July 2004 • NREL/SR-510-36242

Subcontractor Report

Business Management for Biodiesel Producers

August 2002–January 2004

Jon Van Gerpen
Iowa State University
Ames, Iowa

National Renewable Energy Laboratory
1617 Cole Boulevard, Golden, Colorado 80401-3393
303-275-3000 • www.nrel.gov

Operated for the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
by Midwest Research Institute • Battelle

Contract No. DE-AC36-99-GO10337

July 2004 • NREL/SR-510-36242

Business Management for Biodiesel Producers

August 2002–January 2004

Jon Van Gerpen
Iowa State University
Ames, Iowa

NREL Technical Monitor: K. Shaine Tyson

Prepared under Subcontract No. ACO-2-31056-01

National Renewable Energy Laboratory
1617 Cole Boulevard, Golden, Colorado 80401-3393
303-275-3000 • www.nrel.gov

Operated for the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
by Midwest Research Institute • Battelle

Contract No. DE-AC36-99-GO10337

Available electronically at http://www.osti.gov/bridge

Available for a processing fee to U.S. Department of Energy
and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865.576.8401
fax: 865.576.5728
email: mailto:reports@adonis.osti.gov

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone: 800.553.6847
fax: 703.605.6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/ordering.htm

This publication received minimal editorial review at NREL

Printed on paper containing at least 50% wastepaper, including 20% postconsumer waste

Business Management for Biodiesel Producers

Background of Biodiesel and the Liquid Fuels Industry

Business Start-up Issues

Legal and Regulatory Issues

Operational Concerns

1. Introduction to Biodiesel

The material contained in this book is intended to provide the reader with information about biodiesel in four basic areas:

1) Biodiesel and the liquid fuels industry
2) Biodiesel business start-up issues
3) Legal and regulatory issues
4) Operational concerns

Information about production of biodiesel and maintaining quality control are covered in separate publications.

Biodiesel is an alternative fuel for diesel engines that is receiving great attention around the world. Although it attracts the most attention because it is renewable, it can be used either pure or in blends with diesel fuel in unmodified diesel engines, and it reduces some exhaust pollutants.

What is biodiesel?

Biodiesel is defined as the mono-alkyl esters of fatty acids derived from vegetable oils or animal fats. In simple terms, biodiesel is the product you get when a vegetable oil or animal fat is chemically reacted with an alcohol to produce a new compound that is known as a fatty acid alkyl ester. A catalyst such as sodium or potassium hydroxide is required. Glycerol is produced as a byproduct. The approximate proportions of the reaction are:

100 lbs of oil + 10 lbs of methanol $\rightarrow$ 100 lbs of biodiesel + 10 lbs of glycerol

Soybean oil is the most popular feedstock in the United States. Soybeans are a major U.S. crop and government subsidies may be available to make the fuel economically attractive to consumers who need or want to use a nonpetroleum-based fuel. Biodiesel from soybeans is sometimes called soydiesel, methyl soyate, or soy methyl esters (SME). In Europe, most biodiesel is made from rapeseed oil and methanol and it is known as rapeseed methyl esters (RME). The University of Idaho has done considerable work with rapeseed esters using ethanol, which produces rapeseed ethyl esters (REE). [see http://www.uidaho.edu/bae/biodiesel/]

Biodiesel can also be made from other feedstocks:

1. Other vegetable oils such as corn oil, canola (an edible variety of rapeseed) oil, cottonseed oil, mustard oil, palm oil, etc.
2. Restaurant waste oils such as frying oils
3. Animal fats such as beef tallow or pork lard
4. Trap grease (from restaurant grease traps), float grease (from waste water treatment plants), etc.

All vegetable oils and animal fats consist primarily of triglyceride molecules as shown schematically in Figure 1-1.

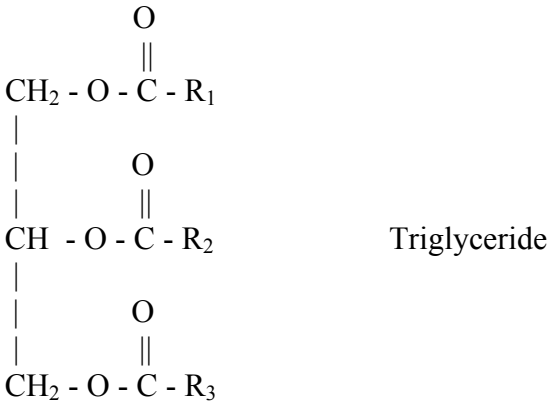


Figure 1-1. Triglyceride Molecule

In this figure, R_1, R_2, and R_3 represent the hydrocarbon chains of the fatty acid elements of the triglyceride. In their free form, the fatty acids have the configuration shown below.

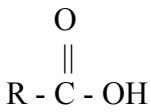


Figure1-2. Free Fatty Acid

In Figure 1-2, R is a hydrocarbon chain of greater than 10 carbon atoms.

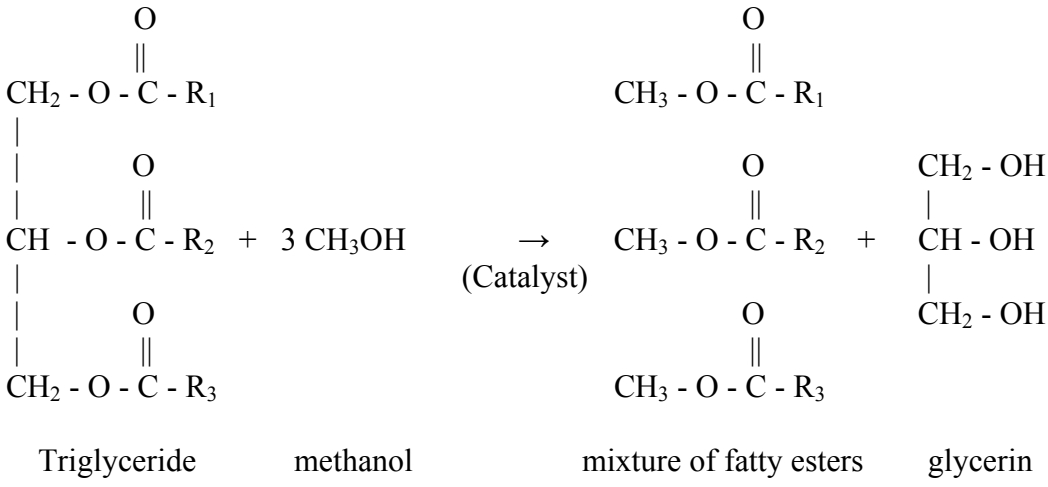


Figure 1-3. Transesterification Reaction to Make Biodiesel

Table 1-1. Composition of Various Oils and Fats.

Oil or fat	14:0	16:0	18:0	18:1	18:2	18:3	20:0	22:1
Soybean		**6-10**	**2-5**	**20-30**	**50-60**	**5-11**		
Corn	**1-2**	**8-12**	**2-5**	**19-49**	**34-62**	**trace**		
Peanut		**8-9**	**2-3**	**50-65**	**20-30**			
Olive		**9-10**	**2-3**	**73-84**	**10-12**	**trace**		
Cottonseed	**0-2**	**20-25**	**1-2**	**23-35**	**40-50**	**trace**		
Hi linoleic Safflower		**5.9**	**1.5**	**8.8**	**83.8**			
Hi Oleic Safflower		**4.8**	**1.4**	**74.1**	**19.7**			
Hi Oleic Rapeseed		**4.3**	**1.3**	**59.9**	**21.1**	**13.2**		
Hi Erucic Rapeseed		**3.0**	**0.8**	**13.1**	**14.1**	**9.7**	**7.4**	**50.7**
Butter	**7-10**	**24-26**	**10-13**	**28-31**	**1-2.5**	**.2-.5**		
Lard	**1-2**	**28-30**	**12-18**	**40-50**	**7-13**	**0-1**		
Tallow	**3-6**	**24-32**	**20-25**	**37-43**	**2-3**			
Linseed Oil		**4-7**	**2-4**	**25-40**	**35-40**	**25-60**		
Tung Oil		**3-4**	**0-1**	**4-15**		**75-90**[**]		
Yellow Grease*	**1.27**	**17.44**	**12.38**	**54.67**	**7.96**	**0.69**	**0.25**	**0.52**

Peterson, C.L., "Vegetable Oil as a Diesel Fuel: Status and Research Priorities," ASAE Transactions, V. 29, No. 5, Sep.-Oct. 1986, pp. 1413-1422.
Linstromberg, W.W., Organic Chemistry, Second Edition, D.C. Heath and Company, Lexington, Mass., 1970.
* Typical analysis: listed in Tat, M.E. and J.H. Van Gerpen, "Fuel Property Effects on Biodiesel," ASAE Paper 036034, American Society of Agricultural Engineering Annual Meeting, Las Vegas, NV, July 27-30, 2003.
** The dominant fatty acid in tung oil is a conjugated isomer of linolenic acid called eleostearic acid. The three double bonds in eleostearic acid are located at 9:10, 11:12, and 13:14 instead of at 9:10, 12:13 and 15:16 as in linolenic acid.

Transesterification is the process of reacting a triglyceride molecule with an excess of alcohol in the presence of a catalyst (KOH, NaOH, $NaOCN_3$, etc.) to produce glycerin and fatty esters. The chemical reaction with methanol is shown schematically in Figure 3. The mixture of fatty esters produced by this reaction is known as biodiesel.

The properties of the biodiesel fuel are determined by the amounts of each fatty acid used to produce the esters. Fatty acids are designated by two numbers: the first number denotes the total number of carbon atoms in the fatty acid and the second is the number of double bonds. For example, 18:1 designates oleic acid, which has 18 carbon atoms and one double bond. Table 1-1 shows the fatty acid compositions of a number of common vegetable oils and animal fats. The names of the fatty acids given in Table 1-1 are as follows:

14:0 Myristic Acid (tetradecanoic acid)
16:0 Palmitic Acid (hexadecanoic acid)
18:0 Stearic Acid (octadecanoic acid)
18:1 Oleic Acid
18:2 Linoleic Acid
18:3 Linolenic Acid

20:0 Arachidic Acid (eicosanoic acid)
22:1 Erucic Acid

How much biodiesel can be made?

Using the rough guideline that a pound of oil or fat will give a pound of biodiesel, we can use the total production of fats and oils in the United States to estimate the impact of biodiesel on total diesel consumption. Table 1-2 shows the annual production figures for vegetable oils and animal fats.

Table 1-2. Total Annual Production of US Fats and Oils.
[from Pearl, G.G., "Animal Fat Potential for Bioenergy Use," Bioenergy 2002, The Tenth Biennial Bioenergy Conference, Boise, ID, Sept. 22-26, 2002.]

Vegetable Oil Production (Billion pounds/yr)	
Soybean	18.340
Peanuts	0.220
Sunflower	1.000
Cottonseed	1.010
Corn	2.420
Others	0.669
Total Veg. Oil	23.659

Animal Fats (Billion pounds/yr)	
Edible Tallow	1.625
Inedible tallow	3.859
Lard & Grease	1.306
Yellow Grease	2.633
Poultry Fat	2.215
Total Animal Fat	11.638

Table 1-3. Sales of On-highway Diesel Fuel
[data from Energy Information Administration, www.eia.doe.gov]

	On-highway Diesel	
	(billion gallons/yr)	(billion pounds/yr)
1996	26.96	191.1
1997	28.61	202.9
1998	30.15	213.8
1999	32.06	227.3
2000	33.13	234.9

As can be seen, in the United States, soybean oil dominates the vegetable oil market comprising over 75% of the total vegetable oil volume. Animal fats total almost 50% of the vegetable oil market. The combined vegetable oil and animal fat production totals about 35.3 billion pounds per year. At about 7.6 pounds per gallon of oil, this production would equal 4.64 billion gallons of biodiesel. It should be noted that this total actually double counts some of the production since a portion of the vegetable oil production will be recycled as yellow grease.

Table 1-3 provides the total consumption of on-highway diesel fuel from 1996 to 2000.

It is obvious that biodiesel is not going to completely replace petroleum-based diesel fuel in the near future. Even with the unrealistic scenario that all of the vegetable oil and animal fat were used to produce biodiesel, we could only replace about 15% of the current demand for on-highway diesel fuel. So, why bother with biodiesel?

There are five primary reasons for encouraging the development of biodiesel in the United States.

1. It provides a market for excess production of vegetable oils and animal fats. There is increasing demand around the world for soybean meal to provide the protein for human and animal consumption. If new markets are not found for the soybean oil, then the price will be low and farmers will have even more difficulty producing a profit. The animal by-products industry also has a problem with more supply than the current market can absorb. This is compounded by the potential for even greater restrictions on the use of animal fats in animal feeds because of concerns about the spread of BSE (Bovine Spongiform Encephalopathy - Mad Cow Disease).

2. It decreases the country's dependence on imported petroleum. Obviously, this reason should not be overemphasized since the percentage of the country's fuel supply that can be replaced with biodiesel will be small. However, petroleum markets tend to be sensitive to small fluctuations in supply so an additional source of fuel can have a surprising impact on keeping fuel prices stable.

3. Biodiesel is renewable and contributes less to global warming than fossil fuels due to its closed carbon cycle. Because the primary feedstock for biodiesel is a biologically-based oil or fat, which can be grown season after season, biodiesel is renewable. And, since most of the carbon in the fuel was originally removed from the air by plants, there is very little net increase in carbon dioxide levels. However, some fossil carbon is contained in the methanol used to make methyl esters, and some fossil fuel is used during the production process. A life cycle study on biodiesel use in an urban bus conducted by the National Renewable Energy Laboratory [1] found that CO_2 emissions were reduced by 79% for pure biodiesel compared with petroleum diesel fuel. Again, this reason should not be overemphasized because biodiesel does not have the potential to make a major impact on the total carbon dioxide production.

4. The exhaust emissions from biodiesel are lower than with regular diesel fuel. Biodiesel provides substantial reductions in carbon monoxide, unburned hydrocarbons, and particulate emissions from diesel engines. . While the carbon monoxide and unburned hydrocarbons from diesels are already very low compared with gasoline engines, biodiesel reduces them further. Particulate emissions, especially the black soot portion, are greatly reduced with biodiesel. Unfortunately, most emissions tests have shown a slight increase in oxides of nitrogen (NOx) emissions with biodiesel. This increase in NOx can be eliminated with a small adjustment to the engine's injection timing while still retaining a particulate decrease.

5. Biodiesel has excellent lubricating properties. Even when added to regular diesel fuel in an amount equal to 1%-2%, it can convert fuel with poor lubricating properties, such as modern ultra-low-sulfur diesel fuel, into an acceptable fuel.

These are the primary reasons for the growth in interest in biodiesel.

References

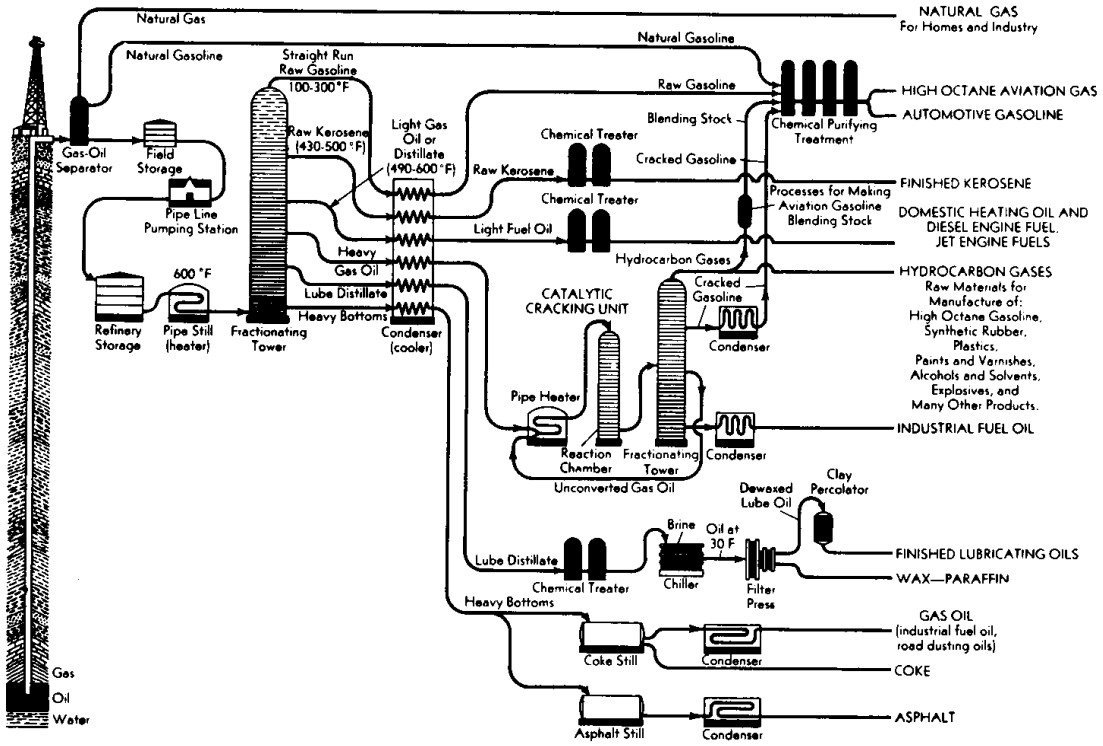
1. Sheehan, J., V. Camobreco, J. Duffield, M. Graboski, and H. Shapouri, Life Cycle Inventory of Biodiesel and Petroleum Diesel for Use in an Urban Bus," Report from the National Renewable Energy Laboratory for the U.S. Dept. of Energy's Office of Fuels Development and for the U.S. Department of Agriculture's Office of Energy, NREL/SR-580-24089, May 1998.

2. Review of Diesel Fuel Properties and Characteristics

What is this stuff we want to replace?

Diesel fuel is derived from petroleum through a refining process. Figure 2-1 shows a schematic diagram of the refining process from the petroleum extraction to the finished product. As shown in the figure, petroleum is separated into fractions whose distinguishing feature is their different boiling points. Table 4 shows the boiling point ranges corresponding to the various commercial fuels.

As indicated in the table, kerosene, jet fuel (Jet A), and No. 1 diesel fuel are the same fraction of petroleum. In most refineries, this fraction is straight run, that is, it is produced directly from compounds that were present in the crude petroleum. In contrast, No. 2 diesel fuel may contain some straight run material but it also contains streams that are byproducts of the refining processes that produce gasoline. No. 2 diesel was traditionally used as a "dumping ground" for refinery streams that could not be economically processed into higher value fuels.



from: Obert, E.F., Internal Combustion Engines and Air Pollution, Intext Publishers, New York, 1973.

Figure 2-1. Schematic of Petroleum Refinery Processes

Table 2-1. Typical Refinery Products

Product	Boiling Range °C	Boiling Range °F
LPG	-40 - 0	-40 - 31
Gasoline	30 - 200	80 - 400
Kerosene, Jet Fuel, #1 Diesel	170 - 270	340 - 515
#2 Diesel, Furnace Oil	180 - 340	350 - 650
Lube Oils	340 - 540	650 - 1000
Residual Oil	340 - 650	650 - 1200
Asphalt	540 +	1000 +
Petroleum Coke	Solid	

From: Schmidt, G.K. and Forster, E.J., "Modern Refining for Today's Fuels and Lubricants," SAE Paper 861176, 1986.

ASTM Specifications for Diesel Fuel Oils (D 975-97)

Diesel fuel is characterized in the United States by the ASTM standard D 975. This standard currently identifies five grades of diesel fuel as described below. New grades to reflect the reduction in sulfur content required by the EPA in 2006 are under consideration by the ASTM.

Grade No. 1-D and Low Sulfur 1-D: A light distillate fuel for applications requiring a higher volatility fuel for rapidly fluctuating loads and speeds as in light trucks and buses. The specification for this grade of diesel fuel overlaps with kerosene and jet fuel and all three are commonly produced from the same base stock. One major use for No. 1-D diesel fuel is to blend with No. 2-D during winter to provide improved cold flow properties. Low sulfur fuel is required for on-highway use with sulfur level < 0.05%.

Grade No. 2-D and Low Sulfur 2-D: A middle distillate fuel for applications that do not require a high volatility fuel. Typical applications are high-speed engines that operate for sustained periods at high load. Low sulfur fuel is required for on-highway use with sulfur level < 0.05%.

Grade No. 4-D: A heavy distillate fuel that is viscous and may require fuel heating for proper atomization of the fuel. It is used primarily in low and medium speed engines.

ASTM D 975 specifies the property values shown in Table 2-2 for these grades of diesel fuel. The surprising aspect about ASTM D 975 is how few requirements are actually included. The standard says nothing about the composition of the fuel or its source. It only defines some of the property values needed to provide acceptable engine operation and safe storage and transportation. The essential characteristics of diesel fuels will be described in the following paragraphs.

Table 2-2. Requirements for Diesel Fuel Oils (ASTM D 975-97)

Property	Grade LS #1	Grade LS #2	Grade No. 1-D	Grade No. 2-D	Grade No. 4-D
Flash point °C, min	38	52	38	52	55
Water and sediment, % vol, max.	0.05	0.05	0.05	0.05	0.50
Distillation temp., °C, 90%					
Min.	--	282	--	282	--
Max.	288	338	288	338	--
Kinematic Viscosity, mm^2/s at 40°C					
Min.	1.3	1.9	1.3	1.9	5.5
Max.	2.4	4.1	2.4	4.1	24.0
Ramsbottom carbon residue, on 10%, %mass, max.	0.15	0.35	0.15	0.35	--
Ash, % mass, max.	0.01	0.01	0.01	0.01	0.10
Sulfur, % mass, max	0.05	0.05	0.50	0.50	2.00
Copper strip corrosion, Max 3 hours at 50°C	No. 3	No. 3	No. 3	No. 3	--
Cetane Number, min.	40	40	40	40	30
One of the following Properties must be met:					
(1) cetane index	40	40	--	--	--
(2) Aromaticity, % vol, max	35	35	--	--	--
Cloud point, °C, max.	Determined by local climate. Should be 6°C higher than the tenth percentile minimum ambient temperature for the region. For Iowa:				

Month	10th % minimum temp
Oct	-2°C
Nov	-13
Dec	-23
Jan	-26
Feb	-22
Mar	-16

Cold Flow Properties

Operators of diesel equipment are well aware of the tendency of diesel fuel to gel or solidify at low temperatures. Some of the long chain hydrocarbons in Number 2 diesel fuel, known as waxes, will usually start to develop crystals at around –9.4° C (15° F). If allowed to agglomerate, these crystals will grow large enough to plug fuel filters and fuel lines. While anti-gelling additives can be used to disrupt the agglomeration process and lower the allowable operating temperature of the fuel, the most common remedy is to

blend #1 and #2 diesel fuel together.

