prices, B20, B2-5 and B99-100 in October 2006 (in \$/gallon)**



Source: Compiled by IFQC's Global Biofuels Center citing data from DOE's Clean Cities Alternative Fuel Price Report, October 2006.

### 3. The USDA's Commodity Credit Corporation (CCC) Program

Another significant driver of biodiesel production and consumption is the USDA's Commodity Credit Corporation (CCC) Bioenergy program.<sup>5</sup> The program makes monies available to eligible producers of bioenergy fuel, based on the quantity of bioenergy produced during a fiscal year that exceeds the quantity of bioenergy produced during the preceding fiscal year. "Bioenergy fuel" includes ethanol *and* biodiesel. The program was suspended in June 2006 due to lack of funding, but both ethanol and biodiesel producers are pushing Congress to have the program reinstated and funded.

The payment were as follows: (1) Producers of less than 65 million gallons shall be reimbursed 1 feedstock unit for every 2.5 feedstock units of eligible commodity used for increased production; (2) Producers of more than 65 million gallons shall be reimbursed 1 feedstock unit for every 3.5 feedstock units of eligible commodity used for increased production. Approximately \$150 million was made available each fiscal year, beginning fiscal year 2003 through fiscal year 2006. In the first quarter of 2006, approximately \$4.25 million in payments were paid out to biodiesel producers for approximately 36 million gallons in production.<sup>6</sup>

CCC payments for expansion of biodiesel production in the fiscal years 2004-06 are \$1.45-\$1.47 (2002 dollars) per gallon for soybean oil biodiesel and 89-91 cents per gallon for yellow grease biodiesel. CCC payments effectively reduced the variable cost of additional soybean oil and yellow grease biodiesel to \$1.10 and 53 cents per gallon, respectively, in fiscal year 2004. In 2005, biodiesel producers in the program received more than \$32 million in payments and produced more than 50 million gallons of B100.

<sup>5</sup> See USDA Commodity Credit Corporation, *Bioenergy Program*, available at <http://www.fsa.usda.gov/FSA/webapp?area=home&subject=coop&topic=pai-be> last visited Jan. 22, 2007.

<sup>6</sup> See footnote 5.

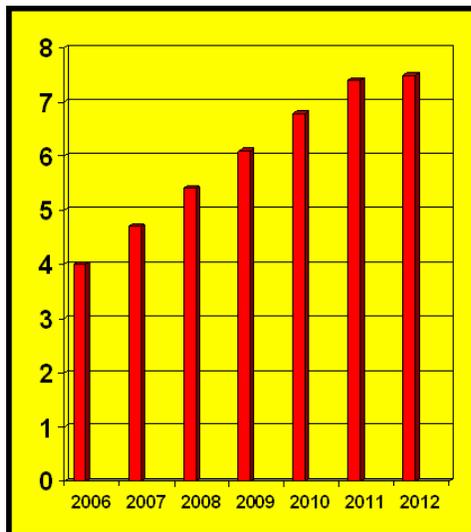
#### 4. EPACT 2005

Congress enacted the EPACT 2005 in August 2005, and included a number of provisions meant to spur the production and use of biodiesel.<sup>7</sup> In particular, EPACT 2005 provisions include biodiesel as part of the “applicable volume” in the renewable fuels standard (RFS) (discussed in the next section below). EPACT 2005 also extended the biodiesel tax credit to 2008 from 2006 and included a new tax credit for renewable diesel. These and other important biodiesel-related provisions are summarized below.

##### *i. The Renewable Fuels Standard Rulemaking*

The RFS will require a specific amount of renewable fuel, the “applicable volume” to be used in the nationwide gasoline pool. The volume would increase each year, as shown in the graphic below:

**Figure 5. U.S. Motor Fuel RFS Targets, in Billion Gallons/Year**



Source: Compiled by IFQC's Global Biofuels Center, citing EPACT 2005.

Biodiesel is most certainly a qualifying renewable fuel under the RFS program. In fact, EPA recognized that the statutory definition of biodiesel, which is a diesel fuel substitute produced from nonpetroleum renewable sources, differs from the ASTM D 6751 definition of biodiesel, which includes only esters. Thus, EPA has proposed to divide the statutory definition into two parts: ester biodiesel and non-ester renewable diesel. EPA has defined these two renewable fuels as follows:

- **Biodiesel:** 1) meets the registration requirements for fuels and fuel additives established by the EPA; 2) is a mono-alkyl ester; 3) meets ASTM specification D-6751-02a; 4) is intended for use in engines that are designed to run on conventional, petroleum-derived diesel fuel, and 5) is derived from nonpetroleum renewable resources including, but not limited to, animal wastes, including poultry fats and poultry wastes, and other waste

<sup>7</sup> U.S. House of Representatives, Committee on Energy & Commerce, Energy Policy Act of 2005 (Pub. L. 109-58) available at [http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109\\_cong\\_public\\_laws&docid=f:publ058.109](http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_public_laws&docid=f:publ058.109) last visited Jan. 22, 2007.

materials, or municipal solid waste and sludges and oils derived from wastewater and the treatment of wastewater.

- **Non-Ester Renewable Diesel:** The term “non-ester renewable diesel” means a motor vehicle fuel which: 1) meets the registration requirements for fuels and fuel additives established by EPA; 2) is not a mono-alkyl ester; 3) is intended for use in engines that are designed to run on conventional, petroleum-derived diesel fuel; and 4) is derived from nonpetroleum renewable resources including, but not limited to, animal wastes, including poultry fats and poultry wastes, and other waste materials, or municipal solid waste and sludges and oils derived from wastewater and the treatment of wastewater.

As proposed by EPA in September 2006, refiners, importers and blenders (other than oxygenate blenders) are those parties who will be responsible for complying with the RFS and must show that a required volume of renewable fuel is used, their “Renewable Volume Obligation” (RVO). The required volume will be determined by multiplying their annual gasoline production by a percentage standard specified by EPA. This means the Agency will have to take the applicable volume for a particular year, convert that to a percentage of gasoline production, and then determine a party’s individual obligation based on this percentage and the total gasoline production or import volume in a calendar year.

The percentage standards must be converted into the volume of renewable fuel applicable to each individual obligated party, for which they will be responsible for meeting through tracking their Renewable Identification Numbers (RINs). These RINs will be assigned to each batch of renewable fuel and will serve as documentation to help facilitate a credit trading program.

EPA has also proposed Equivalence Values (EVs) for renewable fuels to facilitate a credit trading program consistent with EPCRA 2005 provisions. Equivalence Values are assigned based on the renewable content of the fuel. Ethanol is assigned a value of “1” even though ethanol fuel contains 5% petroleum-based denaturants. While the methanol content of biodiesel fuel is considered to be “non-renewable,” the rounding of EVs and the placement of the various fuels into “bins” assures that the mono-alkyl esters are not penalized. Further, with its greater energy content, biodiesel fuel is assigned a value or credit of “1.5,” providing an added incentive for refiners to sell biodiesel fuel blends. All proposed EVs are shown in Table 1 below:

**Table 1. Proposed Equivalence Values for Some Renewable Fuels**

Renewable Fuel	Equivalence Value (EV)
Cellulosic biomass ethanol or waste-derived ethanol	2.5
Ethanol from corn, starches, sugar	1.0
Biodiesel (ester)	1.5
Non-ester renewable diesel	1.7
Butanol	1.3
ETBE from corn ethanol	0.4

*Source: EPA RFS Proposal, page 51.*

The Methanol Institute submitted comments to the Agency on the RFS rulemaking, and in August 2006, held a conference call meeting with key officials from EPA preparing the rulemaking to discuss the significant role methanol plays in the biodiesel fuel production process. In comments to EPA on the proposed rulemaking, MI stated, “MI is pleased with the fair treatment that EPA has given to methanol with respect to the Equivalence Value assigned to mono-alkyl ester biodiesel and the rounding of Equivalence Values to create a “level playing

field” for biodiesel fuel produced using alcohol feedstocks.” The MI comments also urged EPA to add renewable methanol to its listing of renewable feedstocks.

The RFS rulemaking is expected to be finalized and released by EPA in March 2007.

*ii. Tax Incentives for Small Agri-Biodiesel Producers, EPACT Sec. 1345*

The legislation created a new tax credit for small agri-biodiesel producers with production capacity not in excess of 60 million gallons of 10 cents per gallon for the first 15 million gallons of agri-biodiesel produced.

*iii. Renewable Diesel, EPACT Sec. 1346*

This provision clarified that renewable diesel is to receive the same tax treatment as biodiesel under the tax code, thus it will receive \$1.00/gallon credit. “Renewable diesel” is defined as diesel fuel derived from biomass using a thermal depolymerization process that meets EPA’s fuels and fuel additive registration process and meets the ASTM standard for diesel, D 975, or for fuel oils, D 396. This provision is effective with respect to fuel sold or used after December 31, 2005.

Notably, there is very little renewable diesel produced in the U.S. right now; however, there are several plants under construction in Europe and several companies are looking to commercialize new technologies to produce renewable diesel using the same, if not more, renewable feedstocks as biodiesel. The main difference is that several of these renewable diesel technologies do not use the transesterification process; rather, many “hydrotreat” the feedstock, reacting it with hydrogen to produce a renewable diesel fuel.

5. Other Incentive Programs Offered at the Federal and State Levels

Aside from these incentives, both federal and state governments offer a broad range of other incentives to spur the production and use of biodiesel. The federal government offers several such programs, but not as many as are offered for ethanol. These programs are summarized in the table below.

**Table 2. Other Federal Incentives Meant to Spur Biodiesel Production and Use**

Federal Agency that Administers/ Oversees	Type of Incentive	Who Receives Incentive	Commonly Known As	Summary
IRS	Income Tax Credit	Infrastructure Providers	Alternative Fuel Infrastructure Credit	Provides a tax credit in an amount equal to 30% of the cost of any qualified AFV refueling property placed into service in the U.S. – which includes E85 and 20% or more biodiesel mixtures (B20). The credit cannot exceed \$30,000 subject to an allowance for depreciation and \$1,000 in any other case. The tax credit does not apply to residences, and expires after December 31, 2009.

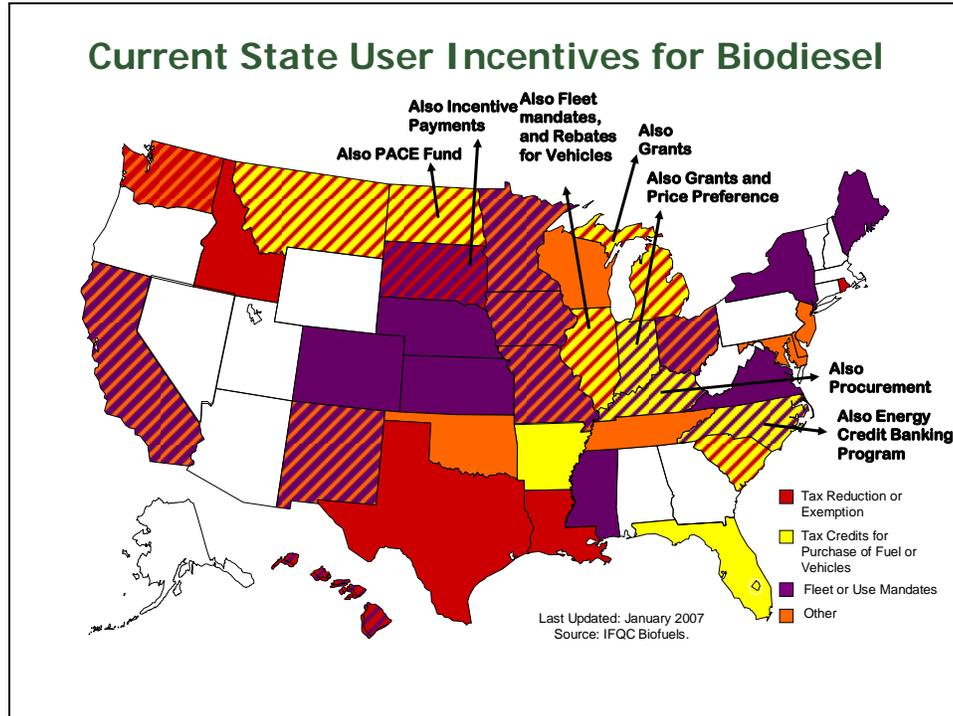
Federal Agency that Administers/ Oversees	Type of Incentive	Who Receives Incentive	Commonly Known As	Summary
Environmental Protection Program (EPA)	Grant Program	School Districts	Clean School Bus Program	Clean School Bus USA reduces operating costs and children's exposure to harmful diesel exhaust by limiting bus idling, implementing pollution reduction technology, improving route logistics, and switching to biodiesel. In fiscal year 2005, the program offered \$7.5 million in cost-shared grants to help school districts upgrade their diesel fleets. The Energy Bill of 2005 utilizes this EPA program to grant up to 50% cost share (depending on the age and emissions of original bus) to replace school buses with ones that operate on alternative fuels or low-sulfur diesel, or up to 100% for retrofit projects. \$55 million are authorized for both 2006 and 2007, and "such sums as necessary" for 2008-2010.
USDA	Grant Program	Ag Producers & Small Businesses	Renewable Energy Systems and Energy Efficiency Improvements Grant	In fiscal year 2005, the U.S. Department of Agriculture Office of Rural Development made available \$22.8 million in competitive grant funds and guaranteed loans for the purchase of renewable energy systems and energy improvements for agricultural producers and small rural businesses. The project must occur in a rural area and implement precommercial or commercially available and replicable technology. Research and development does not qualify. The applicant must provide at least 75% of eligible project costs, and grant assistance to a single individual or entity cannot exceed \$750,000. Eligible projects include biofuels, hydrogen, and energy efficiency improvements, as well as solar, geothermal, and wind.

Source: Compiled by the Global Biofuels Center, 2005.

Many states are following the federal government's lead and are offering similar programs and incentives to spur biodiesel production and use. First, the state of Minnesota has mandated the use of B2 in all diesel fuel; while Illinois requires it for fleets. In 2006, Iowa, Washington and Louisiana enacted legislation to require biodiesel within the next year or so. California Governor Arnold Schwarzenegger issued an Executive Order to produce and use a minimum of 20% biofuels within the state by 2010, 40% by 2020 and 75% by 2050.

More than 25 states provide either user or producer incentives for biodiesel. Several provide both types of incentives and include: Pennsylvania, North Carolina, Illinois, Indiana, Texas, North Dakota and Minnesota. A handful of states, approximately nine at this time, provide incentives to biodiesel producers to build facilities in their states, typically offering tax credits, grants and other financial incentives. Most biodiesel user incentives typically fall into the following categories: tax exemptions, tax reductions/deductions; tax credits for the purchase of AFVs or biodiesel; and, fleet mandates. Two states provide fuel rebate programs, and two provide revolving funds for fleet biodiesel purchases. The figure below summarizes state incentives for biodiesel users.

Figure 6. Summary of State Incentives Meant to Spur Biodiesel Use



Source: Compiled by the Global Biofuels Center, January 2007.

#### D. International Biodiesel Developments and Public Policy Initiatives

Other countries have also instituted public policy initiatives to encourage biodiesel production and use, and have done so generally through a combination of fiscal incentives and mandates or voluntary targets, as the chart below shows:

Table 3. Biodiesel Initiatives in Other Countries

Country	Initiative	Fiscal Incentives	Primary Feedstock
Argentina	Legislation enacted in 2006 would require 5% mandatory use of biodiesel and ethanol three years after enactment	Yes, total tax exemptions for biodiesel from excise duty, sales and income taxes for 15 years	Soy
Australia	Biofuels Action Plan: 350 million liters (92 million gallons) target by 2010	Yes	Looking at all options
Bolivia	Government looking at implementing a B2 blend by 2007, increasing to B20 by 2015	Not at this time	Likely palm
Brazil	Voluntary B2 program becomes mandatory in 2008; B5 by 2013	Yes	Soy, mamouna, palm, babassu (nut), tallow, dende palm, sunflower

Country	Initiative	Fiscal Incentives	Primary Feedstock
Canada	Proposed Renewable Fuels Standard – 2	Yes, excise tax exemptions offered by some provinces	Tallow, yellow grease, fish oil, canola
Europe	Biofuels Directive: Voluntary targets require 2% by energy content penetration of biofuels into the gasoline and diesel pools by 2005; 5.75% by 2010	Yes, a number of members states offer excise tax exemptions or reductions to support biofuels' introduction.	Rapeseed
Indonesia	Biofuel consumption to reach 2 vol% total fuels by 2010; 5% by 2025	Not at this time	Palm oil
Malaysia	"National Biofuels Policy"; looking to implement B5 program	Not at this time	Palm oil
New Zealand	Voluntary target of 65 million liters (17 million gallons) by 2012	Not at this time	Tallow
Panama	Government looking at implementing a B2 blend by 2007, increasing to B20 by 2015	Not at this time	Palm, mustard seed, vegetable oils
Thailand	B5 by 2007, B10 by 2010	Yes	Palm
Uruguay	B2 in 2008, increasing to B5 in 2015	Yes	Animal fats and vegetable oils

Source: Global Biofuels Center, December 2006.