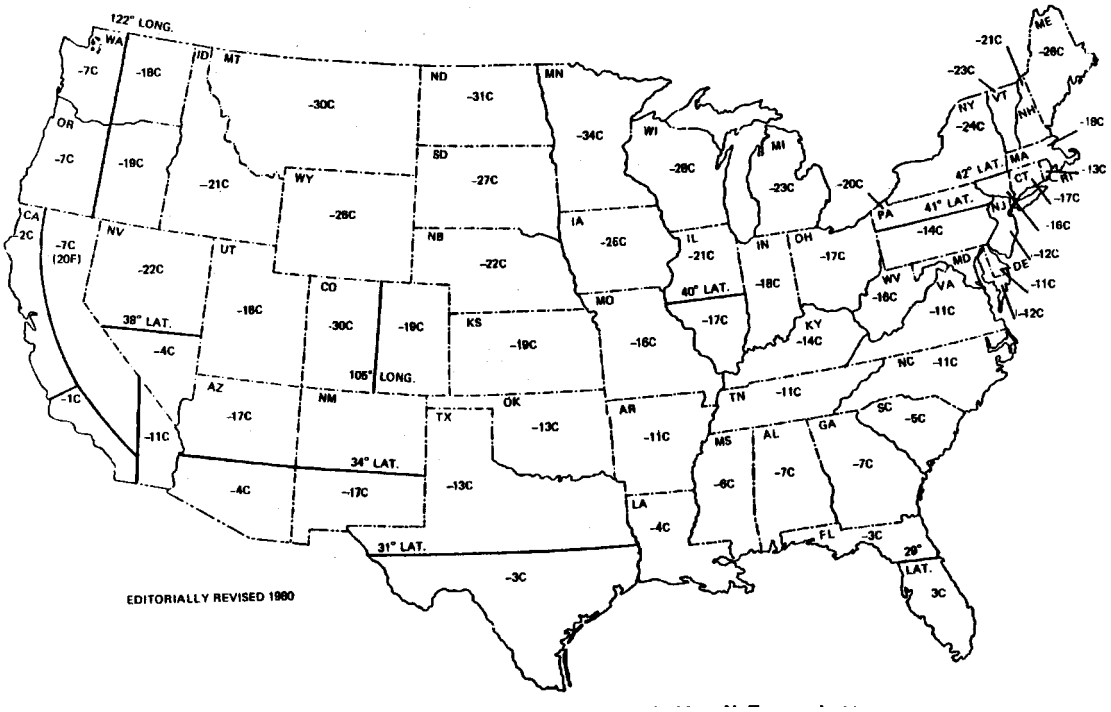


Figure 2-2. 10th Percentile Minimum Air Temperatures for January (ASTM D 975-97)

Number 1 diesel fuel can generally operate below –40ºC (-40° F) without crystallization. So-called "winter
blends" of #1 and #2 are used in the northern United States to provide low temperature operability. ASTM D 975 does not specify a specific value for the cold flow requirements of diesel fuel. Instead, it suggests that one measure of cold flow, the cloud point, which is described below, be no more than 6°C higher than the 10th percentile minimum ambient temperature for the month the fuel will be used. The 10th percentile temperature corresponds to the minimum temperature that would be reached no more than 3 days out of 30 for the month. Figure 2-2 shows the values of 10th percentile temperatures during the month of January. ASTM D 975 contains similar maps for other low temperature months in the United States.

Biodiesel will generally start to gel at higher temperatures than #2 diesel fuel. Soybean oil-based biodiesel will form crystals at about 0°C and biodiesel from saturated fats, such as are commonly found in animal fats and greases, can form crystals at higher temperatures. Low quality biodiesel produced with an incomplete reaction can behave in a similar manner as the mono- and di-glycerides crystallize even at high temperatures. Partially reacted monoglycerides containing saturated fatty acids have high melting points and very low solubility in methyl esters. These compounds can fill fuel filters with a creamy deposit. The user may think the fuel was made from a feedstock that provides a high cloud point when in fact the problem is with the completeness of the reaction. There are four primary measures of cold flow properties. These are described below.

1. Cloud Point - The cloud point is the temperature at which a cloud of wax crystals first appears in a fuel sample that is cooled under conditions described by ASTM D 2500. The cloud point is determined by visually inspecting for a haze in the normally clear fuel. The apparatus used for this test (and the pour point) is shown in Figure 2-3.

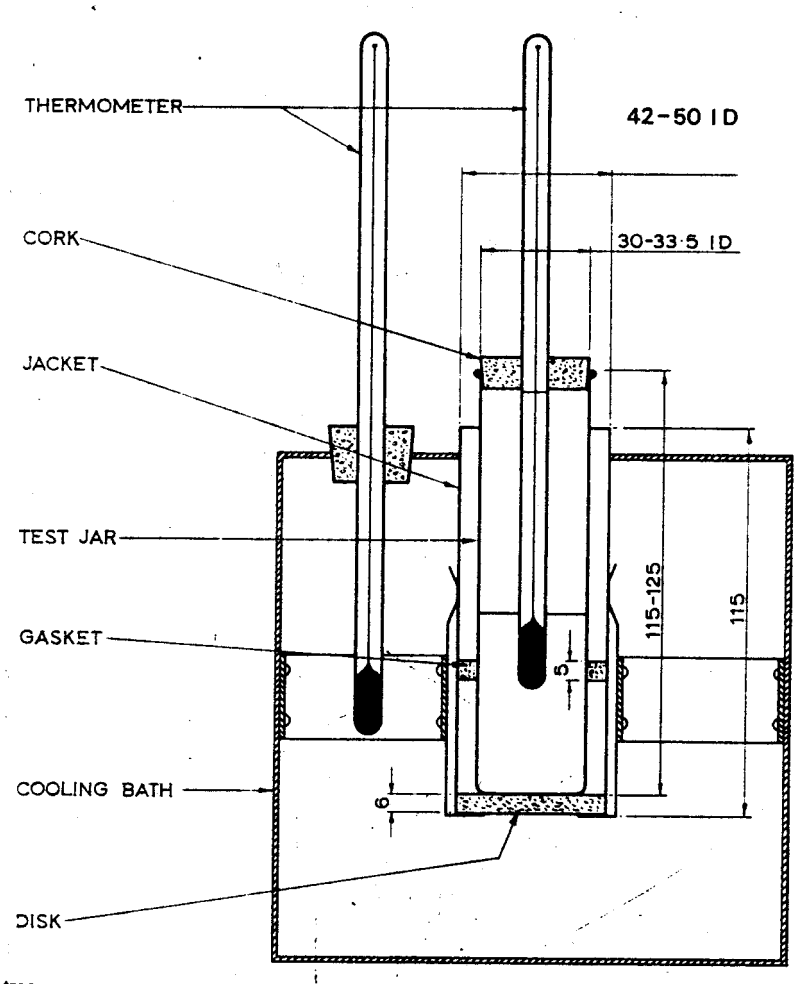


Figure 2-3. Cloud Point and Pour Point Apparatus

2. Pour Point - The pour point is the lowest temperature at which movement of the fuel sample can be determined when the sample container is tilted. The apparatus used is the same as for the Cloud Point and is shown in Figure 6. The sample must be cooled following the procedure described in ASTM D 97. At every 3°C of cooling, the sample is inspected and when no movement is detected after 5 seconds, the test is stopped. 3°C is added to the temperature where no movement was observed and this is the pour point. Pour points are always expressed in multiples of 3°C.

3. Low Temperature Flow Test (LTFT) - The LTFT is designed to evaluate whether a fuel can be expected to pass through an engine fuel filtration system. The test determines

the lowest temperature at which 180 ml of fuel can be drawn through a 17μm screen in 60 seconds or less with 20 kPa of vacuum. The procedure is defined in ASTM D 4539.

4. Cold Filter Plugging Point (CFPP) - The cold filter plugging point, as defined by International Petroleum Standard IP-309 and ASTM D 6371-99, is similar to the LTFT test. It determines the lowest temperature where 20 ml of fuel can be drawn through a 45 μm screen in 60 seconds with 200 mm of water (1.96 kPa) of vacuum. The apparatus is shown in Figure 2-4.

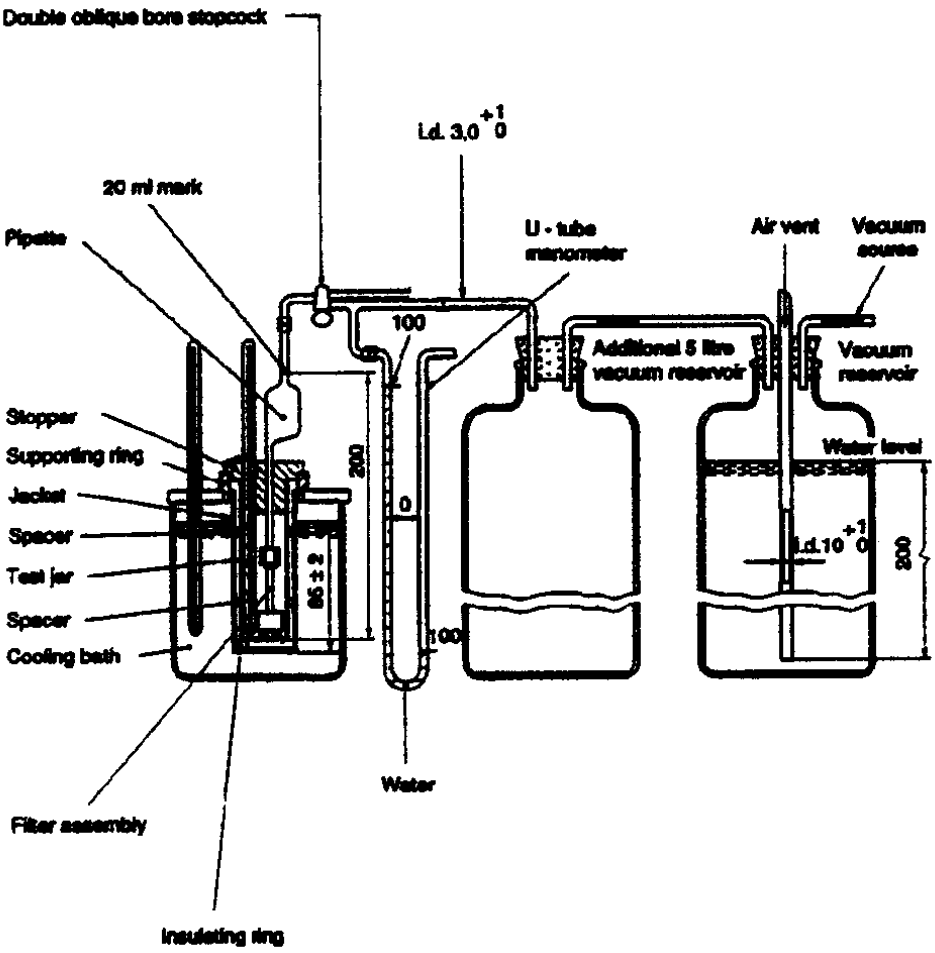


Figure 2-4. CFPP Apparatus

The cloud point is the highest temperature used for characterizing cold flow and the pour point is the lowest. The LTFT and CFPP temperatures will usually be somewhere between the cloud and pour points.

The pour point of a fluid can be lowered with additives. Most pour point depressants, also known as cold flow improvers, work on similar principles. As the fuel sample is cooled, small wax crystals form. The temperature at which this occurs is the cloud point. As the sample is cooled further, the crystals agglomerate and grow in size until the entire sample

solidifies. Most pour point depressants do not alter the initial formation of the crystals and thus they do not generally affect the cloud point. Rather, they inhibit the crystals from combining and growing to a size large enough to plug filters. The additives are generally waxes that are used in small amounts. They surround the small crystals and provide a barrier to agglomeration.

Volatility

Distillation Curve - (ASTM D 86) The distillation curve is determined by relating the fraction of a fuel sample that is removed by heating a fuel sample to progressively higher temperatures. Typically, the curve is characterized by the initial point, the temperature at which the first drop of liquid leaves the condenser, the temperatures at each 10% of the liquid, and the end point. Since diesel fuel consists of hundreds of different compounds, a distillation curve provides important information about the composition of the fuel. However, biodiesel usually contains only 4 to 5 major compounds that all boil at about the same temperature. In addition, the boiling temperature is so high at atmospheric pressure that the biodiesel compounds usually decompose (crack) during the distillation test. Distillation tests following ASTM D 86 are not appropriate for biodiesel. The ASTM standard D 6751 specifies a distillation test although it recommends ASTM D 1160, which is conducted under vacuum. While this test will allow the biodiesel to be distilled without decomposing, the procedure specified in the technique for converting the distillation curve back to atmospheric pressure is only valid for petroleum products and should be used with caution for biodiesel.

Flash Point - (ASTM D 93) The flash point is the lowest temperature at which a combustible mixture can be formed above the liquid fuel. It is dependent on both the lean flammability limit of the fuel as well as the vapor pressure of the fuel constituents. The flash point is determined by heating a sample of the fuel in a stirred container and passing a flame over the surface of the liquid. If the temperature is at or above the flash point, the vapor will ignite and an easily detectable flash can be observed. The flash need not correspond to a sustained flame. The “fire point” is sometimes used to designate the fuel temperature that will produce sufficient vapor to maintain a continuous flame.

Ignition Indices

One of the most important properties of a diesel fuel is its readiness to autoignite at the temperatures and pressures present in the cylinder when the fuel is injected. The *cetane number* is the standard measure of this property although it is difficult to measure precisely and has been criticized in recent years for not accurately reflecting the autoignition conditions in modern turbocharged engines, particularly with alternative fuels. The *cetane index* is derived from correlation equations based on large numbers of cetane number tests. It is intended to provide a rough estimate of the cetane number. These quantities are described below.

Cetane Number - The cetane number is an engine-based test that follows ASTM standard D613. It is based on a special engine produced by Waukesha Engine Company

that is similar to the Octane Test Engine used for rating gasolines. The engine is a single cylinder, indirect injection diesel engine. The engine speed is fixed at 900 rpm and while the engine is naturally aspirated, the intake air temperature is held at 150°F. The test is based on a careful adjustment of the fuel/air ratio and the compression ratio to produce a standard ignition delay (the period between the start of fuel injection and the start of combustion) of 13 degrees while operating on the test fuel.

Then the engine is switched to operate on a blend of two reference fuels. Different blends are tested until a formulation is found that restores the ignition delay to 13 degrees. The primary reference fuels are n-cetane (n-hexadecane), which has a cetane number of 100 and heptamethylnonane (HMN), which has a cetane number of 15. When the ignition delay is restored to 13 degrees, the cetane number is computed from the following relationship:

Cetane Number = % n-cetane + 0.15 (%HMN)

Since the price of the primary reference fuels is quite high, most commercial cetane testing is done with secondary reference fuels that have been calibrated to known cetane values. Phillips Petroleum supplies these secondary reference fuels.

Cetane Index - The cetane index is a calculated quantity that is intended to approximate the cetane number. It is much cheaper to determine than the engine-based cetane number but its accuracy is limited to the type of fuel on which it is based. It generally does not provide an accurate indication of cetane number if the fuel contains cetane-improving additives or for non-petroleum-based alternative fuels. Two methods are available for computing the Cetane Index.
1. ASTM standard D 976 gives the following empirical equation for the Cetane Index:

$$\text{Cetane Index} = 454.74 - 1641.416\,D + 774.74\,D^2 - 0.554\,T_{50} + 97.803[\log_{10}(T_{50})]^2$$

where D = fuel density at 15°C in g/ml.
and T_{50} = the temperature corresponding to the 50% point on the distillation curve in degrees C.

2.ASTM D 4737 gives the Cetane Index according to the following four-variable equation:

$$\text{Cetane Index} = 45.2 + 0.0892(T_{10}N) + 0.131(T_{50}N) + 0.0523(T_{90}N) + 0.901B(T_{50}N) - 0.420B(T_{90}N) + 4.9\times10^{-4}(T_{10}N)^2 - 4.9\times10^{-4}(T_{90}N)^2 + 107B + 60\,B^2$$

where $T_{10}N = T_{10} - 215$
$T_{50}N = T_{50} - 260$
$T_{90}N = T_{90} - 310$

when T_{10}, T_{50}, and T_{90} are temperatures at 10%, 50%, and 90% volume distilled in degrees C
and B = [exp(-3.5DN)] - 1
when DN = density at 15°C (kg/liter) - 0.85

Example Calculation

The following data were obtained from a commercial fuel testing laboratory for a sample of #2 diesel fuel.

API Gravity	34.1
Higher heating Value	19,461 Btu/lbm
Lower Heating Value	18,309 Btu/lbm
T_{10}	413°F (212.0°C)
T_{50}	502°F (261.4°C)
T_{90}	592°F (311.4°C)

The cetane number was measured by ASTM D 613 on two occasions and the following results were obtained:

March 8, 1994	47.8
April 15, 1994	45.7

Calculate and compare the calculated cetane indices using the two equations given above with the measured values shown.

Preliminary calculations:

$$S.G. = \frac{141.5}{API + 131.5} = 0.8545$$

$$\rho = 0.8545(999.1 g / ml) = 0.8537 g / ml$$

ASTM D 976:

$$\text{Cetane Index} = 454.74 - 1641.416\,(0.8537) + 774.74\,(0.8537)^2 - 0.554\,(261.4) + 97.803\,[\log_{10}(261.4)]^2$$

$$= \mathbf{44.8}$$

ASTM D 4737:

$$DN = 0.8537 - 0.85 = 0.0037$$

$$B = \exp(-3.5 \times 0.0037) - 1 = -0.0129$$

$$\text{Cetane Index} = 45.2 + 0.0892\,(-3.0) + 0.131\,(1.4) + 0.0523\,(1.4) + 0.901\,(-0.0129)\,(1.4) - 0.42\,(-0.0129)\,(1.4) + 4.9\times10^{-4}\,(-3)^2 - 4.9\times10^{-4}\,(1.4)^2 + 107\,(-0.0129) + 60\,(-0.0129)^2$$

$$= \mathbf{43.8}$$

Note that the two measured cetane numbers are 2.1 apart. ASTM D 613 states that the repeatability of the measurement (in this cetane number range) is such that two measurements taken on the same material by the same operator with the same equipment at identical operating conditions will be within 0.7, 95% of the time. However, the reproducibility, which is the difference between two measurements taken by different operators in different laboratories may be as large as 2.6. Since the two cetane number measurements in this case were taken one month apart, the reproducibility specification is probably more applicable.

The calculated values of cetane index are about 2-3 numbers below the average of the two measured cetane numbers. ASTM D 976 says that the first equation will be within +/- 2 cetane numbers for 75% of typical distillate fuels. No precision estimates are given for D 4737, the four variable equation. Both cetane index equations are based on data from petroleum-based fuels and should not be used for biodiesel.

Cetane improvers - Cetane improvers are fuel additives that are designed to readily decompose to give precursors to combustion and thus enhance the rate at which auto-ignition occurs in a diesel engine. Typical compounds used are alkyl nitrates, ether nitrates, dinitrates of polyethylene glycols, and certain peroxides. Due to low cost and ease of handling, alkyl nitrates such as 2-ethylhexylnitrate (EHN) are the most widely used cetane improvers.

Density

Specific gravity - The density of petroleum products is usually expressed as a specific gravity. The specific gravity is defined as the ratio of the mass of a volume of the fuel to the mass of the same volume of water. It is dependent on the temperature of both the fuel and the water. It will commonly be expressed as "sp gr @ 60°F/60°F" which means that both the fuel and water were at 60°F. No. 1 diesel fuel will typically have a specific gravity of 0.81 and No. 2 diesel fuel will be around 0.840 to 0.855. Most biodiesel is between 0.87 and 0.88.

API - The API gravity is a widely used measure of a fuel's density. It is related to the specific gravity of the fuel by the following equation:

$$API = 141.5/[\text{sp gr @ } 60°F/60°F] - 131.5$$

Viscosity

Viscosity is a measure of a fluid's resistance to flow. The greater the viscosity, the less readily the liquid flows. The viscosity of petroleum oils is a strong function of temperature with the viscosity decreasing as the temperature increases. ASTM D445 is a standard test procedure for determining the kinematic viscosity of liquids. It provides a measure of the time required for a volume of liquid to flow under gravity through a calibrated glass capillary tube. The kinematic viscosity is then equal to the product of this time and a calibration constant for the tube. The dynamic viscosity can be obtained by

multiplying the kinematic viscosity by the density of the fluid. Biodiesel is more viscous than No. 2 diesel fuel but only by a small amount. Depending on feedstock and amount of oxidation, biodiesel viscosity will vary between 4.0 and 6.2, while No. 2 diesel fuels tend to fall in the a narrower range of 2.4 to 2.6.

Fuel Stability

A fuel is considered unstable when it undergoes chemical changes that produce undesirable consequences such as deposits, acidity, or a bad smell. There are three different types of stability commonly described in the technical literature.
1. *Thermal stability* addresses fuel changes that occur due to elevated temperature. These changes may occur at conditions encountered in modern fuel injection systems as fuel is recirculated through the engine head and back to the fuel tank.
2. *Oxidative stability* refers to the tendency of fuels to react with oxygen at temperatures near ambient. These reactions are much slower than those that would occur at combustion temperatures, and they produce varnish deposits and sediments.
3. *Storage stability* is also a frequently used term and refers to the stability of the fuel while it is in long-term storage. These terms are not necessarily exclusive terms. For example, oxidative attack is probably one of the primary concerns of storage stability but storage stability might also involve issues of water contamination and microbial growth.

Heating Value, Net and Gross

There are actually two heating values in common use, the higher, or gross, heating value and the lower, or net, heating value. Both quantities are determined using a calorimeter where the heat transfer from the hot combustion gases is measured as the gases are cooled to the initial temperature of the reactants. The higher heating value assumes that all of the water in the products is condensed liquid while the lower assumes all of the water is present as vapor, even though the product temperature may be below the dew point temperature. The lower heating value is the most common value used for engine applications. It is used as an indicator of the energy content of the fuel. In general, the higher the heating value of the fuel, the less fuel that will be required to do a given amount of work. Biodiesel generally has a lower heating value that is 12% less than No. 2 diesel fuel on a weight basis (16,000 Btu/lb compared with 18,300 Btu/lb). Since the biodiesel has a higher density, the lower heating value is only 8% less on a volume basis (118,170 Btu/gallon for biodiesel compared with 129,050 Btu/gallon for No. 2 diesel fuel).

Biological Attack

Certain types of bacteria and fungi can grow in diesel fuel storage tanks. These microorganisms can be either aerobic or anaerobic but typically require some water to be present. The organisms generally grow at the interface between the fuel and water. They can plug fuel filters and increase the acidity of the fuel, causing corrosion. Although very limited test data are available, biodiesel is also expected to be prone to the growth of microorganisms. The preferred method to control growth of microbes in fuel is to

eliminate the conditions that allow their growth. Usually this means removing water from the fuel. Treatment of the fuel with a chemical biocide can eliminate microorganism growth, but it will also affect the toxicity and biodegradability of the fuel.

Lubricity

Lubricity can be defined as: "The property of a lubricant that causes a difference in friction under conditions of boundary lubrication when all the known factors except the lubricant itself are the same. The lower the friction, the higher the lubricity." [Kajdas, C., S.S.K. Harvey, and E. Wilusz, *Encyclopedia of Tribology*, Elsevier, New York, 1990.]

Lubricity is actually a very difficult property to characterize. In spite of the definition's attempt to separate the lubricity as a fluid property, it is also strongly dependent on the method used to measure it and on the characteristics of the solid surfaces being lubricated. For example, as friction occurs, small particles of the solid material may be removed and entrained in the lubricant. In some applications, these particles will be swept away by a flow of lubricant while in others, the particles stay in the vicinity of the surface contact. Particles that are present in the area of surface contact may act very differently. In some cases, they may act as an abrasive to increase wear while in other cases, the particles may shield the surface from further wear. When trying to characterize lubricity, it is important to use a measurement technique that correlates well with the actual lubrication situation. In the case of diesel fuel, the fuel acts as a lubricant for the finely fitting parts in the diesel fuel injection system. While all diesel fuel injection systems depend on the fuel to act as a lubricant, rotary pump style injection systems seem to be the most sensitive to fuel lubricity.

The need for diesel fuel lubricity has been recognized for many years. Most early concern focused on the use of No.1 diesel fuel in place of No.2 diesel fuel under cold weather conditions. Higher wear rates with No.1 diesel fuel would be aggravated by No.1 diesel fuel's lower viscosity. However, when the U.S. Environmental Protection Agency mandated that the sulfur content of on-highway diesel fuel be lowered from 5000 ppm to 500 ppm in 1993, fuel lubricity captured national attention. There is still disagreement about what specific fuel changes are caused by the sulfur reduction that result in lubricity reduction. Some have suggested that sulfur compounds themselves provide lubricity, others have suggested that nitrogen compounds or naphthenic hydrocarbons are responsible. In any case, there is general agreement that the severe hydrotreating process used by petroleum refineries to remove sulfur results in lower fuel lubricity. Recent EPA regulations will lower the sulfur content of diesel fuel to 15 ppm by 2006. This change is expected to worsen fuel lubricity. The addition of small amounts of biodiesel (0.25% to 2%) to diesel fuel has a dramatic effect on the lubricity of that fuel. Pure biodiesel and high level blends have excellent lubricity.

There are two methods that are commonly used to measure lubricity: the Scuffing Load Ball On Cylinder Lubricity Evaluator (SLBOCLE - ASTM D 6078-99) and the High Frequency Reciprocating Rig (HFRR - ASTM D 6079-99). The apparatus used for the SLBOCLE test is shown in Figure 2-5. This test involves placing a steel ball bearing against a rotating steel ring whose lower edge is immersed in the test fluid. Weight is

gradually applied to the ball until a “scuff” mark is seen on the rotating ring. The tangential force is also measured and the point of scuffing is indicated by a large increase in the friction coefficient. The EMA has indicated that a weight of 3150 grams is representative of an acceptable lubricity level. The higher this number, the better the fuel lubricity.

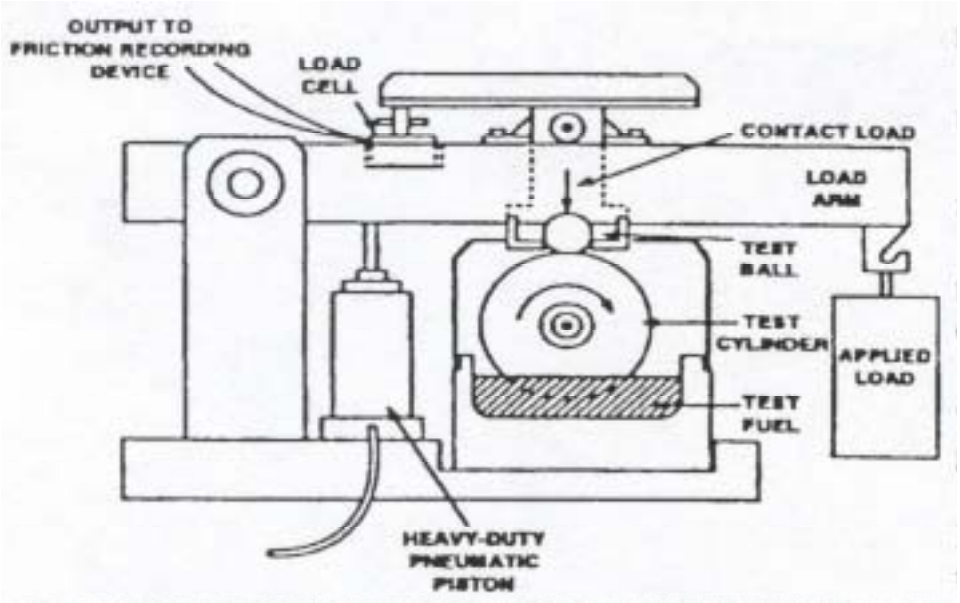


Figure 2-5. Scuffing Load Ball On Cylinder Lubricity Evaluator (SLBOCLE - ASTM D 6078-99)

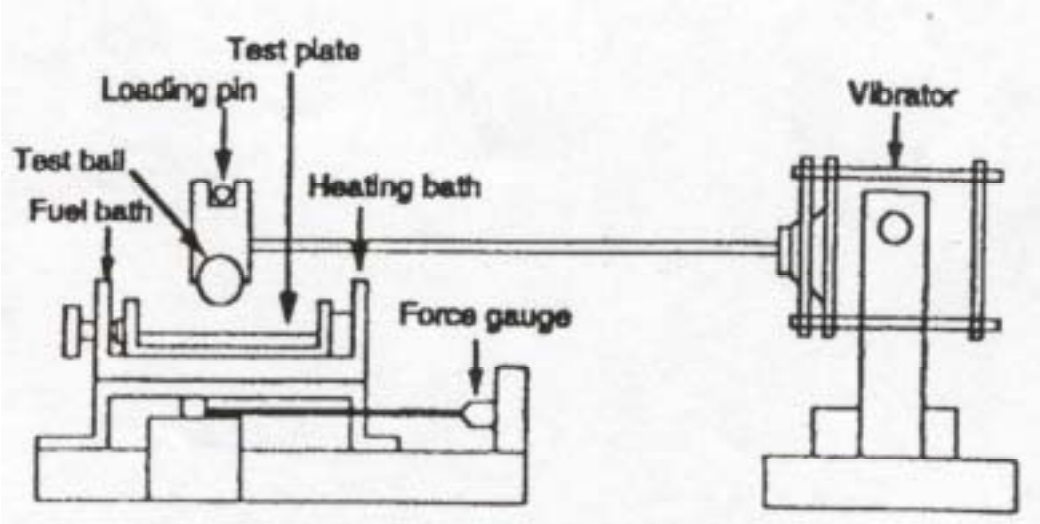


Figure 2-6. High Frequency Reciprocating Rig (HFRR - ASTM D 6079-99)

The HFRR test also uses a steel ball but in this case the ball is held against a stationary disk and the ball is reciprocated back and forth across the disk with a frequency of 50 hertz. This apparatus is shown in Figure 2-6. The applied load is 200g and the test duration is 75 minutes. The wear scar produced on the disk is measured and a scar diameter of less than 450 micron is considered to be acceptable.

Measurements of Lubricity

Schumacher and Adams [10th Biennial Bioenergy Conference – Bioenergy 2002, Boise, Idaho, Sept. 22-26, 2002] have measured the effect of low-level blends of soybean-based biodiesel on biodiesel that has been produced to meet 15 ppm sulfur levels. Figure 2-7 shows SLBOCLE results for No. 2 diesel fuel with small amounts of biodiesel. As little as 1% biodiesel could change the diesel fuel from an unacceptable level to an acceptable level.

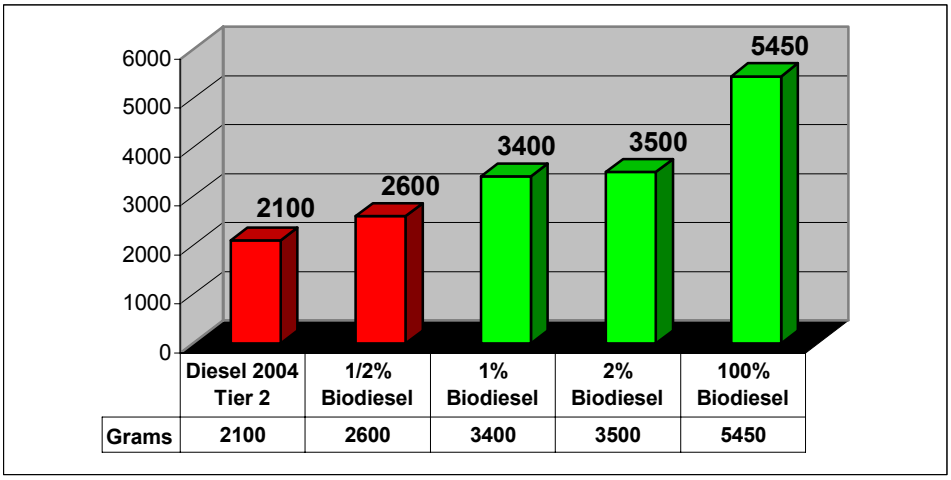


Figure 2-7. SLBOCLE for #2 Diesel 2004 Tier 2 Fuel, Biodiesel, and Biodiesel Blends

Figure 2-8 shows the same effect for No. 1 diesel fuel that has also been treated to lower the sulfur content to less than 15 ppm. In this case, the lubricity of the original No. 1 diesel fuel was so low that even 2% biodiesel was not able to bring the lubricity back up to the acceptable level of 3150 grams. However, the lubricity was greatly improved and it is unlikely that the engine would suffer damage from short term use at a lubricity level of 2880 grams.

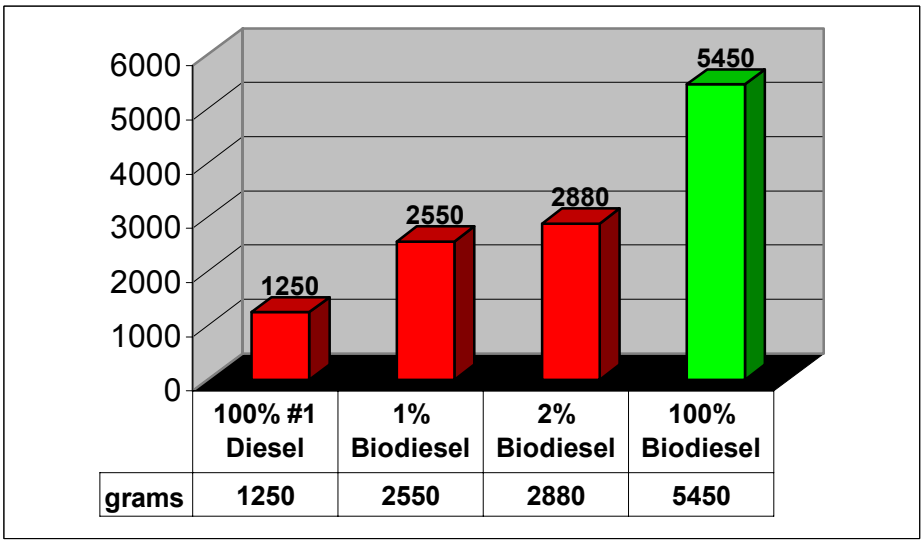


Figure 2-8. SLBOCLE for #1 Diesel Fuel, Biodiesel, and Biodiesel Blends

3. Introduction to the Liquid Fuels Production, Marketing, and Regulatory System

Introduction

Biodiesel producers and users are inextricably tied to the petroleum industry. Biodiesel fuel is mixed with petroleum derived "petro"-diesel, marketed through the conventional petroleum marketing system, and used in engines designed to operate on petro-diesel. The biodiesel blends, whether B2 to B5 (2 % to 5% biodiesel in 98% to 95% petro-diesel), B20 or B100, are subject to the same engine performance and emissions expectations as petro-diesel. The fact that the original compression ignition (diesel) engines were designed to operate on peanut oil is historically interesting, but the reality of today's liquid fuel business is that as biodiesel producers, we are competing in a petroleum dominated market.

The instructional goals for this module are:

1. Describe five essential characteristics of the liquid fuels industry and discuss how they came to be;
2. Describe the production and marketing pathway followed by petro-diesel and contrast it with the production of biodiesel;
3. Describe the performance factors and regulations that drive the quality and use of diesel fuels; and,
4. Examine briefly diesel fuel markets and how biodiesel fits into these markets.

Origins of the Petroleum Liquid Fuels Industry

The liquid fuels industry has its roots in the production of light for households, industry, and towns. Lamps that used animal fats, vegetable oils, and rarely, crude petroleum as fuels have a history more than 5,000 years old. The lamps provided poor light and were smoky, but were better than torches and less expensive than candles for common use.

Petroleum has an equally long history of use by humans, but more for medicinal properties, as a lubricant, a sealant for ships, and some use as a fuel for torches and other applications. The oil was derived from natural seeps that occur in many parts of the world.

The first true liquid fuels industry was the recovery of sperm whale oil that began in the 1700's. The industry flourished, particularly in the United States. However, by about 1850, the population of sperm whales had declined significantly and the whaling trade was becoming less profitable. With increasingly urban, industrial age populations, a new source of liquid fuel was needed.

With the decline in availability of whale oil, there was a search for new sources of lighting fuels. About this same time, chemists in Galacia developed a method for refining the crude petroleum from the seepage springs into a clear liquid that burned with a bright, non-smoky flame. This fraction was called "kerosene" and the race for oil was on.

In August 1859, Edwin Drake completed the first oil well in Western Pennsylvania. The result was a chaotic rush to drill, refine, and market this new lighting fuel that quickly spread throughout the world.

The rush for oil was largely dominated by Americans, with the British, Russians, and Romanians as significant players. However, one man, John D. Rockefeller, gathered enough power to create the defining characteristics of the industry that continue until today. These characteristics are an industry that is:

1. Vertically integrated
2. Capital intensive
3. Competitive/collaborative
4. Standards driven
5. Multinational.

Each of these attributes are discussed further below.

Industry Characteristics - Vertically Integrated

The oil boom came shortly after the Gold Rush and had many similarities to it. With each new strike, hundreds of seekers drilled as many holes as they could, as fast as they could. As much oil was spilled as was produced, refined, and shipped. The new fields often played out very quickly because there was no understanding of how the oil was situated underground or how to most effectively recover it. The most important persons in the Oil Patch were the "wildcatters" who found techniques to identify promising locations for drilling.

At the same time, the refining techniques were not much more advanced than the distillation of moonshine whiskey. In fact, some stills were pressed into service to recover kerosene. A kerosene product that had not been refined enough contained too much of the more flammable fraction, gasoline, and too often exploded in the lamps of the unknowing customers.

At first, the kerosene product was transported in modified water wagons and marketed door-to-door. As the industry grew, there was a growing partnership with the railroads that defined Big Business in the late 1800's and early 1900's. One outcome of this alliance was the Sherman Anti-Trust Act of 1890. An additional innovation for transport was the use of pipelines to move crude oil from the oil field to larger, more sophisticated refineries some distance away.

John D. Rockefeller created and dominated the petroleum industry. His influence continues today. He was first a marketer, with the promise that Standard Oil products will have a high, consistent quality for the consumer. This meant improvements in refining techniques and control of the refining operations. Higher quality refining meant that the refineries were more expensive, so they were consolidated, requiring a system for transporting crude oil to the refinery, and refined product to the consumer.

In order to minimize the price and availability boom-bust pattern, control of production sites and control of the amount of crude produced was necessary. Thus, Standard Oil was one of the first, and definitely the largest fully vertically integrated company in history.

American oil interests were not alone in the world. The British were still an empire, and they actively pursued integrated production, refining and marketing concessions throughout the world. In this era Shell Oil, Royal Dutch Oil, and several national oil companies were begun.

With the advent of the electric light and centralized power production, coincident with the invention of spark ignition and compression ignition engines, petroleum entered the transportation fuel business. A key figure in establishing this shift was a little-known Secretary of the Admiralty (British) by the name of Winston Churchill. He insisted that the British Navy be petroleum powered, instead of coal powered. World War I affirmed his decision.

Industry Characteristics - Capital Intensive

Locating new oil fields has become a highly technical science, but the odds of success in a new area are still small. Even drilling in a known field is expensive. Increasingly, new fields are remote, deep, and either wet, cold, or both.

Pipeline systems have been built throughout the world to move oil from the source to the refinery, or to oil tankers for further transport. Building, maintaining, and, occasionally, defending these transport systems is the most expensive single business in the world.

Refining has transformed into refining and petrochemical processing. World class refineries in the capacity range of 200,000 barrels to more than 500,000 barrels per operating day represent capital investments in the billions of U.S. dollars at a single site.

With the rise of the petrochemical complex, the refiners can sell a fraction of their product within the organic chemicals market at very reasonable profit margins, and recover the cost of the raw material from fuel sales. This is one factor in the large variations in fuel price with changes in oil availability or the spot price of a barrel of oil.

Industry Characteristics - Competitive/Collaborative

At first, anyone with a drill, a still, and enough resources to open a well could become an independent producer. As the industry became more sophisticated, and as Standard Oil grew, the smaller independents were pushed out of refining and distribution. There are still a number of independent "wildcatter" operations seeking new oil fields, but the cost of leases to explore are prohibitive. The most recent rounds of large corporation consolidations have nearly re-created organizations similar to the original Standard Oil.

The large companies' goal has long been stability in terms of market share, quantity, and price. In the early years, the drive for stability lead to a number of agreements dividing the world into market regions, and in more recent years into production regions.

In the early days, the small companies' goal was quick profits. Many of the smaller, but successful, companies merged to create names like Texaco, Sinclair, Conoco, and Phillips that have persisted until recently.

The costs of developing and maintaining large production operations overseas lead to a number of collaborations among the larger companies to fund the exploration and development of the fields, the transport infrastructure, and to deal with different and occasionally unstable governments.

The costs of developing the scientific foundation for the refining and, later, the petrochemical business lead to a unique collaboration. The American Petroleum Institute was founded by the large oil companies. The Institute was, and is, used as a forum to represent the industry, but also as a way of combining resources to discover basic chemical and physical properties and principles that form the foundation for the petrochemical industry worldwide.

The smaller oil companies, specifically in Texas, created another collaboration with long lasting significance. The small companies were developing the rich Texas oil fields in a manner that was destructive for all concerned. The producers united and asked the State of Texas to step in and manage the allocation of production of oil in a manner that was equitable and would minimize the boom/bust trends.

The result was the Texas Railroad Commission that continues to function today. The impact of the Commission is felt at the international level, as it was the model for the creation of the Organization of Petroleum Exporting Countries (OPEC) that now represents multi-national interests in petroleum production.

Industry Characteristics - Standards Driven

The twin concepts of using quality as the basis for marketing and verifiable standards as a measure of quality largely began with the petroleum industry. The technical orientation of the industry from its early days allowed the industry to respond fairly easily when the

market shifted from kerosene for lighting to gasoline, diesel, and fuel oil for transportation. The use of specifications based on properties of the fuels that were tied to engine specifications made it possible to use chemical property predictions to predict engine performance.

In 1934, the API began Project 44, a complete characterization of the physical and chemical properties of all the compounds in a "standard" barrel of oil. The project continues today, but the results are the foundation of modern physical-organic chemistry.

The need for standardized, repeatable testing methods for the petroleum industry was responsible, in part, for the establishment of the American Society for Testing Materials, ASTM. Today, ASTM continues in its role as a forum for interested parties to establish specifications for the properties and performance of a wide range of materials. An additional function of ASTM is to establish and validate methods to measure the properties used in the standards.

The current trends towards placing emissions and health standards on fuels and engine emissions is a logical result of the standards-driven liquid fuels industry.

Industry Characteristics - Multinational

The initial efforts to develop markets in the Far East led to competition along colonial lines, but with U.S. companies and expertise as key participants. For some companies, going international was a way to expand market-share and profits without disturbing the stability of the market within the U.S. For the British, expansion around the world was necessary to provide a secure supply of fuel oil for the British Navy.

As the international markets developed, and competitors such as Russia, Romania, Mexico, and later the Middle East became producers, the issue was balancing of supply and demand. There were a number of meetings among the industry leaders that established market territories and in the Middle East, national boundaries.

The formation of OPEC, in a way, completed the circle of supply balancing attempts by using the Texas Railroad Commission model to structure their collaboration as producers. At first OPEC was not particularly effective, but the Oil Embargo of 1973 restructured the international economy, as well as the international petroleum industry.

Production and Marketing of Petroleum Products

The path of production of all petroleum-derived liquid fuels is essentially the same. First, there is a phase of exploration to find new fields where oil (or natural gas) can be recovered. The resource is accessed through drilling into the formation where it is trapped, and the resource is produced.

In the early life of an oil or gas field, the naturally occurring pressure in the formation pushes the fluid into and up the well bore. Oil is pumped, in part to control the flow rate

to the surface. As a field ages, the pressure drops and the recovery rate slows. Some stripper wells may only produce a few barrels per day. There are a number of formations where secondary means of recovery, such as water flooding are used to recover additional oil. There is no risk in finding the wells, but the recovery operation is not always as effective as it might have been.

Refining and petrochemical complexes vary from small refiners with low capacity and few products, to massive complexes. In some areas, such as the Texas Gulf Coast, the chemical complexes are interconnected, sharing products and raw materials to make fuels, polymers, and basic chemicals for a wide range of end uses.

For those of us involved in biodiesel, the interface with the liquid fuel industry is at the level of the fuel distributor. Bulk fuel product can be transported to the distribution terminal by pipeline, boat, of truck. It is at the terminal the biodiesel blends are most commonly created for sale.

Fuel distributors commonly operate under a franchise with the petroleum company. Their business is to provide fuel to company stations, to fleet purchasers, and to customers on the spot market. Some of the large truck stop chains have their own distributor network, but usually in collaboration with a specific refiner.

It is most typical that the biodiesel producer will deliver their product as B100 to the distribution terminal. At the terminal, the biodiesel is added on top of the petro-diesel fuel. Commonly this will be in the tanker used to move the fuel to market. The two fuels will mix due to the motion in the tanker. The biodiesel is slightly heavier than petro-diesel, which is why it is added to the top of the tank.

The Refiner's View of Diesel Fuel

In the refinery, the different products from the sequence of distillation towers at the beginning of the operation are referred to as "cuts". The lightest cut is a mixture of hydrocarbon gases such as methane, ethane and propane. Butane is an intermediate cut that can be sold as a fuel, converted into other chemical products, or added to gasoline in winter. The gasoline and kerosene cuts are next in order. Diesel is a cut below kerosene and above the valuable gas oil cut. The gas oil cut can be reformed into gasoline, increasing the total production.

Sulfur is a poison to the catalysts used to control harmful emissions from internal combustion engines. Crude oil with high sulfur content can be treated to remove the sulfur, but in many cases the sulfur compounds will naturally distill out in the diesel cut. Until recently, there have been minimal restrictions on the sulfur content in diesel fuel. However, the market for diesel fuel is extremely large, and mostly for heavy-duty truck engines. The emissions from these engines have been increasingly identified as sources of air pollution and possible health risks. New regulations of emissions from diesel engines are key factors in creating a market niche for biodiesel.

Factors Creating the Market for Biodiesel

Increasingly stringent enforcement of the Clean Air Act has led to requirements of lowered sulfur content and fewer particulate emissions from diesel fuel. There are more questions regarding the long-term health effects of exposure to diesel particulates. Particularly in Air Quality Non-attainment areas, there are questions of how to meet these more stringent requirements. Biodiesel blends add lubricity to low-sulfur diesel fuels, and significantly reduce particulate emissions.

Diesel Fuel Marketing

The dominant market for diesel fuel is over-road trucking. The fuel supply system for the trucking industry is predominantly through company-serviced truck stops. The same jobber that delivers gasoline to the truck stop will likely also deliver diesel fuel. Unless the petroleum company and the local jobber approve of the blending and sale of biodiesel blends at their facilities, there will be no biodiesel sales.