Several of these initiatives are summarized in more depth as follows:

- Argentina:** Currently, there are approximately 10 plants with a total production capacity of 60,000 tons per year (68 million liters/year or 18 million gallons/year). There is also a tax incentive structured wherein biodiesel producers will receive a 15-year exemption from the country's 15 cents per liter diesel tax, as well as exemptions from the country's gross receipts, income and property taxes, subject to meeting certain requirements. A B5 requirement or mandate for both gasoline and diesel was enacted in 2006.
- Australia:** The country has established a goal for renewable fuels to contribute at least 350 million liters to the total fuel supply by 2010, which represents some 1 vol% of the combined transport fuel pool. However, the Australian biofuels industry has faced some market barriers including low-consumer confidence and high-commercial risk. Still, oil companies have indicated that they are prepared to work with the government to ensure that the target is reached. As a result of initiatives to be undertaken by government and industry, the Australian government and its Biofuels Taskforce predict that biodiesel production capacity will increase substantially in the period to 2010.
- Brazil:** In December 2004, Brazil officially launched its National Biodiesel Program, which introduced biodiesel into the domestic market beginning in 2005. The Program aims to reduce the country's diesel imports while stimulating the domestic agricultural industry that will produce the plant sources needed to make the fuel. In January 2005, Brazilian lawmakers passed LEI No. 11.097, a law that authorizes the voluntary sale of biodiesel fuel for the next three years with a mandatory B2 content starting January 2008; in 2013, B5 will be required. The voluntary program is expected to create 840 million liters/year (221 million gallons) market for biodiesel until the B2 program becomes mandatory in 2008. In 2008, a 1 billion liters/year (264 million gallons) market will be created, according to Agencia Nacional do Petroleo (ANP), which is administering the

program. The program is also expected create employment for 65,000 small farm families.

- **Canada:** The government will propose a regulation within the next year to require 2% renewable fuel content in diesel and heating oil “upon successful demonstration of renewable diesel fuel use under the range of Canadian conditions.” Such requirement would not be in place by 2010, but is intended to start no later than 2012. Still, there is at this time very little biodiesel produced in Canada, at less than 100 million liters. The federal government has stated that before biodiesel can become commercially viable more R&D must be done to make its production cost-effective and address the cold flow issues that biodiesel presents.<sup>8</sup> However, it is the high cost of production that remains the greatest obstacle to market penetration for biodiesel in blends or as a pure fuel. Still, the interest in biodiesel exists and the government has created a Biodiesel Initiative to overcome barriers to the wide-scale commercialization of biodiesel in the country.
- **European Union:** The policy framework for the development of a biofuels market in the European Union (EU) is Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport.<sup>9</sup> This Directive sets a voluntary target of 2% biofuel consumption (by energy content) in 2005 rising by 0.75% per year, culminating in a target of 5.75% (also by energy content) in 2010, and includes both ethanol and biodiesel. From a regional perspective the EU as a whole is still far from meeting its 2 vol% (by energy content) consumption target by 2005, even though some of its member states (namely, Germany, France and Italy) are some of the largest biodiesel producers and users in the world.

At the opening of International GreenWeek in Berlin in January 2007, José Manuel Barroso, President of the European Union, announced the start of a “low carbon revolution which the European Union hopes to stimulate through its integrated European energy policy.” The European Commission submitted a series of proposals for a “unilateral” 20% reduction in greenhouse gas emissions by 2020 from 1990 levels, in an effort to reduce the EU’s dependence on imported oil and trigger a new “industrial revolution.” While members of the 27-nation block can determine which combination of renewable technologies to deploy for heating, power and transport, the energy strategy includes a “hard target” of 10% of vehicle fuels coming from biofuels. Given the fact that ethanol plays such a small role in Europe, this is largely seen as a biodiesel mandate.

European biodiesel producers had hoped for an even higher limit. According to Raffaello Garofalo, secretary–general of the European Biodiesel Board, “We are disappointed. Our industry is already producing biodiesel in large quantities in France and Germany, in some cases more than 5% (of total transport fuel demand).” Also at GreenWeek, Europe’s largest food and agriculture exhibition, EU Agriculture Commissioner Mariann Fischer Boel commented that the production of bioenergy could create up to 300,000 new jobs throughout Europe, mainly in rural districts. Next week, the foreign affairs ministers council will hold its first discussion of the Commission’s

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<sup>8</sup> See Natural Resources Canada, Research, *available at* <http://oee.nrcan.gc.ca/transportation/fuels/biodiesel/biodiesel.cfm?attr=8> (last updated Oct. 26, 2006); see also Canadian Renewable Fuels Association, Biodiesel in Canada, *available at* <http://www.greenfuels.org/biodiesel/world.htm#d> (last updated Mar. 30, 2006).

<sup>9</sup> DIRECTIVE 2003/30/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport *available at* [europa.eu.int/eur-lex/pri/en/oj/dat/2003/l\\_123/l\\_12320030517en00420046.pdf](http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_123/l_12320030517en00420046.pdf) (last visited Jan. 22, 2007).

energy package, and an EU summit to adopt the action plan and launch the Common European Energy Policy will be held in March.

An emerging theme in the EU is concerned with the cost of maintaining fiscal incentives to support biofuels. This has resulted in certain countries such as Austria, France, Slovenia, Hungary, Germany and UK introducing mandates that require a given percentage of transport fuels to be substituted with biofuels. Sweden and the Netherlands are considering similar schemes as well. A brief summary of member state developments are shown in the table below.

**Table 4. Biofuels Developments in Major European Biodiesel Producer/User Countries**

Country	National Biofuel Targets	Mandatory (M) / Voluntary (V)
<b>Austria</b>	Since 1 October 2005: 2.5 % (by energy content) From 1 October 2007: 4.3% From October 1 2008: 5.75%	M
<b>France</b>	Obligation for fuel suppliers, under a tax for not complying with biofuel incorporation (TGAP). 2006: 1.75% 2007: 3.50% 2008: 5.75% 2010: 7%	M
<b>Germany</b>	2005: 2% (by energy content) January 2007: Biofuels obligation 4.4% for biodiesel and 1.2% for bioethanol (by energy content) 2010: 6.75% Total Biofuels mandate	V M (2007)
<b>Italy</b>	2005: 1% (by energy content) to increase annually until 2010. A law mandating the blending of biofuels has been delayed from July 2006, to January 2007, but actually effective January 2009. The blending was to be 1% (volume) but should now be 2.5%, increasing yearly to 5% in 2010.	V M (2007)
<b>Spain</b>	2005: 2%	V
<b>Sweden</b>	2005: 3%	V
<b>The Netherlands</b>	2006: tax exemption granted to biofuels blends with max 2% by energy content, exemption proportional with % biofuels). 2007: 2% (by energy %) mandatory for both gasoline & diesel. Biofuels % to be increased gradually yearly to reach 5.75% (by energy %) by 2010.	M
<b>United Kingdom</b>	2005: 0.3% 2008/09: 2.5% (by energy content) 2009/10: 3.75% 2010/2011: 5%.	V M (2008/9)

*Note: The above listed countries account for more than 80% of the EU25's potential biodiesel market.  
Source: Global Biofuels Center, December 2006.*

- **India:** In 2003, the country's Planning Commission drafted plans to encourage the widespread planting of *Jatropha curcas* trees as a source of oilseeds for processing into biodiesel. *Jatropha* was chosen specifically as its oil is non-edible and for its tolerance to drought and ability to flourish on wasteland. It therefore does not compete with food

crops for arable land. The government plans to extend trials of B5 to commercial use by 2006/7 with B20 being introduced by 2011-2012.

- **Malaysia:** Malaysia is the world's largest producer of palm oil – although it is also a net oil and gas exporter – consuming biodiesel domestically would reduce the cost of retail fuel subsidies. In 2003, according to the Malaysian Palm Oil Board (MPOB), Malaysia exported about 92% of its palm oil production of 13.4 million metric tons. The government released its National Biofuel Policy and is looking at B5.
- **Thailand:** PTT, Thailand's national oil company, has further stated that it will introduce B5 into the market in 2007. The Biodiesel Development and Promotion Committee have approved a budget for biodiesel development and promotion for 2005-2012 of Baht 1.3 billion (US\$31.8 million).