The task of the biodiesel producer is to deliver clean, on-specification B100 to the distributor. Strategies to ensure the delivery of top quality biodiesel to the blender include:

- Clean, dry transport tanks;
- Clean, dry storage tanks;
- Making and certifying the specified blend levels;
- Minimizing storage time before transport and sales; and,
- Requiring high quality petro-diesel blend stock (ASTM D 975).

Summary

The liquid fuels industry and the production of biodiesel share the attribute of standards-driven quality control for the fuels. However, biodiesel producers tend to be somewhat regionally focused with respect to feedstock and markets and most at this time are product specific; they make biodiesel and glycerol. Biodiesel capital investments are lower by far, but the typical capacities are also lower. Biodiesel has the opportunity to become a collaborator with the general implementation of low-sulfur diesel standards requiring effective lubricity additives.

4. Business Plan Development

Many individuals considering entering the biodiesel field are looking to start new businesses. A necessary first step for all new businesses, especially if external funding is sought, is the development of a business plan. While much of the material in the following chapter will be well-known to individuals already engage in successful businesses, we have worked to give special attention to those aspects that relate specifically to biodiesel companies.

Why Write a Business Plan?

It is extremely important to the success of your operation that you, the owner/CEO, write the business plan. Often times the process of writing a business plan is more beneficial than the plan itself. It is also a living document that changes as the company evolves.

Parts of a Business Plan

The business plan should consist of eleven separate sections, each one beginning on a new page.

1. Business Request Page
2. Table of Contents
3. Executive Summary
4. Business Description
5. Management
6. Market Analysis
7. Marketing Plan
8. Product of Services
9. Manufacturing Plan
10. Financial Data
11. Supporting Documents

A business plan may be a document written to persuade a lender or lenders to provide capital for your venture. A business plan is an essential management tool for your business. It may serve as the implementation plan for a strategic plan. The business plan outline in this handout applies to an entrepreneur or a businessperson seeking money for a new business startup or a business expansion.

Ten Key Points to Remember When Writing a Business Plan

1. Be honest. Do not be overly optimistic or try to hide limitations or weaknesses.

2. Write in easy to understand terms. Avoid jargon and terms that are unfamiliar to people outside of your industry.

3. Describe your company's image. You need to convince the reader you understand all aspects of the business.

4. Provide the reader with an understanding of your business and how you will use the loan.

5. Evaluate the company's management team. This is a major focus of the plan. Point out the strengths and weakness and how you are going to address these weaknesses.

6. Answer these three strategic planning questions:

- Where are we now?
- Where do we want to be?
- How do we get there?

7. Quantify your market, sales, production, and cost data. Do not generalize. Be specific. Use data to help tell the story.

8. Begin each major section on a new page with the appropriate title (for example, Marketing Plan).

9. The actual content of the business plan will vary depending on the nature and complexity of the business, the stage of development, and the type of financing needed.

10. The business plan may be used as a sales document. The content and quality of the plan should be representative of your company.

Business Request Page

When writing up the Business Request Page you should include your business description with general information such as your company name, address and contact information. If you are requesting financing include the requested dollar amount.

Other information you should include is the terms and predicted timeline should include month and year the loan is required; the purpose of the loan should be specific. Also include how money will be spent, the type of collateral, dollar amount, and type of equity you are proposing. As owner how much cash will you invest, or what type of assets will you contribute? Finally list the contact person at the firm who is responsible for the proposed business plan.

Executive Summary

The executive summary should contain a brief synopsis of the business plan development. It gives the readers an overall summation of the company and highlights the main points of the business plan.

The Business description should contain the following information:

- Name
- Starting date
- Location
- Biodiesel Plant description (type of process, type of feedstock, type of glycerol processing—80% raw, 95% technical grade, or 99.7% kosher grade)
- Significant company history
- Business goals
- Type of company (Corporation, LLC….)

Make sure to include name, address, plant or store description and brief history.

The main points include the following categories and will be explained in more detail later:

- Management expertise: Discuss the key persons involved in the business and summary of relevant expertise or past business.

- Market analysis and strategy: Who are the customers? Where are they located? What market niche will you serve? Who is your competition? What is the market (sales) potential? How will you sell or market your products?

- Targeted market and demand: Discuss the main targeted markets you are going to try and capture and the demand in those markets.

- Product/Services: Give a description of the product or service. What differentiates your product from existing products? What features of your product will give you a competitive edge in the marketplace? What is the product's current state of development: do you need further R&D; do you have blueprints but no prototypes; is a prototype built and ready for production? What type of protection do you need: patents, trademark or copyright?

- Description and stage of development: What is your current stage of development? Describe each stage and the projected time frame to achieve each stage of development.

- Manufacturing Plan: What are the materials, supplies, and equipment you will need to manufacture your product? How are you going to accomplish this and what steps must you follow? How does this relate to the biodiesel process you are going to use and its related feedstock?

- Financial Information: Financial Information should be included if the business plan is for the purpose of borrowing money. Describe what the sources of funds are and give a breakdown of the amount each source is supplying. Give an

explanation of why the money is needed and how it will be used. Finally, show your proposed repayment plan for these funds along with a break-even summary.

In the case of a turnaround situation for a company, describe the steps you will be taking to accomplish this task. It is important in the case of a turnaround situation that goals are set for evaluating the success in making the transition and turning the company financials into the positive.

Business Description

The business description illustrates the current status of the business and the future direction of the business by providing information on the demographics of your company. The business description should include basics such as name, type of business (partnership, etc), and go on to finer details that identify your unique competitive advantage. We will go through the business description section by section.

Company history: Company history describes the company's development, or information about how your idea developed.

Discussion of the biodiesel industry: Discuss the biodiesel industry and provide any information that may be relevant to your business.

Legal structure: The organization of the business should take into account the legal and tax ramifications.

Employment: Determine the number of employees needed to meet staffing needs and consider employees' age distribution. Briefly discuss employees' qualifications to do the work based on training, education and/or experience.

Mission statement: A business mission statement should include the company's philosophy and values on serving their customers for current and future products provided by the business.

Business goals: Discuss where the company is today (current status), and where it wants to be (company goals) in the future. State goals quantitatively. Analyze your company in terms of strengths, weaknesses, opportunities, and threats (SWOT).

Specific line of products/services: When describing the specific line of products/services, it is important to keep in mind who your customers are and how the products/services being offered affect their needs and wants. Channels of distribution, seasons of operation, and even hours of operation will affect your customers.

Management Skills

Here are six skills or traits that one should look for in their management:

1. Ability to identify and develop business strategies
2. Ability to organize and maximize efficiency
3. Able to coordinate all activities
4. Ability to understand and adjust business plan
5. Ability to delegate
6. Ability to control and supervise the business

The most critical part of a business plan is the management section. The management of a business faces many diverse circumstances and dynamitic challenges on a daily basis. The management team of your business must be able to stay on top of the changing markets and adapt to these changes while running the business in an efficient manner. It is key that the management team works as a team to delegate tasks, remain in control, and plan for the future of the business while meeting the demands of today.

Hence, it is the management of a business that provides the business with the ability to implement the plan from paper to reality. . Therefore, in this section, be honest, but do not be modest or boastful.

Let's look specific points to cover in the Management section of your business plan.

Management

The first five areas that should be addressed in the management section are:

- Key personnel
- Management team
- Reporting relationships
- Directors/Advisors
- Staffing plan

Key personnel: List the key management personnel and their duties and responsibilities. Resumes should be included in the supporting documents to show management has experience and skills needed to manage the company. Emphasize past successes and current roles in the business

Management team: Explain how diversities and similarities (in education, training, experience, etc.) among the key personnel will make a management team that will lead the business to success.

Reporting relationships: Define responsibilities of the officers. Also define the reporting relationships. Organizational charts give a clear picture of the company's management

structure and who is responsible for what divisions and/or tasks. Include salary structure and ownership shares in this section.

Directors/Advisors: Determine the form of the business and define who the board of directors and outside advisory services are in the management of the business.

Staffing plan: Discuss management needed in the organization, how you will fill key slots, hiring plans and the date positions will be filled. Also consider the ability to house more employees for potential growth.

The next five areas that should be addressed in the management section are:

- Business organization
- Ownership
- Management duties
- Investment
- Competitive advantage

Business organization: Define your business organization.

Ownership: State the names of stockholders and shareholders.

Management duties: Discuss the managers or private firms who will handle the management duties. Include internal control systems for accounting, inventory and management information reporting systems.

Investment: Amount of money invested by the owners.

Competitive advantage: A successful business will tailor how their products and services are being offered to meet the demands of their customers, giving the business a competitive edge by using the management team's experience and/or skills.

Market Analysis

Market analysis is needed for the products that will be produced by your company. While biodiesel is probably the main product (and it is used as an example in the discussion that follows) your company may also be selling glycerol and other byproducts. When you consider market analysis you should ask yourself the following questions:

- Who are the customers of biodiesel?
- What biodiesel products are they going to buy?
- Quantity of product needed at this time?
- What is the best approach to get the product or service to the customers?
- What are the future prospects for the business?

The market section will answer questions and considerations like these by discussing the marketing mix: Product/Service, Distribution channels, Price, and Promotion. This section looks at the elements in the marketing mix in comparison to the industry and more specifically, against your competition.

Who are the customers of biodiesel?
Determine and understand the preliminary biodiesel market area and identify potential target markets.

What biodiesel products are they going to buy?
Gather information regarding the biodiesel market area and target markets.

Quantity of product needed at this time?
Analyze information to project sales.

What is the best approach to get the product or service to the customers?
Study data available from the industry. Pay particular attention to transportation. Plant location relative to the feedstock and the major markets will be a major factor in the selling price.

What are the future prospects for the business?
Set a business course.

The market analysis will help you answer these questions by analysis of these areas:
1. Focus on target markets
2. Discuss the demographics of potential customers and why they want your product
3. Look at the willingness of people to buy your product; and
4. Show that your business will be able to survive and grow

So let's look at the points that should be included in your business' market analysis section.

Market Analysis - Customers

Customers: Identify customers and potential customers. Discuss demographic information about customers such as age, sex, income, type of work and where they are located. Determine the customer by targeting the market you are going after. This will help focus your sales effort.

Let us now look at a method in identifying your customer called target market analysis, which will help you understand your targeted market.

Target Market & Analysis

According to Iowa Small Business Development Centers, a target market is the prime user of current product and/or service that are similar to your business. In this case, the target market is the user of diesel fuel.

Identify who the customers are. Your potential market is your future customers, also referred to as targeted market.

There are three components of a target market analysis and they are:

- Use preliminary market data to identify potential target market
- Identify where the target market is located
  - Geographic boundaries and/or characteristics
- Identify who the target market is
  - Demographics and socioeconomic characteristics

Preliminary market information can come from a variety of sources; gather as much information about the market as you can.

Pick or determine the geographic boundaries of your targeted market or customer. Sometimes the geographical boundaries are formed by unique characteristics of the targeted market you have determined to pursue.

After determining your target market, gather as much information about your market and the customer as you can. All this information will help you decide how you are going to capture the market.

An important concern for the biodiesel industry is whether the primary market is individual consumers or organizations. This will be affected by the nature of any government subsidies and mandates that may be in place. If the market has a major consumer component, two additional items to consider in your target market analysis are:

- If having difficulties identifying the target market, look for variables in your potential market.
- Variables include:
  - Age, occupation, education
  - Family Cycle (intergenerational use)
  - Commercial, non-commercial, agriculture

Variables may offer some insight to who makes up the target market. Family life cycle for example: If the wife is a customer will her husband be a customer too? Or if one generation is a customer, will future generations (or other members) of that family be loyal customers of yours too?

Other variables may include modes of transportation used by the potential market, competitors, and type of business customer (i.e. commercial or noncommercial).

If the market is composed mainly of organizations, the analysis should focus on the potential from the following groups:

- Federal Government fleets that must meet EPACT requirements
- States that are pushing mandates for biodiesel
- School boards that are concerned about student exposure to diesel fumes as the students wait in queues to either board buses or unload from buses
- Cities with pollution concerns (biodiesel would have to have a proven NOx reducer additive)
- Fleet operations that want a green fuel
- Underground mines that need to reduce particulate emissions

Market Area Analysis

When we talk about market area analysis we are talking about the following:

- Gather information regarding the market area and target markets
- Population figures for present and future
- Check Bureau of Census for information on age, income, sex, occupation and education
- Identify the transient populations (if applicable)

For population figures for the present and future you may want to check past population for a greater scope - look for increases and decreases to indicate booms or busts within the specific area. Use census information and Web sites to find this information. Also economic development in your area or the area where your market is found can be a great resource for this information.

Market Analysis & Market Size and Trends

Market size and trends: Discuss market in current unit and dollar size. Include future industry growth and trends. Support with documentation.

One of the most important areas to look at is market trends. Items we want to find out in this area are:

- What economic trends affect the business?
    - Information on economic trends will reflect where the industry is now in relation to age, direction, and business cycle.
- Positive trends versus negative trends
- Information on economic trends (Regulatory trends)
- Trends with competitive fuels or fuel technologies
- Feedstock trends

- Technology trends
- Government price supports

Information on economic trends will reflect where the industry is now in relation to age, direction, and business cycle. Examples of trends include size, ages, areas, and increases and decreases.

Size trends: Are customers buy larger quantities or smaller?
Ages trends: Is the target market younger than it was five years ago? Is teenage spending down from a year ago?
Area trends: Is there more spending in downtown locations? Are rural agencies having an increase in their contract cliental?

Positive economic trends need to be considered in relation to negative trends. Example: Store A is a downtown store that sells a variety of clothing to teenagers and young adults. An economic trend that downtown spending is down would be a negative trend for this store. However, if teenage spending is up, this positive trend may outweigh the effects from the negative trend of a decrease in downtown spending.

Economic trend information can be found in a variety of places for both general trends for the country and industry specific trends. Sources for trend information include U.S. Department of Commerce, Census Bureau Data Annual Survey, Current Industrial Reports, and Trade Journals.

Regulatory trends can have a profound affect on the biodiesel industry. It can affect how fast the industry can grow and climate in legislative bodies of the government toward biodiesel and renewable fuels.

Trends with competitive fuels or fuel technologies will help you understand how biodiesel fits in the market place with respect to other fuels and fuel technologies. These trends can give you an insight to the financial viability of biodiesel production in your area.

Feedstock trends will affect the cost structure of your business plan. Historical trends can help identify the best feedstock to use in your specific case.

Technology trends need to be considered to determine future needs in the area of biodiesel production and use. These trends will help identify new markets as technology is developed for equipment and uses of biodiesel.

Market Analysis - Competition

Competition:
Identify the competition and where they are located. Discuss competitors' annual sales volume, market share, strengths and weaknesses. Discuss key differences of your

company and product compared to the competition and your product price compared to the competitors' price.

Market Area Analysis

- Check for future community developments that could affect major changes
- Identify and understand competitors (biodiesel competors and other alternative fuel or diesel fuel competitors)
- Determine how much is spent on product/service (diesel fuel) in the area through retail locations or commercial distribution terminalsDetermine cost, selling price and benefits of competitive products

This will help you identify what your customers have been buying or are going to buy, and whom they are going to buy from.

Market Analysis - Estimated market share and sales

Estimated market share and sales:
Include projected unit and dollar sales and area of the sales territory.

Analyze Information to Project Sales

A few methods to use to determine projected sales are:

- Calculate the average number of people per business in your area
- For more information, you may want to try a test market
- Survey your potential market
- Research trade and government publications on market size and distribution

Surveys give direct information from the potential target market for analysis. Test markets and surveys will give you information on the current market position and on how your product compares to the competition.

Market Analysis - Product distribution and sales

Product distribution and sales:
Discuss how this type of product is sold in the market place. Discuss distribution and your plans compared to customary practices.

Analyze Information on product distribution and sales

To gain the necessary information on product distribution and sales, you can:

- Talk with similar businesses in other (but similar) communities about the market area

- Ask manufactures, suppliers, and distributors for their information about a possible market in your area of interest

Analyzing information on projected sales will give you a better understanding of the demand for your product/services. This will also help you to decide the quantity of products needed at this point in time.

Market Analysis - Competitive Advantage

Competitive advantage: Discuss the competitive advantages of your company and product compared to industry and competition.

Ask yourself these three questions to help you determine your competitive advantage:

- What makes your company unique?
- What is it that draws customers to you instead of your competition?
- How do you plan to keep your competitive edge so customers continue buying from your business?

These can be some of the hardest and most important questions to answer. These are the same questions that the banker or lending institution will be asking. They will address why you think the customers will purchase your product over the competition and ultimately lead to your projected sales. You need a reason to set you above the competition in your customer's eyes.

Market Analysis - Analysis

Analysis: Analyze strengths and weaknesses of your product line and company versus competitors' product line and company.

- Strengths versus weaknesses
- Your product line versus competitors product line
- Your company versus the competitors company

Be honest and try to be as objective as possible when comparing your company to that of the competitor. Any weakness you point out should be addressed in your business plan, as well as how you are going to improve them.

Market Planning Questions

SBDC of Iowa suggests that you ask yourself these questions when writing your market plan.

- Is there a real customer need?

- Can you get a price that gives you good margins?
- Is your company a credible source for the product?
- Does the Biodiesel product or service produce a clear benefit significantly better than the competition?
- Is there a cost effective way to get the message and product to the customer?
- How and where are you going to sell your Biodiesel product?

I will cover these specific points associated with the marketing section again by using a different approach in the following slides to help you in writing your market plan and in determining the answers to these questions.

Marketing Plan

In this section we will cover three main areas:

- Marketing goals and objectives
- Overall marketing strategy
  - Catching your customers
  - Capturing your customers
- Sales methods
  - Advertising
  - Ensure projected sales level

The Marketing Plan section of your business plan development show that you know how and where to sell your product.

Marketing goals and objectives: What do you plan to do with the marketing effort? What are sales forecast targets?

Overall marketing strategy: A key element to discuss is the market niches the company will have. Discuss how customers will be identified and sold; pricing strategy-pricing policy versus competition policy; service and warranty policies; how you will capture customers from competitors; credit terms. Include goals and timetables.

Sales methods: Discuss advertising and promotion policy; sales force management; sales staffing -manufacturing representatives or company sales force; sales area; distribution and sales methods -factory direct, dealers or wholesalers; how the sales methods will ensure projected sales levels are attained.

Three additional areas are:

- Test markets

  - Determine acceptance/demand for product
  - Offered for a limited time
- Marketing budget
  - Allocation of money
- Key assumptions

Test markets: Provide results of completed test marketing or outline the plan to conduct test marketing. Test market may be used to determine acceptance/demand by producing a limited amount of product and/or offering services for a limited time. This will help you determine the interest in your product and/or service and help you in identifying future customers. A recent example of a test market is one done by Hershey's Chocolate. Hershey's decided to conduct a market analysis on a possible new product buy using a test market strategy. They offered two different types of Hershey's Kisses, Dark Kisses and Creamy Kisses, for an eight-week time period across the United States. Hershey's is now using the information gathered from their test market of dark chocolate and creamy chocolate Hershey's Kisses to determine if there is a market for these new products.

Marketing budget: Show the budget with dollars allocated for advertising, travel, sales balances and commissions, promotional materials, trade shows, samples.

Key assumptions: Keeping up with changes and making plans for those changes.

Future Business Prospects

Once you address the current plans or state of your business markets, you should address future prospects by asking the following question:

- Is your target market the same tomorrow as yesterday, or even today?

After deciding on the answer, explore the following:

- Expanding target market
- Possible contracts
  - Commitment to the market
  - Renewals

Contracts lock in a select market for a certain time frame. Will your market renew those contracts?

Continuing to talk about the future business prospects, you can identify market share and its changes by looking at the following:

- Identify market share and its changes for your business

- People in the area
- Dollars per person spent in the area
- Number of businesses in the area
- Square footage of local businesses
- Locations of business

These are things to keep in mind as time passes and things change. You want your business to keep its competitive edge, so keep in mind what changes customers want and what is changing with your competitors.

Now let's look at market surveys:

- Conduct a survey
- Select type of survey
- Brief and specific
- State the point of the survey
- Give information on your business
- Find information on need of area market
- Pre-test and re-work

Know what is changing and what is happening with both your customers and competitors. This can be done through surveys.

Select the type of survey (telephone, mail, and/or personal). Tell the people who you are surveying: who you are, why you are doing the survey, the amount of time the survey will take, and the value of the survey to you.

The last four areas to consider in determining your future business prospects are:

- Test markets
- Helpful in determining and understanding the changes to the market
- Stay abreast of local, state, and federal regulations
- Check insurance coverage
- Consider political, aesthetic, and ethical trends

Test markets can be helpful in determining the interest in a new service or product line. Know changes in regulations so your business can continue. Stay updated with licenses, patents, sales permits, labor laws, and copyrights so your business can continue to grow and prosper.

Keep insurance coverage updated and renewed to avoid any mishaps. Check into insurance coverage such as property, life, liability, workers compensation, and any other coverage your business may need.

There are many considerations that change over time. Be mindful of the political climate and other such considerations when planning for the future.

Products and Services

There are six areas to address in the category of product and services. The first three are:

- Description of complete product line or services offered
  - Quality of goods and services
- Legal protection
  - Patents, copyrights, legal, and technical considerations
- Comparison to competitor's products or service

The purpose of the Products and Service section is to give a clear picture of your product or service. Whenever possible, use photographs, sketches, digital images, or any other visual aids to present your product/service in the clearest manner. In this section, marketing material used to promote the product should also be included.

Description of complete product line or services offered: Discuss product features and/or quality of products and services. Explain the objective of the product/service.

Legal protection: Patents, copyrights, trademarks.

Competitor's comparison: How do your products/services differ from your competitors? What are the similarities?

The remaining three points to include in the Products and Services sections are regulatory agency requirements, competitive advantage, and customer benefits.

- Regulatory agency requirements
  - Know regulations
- Competitive advantage
- Customer benefits
  - Product
  - Service

Regulatory agency requirements: Know the requirements, restrictions, and limitations enforced by regulatory agencies that affect your business.

Competitive advantage: Determine your unique competitive advantages versus the competition. What makes your product/service stand out compared to your competitors?

Customer benefits: Benefits the customers have from using your product/service. Also look in terms of your staff. Benefits to customers may include the qualities of your employees: their knowledge, experience, and/or attitude.

Manufacturing Plan

The objection of the manufacturing plan sections is to demonstrate that you know how to produce the product, and you can produce a quality product in quantities in a sufficient amount of time to meet customer demand. The following points will help you convince the reader of your business development plan that you can do this.

- Facility
- Location – Site Selection
  - Plant location is important to reduce transportation costs
  - If using soybean oil, the plant should be located near crushing or extraction facilities
  - If using yellow grease, the plant location should be in an area with sufficient population to generate the feedstock for the plant
- Production
  - Methods (Feedstock processing capability – no, low, or high FFA)
  - Equipment
  - Timeline
  - Degree of productivity

Facility: Size of facility needed with a plant layout sketch. It may be a good idea to plan for capital improvements. Minimum economic size for a plant will depend on feedstock type and the extent of processing to be conducted on-site. The minimum economic size for a glycerol refining plant may be much larger than the glycerol produced by a minimum size biodiesel plant.

Locations: City, state and address where plant will be located.

Production: Discuss how this plan for a product will transform into a reality. Discuss your production methods and the state of art of your production process. Explain what equipment is needed. Discuss how the manufacturing operation will help make the business a success. Detail your production capacity versus sales needs. Include product literature on key pieces of equipment you will purchase and why you are buying that piece. Discuss how you will produce or provide the service or product.

Other topics to address in your manufacturing plan are:

- Staffing
- Inventory

- Quality
- Raw Material
- Environmental issues

Staffing: Describe the size of the workforce needed. . Discuss the skills needed in the ideal worker. Also discuss possible training programs to build upon skills and talents possessed by the workers.

Inventory: Inventory policy for raw material and finished goods. Discuss how you plan to keep track of materials to avoid over ordering, or lack of essential materials during crucial production timeframes. You need to include plans for providing the working capital to maintain the finished goods inventory.

Quality: Quality control, quality assurance plans and plans to implement ISO 9000 or BQ 9000.

Material: Raw materials needed and sources of supply. List key suppliers.

Environmental issues: Environmental issues and any anticipated environmental factors. Discuss your environmental compliance program.

The final four areas to address in your manufacturing plan are:

- Condition of production assets
- Manufacturing process advantages
- Government requirements
- Key assumptions

Condition of production assets: What is the condition of your production facilities and equipment? Are you using the state of the art equipment?

Manufacturing process advantages: State any unique competitive advantage you have in the manufacturing process arena. How are you doing it differently than your competitors and why are they not following in your footsteps?

Government requirements: Discuss how you intend to comply with governmental agencies requirements such as OSHA for safety and air quality permits for the state and federal government.

Key Assumptions. What are the key assumptions you used in developing your manufacturing plan?

Financial Data

In the Financial Data section, you want to illustrate how you can make a profit, have positive cash flow and be able to repay any debt. The following points will aid you in completing this section.

The first few areas we will cover are:

- Sources and applications of funding
- Equipment list
- Pro forma balance sheet
- Break-even analysis
- Income projections

Sources and applications of funding: Where is the funding coming from and what is it being used for.

Equipment list: Include the model and serial number if known.

Pro forma balance sheet: Make sure to include notes and explanations on your pro forma balance sheet.

Break-even analysis: Explain how you plan to break even.

Income projections: This should be a three-year projection with notes of explanation. The first year should be done on monthly projections and then the remaining years should be done on quarterly or annual basis.

The next areas to consider are:

- 12-month cash flow
- Cost of goods sold
- Audited financial statements
- Collateral
- Aging accounts payable and accounts receivable (for an existing business)
- Personal financial statements

12-month cash flow: Include notes of explanation.

Cost of goods sold: Make a detail schedule for the cost of goods sold.

Audited financial statements: Use and keep audited financial statements for the past 3-5 years.

Collateral: Make a list of collateral offered to secure loan(s).

Aging accounts payable and accounts receivable: For existing businesses, financial data can be obtained from accounts payable and accounts receivable information.

Personal financial statements: Owners with 20% or more ownership should keep a personal financial statement. Personal financial statements should be done for each owner.

Balance Sheet

The following pages show examples of a Balance Sheet and an Income Projection Sheet.

Balance Sheet

CURRENT ASSETS
- Cash $_____
- Accounts Receivable $_____
- Inventory $_____

TOTAL CURRENT ASSETS $_____

PROPERTY & EQUIPMENT
- Land & Buildings $_____
- Fixtures & Equipment $_____
- Vehicles $_____
- TOTAL $_____

- Less accumulated depreciation $_____
- NET PROPERTY & EQUIPMENT $_____

OTHER ASSETS
- Licenses $_____
- Goodwill $_____

TOTAL ASSETS $_____

CURRENT LIABILITIES
- Notes Payable $_____
- Accounts Payable $_____
- Accrued Expenses $_____
- Taxes Owed $_____
- Current Portion, Long Term Debt $_____
- TOTAL CURRENT LIABILITIES $_____

LONG TERM DEBT
- Loans $_____

TOTAL LIABILITIES $_____

STOCKHOLDER'S EQUITY
- Capital Stock $_____
- Paid-In Capital $_____
- Retained Earnings $_____
- TOTAL NET WORTH $_____

TOTAL LIABILITIES & NET WORTH $_____

Income Projections

INCOME PROJECTS

	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Yr 20xx	Yr 20xx
SALES						
Cost of Sales						
Material						
Labor						
Supplies						
Gross Profit						
OPERATING EXPENSES						
Officers Salaries						
Office/Mgr's Salaries						
Payroll Expenses						
Supplies (office)						
Advertising						
Travel						
Depreciation						
Freight/Postage						
Insurance						
Utilities						
Accounting/Legal						
Real Estate & Pers. Taxes						
Telephone						
Repairs & Maintenance						
Misc. Expenses						
Auto/Truck Expenses						
Rent or Lease Expenses						
Product Testing						
Total Expenses						
Operating Profit						
Interest Expense						
Other Income						
Other Expense						
Net Profit (Before Income Taxes)						
Estimated Income Taxes						
NET PROFIT						

General Supporting Documents

A list of some general supporting documents:

- Letters from future customers
- Plant layout
- Product brochures, promotional materials
- Resumes
- Market research data
- Patent or trademark information
- Letters of financial commitment

Letters from future customers: These can also be contracts or letters of intent to do business with you.

Plant layout: A general plant layout should be included. This will show that you have done enough engineering or development work to know that the building size for your business is adequate.

Product brochures, promotional materials: These materials should have been developed and used to describe your product to the potential customer market. They don't have to be very fancy at first, but need to contain information about your business and products.

Resumes of all key personnel: Make sure all your upper management resumes are included.

Market research data: Includes documented evidence of market growth, trends, and statistics

Patent or trademark information: Legal documentation

Financial commitments from primary investors for capital or working capital, etc.

Critical Risks & Problems Supporting Documents

In the Supporting Documents section, include critical risks and problems that you think may occur. Identify and discuss major risks and problems that you think you may encounter. Feedstock price swings and pricing differential between soy oil and yellow grease are potential risk factors. Glycerol pricing and the potential for a glut in the glycerol market are also risks.

Discuss risks including, but not limited to, the company, industry, personnel, market, product, and financing. Indicate which assumptions or potential problems are most critical and how your plans reduce the impact of unfavorable developments. This is one

area that you can address any weaknesses of your company that were mentioned in previous sections of your business plan.

A short list of some other supporting documents that might fit in these areas are:

- Price cutting by competitors (including loss of mandates, loss or changes in subsidies, or changing competitive advantage of other producers as a result of state subsidies, etc.)
- Any potentially unfavorable industry-wide trends
- Design or manufacturing costs in excess of estimates
- Sales projections not achieved
- Product development schedule not met

Other potential risk areas that should be addressed are:

- Difficulties or long lead times encountered in the procurement of parts or raw materials
- Difficulties encountered in obtaining bank credit lines because of tight money (or because product market is considered risky)
- Larger than expected innovation and development costs to stay competitive
- Availability of trained labor

If your process uses an uncommon raw material or one that is transported from a far distance, it might be difficult to obtain or take long times for you to receive them. Describe how you are going to deal with this situation and meet customer needs.

In times of a growing economy, money can be in tight supply. This might mean higher than normal interest rates or difficulty in finding banks that are willing to work with new startup companies. Biodiesel markets may be considered risky because they may depend on mandates or subsidies. Typically, debt financing is difficult to obtain and equity financing makes up a larger share of financial commitments.

Some processes or industries require state of the art technology to stay competitive. The computer industry is one that has a high cost for research and development.

The labor market might be tight and it will be hard to find good workers. This can affect the ability to hire the workforce that you need to efficiently work at your plant.

Resources for Information

Here are some resources for additional information on writing and developing a business plan. Some of them are found only in Iowa, but comparable organizations should be available in your states, too.

- Iowa State University Extension
- Center for Industrial Research and Service
- Iowa Manufacturing Extension Partnership
- John Pappajohn Entrepreneurial Centers
- Small Business Development Centers
- U.S. Small Business Administration

Again, here are other resources that are available and many times can be accessed over the Internet.

- Iowa Department of Economic Development
- Iowa Workforce Development
- Iowa Secretary of State
- Iowa Department of Revenue and Finance
- Local agencies in your area (Economic Development, City Council, ...)
- USDA and Value Added Agriculture Extension
- National Biodiesel organizations

Acknowledgements

- Small Business Development Centers
- Iowa Manufacturing Extension Partnership
- Center for Industrial Research and Service
- Iowa State University Extension
- National Renewable Energy Laboratories
- "How to Write a Business Plan" by Verl Anders, CIRAS

5. Financing

Introduction

Financing is one of the most important facets of starting or expanding a business. It is financing that will fund the manpower, equipment purchases, and day-to-day expenses related to creating or expanding a business. There are a number of sources for money to start your business.
Financing will be broken down into the following areas:

- Federal Sources
- State Sources*
- Local/Community Sources
- Other Sources

*Many of the state sources listed below are specific to Iowa, because of resources available in preparing this manuscript. Please note that there are similar programs available in most states.

Federal Sources of Financing

United States Department of Agricultural (USDA)

There are many federal sources of financing but in the value added agriculture and rural development, the USDA is one of the best sources. The amounts allocated for the fiscal year 2003 from the USDA are listed below:

Fiscal Year 2003 Program Levels:

- Business and Industrial Loan Guarantee Program - $894 million plus $309 million carryover
- Rural Business Enterprise Grant Program - $46.6 million
- Intermediary Re-lending Program - $39.74 million
- Rural Economic Development Loan - $14.86 million
- Rural Economic Development Grant - $4 million
- Rural Business Opportunity Grant - $2.98 million

Program: Business and Industrial Loan Guarantee Program
The Business and Industrial Loan Guarantee Program provides guarantees on loans of up to $10 million made by private lenders for start-up or expansion purposes to businesses located in rural areas with populations of less than 50,000.

This nationwide program can be used to provide a loan guarantee for a commercial loan from a bank. The guarantee commonly ranges from 70%-90% of the loan based on a set of criteria to evaluate the risk and viability of the business venture. This has been very popular with value added

agriculture businesses, although any type of business can apply for the loan guarantee program.

Program: Rural Business Enterprise Grants
The Rural Business-Cooperative Service (RBS) makes grants under the Rural Business Enterprise Grants (RBEG) Program to public bodies, private nonprofit corporations, and Federally-recognized Indian Tribal groups. The funding can be used to finance and facilitate development of small and emerging private business enterprises located in areas outside the boundary of a city or unincorporated areas of 50,000 or more and its immediately adjacent urbanized or urbanizing area. The public bodies, private nonprofit corporations and federally recognized Indian tribes receive the grant to assist a business. GRANT FUNDS DO NOT GO DIRECTLY TO THE BUSINESS.

Who is Eligible?
Eligibility is limited to public bodies, private nonprofit corporations, and Federally-recognized Indian Tribal groups. Public bodies include incorporated towns and villages, boroughs, townships, counties, States, authorities, districts, Indian Tribes on Federal and State reservations, and other Federally-recognized Indian Tribal groups in rural areas. The small and emerging businesses to be assisted must have less than 50 new employees and less than $1 million in gross annual revenues.

How May Funds be used?
Funds are used for the financing or development of a small and emerging business. Eligible uses are: technical assistance (providing assistance for marketing studies, feasibility studies, business plans, training etc.) to small and emerging businesses; purchasing machinery and equipment to lease to a small and emerging business; creating a revolving loan fund (providing partial funding as a loan to a small and emerging business for the purchase of equipment, working capital, or real estate); or construction of a building for a business incubator for small and emerging businesses.

Limitations:
Grants cannot be used for:

1. Agricultural Production.
2. Comprehensive area-wide planning.
3. Loans by grantees when the rates, terms, and charges for those loans are not reasonable or would be for purposes not eligible under RBEG regulations.
4. Development of a proposal that may result in the transfer of jobs or business activity from one area to another. This provision does not prohibit establishment of a new branch or subsidiary.
5. Development of a proposal, which may result in an increase of goods, materials, commodities, services, or facilities in an area when there is not sufficient demand.

6. For programs operated by cable television systems.
7. To fund part of a project which is dependent on other funding, unless there is a firm commitment of the other funding to ensure completion of the project.

All applications are considered without regard to race, color, religion, sex, national origin, age, marital status, or physical or mental handicap (provided applications have the capacity to enter into a legal contract) of the members of the groups applying for assistance. Service must be extended on the same basis.

How are Applications Processed?

Applicants are required to submit a preapplication with supporting data before a formal application is made. RBS will tentatively determine eligibility and funding priority score. The Agency will inform the applicants when to assemble and submit a formal application.

Where Should Applications be filed?

Forms are available from and may be filed in any USDA Rural Development State Office. Check your telephone directory under "Federal Government" or call the RBS National Office Specialty Lenders Division, (202) 720-1400. To view and print the forms go tohttp://forms.sc.egov.usda.gov/eforms/default1.htm and for regulations go to http://rdinit.usda.gov/regs/regs_toc.html.

We recommend discussing the proposed project and process with your local State or area office before completing the application.

Other Conditions

Applicants for grants to help develop private business enterprises must file written notice of intent with the State single point of contact consistent with Intergovernmental Review requirements. Federally recognized Indian Tribes are exempt from this requirement.

Applicants for grants to establish a revolving loan program must include detail on the applicant's experience operating a revolving loan program, proposed projects, applicant's financial ability to administer a revolving fund, the need for a revolving fund, and other funds proposed to leverage funds made available under this program.

All community projects funded by RBS are subject to an environmental assessment in accordance with the National Environmental Policy Act.

Program: Intermediary Re-lending Program

Another possible source of finance from the United States Department of Agricultural USDA) is the Intermediary Re-lending Program. This program provides loans to intermediaries to establish a revolving loan fund. The intermediary then re-lends the funds for business development projects in rural areas with populations of less than 25,000.

Loans from intermediaries to ultimate recipients must be for the establishment of new businesses, the expansion of existing businesses, creation of employment opportunities, saving of existing jobs, or community development projects. The interest rate on loans to intermediaries is 1 percent per annum. The intermediary and the ultimate recipient negotiate the interest rate charged to ultimate recipients.

Program: Rural Economic Development Loans

Purpose

- Provides zero-interest loans to electric and telephone utilities financed by the Rural Utilities Service (RUS), an agency of the United States Department of Agriculture, to promote sustainable rural economic development and job creation projects.
- Reference: Section 313 of the Rural Electrification Act of 1936 and 7 CFR 1703, Subpart B.

Eligibility and Disposition of Loan Proceeds

- Zero-interest loans can be made, at the discretion of the Administrator of the Rural Business-Cooperative Service (RBS), to any RUS electric or telephone utility that is not delinquent on any Federal debt or in bankruptcy proceedings.
- The RUS utility is required to re-lend, at zero-percent interest, the loan proceeds to an eligible "third-party recipient" for the purpose of financing job creation projects and sustainable economic development within rural areas. Priority is given to financing third-party recipient projects that are physically located in rural areas having a population of less than 2,500 people.
- The RUS utility receiving the zero-interest loan is responsible for repaying the loan to RBS in the event of delinquency or default by the third-party recipient.

Third Party Recipients

Third-party recipients may be private or public organizations having corporate and legal authority to incur debt. If you are interested in a loan as a third-party recipient, you must apply to the RUS utility in your area, not to RBS.

Eligible Loan Purposes

Zero-interest loans will be provided to third-party recipients to finance projects that promote economic development and job creation in rural areas. Examples include but are not limited to:

- Business expansions and business startups, including cost of buildings, equipment, machinery, land, site development, and working capital.
- Community infrastructure necessary for economic development and job creation purposes.
- Community facilities and services necessary for economic development and job creation purposes.

- Medical facilities and equipment to provide medical care to rural residents.
- Educational facilities and equipment to provide training and job enhancement skills to rural residents to facilitate economic development.
- Business incubator projects to assist in developing emerging enterprises.

Ineligible Loan Purposes
Zero-interest loans will not be used by the RUS utility or the third-party recipient for:

- Projects related to the sponsoring RUS utility that would, in the judgment of RBS, create a conflict of interest, or present a potential for or the appearance of a conflict of interest.
- Project costs incurred by the third-party recipient prior to filing of the completed application with RBS.
- Refinancing or paying off any existing debt owed by the third-party recipient.
- Electric or telephone purposes related either to the RUS utility or the third-party.
- Projects located in areas covered by the Coastal Barrier Resources Act or projects that would adversely impact the environment.
- Projects that will be used for residential purposes or entertainment purposes at the residential level.
- The purchase of an established business or operation or to primarily transfer property or real estate between owners without making substantial improvements or additions that will result in long-term job creation.
- Projects that will result in the transfer of existing employment or business activities from one area to another.

Availability of Funds and Loan Award Size
For information concerning the amount of funds available for zero-interest loans under the Rural Economic Development Loan program, as well as the maximum and minimum loan award size, please contact the Rural Development State Office servicing your State.

Supplemental Financing Requirement for Third-Party Projects

- Minimum requirement - 20 percent of the amount of RBS zero-interest loan. Priority will be given to third-party recipient projects with greater than 20 percent supplemental financing.
- No in-kind contributions accepted as supplemental financing.

Loan Repayment Terms between RUS Utility and RBS

- RUS utility signs a 10-year promissory note, payable to the Government. Lesser term notes are acceptable.
- Note will carry a zero-interest rate.
- Principal repayment will be on a monthly basis.

- Deferment of principal payments may be included within the note term. The deferment period for an established third-party business will be limited to 1 year; for a startup business or community infrastructure project, 2 years.

Loan Repayment Terms between RUS Utility and Third-Party Recipient

- Terms will mirror those provided by RBS to the RUS utility.
- The third-party recipient will provide collateral to the RUS utility that is acceptable to the RUS utility.
- Reasonable loan servicing fees may be charged by the RUS utility to the third-party recipient, not to exceed 1 percent a year on the unpaid principal balance of the loan.

A "Complete Application" must consist of: (Refer to 7 CFR 1703.34)

- Standard Form 424, "Application for Federal Assistance" signed by the RUS utility.
- RUS utility Board of Directors resolution requesting the third-party loan.
- Miscellaneous Federal forms and certifications as set forth in 7 CFR 1703.34.
- Narrative discussion of the third-party project consisting of the following:
    - "Selection Factors" as set forth in 7 CFR 1703.35
    - "Project Description" as set forth in 7 CFR 1703.36
    - Discussion regarding environmental impact of the third-party project.

Application Filing, Review, and Selection

- Applications may be filed on any official workday at any Rural Development State Office.
- A simultaneous filing must also be sent to the State single point of contact for State and local governments, if applicable.
- Application selection is competitive. Applications are awarded priority points by RBS based on the selection factors, and the highest-ranked applications are selected for funding.

Some of the factors considered by RBS when making awards include:

- Nature of the project (business expansion or startup, community infrastructure, etc.)
- Direct job creation resulting from the proposed project
- Long-term improvements in economic development resulting from the project
- County economic conditions -- unemployment rate and per capital personal income
- Number of long-term jobs to be created per $100,000 of total project cost
- Physical location of project in rural area of less than 2500 people
- Loan repayment ability of the third-party recipient based on its business plan

Please refer to the regulation for details concerning the selection factors and priority points.

The following financial data is as of September 30, 2000:

- Caseload of Total Borrowers and Funds Outstanding Map (http://www.rudev.usda.gov/rbs/busp/redlmap1.html)
- Cases and Funds Map (http://www.rurdev.usda.gov/rbs/busp/redlmap2.html)
- Obligations by State for 1996 through 2000 (http://www.rurdev.usda.gov/rbs/busp/redlst2.html)

Forms:

- Application for Federal Assistance (Standard Form 424)
- Certification Regarding Debarment, Suspension, and Other Responsibility Matters -- Primary Covered Transactions (Form AD-1047)
- Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion -- Lower Tier Covered Transaction (Form AD-1048)
- Disclosure of Lobbying Activities (Standard Form LLL)

If applying for a grant, the applicant must also submit:

- Certification Regarding Drug-Free Workplace Requirements (Form AD-1049)

Program Administration
The program is administered at the State level by Rural Development State Offices. To obtain the addresses and telephone numbers of State Offices, visit the Rural Development Field Office website (http://www.rurdev.usda.gov/recd_map.html). For further information on this program, please call the State Office servicing your State.

We recommend discussing the proposed project and process with your local State or area office before completing the application.

Program: Rural Economic Development Grants
Purpose

- Provides grant funds to electric and telephone utilities financed by the Rural Utilities Service (RUS), an agency of the United States Department of Agriculture, to promote sustainable rural economic development and job creation projects through the operation of a revolving loan fund program.
- Reference: Section 313 of the Rural Electrification Act of 1936 and 7 CFR 1703, Subpart B.

Eligibility and Use of Grant Proceeds

- Grants can be made, at the discretion of the Administrator of the Rural Business-Cooperative Service (RBS), to any RUS electric or telephone utility that is not delinquent on any Federal debt or in bankruptcy proceedings.
- The RUS utility is required to operate and administer a revolving loan fund program using the grant proceeds. The fund will be operated by the RUS utility in accordance with an RBS-approved revolving loan fund plan.
- To establish the revolving loan fund, the RUS utility is required to contribute to the fund an amount equal to 20 percent of the grant. This contribution will be provided by the RUS utility from its own sources and will remain as part of the fund until the fund is terminated.

Third-Party Recipients and Uses of Loans from the Fund:

- Initial loans, at zero-interest, from the revolving loan fund may only be made to:
    - Non-profit entities or public bodies for community development projects and community facilities and services.
    - Non-profit entities, public bodies, or for-profit entities for educational facilities.
    - Non-profit entities, public bodies, or for-profit entities for medical facilities.
    - Non-profit entities and public bodies for business incubators to assist in developing emerging enterprises.
- Subsequent loans, at an interest rate not to exceed prime, may be made to for-profit entities, non-profit entities, or public bodies for any rural economic development purpose eligible under the program in accordance with the RUS utility's revolving loan fund plan. Subsequent loans are made using repayment funds from the initial loan.

Ineligible Purposes

Grant funds will not be used by the RUS utility or the third-party recipient for:

- Projects related to the sponsoring RUS utility that would, in the judgment of RBS, create a conflict of interest, or present a potential for or the appearance of a conflict of interest.
- Project costs incurred by the third-party recipient prior to filing of the completed application with RBS.
- Refinancing or paying off any existing debt owed by the third-party recipient.
- Electric or telephone purposes related either to the RUS utility or the third-party recipient.
- Projects located in areas covered by the Coastal Barrier Resources Act or projects that would adversely impact the environment.

- Projects that will be used for residential purposes or entertainment purposes at the residential level.
- The purchase of an established business or operation or to primarily transfer property or real estate between owners without making substantial improvements or additions that will result in long-term job creation.
- Projects that will result in the transfer of existing employment or business activities from one area to another.

Availability of Funds and Grant Award Size

For information concerning the amount of funds available for revolving loan fund grants under the Rural Economic Development Grant program, as well as the maximum and minimum grant award size, please contact the Rural Development State Office servicing your State.

Supplemental Financing Requirement for the Third-Party Project

- The third-party recipient must provide supplemental financing for its project. The minimum requirement is 20 percent of the amount of the loan being provided from the revolving loan fund.
- No in-kind contributions are accepted as supplemental financing.