### E. Production Process, Specifications & Quality Issues

Biodiesel is generally made when fats and oils are chemically reacted with an alcohol, typically methanol, and a catalyst, typically sodium or potassium hydroxide (i.e., lye), to produce an ester, or biodiesel. The approximate percentage proportions of the reaction are as follows in the table below:

**Table 5. Biodiesel Production Input and Output Levels**

Process Input Levels		Process Output Levels	
Input	Volume Percentage	Output	Volume Percentage
Oil or Fat	87%	Ester	86%
Alcohol	12%	Alcohol	4%
Catalyst	1%	Fertilizer	1%
		Glycerin	9%

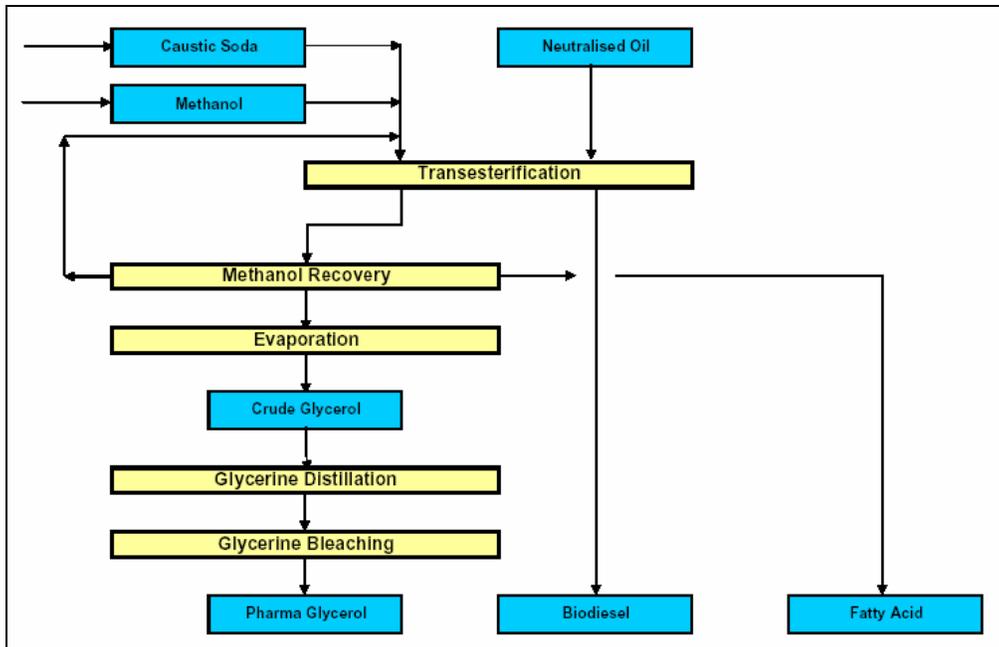
*Source: National Biodiesel Board.*

This production process is generally known as transesterification, and includes the following processes:

- Base-catalyzed transesterification of the oil with methanol.
- Direct acid-catalyzed esterification of the oil with methanol.
- Conversion of the oil to fatty acids, and then to alkyl esters with acid catalysis.

The basic production process is summarized in the figure below.

**Figure 7. The Biodiesel Production Process**



Source: MAN Ferrostaal.

Excess methanol is used to ensure the process is driven to completion. The basic formula is as follows:

**Figure 8. Biodiesel Production Formula**

$$100 \text{ pounds of oil} + 20 \text{ pounds of methanol} = 100 \text{ pounds of biodiesel} + 10 \text{ pounds of glycerol} + 10 \text{ pounds of methanol}$$

Source: Methanol Institute.

Since biodiesel is less dense than the glycerol, it floats on top of the glycerol and may be pumped off, or the glycerol can be drained off the bottom. Residual methanol from this reaction is typically removed after the biodiesel and glycerin have been separated, to prevent the reaction from reversing itself. The methanol is cleaned and recycled back to the beginning of the process. Glycerol (used in pharmaceuticals and cosmetics, among other markets) and fertilizer materials are produced as co-products.

Biodiesel IS NOT raw or refined vegetable oils that are unprocessed and should NOT be used as biodiesel fuel. According to the National Renewable Energy Laboratory (NREL), raw or unrefined vegetable oils and greases used in CI engines at levels as low as 10% can cause problems including long-term engine deposits, ring sticking, lube oil gelling, which can reduce the engine's useful life.<sup>9</sup> These problems generally stem from these oils' greater thickness, or viscosity, compared to that of typical diesel fuels for which the engines were designed. These problems are avoided through the refinement of these oils in the biodiesel production process.

### 1. Quality Specifications

<sup>9</sup> National Renewable Energy Laboratory, *2006 Biodiesel Handling & Use Guidelines*, DOE/GO-102006-2288 (Mar. 2006) available at <http://www.nrel.gov/vehiclesandfuels/npbf/pdfs/39451.pdf>.

Specifications for biodiesel have been implemented in several countries around the world, most notably in the U.S., through the American Society of Testing and Materials (ASTM), and in Europe through the European Committee for Standardization (CEN). The relevant committees of these groups that oversee fuel specification development, including standards for biodiesel, are comprised of automobile and engine manufacturers, refining companies, biofuel producers, government entities and other fuel users who agree by consensus on specifications to help ensure good quality fuels for safe and satisfactory operation of vehicles and engines.

In the U.S., the ASTM specification for biodiesel is ASTM D 6751; for the EU, EN 14214. The ASTM specification defines biodiesel as a fuel comprised of mono-alkyl esters of long-chain fatty acids derived from vegetable oils or animal fats. Raw vegetable oils and animal fats that have not been processed do not meet biodiesel specifications. Moreover, the ASTM specification is for biodiesel as a blendstock for blending into diesel, and is not meant to be a specification for B100 as a stand-alone fuel. Note that ASTM standards are not laws in and of themselves; however, many states adopt ASTM standards and transpose them into law. As it pertains to the biodiesel specification, only a few have done so at this time, such as Minnesota.

In Europe, EN 14214 establishes specifications for fatty acid methyl esters for diesel engines. In contrast to ASTM D 6751, B100 that meets this standard could be used unblended in a diesel engine (if the engine has been adapted to operate on B100) or blended with diesel fuel to produce a blend in accordance with EN 590, the European diesel fuel specification. Blends up to 5% of Fatty Acid Methyl Ester (FAME) are allowed in diesel fuel defined by EN 590, which allows for B5 blends to be considered as standard diesel fuel requiring no special markings at the pump. EN 14214 is more restrictive and applies only to mono-alkyl esters made with methanol, fatty acid methyl esters (FAME). The minimum ester content is specified at 96.5%. The addition of components that are not fatty acid methyl esters – other than additives – is not allowed. The table below summarizes diesel and biodiesel specifications for both the U.S. and EU.

**Table 6. Quality Specifications for Diesel and Biodiesel in the U.S. and EU<sup>10</sup>**

Property	UNITED STATES				EUROPEAN UNION			
	ASTM D975-06a Diesel		ASTM D6751-06a Biodiesel		EN 590:2004 Diesel		EN 14214:2003 Biodiesel	
	Spec	Test Method	Spec	Test Method	Spec	Test Method	Spec	Test Method
Flash point, min	No 1D 38°C No 2D 52°C	D93	130°C	D93	55°C	EN 22719	120°C	prEN ISO 3679
Water & sediment, max	0.05% vol	D2709	0.05% vol	D2709				
Water, max					200 mg/kg	EN ISO 12937	500 mg/kg	EN ISO 12937
Total contamination, max					24 mg/kg	EN 12662	24 mg/kg	EN 12662
Distillation temperature (% vol recovered)	90%: 1D <288°C 2D 282-338°C	D86	90%: <360°C	D1160	65%: >250°C 85%: <350°C	EN ISO 3405		
Kinematic viscosity	1D 1.3-2.4 mm <sup>2</sup> /s 2D 1.9-4.1 mm <sup>2</sup> /s	D445	1.9-6.0 mm <sup>2</sup> /s	D445	2.0-4.5 mm <sup>2</sup> /s	EN ISO 3104	3.5-5.0 mm <sup>2</sup> /s	EN ISO 3104
Density					820-845 kg/m <sup>3</sup>	EN ISO 3675	860-900 kg/m <sup>3</sup>	EN ISO 3675

<sup>10</sup> See Hannu Jääskeläinen, *Biodiesel Fuel Standards*, featured on DieselNet and citing ASTM and CEN standards.