Loan Repayment Terms between RUS Utility and Third-Party Recipient

- Initial loans made from the revolving loan fund must carry a zero-interest rate and not exceed a maximum term of 10 years. Lesser term notes are acceptable.
- The RUS utility will determine repayment terms on loans made using the RUS utility's contribution and on subsequent loans made from repayment of the initial loan. The maximum interest rate for these loans is the prevailing prime rate.
- The third-party recipient will provide collateral to the RUS utility that is acceptable to the RUS utility.
- Reasonable loan servicing fees may be charged by the RUS utility to the third-party recipient, not to exceed 1 percent a year on the unpaid principal balance of the loan.

A “Complete Application” must consist of: (Refer to 7 CFR 1703.34)

- Standard Form 424, “Application for Federal Assistance” signed by the RUS utility.
- RUS utility Board of Directors resolution requesting the grant for revolving loan fund purposes.
- Miscellaneous Federal forms and certifications as set forth in 7 CFR 1703.34.
- Narrative discussion of the initial third-party project consisting of the following:
    - “Selection Factors” as set forth in 7 CFR 1703.35
    - “Project Description” as set forth in 7 CFR 1703.36
    - Discussion regarding environmental impact of the third-party project.

- A revolving loan fund plan outlining, among other things, the specific objectives of the revolving loan fund program, its lending parameters, application process, and procedure for monitoring third-party projects.

Application Filing, Review, and Selection

- Applications may be filed on any official workday at any Rural Development State Office.
- A simultaneous filing must also be sent to the State single point of contact for State and local governments, if applicable.
- Application selection is competitive. Applications are awarded priority points by RBS based on the selection factors, and the highest-ranked applications are selected for funding.

Some of the factors considered by RBS when making awards include:

- Nature of the project (medical or educational facilities, community infrastructure or services, etc.)
- Direct job creation resulting from the proposed project
- Long-term improvements in economic development resulting from the project
- County economic conditions -- unemployment rate and per capital personal income
- Physical location of project in rural area of less than 2500 people
- Loan repayment ability of the third-party recipient based on its business plan

Please refer to the regulation for details concerning the selection factors and priority points.

The following financial data is as of September 30, 2000:

- Caseload of Total Borrowers and Funds Outstanding Map (http://www.rurdev.usda.gov/rbs/busp/redgmap1.html)
- Total Cases and Total Funds Map (http://www.rurdev.usda.gov/rbs/busp/redgmap2.html)
- Obligations by State for 1996 through 2000 (http://www.rurdev.usda.gov/rbs/busp/redgst1.html)

Forms:

- Application for Federal Assistance (Standard Form 424)
- Certification Regarding Debarment, Suspension, and Other Responsibility Matters -- Primary Covered Transactions (Form AD-1047)
- Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion -- Lower Tier Covered Transaction (Form AD-1048)
- Disclosure of Lobbying Activities (Standard Form LLL)

If applying for a grant, the applicant must also submit:

- Certification Regarding Drug-Free Workplace Requirements (Form AD-1049)

Program Administration
The program is administered at the State level by Rural Development State Offices. To obtain the addresses and telephone numbers of State Offices, visit the Rural Development Field Office website. For further information on this program, please call the State Office servicing your State.

We recommend discussing the proposed project and process with your local State or area office before completing the application.

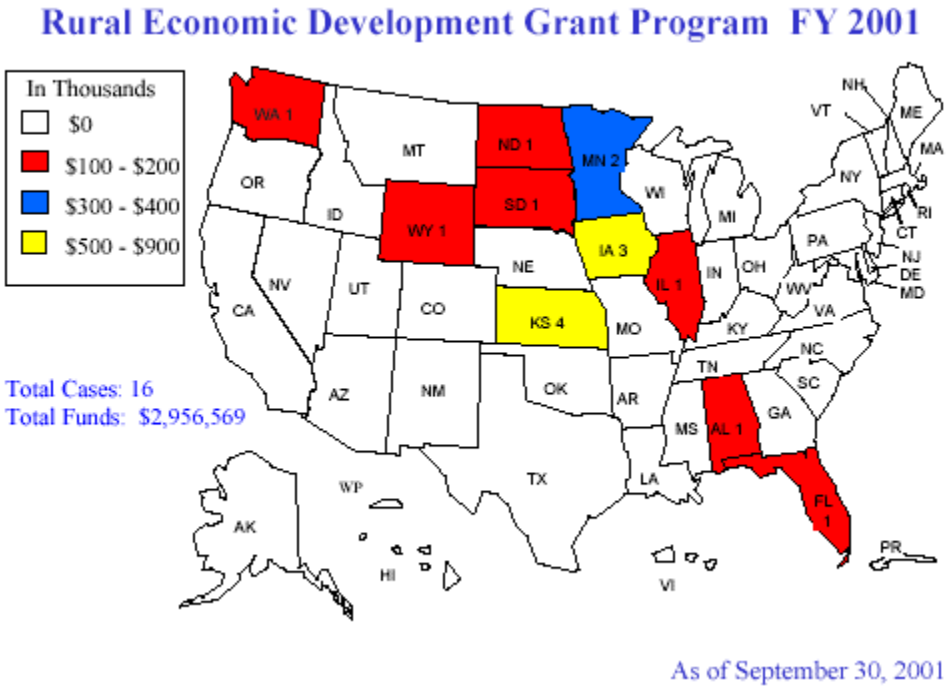


Figure 5-1. Rural Economic Development Grand Program.

Program: Rural Business Opportunity Grants

Purpose
The purpose is to promote sustainable economic development in rural communities with exceptional needs. This is accomplished by making grants to pay costs of providing economic planning for rural communities, technical assistance for rural businesses, or training for rural entrepreneurs or economic development officials.

Eligibility
To be eligible for a Rural Business Opportunity Grant (RBOG) applicant must be a public body, nonprofit corporation, Indian tribe, or cooperative with members that are primarily rural residents. You must have significant expertise in the activities you propose to carry out with the grant funds and financial strength to ensure you can accomplish the objectives of the proposed grant. You must be able to show that the funding will result in economic development of a rural area (any area of a State that is not within the boundaries of a city with a population in excess of 10,000 inhabitants.) Your project must include a basis for determining the success or failure of the project and assessing its impact.

Limitations
Grant funds may not be used for:

- Duplication of current services or replace or substitute support previous provided.
- Pay costs of preparation of application.
- Costs incurred prior to effective date of the grant.
- Fund political activities.
- Acquisition of real estate, building construction or development.

Selection Process
Projects eligible for RBOG funding compete based on certain grant selection criteria. Priority points are awarded to those projects that best meet these criteria and are ranked from the highest to the lowest scoring. The criteria includes the sustainability and quality of the economic activity expected; the amount of leveraging of other funds; economic conditions in the service area, and the project's usefulness as a new best practice. Applications are funded up to the maximum dollars that are available in any given funding cycle.

Availability of Funds
The statutory limit is $1.5 million. The size of grants approved is limited by the amount of program funds available. We expect most grants to be $50,000 or less.

Program Administration
You may file applications with the Rural Development State Office in the State where the grant purposes will be carried out. First, obtain a copy of the program regulation (4284-G) and refer to the application section. A complete application must be filed before it will be scored. [http://www.sc.egov.usda.gov/FormSearch.asp] [http://rdinit.usda.gov/regs/regs_toc.html]

Additional information, copies of the regulations, and forms can be obtained by contacting any USDA Rural Development State Office. Check your telephone directory under "Federal Government" or visit the Rural Development Field Office website to obtain addresses and telephone numbers of State Offices. For further information on this program, please call the State Office servicing your State.

We recommend discussing the proposed project and process with your local State or area office (http://www.rurdev.usda.gov/recd_map.html) before completing the application.

U.S. Small Business Administration (SBA)

The U.S. Small Business Administration (SBA) has many programs available to help the small business owners. Many of them are grouped in the Small Business Administration Loan Programs, which provides a number of guaranteed loan programs designed to meet the needs of small business. It is important to note, however, that the SBA is primarily a guarantor of loans made by private and other institutions.

Program: Basic 7(a) Loan Guaranty

Function
Serves as the SBA's primary business loan program to help qualified small businesses obtain financing when they might not be eligible for business loans through normal lending channels. It is also the agency's most flexible business loan program, since financing under this program can be guaranteed for a variety of general business purposes.
Loan proceeds can be used for most sound business purposes including working capital, machinery and equipment, furniture and fixtures, land and building (including purchase, renovation and new construction), leasehold improvements, and debt refinancing (under special conditions). Loan maturity is up to 10 years for working capital and generally up to 25 years for fixed assets.

Customer
Start-up and existing small businesses, commercial lending institutions
DELIVERED THROUGH: Commercial lending institutions
www.sba.gov/financing/sbaloan/7a.htm
SBA offers multiple variations of the basic 7(a) loan program to accommodate targeted needs.

Program: Certified Development Company (CDC), a 504 Loan Program

Function
Provides long-term, fixed-rate financing to small businesses to acquire real estate or machinery or equipment for expansion or modernization. Typically a 504 project includes a loan secured from a private-sector lender with a senior lien, a loan secured from a CDC (funded by a 100 percent SBA-guaranteed debenture) with a junior lien covering up to 40 percent of the total cost, and a contribution of at least 10 percent equity from the borrower. The maximum SBA debenture generally is $1 million (and up to $1.3 million in some cases).

Customer
Small businesses requiring "brick and mortar" financing

Delivered Through
Certified development companies (private, nonprofit
corporations set up to contribute to the economic development of their communities or regions)
www.sba.gov/financing/sbaloan/cdc504.htm

Program: Micro-loan, a 7(m) Loan Program
Function
Provides short-term loans of up to $35,000 to small businesses and not-for-profit child-care centers for working capital or the purchase of inventory, supplies, furniture, fixtures, machinery and/or equipment. Proceeds cannot be used to pay existing debts or to purchase real estate. The SBA makes or guarantees a loan to an intermediary, who in turn, makes the microloan to the applicant. These organizations also provide management and technical assistance. The loans are not guaranteed by the SBA. The microloan program is available in selected locations in most states.

Customer
Small businesses and not-for-profit child-care centers needing small-scale financing and technical assistance for start-up or expansion

Delivered Through
Specially designated intermediary lenders (nonprofit organizations with experience in lending and in technical assistance)
www.sba.gov/financing/sbaloan/microloans.htm

Program: Loan Pre-qualification

Function
Allows business applicants to have their loan applications for $250,000 or less analyzed and potentially sanctioned by the SBA before they are taken to lenders for consideration. The program focuses on the applicant's character, credit, experience and reliability rather than assets. An SBA-designated intermediary works with the business owner to review and strengthen the loan application. The review is based on key financial ratios, credit and business history, and the loan-request terms. The program is administered by the SBA's Office of Field Operations and SBA district offices.

Customer
Designated small businesses

Delivered Through
Nonprofit intermediaries such as small business development centers and certified development companies operating in specific geographic areas.
www.sba.gov/financing/sbaloan/prequalification.htm

Most lenders are familiar with SBA loan programs so interested applicants should contact their local lender for further information and assistance in the SBA loan application process. Information on SBA loan programs, as well as the management counseling and training services offered by the Agency, is also available from the local SBA office.

Effective December 22, 2000, a maximum loan amount of $2 million has been established for 7(a) loans. However, the maximum dollar amount the SBA can guaranty is generally $1 million. Small loans carry a maximum guaranty of 85 percent. Loans are considered small if the gross loan amount is $150,000 or less. For loans greater than $150,000, the maximum guaranty is 75 percent.

Program: Small Business Innovation Research Grants (SBIR)
Provides small, high technology firms a greater share of federal research development funds.

The Small Business Innovation Research (SBIR) is a competitive, three phase federal funding source, providing qualified small businesses with opportunities to propose innovative R&D projects that meet specific federal needs.

Phase 1 is a feasibility study to evaluate the scientific and technical merit of an idea or technology. Awards are for periods of up to six months in amounts up to $100,000.

Phase 2 expands on the results of Phase 1 and allows consideration of commercialization potential. Awards are for periods up to two years in amounts up to $750,000.

Phase 3 awards support commercialization of the results of Phase 2 and require the use of private sector or non-SBIR federal funding.

Program: Iowa Business Growth Company
Provides fixed-asset loans for land, buildings, remodeling, new construction or equipment. SBA 504 loans are available to qualified small businesses throughout Iowa and provide up to 90 percent financing for most projects.

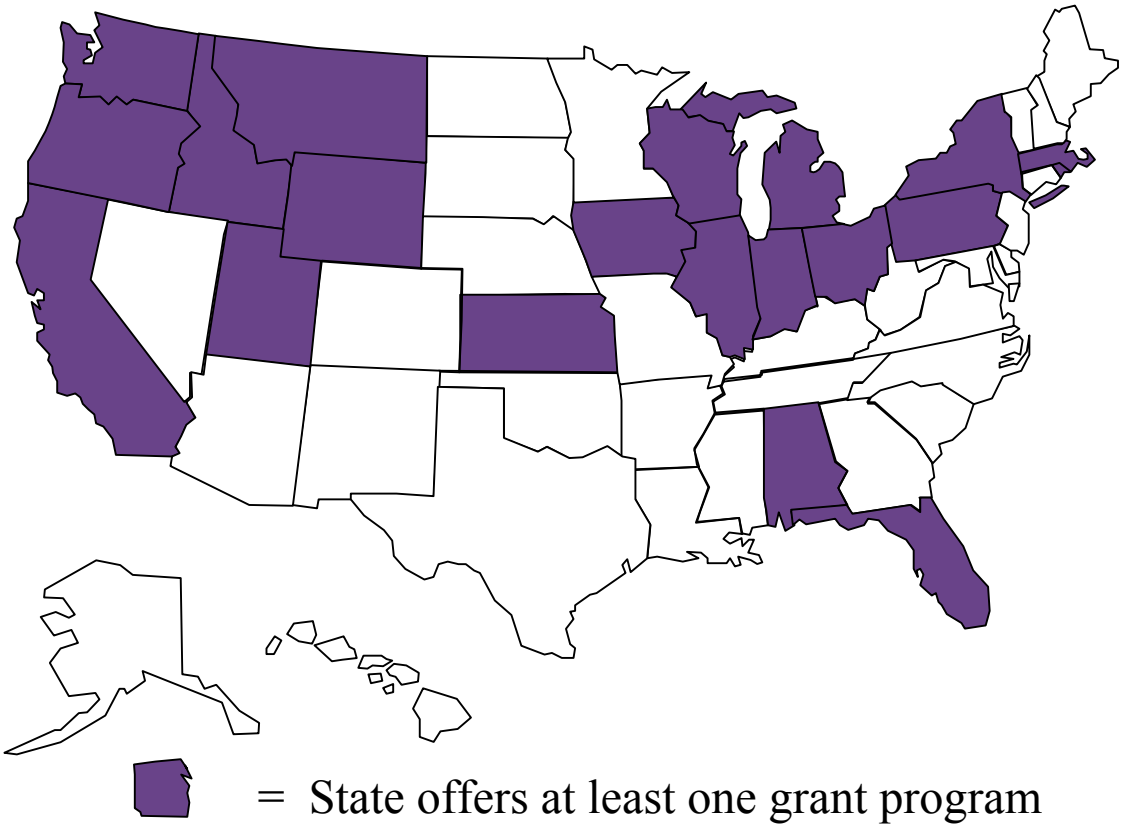
Proceeds from 504 loans must be used for fixed asset projects such as: purchasing land and improvements, including existing buildings, grading, street improvements, utilities, parking lots and landscaping; construction of new facilities, or modernizing, renovating or converting existing facilities; or purchasing long-term machinery and equipment.

The 504 Program cannot be used for working capital or inventory, consolidating or repaying debt, or refinancing.

Interest rates on 504 loans are pegged to an increment above the current market rate for five-year and 10-year U.S. Treasury issues. Maturities of 10 and 20 years are available. Fees total approximately three (3) percent of the debenture and may be financed with the loan.

State Sources of Financing

State sources of financing vary by state and category. One such category to research is renewable fuel. Organizations like DSIRE track such state sources and it can be found on their website http://www.dsireusa.org. A sampling of maps for some of the financing they track by state for renewable fuels follows:

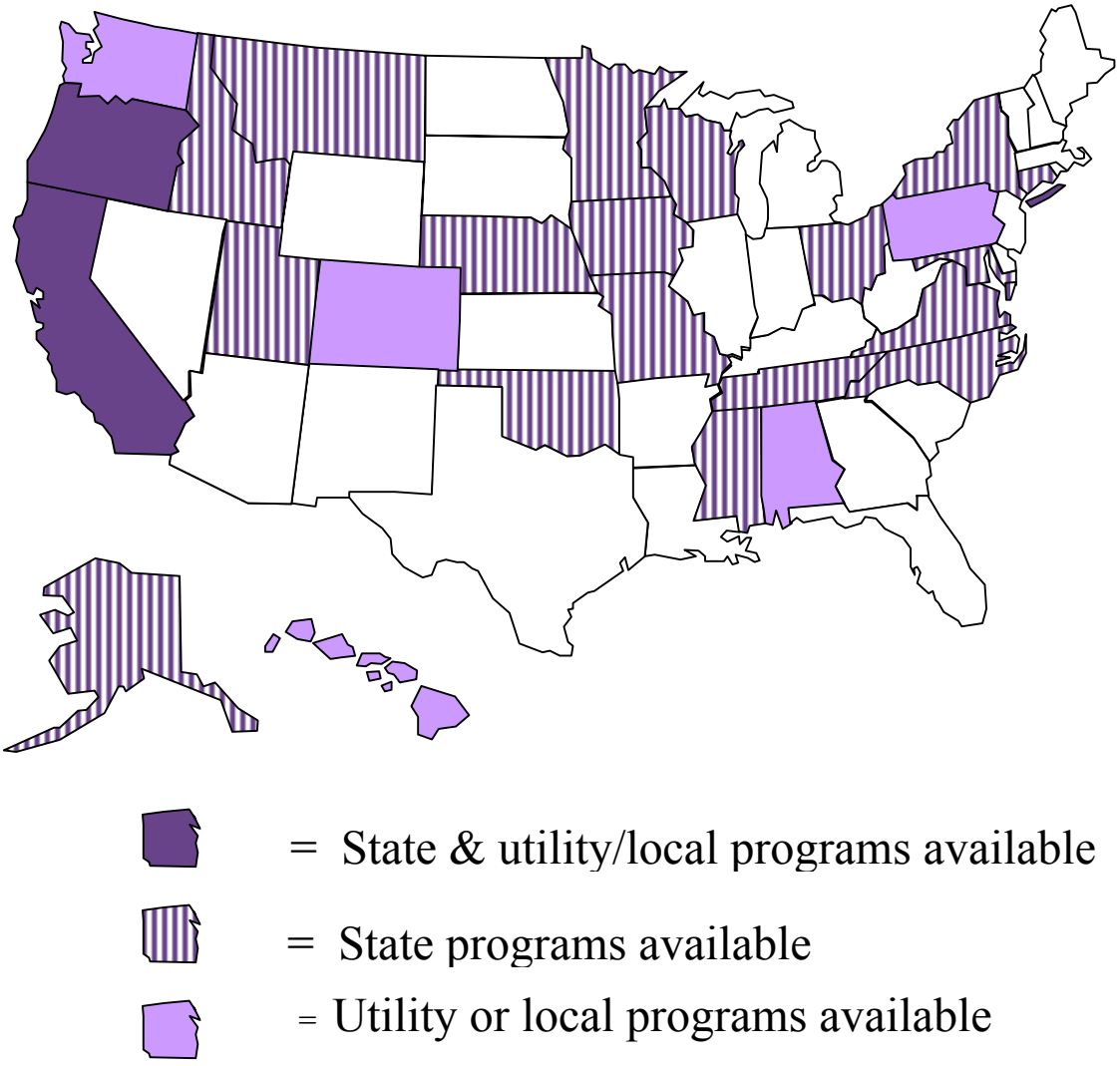


Alabama, California, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Massachusetts, Michigan, Montana, New York, Ohio, Oregon, Pennsylvania, Rhode Island, Utah, Washington, Wisconsin, Wyoming

Source: Database of State Incentives for Renewable Energy (DSIRE)

http://www.dsireusa.org

Figure 5-2. State Grant Programs for Renewables

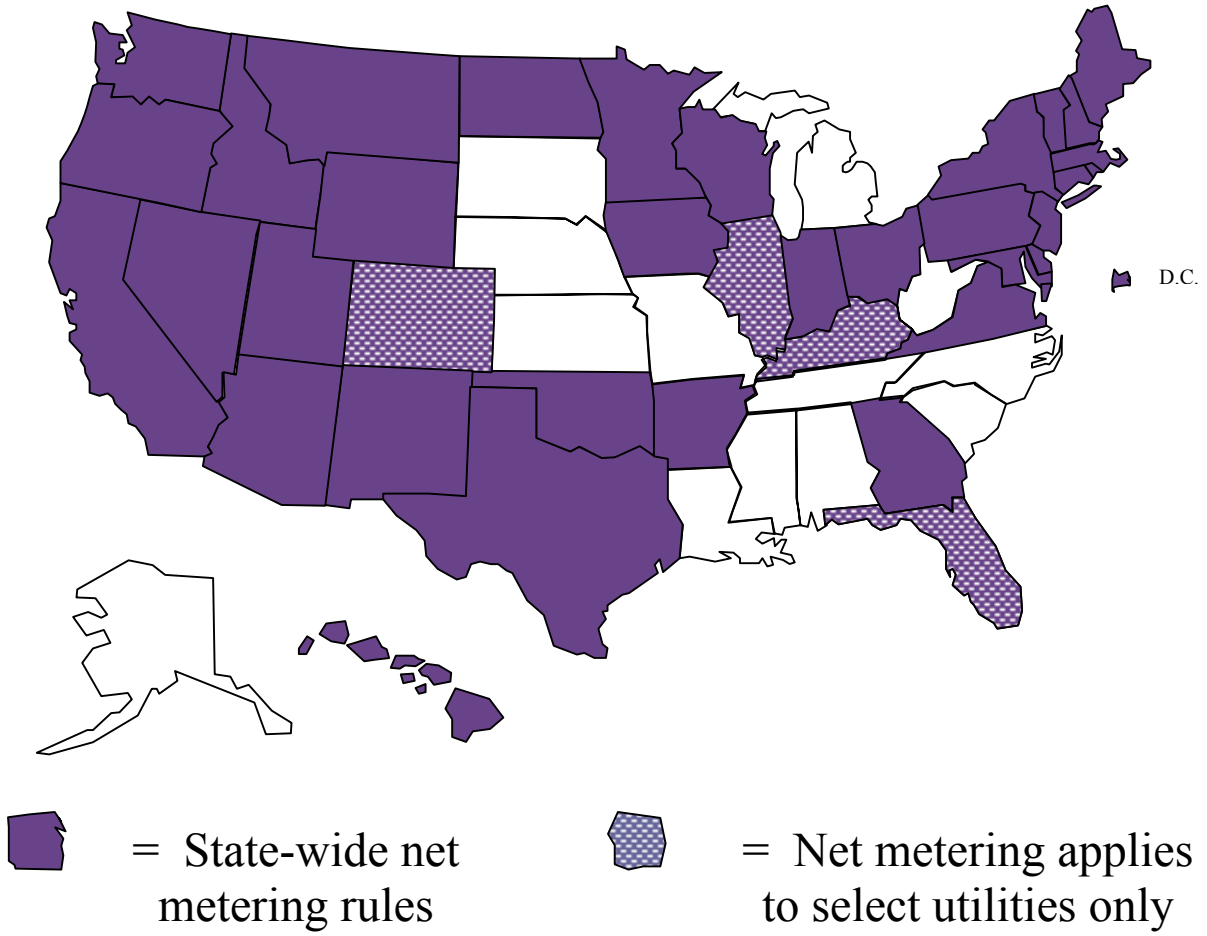


Alabama, Alaska, California, Colorado, Connecticut, Hawaii, Idaho, Iowa, Maryland, Minnesota, Mississippi, Missouri, Montana, Nebraska, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Tennessee, Utah, Virginia, Washington, Wisconsin

Source: Database of State Incentives for Renewable Energy (DSIRE)

http://www.dsireusa.org

Figure 5-3. Loan Programs for Renewable Energy

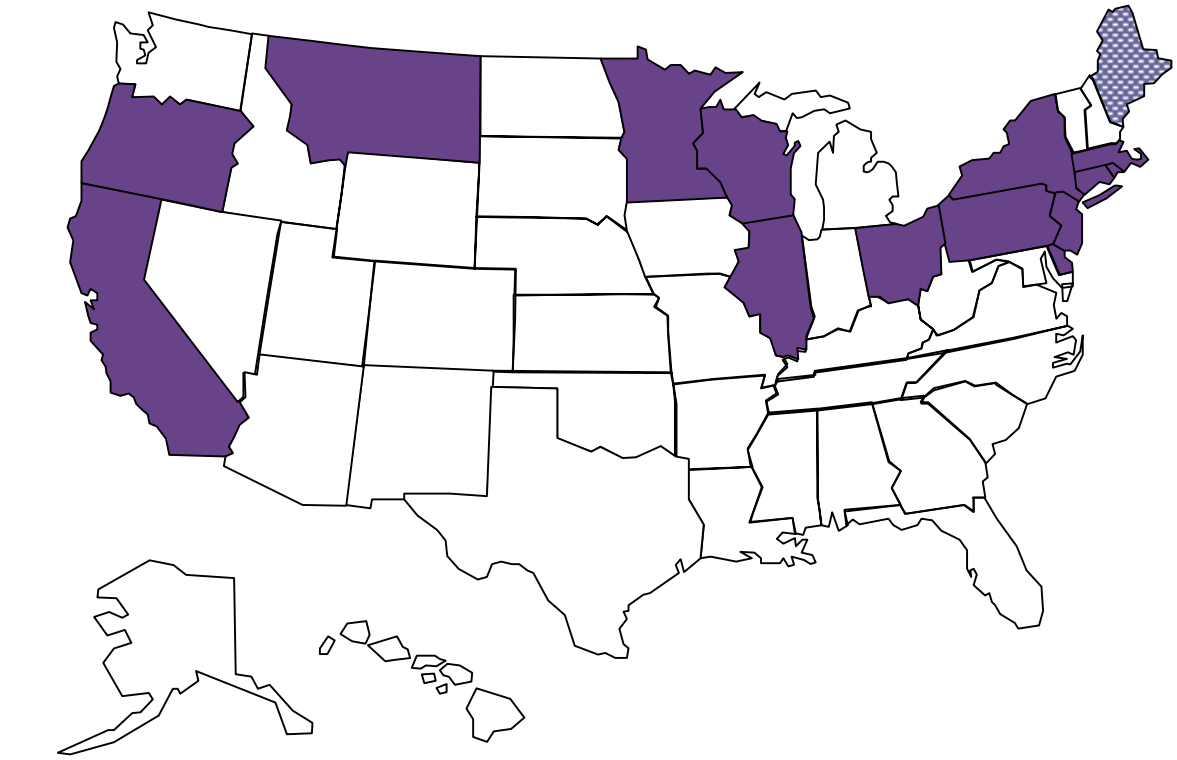


Arizona, Arkansas, California, Colorado, Connecticut, Delaware, District of Columbia, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Minnesota, Montana, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Virginia, Washington, Wisconsin, Wyoming

Source: Database of State Incentives for Renewable Energy (DSIRE)

http://www.dsireusa.org

Figure 5-4. State Net Metering Programs



= State has a PBF for renewables

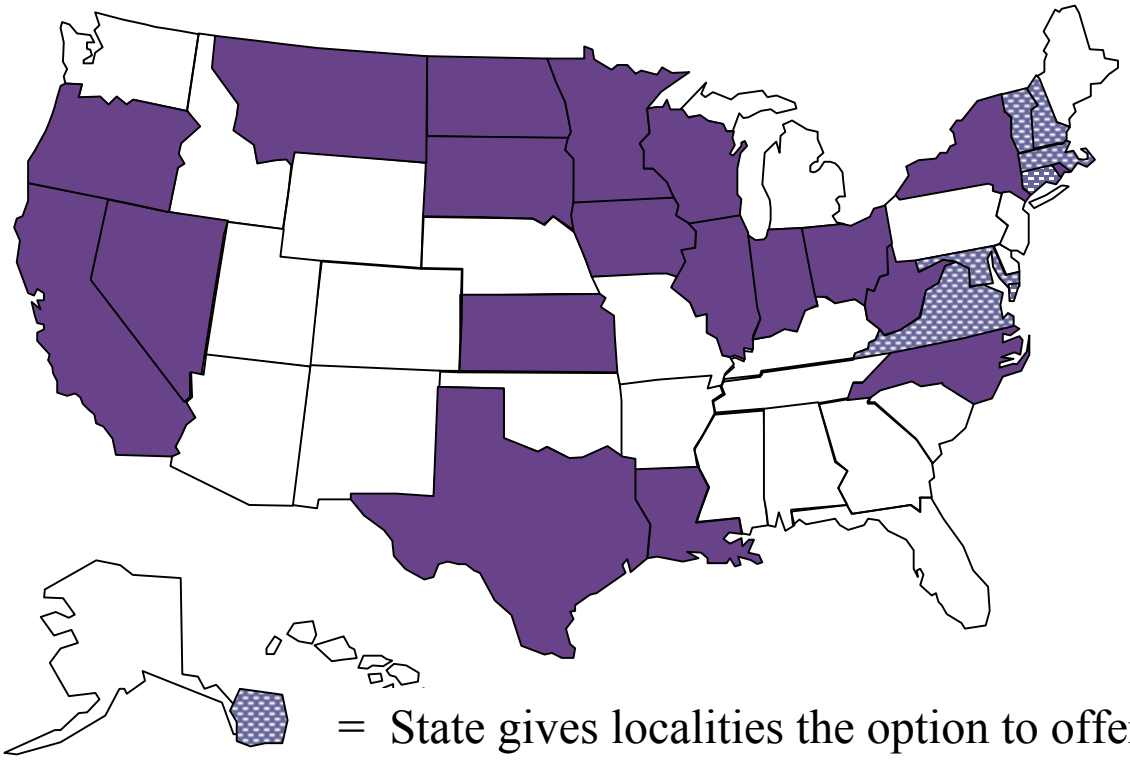
= Funding through voluntary contributions

California, Connecticut, Delaware, Illinois, Maine, Massachusetts, Minnesota, Montana, New Jersey, New York, Ohio, Oregon, Pennsylvania, Rhode Island, Wisconsin

Source: Database of State Incentives for Renewable Energy (DSIRE)

http://www.dsireusa.org

Figure 5-5. States with a Public Benefit Fund (PBF) for Renewable Energy

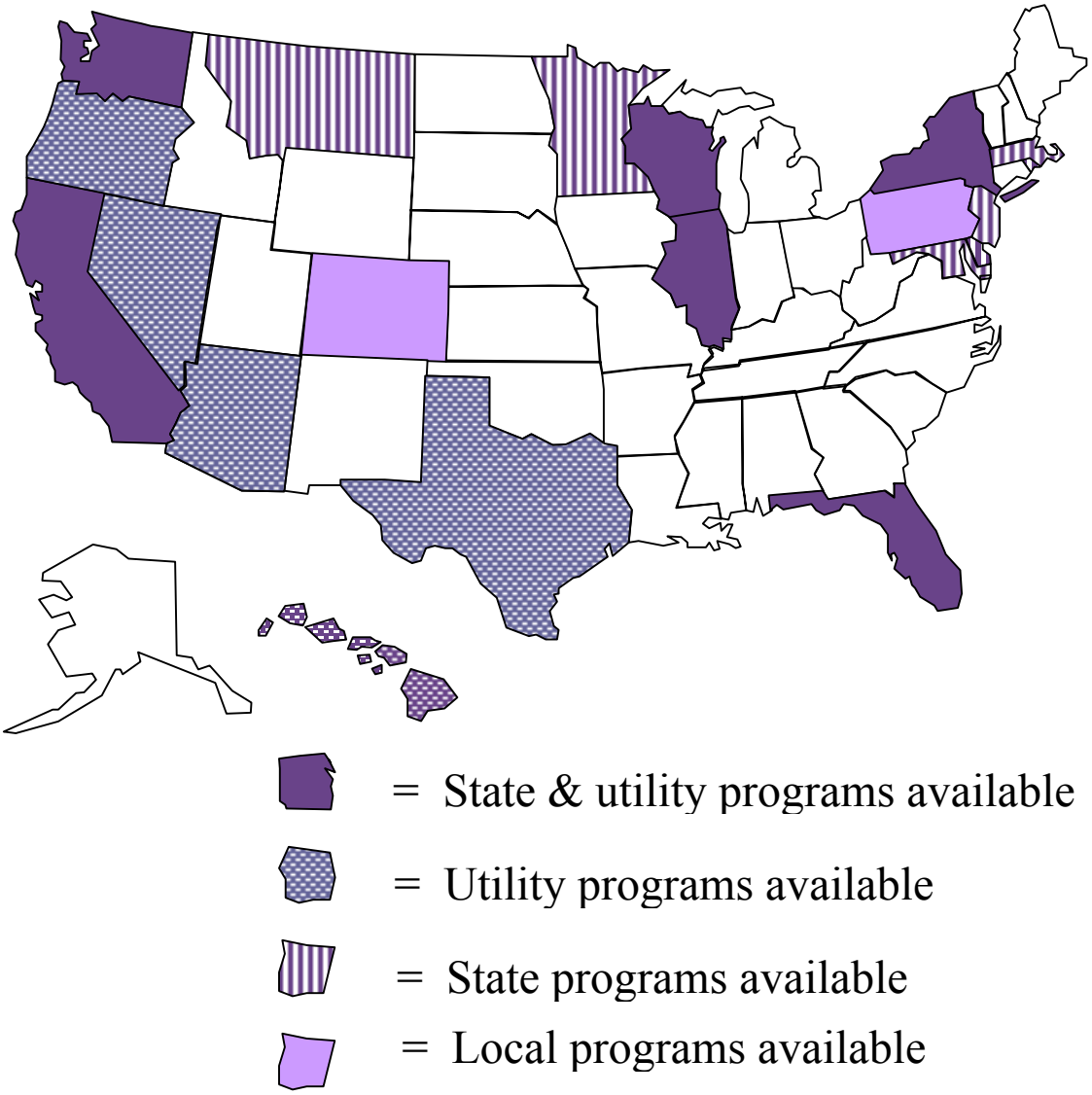


Local option to offer exemption: Connecticut, Iowa (wind), Maryland, Massachusetts, New Hampshire, Vermont, Virginia

State-wide exemptions/special assessments: California, Illinois, Indiana, Iowa (solar), Kansas, Louisiana, Minnesota, Montana, Nevada, New York, North Carolina, North Dakota, Ohio, Oregon, Rhode Island, South Dakota, Texas, West Virginia, Wisconsin

http://www.dsireusa.org

Figure 5-6. States with Local Property Tax Exemptions for Renewables



State & utility programs: California, Florida, Illinois, New York, Washington, Wisconsin

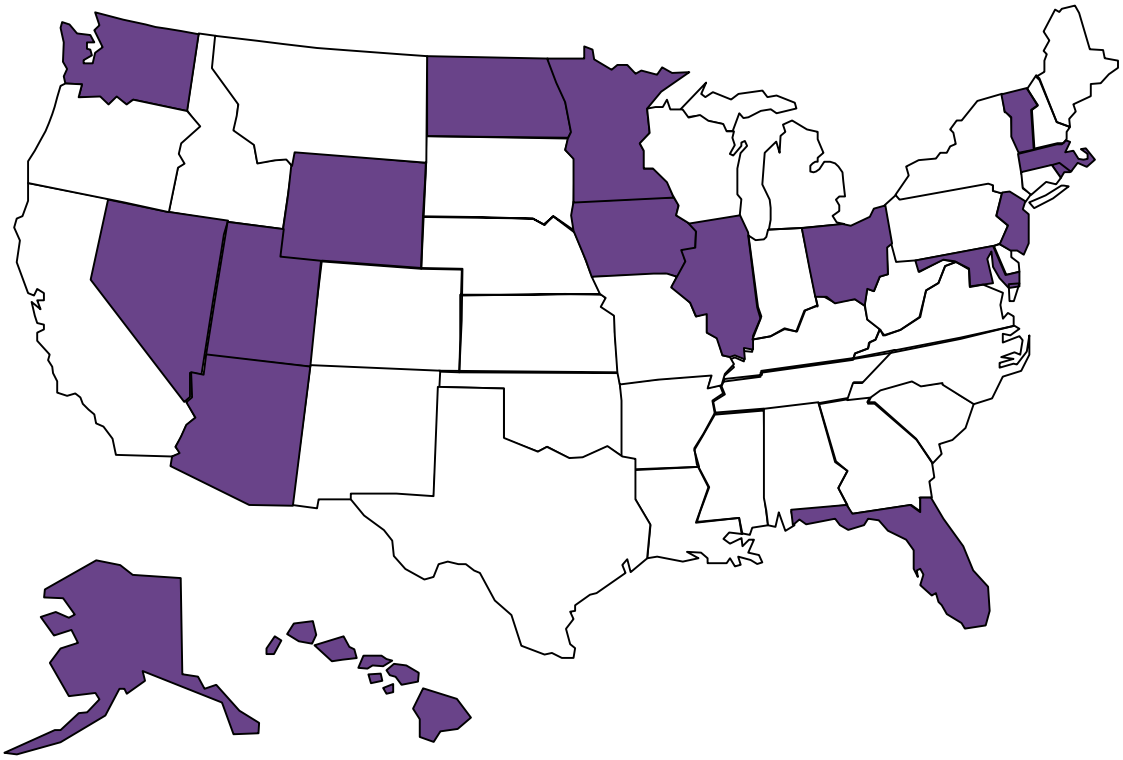
Utility programs: Arizona, Hawaii, Nevada, Oregon, Texas

State programs: Delaware, Maryland, Massachusetts, Minnesota, Montana, New Jersey, Rhode Island

Local programs: Colorado, Pennsylvania

Source: Database of State Incentives for Renewable Energy (DSIRE) http://www.dsireusa.org

Figure 5-7. Rebate Programs for Renewable Energy



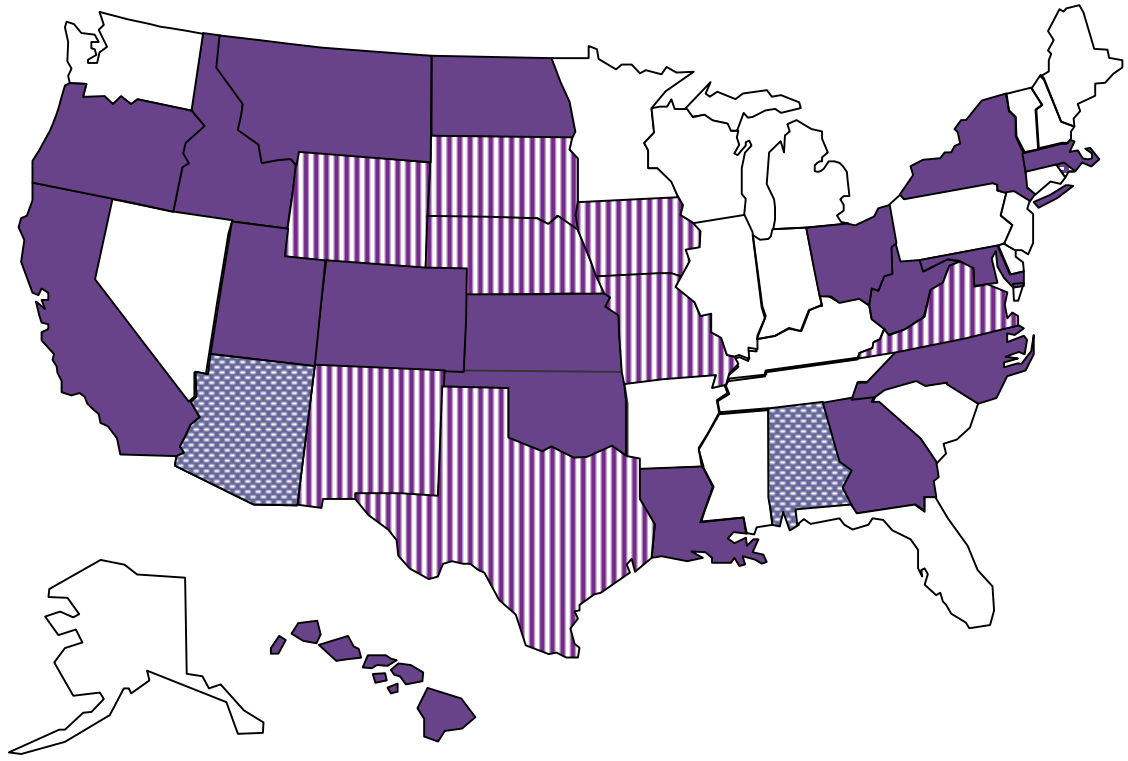
= State offers sales tax exemption

Alaska, Arizona, Florida, Hawaii, Illinois, Iowa, Maryland, Massachusetts, Minnesota, Nevada, New Jersey, North Dakota, Ohio, Rhode Island, Utah, Vermont, Washington, Wyoming, Puerto Rico

Source: Database of State Incentives for Renewable Energy (DSIRE)

http://www.dsireusa.org

Figure 5-8. States with Local Property Tax Exemptions for Renewables



= State offers Personal & Corporate Income Tax Incentives

= State offers only Personal Income Tax Incentives

= State offers only Corporate Income Tax Incentives

Personal & Corporate Tax Incentives: California, Colorado, Georgia, Hawaii, Idaho, Kansas, Louisiana, Maryland, Massachusetts, Montana, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Utah, West Virginia

Personal Income Tax Incentives: Alabama, Arizona, Rhode Island, Puerto Rico

Corporate Tax Incentives: Iowa, Missouri, Nebraska, New Mexico, South Dakota, Texas, Virginia, Wyoming

Source: Database of State Incentives for Renewable Energy (DSIRE)

http://www.dsireusa.org

Figure 5-9. State Income Tax Incentives for Renewable Energy

Iowa Department of Economic Development Financial Assistance

Program: Venture Project Component of the Community Economic Betterment Account (CEBA)
Makes equity-like investments of up to $250,000 to start-up and early-stage businesses.

Specifics on the CEBA program can be obtained from you local economic development agency or organization. The purpose of the CEBA program is to increase employment opportunities for Iowans by increasing the level of economic activity within the state. The program is structured to provide financial assistance to businesses and industries, which require assistance in order to create new job opportunities. The "Venture Project" component is specifically designed for early-stage and start-up businesses. It allows for longer-term job creation and investment performance periods than offered through CEBA.

Program: Financial Assistance Economic Development Set-Aside (EDSA)
Provides financial assistance to companies that create new employment opportunities and/or retain existing jobs, and make new capital investment in Iowa.
The EDSA program provides financial assistance to companies that create new employment opportunities and/or retain existing jobs, and make new capital investment in Iowa. The amount of funding is based, in part, on the number of jobs to be created/retained. Funds are provided in the form of loans and forgivable loans. Projects eligible for EDSA funding include, but are not limited to, the following:

- Building construction or reconstruction
- Land or building acquisition
- Equipment purchases
- Operating and maintenance expenses
- Site development - clearance, demolition and building removal

EDSA investments can be used for working capital but should not be considered a sole funding source. The program leverages other financial support such as bank financing and private investment.

The EDSA program assistance is targeted toward business projects located in communities of fewer than 50,000 in population. At least 51 percent of the created/retained employment opportunities must be made available to individuals presently earning wages defined as low-and-moderate income. The EDSA program can provide assistance up to $500,000.

Program: Entrepreneurial Ventures Assistance (EVA)
Offers technical and financial assistance to eligible start-up and early-stage enterprises. To qualify, applicants must have completed or be participating in entrepreneurial training

from a John Pappajohn Entrepreneurial Center, or have comparable training or experience.

The EVA program provides financial and technical assistance to early-stage technology companies.

An eligible business must be located in Iowa and in an industry sector offering the greatest start-up and growth potential for the state, including but not limited to:

- Biotechnology
- Recyclable materials
- Software development and computer related products
- Advanced materials
- Advanced manufacturing
- Medical and surgical instruments

To qualify, applicants must have completed or must be participating in entrepreneurial training from a John Pappajohn Entrepreneurial Center, or have comparable training and/or experience. Businesses engaged in retail sales, the provision of health care or professional services, and distributors of products or services are not eligible for EVA funds.

Financial assistance of up to $50,000 may be awarded for the purchase of machinery and equipment, and other business acceleration expenses. (The maximum investment available may change; please contact the EVA program manager for more information.) Applicants must identify a specific project and associated costs. EVA funds may be used to finance up to 50 percent of the total project costs. The preferred investment is in the form of a royalty arrangement; terms of the royalty arrangement are flexible and designed to meet the needs of the company. Other investment tools, such as low-interest loans, may be available.

A single applicant may also be awarded up to $10,000 for technical assistance. Technical assistance funds may be used for such activities as product testing, and design improvement, or the purchase of technical or professional expertise. Technical assistance funding is considered a grant, and repayment is not required.

Program: Value-Added Agricultural Products and Processes Financial Assistance Program (VAAPFAP)
Seeks to increase the innovative utilization of Iowa's agricultural commodities.

VAAPFAP may assist projects in two primary categories and a third secondary category:

- Innovative Products and Processes encourages the processing of agricultural commodities into higher-value products not commonly produced in Iowa, or utilizing a process not commonly used in Iowa to produce new and innovative products from agricultural commodities.
- Renewable Fuels and Co-Products encourages the production of renewable fuels, such as soy diesel and ethanol, and co-products for livestock feed.

- A third category, Project Creation Assistance, is also available for projects that may be ineligible under the regular program due to their "precommercial" status. Project Creation Assistance is limited to projects within certain designated Strategic Initiatives.

Program Eligibility Requirements:

- The proposed project must be located in Iowa.
- The business must have a business plan demonstrating a viable market, and managerial and technical experience.
- The business should also have completed a feasibility study documenting the viability of the proposed start-up business.

Projects are also evaluated according to the following criteria:

- The degree to which the facility will increase the utilization of agricultural commodities produced in the state.
- New and innovative
- Feasibility
- The proportion of local match to be contributed to the project.
- The level of need of the region where the existing facility is, or the proposed facility is to be located.
- The degree to which the facility produces a co-product that is marketed in the same locality as the facility.