Property	UNITED STATES				EUROPEAN UNION			
	ASTM D975-06a Diesel		ASTM D6751-06a Biodiesel		EN 590:2004 Diesel		EN 14214:2003 Biodiesel	
	Spec	Test Method	Spec	Test Method	Spec	Test Method	Spec	Test Method
						EN ISO 12185		EN ISO 12185
Ester content					< 5% FAME	EN 14078	> 96.5%	EN 14103
Ash, max	0.01% wt	D482			0.01% wt	EN ISO 6245		
Sulfated Ash, max			0.020% wt	D874			0.02% wt	ISO 3987
Sulfur, max (by weight)	15 ppm	D5453 D2622	15 ppm	D5453	Two grades: 50 mg/kg 10 mg/kg	EN ISO 14596 EN ISO 8754 EN ISO 24269	10 mg/kg	prEN ISO 20846 prEN ISO 20884
Copper strip corrosion	< No 3	D130	< No 3	D130	class 1	EN ISO 2160	class 1	EN ISO 2160
Cetane number, min	40	D613	47	D613	51.0	EN ISO 5165	51.0	EN ISO 5165
Cetane index, min					46.0	EN ISO 4264		
One of: - cetane index - aromaticity	> 40 < 35% vol	D976 D1319						
PAH, max					11% wt	IP 391 EN 12916		
Operability, one of: - cloud point - LTFT/CFPP	Regional requirements	D2500 D4539 D6371						
Cloud point			report	D2500	Location & season dependant	EN 23015		
CFPP					Location & season dependent	EN 116	Location & season dependent	EN 116
Carbon residue, max	1D: 0.15% wt 2D: 0.35% wt	D524	0.050% wt	D4530	0.30% wt	EN ISO 10370	0.30% wt	EN ISO 10370
Acid number, max			0.80 mg KOH/g	D664			0.50 mg KOH/g	EN 14104
Oxidation stability					< 25 g/m <sup>3</sup>	EN ISO 12205	> 6.0 hrs	EN 14112
Iodine value							< 120	EN 14111
Methanol							< 0.20% wt	EN 14110
Linolenic acid methyl ester							< 12.0% wt	EN 14103
Polyunsaturated methyl esters							< 1% wt	No method specified
Monoglycerides, diglycerides & triglycerides							MG <0.8% wt DG <0.2% wt TG <0.2% wt	EN 14105
Group I metals (Na + K)			5 ppm max	UOP 391			< 5.0 mg/kg	EN 14108 EN 14109
Group II metals (Ca + Mg)			5 ppm max	UOP 389			< 5.0 mg/kg	EN 14538
Free glycerin, max			0.020% wt	D6584			0.02% wt	EN 14105 EN 14106
Total glycerin, max			0.240% wt	D6584			0.25% wt	EN 14105
Phosphorous, max			0.001% wt	D4951			10 mg/kg	EN 14107
Lubricity	< 520 µm	D6079			< 460 µm	ISO 12156-1		

Source: DieselNet, citing ASTM and CEN standards.

The table below explains the purpose and importance of the ASTM specifications in D 6751.

**Table 7. ASTM Specifications and Their Importance**

Property & Units	Purpose	Importance
Flash point	Fire safety	B100 flash point is typically higher than diesel to ensure that excess methanol has been removed.
Water and sediment	Prevent corrosion and proliferation of organisms	Set at the same level as for conventional diesel fuel. Excess water can lead to corrosion and provides an environment for the proliferation of microorganisms. Oxidation can increase sediment levels; thus, this test can be used with tests for acid number and viscosity to determine whether fuels have oxidized too much during storage.
Kinematic viscosity	Satisfactory fuel combustion	Minimum viscosity set at the same level as for conventional diesel. Allows for slightly higher viscosity than for conventional diesel fuel.
Sulfated ash	Prevent injector deposits	
Sulfur	Protect exhaust catalyst systems	Biodiesel generally contains less than 15ppm sulfur; NREL recommends ASTM D 5453 as the most appropriate test method for accurate results.
Copper strip corrosion	Indicates difficulties with bronze and copper vehicle components	Same as for conventional diesel. Generally not an issue for biodiesel.
Cetane number	Good engine performance	Conventional diesel must have a minimum cetane of 40; 47 was chosen here because this is the level identified by the U.S. Conference of Weights and Measures as premium diesel and also because 47 is the lowest level found in biodiesel produced and used in the U.S.
Cloud point	Good performance in cold temperatures	A significant issue for the U.S. as biodiesels produced from different feedstocks do perform differently in different geographic and climates in the U.S.
Carbon residue	Indicates tendency of deposits to form on the engine	
Acid number	Ensuring engine deposits do not form	An indicator of free fatty acids (FFAs); acid numbers higher than 0.80 have been found to cause fuel system deposits and reduced life for fuel pumps and filters.
Free glycerin	Biodiesels that exceed these limits can cause storage tank, fuel system, engine fouling, and filter plugging.	
Total glycerin		
Phosphorus content	Prevent damage of catalytic converters	Phosphorus that exceeds these limits can damage catalytic converters. Some vegetable oils do contain 10 ppm or higher phosphorus; biodiesel in the U.S. typically has low phosphorus, around 1 ppm.
Distillation temperature	Incorporated to ensure that fuels have not been contaminated with high boiling materials such as used motor oil.	
Calcium and magnesium; sodium and potassium	Prevents potential negative impacts to advanced diesel exhaust aftertreatment systems, such as particulate traps.	

Source: IFQC's Global Biofuels Center, NREL, *Biodiesel Handling & Use Guidelines*, 2006.

The Engine Manufacturers Association (EMA) released test specifications for biodiesel blends of up to 20 % by volume (B20) in May 2006. These specifications are not an approved national

standard. They outline minimum requirements for fuel properties of biodiesel blends at the point of delivery of the fuel to the end user. They are primarily designed for evaluating the performance of various blends of biodiesel fuels in compression ignition engines. These specifications are for blends which use biodiesel fuel, meeting either the ASTM 6751 or EN 14214 standards, with D1 or D2 or a D1/D2 petroleum diesel fuel blend, meeting ASTM D975 standard. A detailed standards and specifications sheet is available on EMA's website at <http://www.enginemanufacturers.org/>.



Other countries have adopted biodiesel specifications also and include Canada, Brazil, Australia, New Zealand, Philippines and South Korea. Moreover, in January 2007, government leaders from across Asia and the Pacific agreed to reduce their dependence on fossil fuels and promote cleaner technologies to reduce air pollution and address greenhouse gas emissions. The Cebu Declaration of East Asian Energy Security

was signed by leaders from Philippines, Thailand, Myanmar, Indonesia, Malaysia, Singapore, Brunei, Cambodia, Laos, Vietnam, Australia, China, India, Japan, South Korea and New Zealand. The agreement calls biofuels and hydropower sources "important aspects of our national energy policies." The leaders vowed to encourage the use of biofuels and "work towards freer trade on biofuels and a standard on biofuels used in engines and motor vehicles." Currently, there is no Asia-wide standard for biodiesel fuel, which hampers trade across the vast region.

## 2. Recent Biodiesel Quality Issues

### *i. Quality Assurance in Europe*

Reports of biodiesel not meeting specifications in Europe, or "off-spec" biodiesel, are a rare occurrence. However, past surveys of B100 fuel quality by vehicle equipment manufacturers such as Bosch have highlighted relatively high instances of biodiesel being out of specification on oxidation stability and/or CFPP. As a result of such findings, a group of manufacturers and distributors of biodiesel in Germany and Austria have formed the "Arbeitsgemeinschaft Qualitätsmanagement Biodiesel e. V." (AGQM or Working group for Biodiesel Quality Assurance).

Compliance with the mandatory standard and additional voluntary quality criteria and requirements are ensured by an extensive quality management system extending from the raw material to the tank of the biodiesel customer. Of approximately 17,000 filling stations, some 1,700 sell biodiesel and of these, over 1,300 stations have adopted the AGQM quality assurance system under a brand license contract. The owners of these filling stations have pledged to comply with the standards and requirements of the AGQM. This also includes a mutual pledge that only biodiesel based on rapeseed oil methyl ester will be offered for sale at public filling stations. This is due to the fact that several vehicle manufacturers only approve rapeseed methyl ester (RME) for use in their vehicles. The pumps of the participating filling stations are marked with a special symbol showing a yellow drop in a green "Q".

*ii. ASTM B20 and B5 Standards*

There is no separate approved specification for biodiesel blends at this time, though there are proposals pending within ASTM for a B20 standard. There is also a proposal to permit 5 volume percent biodiesel blends (B5) under the current diesel specification, D 975. The current practice for biodiesel blends is to ensure that the diesel meets D 975, and the biodiesel meets D 6751 prior to blending. B20 cannot meet D 975 because it cannot meet the viscosity and distillation standards, though B5 (and lower blends) can meet D 975. Low-level biodiesel blends that meet D 975 can generally be used interchangeably with conventional diesel as long as the biodiesel itself meets D 6751 and the cold flow properties of the blend are adequate for the particular geography, climate and time of year the biodiesel is going to be used.

*iii. Quality Issues in the States*

The state of Minnesota was the first in the nation to require diesel fuels sold in the state to be blended with biodiesel at 2 vol%. The state initially had numerous quality problems since its B2 program began in September 2005, as some biodiesel produced in the state failed to meet ASTM D 6751 specification. As a result of this experience, the National Biodiesel Board (NBB) and the Minnesota Biodiesel Council (MBC) presented an action plan in January 2006 to the Minnesota Department of Commerce (MDC), the state authority charged with enforcing the B2 program, to increase quality control. The measures proposed include:

- Requiring all biodiesel producers to become accredited under the voluntary BQ-9000 quality assurance certification program established by NBB. (Accreditation under the BQ-9000 program is open to all companies actively producing, distributing or marketing, or planning to produce, distribute or market, biodiesel fuel either in its neat form or for use in blending with a petroleum diesel fuel (or similar fuel). Accreditation is awarded for two years following a successful formal review and audit of the capacity and commitment of the applicant to produce or market biodiesel fuel that meets the ASTM D 6751 specification. The accreditation process is comprehensive and includes a detailed review of the applicant's Quality System documentation, followed by a formal audit of the applicant's conformance to its System.)
- Requiring a certificate of analysis for each batch of biodiesel fuel produced; and
- Requiring stronger enforcement procedures from the MDC, including suspensions and fines for producers that sell off-spec fuel.

The quality issues in Minnesota highlight the absolute importance of ensuring that biodiesel meets specifications and what a challenge this presents to producers and blenders of biodiesel. A national fuel quality testing project, co-funded by NBB and the National Renewable Energy Laboratory, found that one-third of biodiesel samples pulled between November 2005 and July 2006 did not meet specification.

To address the quality issue, the NBB in June 2006 approved a comprehensive Fuel Quality Policy and is working with state and federal agencies with authority to regulate fuel and enforce quality.<sup>11</sup> NBB's Fuel Quality Outreach Program has made contact with all state Divisions of Weights and Measures, and encouraged them to adopt ASTM D 6751 into the laws that

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<sup>12</sup> See California Air Resources Board, Draft Advisory on Biodiesel Use, revised Nov. 14, 2006 available at [http://www.arb.ca.gov/fuels/diesel/altdiesel/111606biodsl\\_advisory.pdf](http://www.arb.ca.gov/fuels/diesel/altdiesel/111606biodsl_advisory.pdf).

<sup>11</sup> See National Biodiesel Board, *National Biodiesel Board Issues Winter Weather Advisory*, Nov. 8, 2006 available at <http://www.biodiesel.org>.

regulate fuel quality. According to NBB, half of the states have adopted the ASTM D 6751 specification as part of their fuel quality regulations, and an additional 13 states are planning to adopt the specification or are studying it. Ten states now proactively test biodiesel or biodiesel blends.

Also, the California Air Resources Board (CARB) released in November its Draft Advisory on Biodiesel Use covering biodiesel fuel characteristics, retrofitted vehicles, biodiesel blends and warranty provisions. Under CARB's diesel fuel specification regulations, biodiesel blends of less than 50% (B50) are defined as meeting the definition of diesel. Therefore, biodiesel blends of less than B50 must comply with the sulfur and aromatic specifications of the regulations.

Biodiesel blends of B50 or greater are not defined as diesel fuel and the diesel regulations do not apply to these blends. Note that when using biodiesel as a blend stock to produce complying California diesel fuel, the finished diesel fuel must meet the applicable diesel fuel specifications and, as applicable, any executive order issued for a certified diesel fuel formulation.

CARB has recommended in the draft that if biodiesel blends are used in on- and off-road diesel vehicles, portable engines and stationary engines, the following conditions should apply with respect to biodiesel fuel characteristics:

- The biodiesel portion of the blend complies with ASTM D6751 applicable for 15 ppm sulfur content;
- The diesel fuel portion of the blend complies CARB diesel fuel specifications; and
- The resulting biodiesel blend contains no more than 20% biodiesel by volume.

## **F. Warranty Issues**

The World Wide Fuel Charter (WWFC) is prepared and supported by the Alliance of Automobile Manufacturers (AAM), European Automobile Manufacturers Association (ACEA), Engine Manufacturers Association (EMA) and Japanese Automobile Manufacturers Association (JAMA).<sup>12</sup> The WWFC is a statement by the world's auto industry on the quality of fuels needed to ensure optimal operation of different types of vehicles they manufacture and that are in use around the world. Recommended specifications are provided for four different categories of gasoline and diesel fuels.

The 4<sup>th</sup> Edition of the WWFC released in September 2006 allows the addition of biodiesel at up to 5% by volume diesel fuel Categories 1-3<sup>13</sup>, and thus guarantees vehicles using biodiesel at these blends with the following caveat; for biodiesel, both EN14214 and ASTM D6751, or

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<sup>12</sup> Alliance of Automobile Manufacturers, et al., 4<sup>th</sup> edition World Wide Fuel Charter (Sept. 2006) *available at* <http://www.autoalliance.org/archives/wwfcbrochure.pdf>.

<sup>13</sup> Categories 1-3 refer to the categories of fuels quality that have been established by the WWFC for both diesel and gasoline. There are actually four categories of fuels described briefly here: Category 1: Markets with no or first level of emission control; based primarily on fundamental vehicle/engine performance and protection of emission control systems; Category 2: Markets with stringent requirements for emission control or other market demands; Category 3: Markets with advanced requirements for emission control or other market demands; Category 4: Markets with further advanced requirements for emission control to enable sophisticated NOx and particulate matter after-treatment technologies. For more information, see the World Wide Fuel Charter.

equivalent standards, should be considered. Where biodiesel is used it is recommended that fueling pumps be marked accordingly.

For Category 4 fuels, the WWFC calls for biodiesel to be none detectable (i.e., at or below detection limit of the test method used, which is specified as EN 14078). This means that automakers do not accept biodiesel in the most advanced vehicles and thus will not guarantee warranties. Automakers would reserve the right *not* to repair a vehicle under warranty if the origin of the problem was perceived to be poor or inappropriate fuel quality.

Generally, biodiesel is believed to enhance the lubricity of conventional diesel fuel and reduce exhaust emissions of PM. At the same time, engine and auto manufacturers have concerns about introducing biodiesel into the marketplace, especially at higher levels, because:

- Biodiesel may be less stable than conventional diesel fuel, so precautions are needed to avoid problems linked to the presence of oxidation products in the fuel. Some fuel injection equipment data suggest such problems may be exacerbated when biodiesel is blended with ultra-low sulfur diesel fuels.
- Biodiesel may negatively impact natural and nitrile rubber seals in fuel systems. Also, metals such as brass, bronze, copper, lead and zinc may oxidize from contact with biodiesel, thereby creating sediments. Transitioning from conventional diesel fuel to biodiesel blends may lead to an especially large increase in sediments that may plug fuel filters. Thus, fuel system parts must be specially chosen for their compatibility with biodiesel.
- Neat (100%) biodiesel fuel and high concentration biodiesel blends have demonstrated an increase in NO<sub>x</sub> exhaust emission levels. However, a new study released by NREL in late 2006 evaluated the effect of the biodiesel blend B20 on NO<sub>x</sub>, finding that the impact on NO<sub>x</sub> emissions varied depending on the engine/vehicle technology and the drive cycle ranging from 5.8% to 6.2%. The report concluded that while individual engines might show increase or decrease in NO<sub>x</sub>, on average there is no net effect. Nevertheless, this is an issue that continues to be investigated by the automobile industry, engine manufacturers, biodiesel producers, the federal government and others.
- Biodiesel fuel that comes into contact with the vehicle's shell may be able to dissolve the paint coatings used to protect external surfaces.

In Europe, some manufacturers have sanctioned the use of certain vehicles with B100 or B30 fuels, but the majority of vehicles are only approved for use with EN590 diesel, which by definition currently contains a maximum of 5% by volume of biodiesel. Automakers have raised concerns over the suggested increase in the blend limit to 10% by volume due to concerns over compatibility of such a fuel with the existing fleet and the potential for increased emissions. As regards new vehicles, automakers are not opposed in principle given that a B10 standard is established and EN14214 is reconsidered.

In the U.S., the general position of most automakers is that biodiesel blends up to 5 volume percent (and in some cases up to 20%) is acceptable as long as it meets ASTM D 6751. Moreover, the American Trucking Association, which represents the nation's trucking industry, has also approved the use of B5. Many are concerned about blends higher than 5% because of quality and stability (discussed above) and want a B20 ASTM standard. Of course, manufacturers do warrant their products against defects associated with materials and

workmanship and the use of biodiesel in and of itself does not void the warranty – this is prohibited by a federal law known as the Magnuson-Moss Warranty Act. The table below summarizes the position statements and recommendations on biodiesel usage.

**Table 8: OEM Positions and Recommendations on Biodiesel Usage**

<b>Manufacturer</b>	<b>Position</b>
Engine Manufacturers Association (EMA)	B5 acceptable if it meets D 6751.
Caterpillar	Many engines approved for B100; for others only B5 is acceptable. Must meet D 6751.
Cummins	All engines approved for B5; must meet D 6751.
DaimlerChrysler	B5 acceptable for all vehicles, but must meet D 6751.
Detroit Diesel	B20 approved for all engines/vehicles, but must meet DDC specific diesel fuel specification.
Ford	B5 acceptable for all vehicles, but must meet both D 6751 <b>and</b> EN 14214.
General Motors	B5 acceptable for all vehicles, but must meet D 6751.
International Truck and Engine	B20 acceptable for all engines, but must meet D 6751.
John Deere	B5 acceptable for all engines, but must meet D 6751.
Nissan Diesel	B5 acceptable for all engines, but must meet D 6751.
Volkswagen	B5 acceptable for all engines, but must meet fuel quality standards (D 6751 or EN 14214).
Volvo Truck Corp.	B5 acceptable for all engines.
<b>Fuel Injection Equipment Manufacturer</b>	<b>Position</b>
Bosch	B5 acceptable for all vehicles, but must meet EN 14214.
Case IH	B5 acceptable for all vehicles, but must meet EN 14214 or D 6751; B20 acceptable for certain applications.
Delphi	B5 acceptable for all vehicles, but must meet D 6751.
Kubota	B5 acceptable for all vehicles, but must meet EN 14214 or D 6751; diesel portion must meet EN 590 or ASTM D 975.
New Holland	B20 acceptable for all vehicles, but must meet D 6751.
Stanadyne	B20 acceptable for all vehicles, but must meet D 6751.

Source: Global Biofuels Center. See also, NBB, Fact Sheet: Standards & Warranties, available at [http://biodiesel.org/resources/fuelfactsheets/standards\\_and\\_warranties.shtm](http://biodiesel.org/resources/fuelfactsheets/standards_and_warranties.shtm).

## **G. The Safe Handling of Biodiesel and Methanol**

Methanol plays a critical role in the production of biodiesel. Methanol, also known as wood alcohol or methyl alcohol, is made primarily from natural gas or coal, and is also produced from renewable resources such as landfill gas and digester gas. Moreover, methanol is an essential chemical building block used to make hundreds of products that touch our daily lives, from plastics and paints, to construction materials and clothing. Strong economic growth has methanol demand increasing at a healthy 4% per year on a global basis. The emergence of biodiesel in virtually every major region in the world adds tremendous potential to the methanol picture. While starting from a small base of less than 100,000 metric tons in 2005, global methanol demand for biodiesel production could reach as much as 1.5 million metric tons by 2010.

On the supply side, the methanol industry is undergoing fundamental changes through a process of expansion and rationalization. Vast reserves of natural gas have been discovered in many parts of the world, including the Caribbean, South America and the Middle East/Africa. In some of these regions, natural gas is available at a cost of less than \$1.00 per million BTUs. New “mega-methanol” plants with production capacities of 5,000 tons per day (1.7 million tons

annually or about 600 million gallons) are being built in countries such as Trinidad and Tobago. The global methanol industry is being rapidly transformed into a dynamic chemical and fuels powerhouse that is seen as a key strategic partner to the also dynamic and burgeoning global biodiesel market.

It is true that biodiesel and methanol are biodegradable, which means that both will dissipate quickly after a spill. Biodiesel also has a high flashpoint and low volatility, so it does not ignite as easily as conventional diesel, increasing the margin of safety in its handling. Biodiesel degrades four times faster than conventional diesel and is not particularly soluble in water. It is nontoxic, so it is generally safe to handle, transport, and store. Methanol is a colorless liquid with a faint alcohol odor that is fully soluble in water and readily biodegradable in both water and soil.

Even though biodiesel and methanol are both biodegradable, extreme care and caution needs to be applied in handling them both, particularly methanol. Many individuals are buying methanol from race tracks and other suppliers to make their own biodiesel at home, but have little to no knowledge about how to handle methanol properly and how to protect themselves and others from toxic exposure to methanol. When properly contained and handled and when personnel are properly trained, methanol can be a safe and effective product for a wide range of applications, including biodiesel production. It is NOT safe to handle biodiesel or methanol without proper training and instruction from someone who is knowledgeable and qualified.

Methanol is a hazardous chemical that is highly flammable and extremely toxic to humans if ingested or if vapors are inhaled. Direct exposure to methanol should be avoided, as methanol can be harmful if swallowed, absorbed through the skin, or inhaled. Ingestion of as little as one to four ounces can cause irreversible injury to the nervous system, blindness or even death. Methanol can cause poisoning, systemic acidosis, optic nerve damage and central nervous system (CNS) effects. Methanol can also degrease the skin, which may cause dermatitis. Symptoms of acute methanol exposure may include headache, weakness, drowsiness, nausea, difficult breathing, drunkenness, eye irritation, blurred vision, loss of consciousness, and possibly death. Patients may improve and then get worse up to 30 hours later.

In addition, there are serious fire hazard concerns. Accumulations of methanol vapors in confined spaces may explode if ignited, and containers filled with methanol may rupture violently if exposed to fire or excessive heat for a prolonged duration. Methanol is flammable within a specific temperature range – between 50°F and 106°F – and will not burn below these temperatures. Methanol burns with a clear blue flame and may be very difficult to see in bright light or sunlight. Methanol could be burning and you would not be able to tell; your only indicator would be a shimmering “heat haze” or something else burning nearby.

One way to prevent a fire in the event of a methanol spill is to dilute the methanol with at least four parts water. The mixture should be contained; this creates a largest volume of liquid to clean up. Eliminate ignition sources that could cause fires, particularly oxygen and vehicles and restrict access to the spill area. Treat the situation as hazardous – it is. Install fire detection sources, such as heat sensors, infrared cameras, alarms and/or put an operator on watch trained specifically to deal with these hazardous situations.

Below are some additional guidelines to consider specifically as it pertains to the safe handling of methanol:

Safe Handling Guidelines:

- Avoid prolonged or repeated breathing of methanol vapors.
- Methanol should always be kept within closed systems or approved containers and stored in a secure space.
- Wear proper attire when handling methanol, including appropriate footwear, face shields or safety spectacles, gloves and respiratory protection. A full chemical suit, gloves with chemical resistant rubber, a canister with full face mask, and boots are strongly recommended.
- Do not smoke or permit smoking anywhere near the area where methanol is stored. Do not use torches or any ignition source near the area where methanol is stored, as even small amounts of lingering vapors in the area or in an apparently empty storage container can ignite and result in a dangerous blast and/or fire.
- If a methanol spill occurs, stop or reduce discharge of material if this can be done without risk. Isolate the spill or leak area immediately for at least 330 to 660 feet in all directions. Eliminate all sources of ignition, and stay upwind. Do not touch or walk through the spilled material.
- Prevent methanol from entering into waterways, sewers, basements or confined areas. Do NOT pour methanol down the drain. Methanol is a hazardous material and must be disposed of properly. Check with local environmental officials for instructions on how to safely dispose of methanol in your community.
- A vapor suppressing foam may be used to reduce vapors. For small spills (up to 55-gallon drum) absorb with earth, sand or other non-combustible material and transfer to containers for later disposal. For large spills, dike far ahead of liquid spill for later disposal, and follow local emergency protocol for handling.
- Spills into large natural bodies of water, such as rivers and oceans, cannot be contained. For releases into soil, surface water or groundwater, methanol has a half-life of just one to seven days, and given its high rate of biodegradation, methanol spills are not likely to persist. Again, methanol must be disposed of properly, do NOT attempt to dump methanol on the ground or in any body of water. Methanol is used extensively in the nation's wastewater treatment facilities to reverse the damaging effects of nitrate buildup in sensitive aquifers and waterways by accelerating biodegradation. As a flammable and toxic chemical, caution must be exercised to avoid contact with methanol.

#### First Aid Recommendations:

- In case of methanol contact with skin, remove contaminated clothing, wash with soap and water for 15 minutes, and seek medical attention if irritation occurs.
- If methanol comes in direct contact with eyes, immediately flush eyes with copious amounts of tepid water for at least 15 minutes. Ensure that all surfaces and crevices are flushed by lifting upper and lower eyelids. The patient should be taken to a health care facility and referral to an ophthalmologist considered.
- In case of inhalation of methanol vapors, remove individual to fresh air. Asphyxiation from vapors may require artificial respiration.
- Ingestion of methanol is life threatening. Onset of symptoms may be delayed for 18 to 24 hours after ingestion. Due to the risks of aspiration into the lungs, do NOT induce vomiting. The decision to induce vomiting should be left to a medical professional attending the victim. Transport immediately to a health care facility where standard methanol ingestion treatment can be administered. Immediate medical attention is critical!

#### **H. A Final Word: Should You Make Your Own Biodiesel?**

You certainly can make your own biodiesel – many people have for years – and now some companies offer “kits” or at-home production units to make biodiesel. The question is, should you? Following are a few points to consider:

- *In no way* should you be making your own biodiesel unless you receive proper training and instruction from a *professional* on how to store, transport and use biodiesel, methanol and other components of biodiesel (e.g., lye).
- Be wary of claims from Internet sites and Web blogs about how “easy” it is to make your own biodiesel, and be especially aware of Web “recipes” for biodiesel. *Moreover, some Internet companies will sell biodiesel kits, but do not offer any information on obtaining feedstock supplies of vegetable oils, methanol and lye and how to handle them safely.* Before purchasing a biodiesel kit, make sure you have secured access to the necessary feedstock chemicals from a reputable supplier.
- Only purchase materials from reputable suppliers. Methanol is sold in quantities ranging from 55-gallon drums to deliveries of thousands of gallons in trucks, railcars and barges. Many distributors will not ship methanol to a residential or farm address, and some require minimum orders of \$300 or more. The purchase price for methanol will vary considerably depending on the delivered quantity, location and frequency of delivery. For more information on how to purchase methanol, please contact the Methanol Institute. You may visit MI’s web site at [www.methanol.org](http://www.methanol.org), where you will find a simple on-line Methanol Source Request form on the “Biodiesel” page. Simply complete and submit the on-line form, and MI will share your request with a number of methanol producers and distributors.
- Can you assure that the quality of the biodiesel meets specifications? Many biodiesel producers have in-house labs or take other measures to ensure that the quality of the biodiesel they produce meets ASTM standards for optimal performance of diesel engines and vehicles.
- How will you store the biodiesel? Storage is another quality-related issue as biodiesel should be stored for six months or less to ensure it does not become contaminated.
- How much biodiesel will you actually use? If you use a small amount of biodiesel, it may be more cost-effective to simply purchase your biodiesel from a reputable producer or retail distributor. To find a biodiesel supplier in your area, contact the National Biodiesel Board.
- Many people want to make their own biodiesel to partake in fiscal incentives at the state and federal levels; however, these incentives are generally geared toward larger biodiesel producers and petroleum refiners and distributors that blend biodiesel.
- At what percentage will you use the biodiesel? Remember, most engine and vehicle manufacturers warrant their vehicles for use of up to B5. The use of high-level blends (B20+) and pure biodiesel, B100, should probably be avoided.

#### **I. Internet Sources to Consult for More Information**

Following is a list of sources to consult for more information on biodiesel and methanol, but note that this list is not exhaustive:

1. Alliance of Automobile Manufacturers, et al., World Wide Fuel Charter (proposed revision August 2005), <http://www.autoalliance.org>.
2. Australian Biodiesel Association (BAA), <http://www.biodiesel.org.au/>.
3. Biodiesel Association of Canada, <http://www.biodiesel-canada.org/>.
4. Centre for Jatropha Promotion (India), <http://www.jatrophaworld.org/>.
5. Engine Manufacturers Association (EMA), <http://www.enginemanufacturers.org/info/>.
6. European Biodiesel Board, <http://www.ebb-eu.org/>.
7. European Commission, New & Renewable Energies, *Biofuels for Transport*, [http://europa.eu.int/comm/energy/res/legislation/biofuels\\_en.htm](http://europa.eu.int/comm/energy/res/legislation/biofuels_en.htm).
8. European Commission, Agriculture, *An EU Strategy for Biofuels* [http://europa.eu.int/comm/agriculture/biomass/biofuel/index\\_en.htm](http://europa.eu.int/comm/agriculture/biomass/biofuel/index_en.htm).
9. The European Federation of Vegetable Oils Producers (FEDIOL), <http://www.fediol.be/>.
10. 2005 European Barometer of Renewable Energies, 5th Report, Euroserv'er, <http://www.energies-renouvelables.org/>.
11. Malaysian Palm Oil Board (MPOB), <http://www.mpob.gov.my/>.
12. Methanex Corporation, Technical Information & Safe Handling Guide for Methanol (Oct. 2002) available at [http://biodiesel.org/pdf\\_files/Methanol\\_Handling\\_Guide.pdf](http://biodiesel.org/pdf_files/Methanol_Handling_Guide.pdf).
13. Methanol Institute, Biodiesel & Methanol: Working Together available at [www.methanol.org](http://www.methanol.org) (last visited Feb. 27, 2006).
14. Methanol Institute, Methanol Emergency Response available at <http://www.methanol.org> (last visited Feb. 27, 2006).
15. Methanol Institute, Methanol Health Effects available at <http://www.methanol.org> (last visited Feb. 27, 2006).
16. National Biodiesel Board, <http://www.biodiesel.org>.
17. National Biodiesel Accreditation Program, BQ-9000, <http://www.bq-9000.org/>.
18. National Renewable Energy Laboratory, Biodiesel Publications, [http://www.nrel.gov/vehiclesandfuels/npbf/pubs\\_biodiesel.html](http://www.nrel.gov/vehiclesandfuels/npbf/pubs_biodiesel.html).
19. Department of Alternative Energy Development and Efficiency (DEDE), [http://www.dede.go.th/dede/default\\_e.asp](http://www.dede.go.th/dede/default_e.asp).

20. U.S. Department of Energy, Energy Efficiency & Renewable Energy, Alternative Fuels Data Center, *FAQs about Alternative Fuels* available at [http://www.eere.energy.gov/afdc/progs/display\\_faq.cgi?afdc/0](http://www.eere.energy.gov/afdc/progs/display_faq.cgi?afdc/0) (last visited Feb. 27, 2006).
21. U.S. Department of Agriculture, <http://www.usda.gov>.
22. U.S. Environmental Protection Agency, Renewable Fuels Program, <http://www.epa.gov/otaq/renewablefuels/index.htm>.
23. Ministry of Non-conventional Energy Sources (MNES) (India), <http://www.mnes.nic.in/>.
24. Planning Commission (India), <http://planningcommission.nic.in/>.

## J. Biodiesel Unit Conversions

The chart below provides a simple way to convert biodiesel from different units. In the U.S., biodiesel is typically expressed in gallons, while in Europe and other parts of the world, biodiesel is expressed in tons and/or cubic meters.

**Table 9. Biodiesel Unit Conversions**

Metric Tons	m <sup>3</sup>	U.S. Liquid Gallons (in millions)
1,000	1,136	0.30
880	1,000	0.26
3,333	3,788	1.00

*Source: IFQC Biofuels, 2006.*

For a biodiesel with a density of 880 kg/m<sup>3</sup> (the mid-point of the European EN14214 specification) the above table illustrates equivalent quantities of biodiesel expressed in terms of both mass and volume.

## K. More on the Methanol Institute

The Methanol Institute (MI) and its research arm, the Methanol Foundation, represent the global methanol industry. Our mission is to expand markets for the use of methanol as a chemical commodity building block, a hydrogen carrier for fuel cell applications, and an alternative fuel. MI was formed in 1989, during the height of the Clean Air Act debate, and worked to help create the highly successful reformulated gasoline program.

Today, methanol is one of the world's most widely distributed chemical commodities. As a basic building block for hundreds of chemical products, methanol is being used safely and effectively in everything from plastics and paints, to construction materials and windshield washer fluid.

The emergence of fuel cell technologies has the potential to create vast new markets for methanol as the hydrogen carrier of choice. Methanol fuel cell technologies can be used to power zero and near-zero emissions cars, buses and trucks. In the growing market for distributed power, stationary fuel cell systems for residential and commercial applications can also be fueled with methanol, particularly in rural locations that do not have access to natural gas lines. The earliest consumer markets for methanol fuel cell technology will power everything

from laptop computers and cellular phones, to lawnmowers and portable power generators.

MI is encouraging the development of several emerging markets for methanol. Wastewater treatment plants are using methanol to reduce nitrates that can literally kill small and large water bodies. Methanol is also considered a “superior” fuel for electric power turbines, providing an alternative to natural gas and distillate fuels that significantly reduces nitrogen oxide emissions.

Promoting the development of innovative technologies to produce methanol from renewable resources is a central focus of MI. Landfill methanol gas is being purified into a synthesis gas for the production of methanol at pilot plants in New Jersey and New York, and full commercial demonstrations in Ohio and elsewhere.

MI directs international efforts relating to methanol product stewardship and regulatory affairs. For example, MI formed a testing team to respond to the U.S. EPA’s High Production Volume Chemical Testing Challenge Program, completing a rigorous analysis of the health and environmental research available on methanol. This work will form the basis for a review of methanol by the international community.

Read more about the Methanol Institute at <http://www.methanol.org/> or contact the Methanol Institute at +1.703.248.3636.

#### **L. More on the IFQC’s Global Biofuels Center**

The *Global Biofuels Center* highlights and gathers all available information on biofuels globally for our members to enable them to make sound decisions based on industrywide information, experience and analysis. Our objective is to bring into one Center all relevant information from the global biofuels market for stakeholders and decisionmakers around the globe. We do not advocate any position for our members; rather, we serve as an information resource, networker and facilitator. Our members-only site, houses biofuels-related information focusing on production capacities; production/consumption; feedstocks; tax incentives and fiscal policy; specifications; and, legislative and regulatory policy for 50 countries around the world.

Read more about the *Global Biofuels Center* at <http://www.ifqcbiofuels.org> or contact Tammy Klein, Executive Director, Global Biofuels & Americas at +1.701.323.0417.