Any single project may apply for up to $525,000 in assistance. Financial assistance is provided in the form of loans and forgivable loans. Generally, assistance of $20,000 or more is usually awarded as a combination of loans and forgivable loans, with the forgivable portion decreasing as the award size increases.

Program: Export Trade Assistance Program (ETAP)
Provides financial assistance to eligible Iowa businesses wishing to enter new markets by participating in foreign trade shows and trade missions.

This program is available in many other states and also in Europe. It is best to check with your local or international economic development department.

Program: Self-Employment Loan Program (SELP)
Offers low-interest loans of up to $10,000 to low-income owners of new or expanding small businesses.

This program is designed to assist in the creation and expansion of businesses owned, operated and managed by women, minorities, or persons with a disability.

To qualify for a SELP loan, applicants must have an annualized family income that does not exceed current income guidelines for the program. An applicant is automatically eligible for SELP if he or she is receiving Family Investment Plan (FIP) assistance or other general assistance such as disability benefits. The applicant can also qualify for

SELP funds if determined eligible under the Job Training Partnership Act, or is certified as having a disability under standards established by the Iowa Department of Education, Division of Vocational Rehabilitation Services.

SELP loans of up to $10,000 are available. The interest rate is 5 percent, and the loan is to be repaid in monthly installments over a five-year period. The first installment can be deferred for three months.

SELP applicants must obtain a local sponsor for the application process. Examples of a local sponsor include the Institute for Social and Economic Development (ISED), Small Business Development Center (SBDC), the local Job Training Partnership Act (JTPA) representative, or a representative from an area Chamber of Commerce or local community college.

Program: Targeted Small Business Financial Assistance Program (TSBFAP)
Designed to create and expand minority- or women-owned businesses through direct loans of up to $25,000 and loan guarantees of up to $40,000. It also is designed to create and expand minority- or women-owned businesses through direct loans of up to $25,000 and loan guarantees of up to $40,000.

The TSB Financial Assistance Program is designed to assist in the creation and expansion of Iowa small businesses that have annual gross sales of $3 million and are at least 51 percent owned, operated and managed by women, minorities or persons with a disability. The business must be certified as a "Targeted Small Business" by the Iowa Department of Inspections and Appeals before applying for or receiving TSB funds.

Awards may be obtained in one of the following forms of assistance:

- Low-interest loans. Loans of up to $25,000 may be provided at interest rates of 0-5 percent, to be repaid in monthly installments over a five- to seven-year period. The first installment can be deferred for three months for a start-up business and one month for an existing business.
- Loan guarantees are available up to $40,000. Loan guarantees can cover up to 75 percent of a loan obtained from a bank or other conventional lender. The interest rate is at the discretion of the lender.
- In limited cases, equity grants - to be used to leverage other financing (SBA or conventional) - are available in amounts of up to $25,000.

TSB funds may be used to purchase equipment, acquire inventory, provide operating capital, or to leverage additional funding.

Iowa State Treasurer's Office

Program: Iowa Small Business Loan Program
This program provides financing to new and expanding businesses through the sale of tax-exempt bonds. Details can be found on the state's web site.

Program: Link Investments for Tomorrow (LIFT)
LIFT assists with rural small-business transfer, horticulture and alternative agricultural crops.

LIFT Value-Added Agriculture was started in 1999 to help stimulate existing businesses or encourage the establishment of new businesses that add value through the processing of agricultural commodities.

- Value-Added agriculture includes agricultural commodities raised in Iowa that are processed into a more highly-valued state. This program is available for qualifying production agriculture projects. The treasurer's office works closely with the Iowa Department of Economic Development to ensure that the projects approved for funding under this program meet the strategic goals of the State of Iowa in value-added agriculture. Three areas were developed to provide limitations on the use of the funds:

    1. Any project that has been approved or that is otherwise eligible for participation in the regular VAAPFAP program in either the Innovative Products and Processes or Renewable Fuels category.

    2. Any value adding agricultural processing enterprise, regardless of whether or not its product or process is innovative, provided that Iowa farm operators have or are to gain significant equity ownership in the enterprise. Significant equity ownership should mean not less than a 30% ownership share.

    3. If the level of activity in the LIFT Value-Added Agriculture program does not use the funds available in a timely manner, eligibility may be expanded to include farm operator investment in capitol facilities, other than livestock, which are used for the care, feeding or production of livestock products.

- Agricultural commodities, which qualify for this program, are corn, soybeans, oats, hay, hogs, cattle, dairy cattle, sheep, lambs, chickens, turkeys and eggs.
- The borrower must be at least 18 years of age.
- The borrower is not eligible if he/she is currently participating in any LIFT program or has previously participated in any LIFT program other than Traditional Livestock.
- The maximum amount a owner may borrow is $250,000.
- The maximum amount all owners of a value-added project or business may borrow is $1,000,000.
- The Quality Beef project has been granted a waiver to $10 Million.
- The maximum eligibility for all new borrowers is five years.

State of Iowa Financial Assistance

Program: Entrepreneurs with Disabilities (EWD)
The EWD program helps qualified individuals with disabilities establish, acquire, maintain or expand a small business by providing technical and financial assistance. The EWD program helps qualified individuals with disabilities establish, acquire, maintain or expand a small business by providing technical and financial assistance.

To be eligible for the program, applicants must be active clients of the Iowa Department of Education Division of Vocational Rehabilitation Services or the Iowa Department for the Blind.

Technical Assistance grants of up to $10,000 may be used to pay for any specific business-related consulting service such as developing a feasibility study or business plan, or accounting and legal services.

Financial Assistance grants of up to $10,000 may be used to purchase equipment, supplies, rent or other start-up, expansion or acquisition costs identified in an approved business plan. Total financial assistance provided to an individual may not exceed 50 percent (maximum of $10,000) of the financial package. EWD financial assistance must be fully matched by funding from other sources.

State of Iowa Tax Relief

Iowa Corporate Income Tax in which Iowa allows 50 percent deductibility of federal taxes from Iowa corporate income tax, and Iowa corporate income tax may be reduced or eliminated by the New Jobs Tax Credit. This and the following information are examples of state tax relief financing that are available in the state of Iowa. Similar programs are offered in other states and if you check with economic development or the state department of taxation, you can find information on the tax relief.

Program: New Jobs and Income Program
The Iowa New Jobs and Income Program provides a package of tax credits and exemptions to businesses making a capital investment of at least $10.38 million and creating 50 or more jobs meeting wage and benefit targets.

Program: Pollution Control or Recycling Property Tax Exemption
Pollution control and recycling equipment may be eligible for a property tax exemption. Improvements to real property that are primarily used to control pollution of air or water, or primarily used for recycling, may qualify. An application must be filed for exemption.

Program: New Jobs Tax Credit
A business increasing its workforce by at least 10 percent may qualify for this Iowa corporate income tax credit. This credit is equal to 6 percent of the state unemployment insurance taxable wage base. The credit for 2001 is up to $1,074 per new employee and can be carried forward up to 10 years.

Local/Community Sources of Financing

On the city and county level financing can come in the form of Local Tax Abatement. Iowa law allows cities and counties to abate local property taxes for value added to industrial real estate.

This is one of the most widely used incentives for new businesses on a local level. By abating local property taxes, the local community can reduce the tax burden on a new startup company in the beginning years when money is short. Contact your local city council or economic development group for the process to secure this abatement.

Enterprise Zones are another financing program on the local level. Enterprise zones apply to businesses locating or expanding in an Enterprise Zone and may receive the following tax benefits:

- Property tax exemptions on all or part of the costs of improvements to land and buildings for up to 10 years. Certain areas within a state can be designated as an enterprise zone, which allows financing to be available for businesses locating in one of these areas. The economic development web site will have the current enterprise zones listed.

- An investment tax credit of up to 10% on corporate income taxes for investments in machinery and equipment, land, buildings, and improvements to existing buildings.

- Refund of sales, services, or use taxes paid to contractors or subcontractors during construction.

- A 13% research and development activities credit (refundable) on corporate income taxes.

- Supplemental new jobs training withholding credit of 1 1/2% of the gross wages. This credit is in addition to, and not in lieu of, the withholding credit of 1 1/2% authorized for the Iowa New Jobs Training Program.

Additional City and County financial sources include Tax Increment Financing (TIF). Tax Increment Financing can offset the cost of public improvements and utilities, finance direct grants or loans to a company, and provide the local match for federal or state economic development assistance programs.

This financing is often helps with the infrastructure needed in a new development and business startup. It is very common in industrial parks that develop with the first couple of businesses that locate in these industrial parks. Many times the local match for other development programs and grants is just as valuable as the initial monies.

Other Sources of Financing

Venture Capital
In Iowa there is
Venture Network of Iowa (VNI). The VNI is a statewide forum via the Iowa Communications Network in which Iowa entrepreneurs, investors and business advisors interact, network, and find financial and intellectual capital

Venture Network of Iowa was established in 1990 to provide a forum through which inventors and entrepreneurs could interact in the hope of forging profitable, long-term business relationships. VNI has been a valuable catalyst in the formation of new, viable businesses throughout Iowa.

VNI extends a unique opportunity for entrepreneurs to present ideas to an audience of many of Iowa's most adept and eager investors. The “Five-Minute Forum” is an ideal outlet for entrepreneurs to introduce products and services to prospective investors.

VNI offers professionals a resource for reviewing numerous investment opportunities on behalf of clients. In addition, resources are available to any individual or firm interested in funding or managing a business. VNI services the needs of both emerging and existing businesses.

Another Venture Capital Source is the TecTERRA Food Capital Fund. Equity is available for Iowa food processors and biotechnology companies with growth potential, especially those offering ownership opportunities and other benefits to Iowa agricultural producers.

Cybus Capital is a unique, national private equity fund manager, advisor and investment banker. They specialize in helping companies in the North American value-added food chain to:

- Invest or obtain growth capital
- Buy or sell companies
- Otherwise increase or protect stakeholder value through other capital structure events.

Their food and agricultural background includes approximately $2.0 billion in transactions. They have learned to listen to client needs, formulate creative, custom solutions and build lasting relationships with their clients.

Companies they represent include public and private corporations with revenues typically exceeding $5 million, producer groups, pools of capital, and government and academic groups.

Their firm is headquartered in Des Moines, Iowa, at the center of the agricultural production, ag-biotech and related technology commercialization corridor encompassing

both Minneapolis and Kansas City. They also have strategically located field and affiliate offices in Sacramento, California and Denver, Colorado.

Access Capital Electronic Network (ACE-NET) is another venture capital source. ACE-NET is an Internet-based listing service providing information to angel investors on small, dynamic, growing businesses seeking equity financing. This will apply to any state and is a good resource to find venture capital.

Small Business Investment Companies (SBICs)
SBICs fill the gap between the availability of venture capital and the needs of small businesses in start-up and growth situations. SBICs are privately owned investment firms that provide capital plus funds borrowed at favorable rates with an SBA guarantee.

In 1958 Congress created The Small Business Investment Company (SBIC) program. SBICs, licensed by the Small Business Administration, are privately owned and managed investment firms. They are participants in a vital partnership between government and the private sector economy. With their own capital and with funds borrowed at favorable rates through the Federal Government, SBICs provide venture capital to small independent businesses, both new and already established.

All SBICs are profit-motivated businesses. A major incentive for SBICs to invest in small businesses is the chance to share in the success of the small business if it grows and prospers.

Small businesses that qualify for assistance from the SBIC program are able to receive equity capital, long-term loans, and expert management assistance. Venture capitalists participating in the SBIC program can supplement their own private investment capital with funds borrowed at favorable rates through the federal government.

Local power and energy sources
Iowa has the Iowa Energy Center. It has an Alternate Energy Revolving Loan Program described below:

- –Type of Incentive: loan program
- –Eligible Technologies: wind, solar, biomass, hydro
- –Eligible Applicants: commercial, industrial, residential
- –Funding Amounts/Limits: half of financed cost, up to $250,000; 0% interest on AERLP's portion of the loan.

The AERLP provides loans to any individual or organization who wants to build renewable energy production facilities in Iowa. Successful applicants receive a single, low-interest loan that consists of a combination of AERLP funds and lender-provided funds. The AERLP provides 50% of the total loan, up to a maximum of $250,000 at 0% interest. The remainder of the loan is made by the lender at a negotiated interest rate. The maximum loan term allowed for the AERLP funds is 20 years. As the loans are paid back

to the Iowa Energy Center, those funds revolve back into the program and are made available to new applicants.

Database of State Incentives for Renewable Energy (DSIRE)
The Database of State Incentives for Renewable Energy (DSIRE) is a comprehensive source of information on state, local, utility, and selected federal incentives that promote renewable energy. This database contains information on all the states and has an easy map to locate the incentives in your state.
Some of the Federal Incentives for Renewable Energy that DSIRE tracks are:

Corporate Deduction

Deductions for Clean-Fuel Vehicles and Refueling Property
<http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US30F&State=Federal&currentpageid=1>

Corporate Depreciation

Job Creation and Worker Assistance Act of 2002 - Special Depreciation
<http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US38F&State=Federal&currentpageid=1>

Solar, Wind, and Geothermal Modified Accelerated Cost Recovery System (MACRS)
<http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US06F&State=Federal&currentpageid=1>

Corporate Exemption

Federal Excise Tax Exemption for Gasohol
<http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US01F&State=Federal&currentpageid=1>

Corporate Tax Credit

Alcohol Fuel Credit
<http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US32F&State=Federal&currentpageid=1>
Renewable Electricity Production Credit
<http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US13F&State=Federal&currentpageid=1>

Solar and Geothermal Business Energy Tax Credit
<http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US02F&State=Federal&currentpageid=1>

Federal Grant Program

Renewable Energy Systems and Energy Efficiency Improvements Program
<http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US05F&State=Federal&currentpageid=1>

Tribal Energy Program Grant
<http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US07F&State=Federal&currentpageid=1>

Federal Loan Program

Energy Efficient Mortgage
<http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US36F&State=Federal&currentpageid=1>

Energy Star Financing and Mortgages
<http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US22F&State=Federal&currentpageid=1>

Personal Deduction

Deductions for Clean-Fuel Vehicles and Refueling Property
<http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US16F&State=Federal&currentpageid=1>

Production Incentive

Renewable Energy Production Incentive (REPI)
<http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US33F&State=Federal&currentpageid=1>

Resources for Financing

- Iowa Department of Economic Development (IDED)
- State Treasurer's Office
- U.S. Small Business Administration (SBA)
- John Pappajohn Entrepreneurial Center
- United States Department of Agricultural (USDA)
- Iowa Energy CenterInternet

Many of these resources are available in other states, nationwide or are federal organizations. Additional resources can be obtained from the Internet or through local and state economic development agencies. I would also like to acknowledge these resources for material presented in this presentation.

Websites for Financing

- Iowa Department of Economic Development (IDED) http://www.state.ia.us/government/ided/ http://www.iowasmart.com/index.html
- State Treasurer's Office http://www.treasurer.state.ia.us/index.cfm
- U.S. Small Business Administration (SBA) http://www.sba.gov
- John Pappajohn Entrepreneurial Center http://www.pappajohn.com/
- United States Department of Agricultural (USDA) http://www.rurdev.usda.gov
- Iowa Energy Center http://www.iecenergy.iastate.edu

- Database of State Incentives for Renewable Energy (DSIRE)
  http://www.dsireusa.org/

Acknowledgement:

USDA and SBA financing programs were copied from the respective public websites.

6. Identification and Development of Markets

Introduction

Marketing opportunities for biodiesel are segmented along at least five different lines. The segments are:

1. Application - light duty vehicles, heavy duty vehicles, off-road vehicles, heating oil, back up power generation, marine, fixed operations, and mining;
2. Blend level - B2 to B5 (lubricity), B20 (EPACT and possible state mandates), and B100;
3. Environmental performance - emissions reduction, biodegradability, non-toxic;
4. Statutory niches - fleet vehicles, military, over-road vehicles, protected land areas and waterways; and
5. Aesthetic - acceptable odor, renewable, biodegradable.

The factors affecting biodiesel's entry into all of these segments include fuel price and availability, legislative mandates and incentives, environmental regulations, and consumer awareness. The development of a marketing strategy for an individual producer requires an assessment of the local demands for diesel fuel, choice of what segment(s) to address, and development of strategic partnerships to produce, transport, and sell the product.

The instructional goals for this module are:

1. Introduce the different ways to segment the markets for biodiesel fuels;
2. Review the size of the total diesel fuel market and discuss the most important factors that impact each application segment; and,
3. Suggest some strategies for selecting market segments and marketing strategies appropriate to your location and circumstances.

Examining the B100 Markets

The key characteristics that promote the B100 market include the facts that it is 1) non-toxic, 2) biodegradable, 3) renewable, 4) has substantially reduced emissions, compared to petro-diesel, 5) has a non-objectionable odor, and 6) can be used and stored in equipment designed for use with biodiesel with little modification in warmer climates. Each of these attributes can be an advantage in different applications. In addition, B100 has been recognized as an "alternative fuel", which offers benefits for its use as a 20 percent blend in EPAct fleet applications.

The major application segments for B100 include national parks, marine, underground mining, and off-road vehicles. We will examine each segment in turn.

National Parks
Biodiesel is being used in more than 20 national parks across the country. Each park has a slightly different focus (B100, B20, transportation, power, marine) but the sheer versatility of the fuel has been noted. As a result, state park and recreation managers are becoming more interested in biodiesel, particularly in areas frequented by the public.

Marine
Biodiesel has had success in the pleasure boat market because of its more favorable odor, both the fuel and the exhaust, compared with petro-diesel. This has been particularly true in the sailboat market, where fuel cost is a relatively minor consideration. The biodegradability and the demonstrated lower toxicity of biodiesel in spill events are both aesthetic and economic advantages in marine applications. The fuel biodegrades rapidly in the aquatic environment where fines for spills can be as high as $10,000 per day. Numerous tour boats in Florida, Hawaii, and California now use biodiesel to improve the enjoyment of their clientele.

The marine market for diesel fuel is broken into segments as shown in Table 6-1. There has been a high acceptance rate for B100 in the recreational sector, particularly for sailboats. A 5% to 10% penetration in this area would give a 7 to 15 million gallon per year market. Public transit ferries are another potential market but will likely require environmentally based mandates. The commercial marine markets are unlikely to be receptive to B100 for cost reasons.

Table 6-1. Marine Market Size

Application	Diesel Market
Sailboats	4 million gpy
Other Recreational Boats	132 million gpy
Public Transit Ferries	22 million
Commercial Marine	2400 million gpy

Underground Mining
The reduction in particulate emissions and potentially lower health risks from biodiesel are important factors in penetrating the underground mining market. The dominant factor in the market, however, is the fuel cost. The engines are very large and run continuously. High efficiency particulate traps have kept petro-diesel competitive in meeting emission standards. The current consensus is that B100 is probably too costly to play a significant role in underground mining applications, but testing with B20 and other blends is on going.

Off-Road Vehicles
There are several off-road vehicle segments: airports, farming, logging, industrial, and construction. Off-road vehicles and stationary engines are a significant diesel market totaling about 2.1 billion gallons per year. Biodiesel is finding acceptance in areas such as parks, resorts, and forests because of biodegradability, lower emissions, and odor properties. Renewability is an advantage, particularly in areas emphasizing eco-tourism.

The off-road market most likely to see a significant penetration of B100 is for use at airports in air quality non-attainment areas. A 10 percent penetration in this market represents about 1.8 million gallons of B100 annually. By contrast, a 1 percent penetration into the construction market represents a 0.5 million gallon per year market. Farming is a market segment with high interest and motivation, but not for B100. There is a consistent interest for B2 to B10 blends in the soybean growing regions of the U.S.

Examining B20 Markets

The B20 blend was originally chosen as an optimum between reductions in exhaust emissions and fuel cost. B20 provides about a 14% decrease in PM 10 (10 micron particulate matter) emissions, a 9% decrease in CO and a 7% decrease in hydrocarbons, compared with petro-diesel. B20 also causes about a 2% increase in NOx.

Biodiesel is listed as an alternative fuel under the terms of the Energy Policy Act (EPAct) of 1992, as amended by the Energy Conservation Reauthorization Act of 1998 (ECRA). Fleet users have the option to purchase and use 450 gallons of biodiesel in vehicles in excess of 8,500 GVW in-lieu of purchasing an alternative fueled vehicle.

The primary application segments for B20 are:

- Qualifying fleet vehicles under EPAct;
- Non-tactical Military vehicles and GSA vehicles for fuel purchase under CID A-A-59693A, and
- Municipal transit fleets and school buses (although not included under EPAct).

There is extensive documentation of B20's performance in light duty and heavy-duty trucks and in buses. This documentation includes engine performance and fuel economy, emissions testing, and documentation of Tier 1 and Tier 2 health effects.

A key factor in favor of selection of B20 as an alternative fuel is that there is no investment required for new infrastructure to switch to biodiesel. There have been a number of successful trials of B20 by the military and by municipal transit systems. Public and market awareness is increasing.

There may be an opportunity for developing a B20 automobile market, similar to that in Europe and in the voluntary E10 market in the U.S., but the number of diesel-powered automobiles in the U.S. is declining. Heavy trucks that fall within the EPAct requirements are candidates for B20 use. Busses, in theory, should be a substantial market. However, in the urban bus fleet there is substantial competition with CNG powered buses, in spite of the documented lower life-cycle costs for B20 fueled buses. Also, B20 is likely too expensive for the long distance bus lines. Table 6-2 shows the overall sizes for these potential B20 markets.

Table 6-2. Potential Market Size for B20

Application	Diesel Use, GPY
Automobiles	900 million
Light Trucks	1,600 million
Heavy Trucks	25,900 million
Buses	1,300 million
Fleet Vehicles	220 million

Examining B2 to B5 Markets

The low blend option, in the range of B2 to B5, is essentially the use of biodiesel as a diesel fuel additive to enhance lubricity. Low-level blends will also reduce emissions although the reductions will be proportional to the blend level so the reductions may be small. The mandated transition to low sulfur diesel fuels has opened the door to biodiesel's largest potential market, the over-the-road trucking industry. The B2 blend combines improved lubricity performance with a minimal increase in fuel price.

The low blend approach appears to offer the greatest opportunity for significant entry into the major use markets for diesel fuel. The heavy truck market is about 26 billion gallons per year. Railroad engines use 3.4 billion gallons of diesel per year and off-road vehicles account for an additional 2.1 billion gallons. Even a 10 percent penetration of biodiesel into these markets at the B2 level will require 62 million gallons per year of B100 fuel. The recent mandate for the use of B2 in all heavy trucks in Minnesota has drawn attention in a number of other states.

Summary

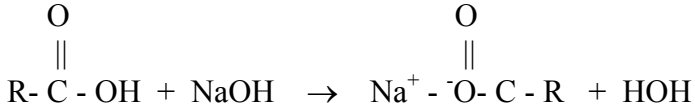
Biodiesel markets are segmented by application and by blend level. The driving forces behind the expansion of biodiesel markets are environmental mandates and superior performance. The cost of the fuel continues to be a negative factor opposing more rapid acceptance of biodiesel. The most likely market, however, is the low (B2 to B5) blends that carry minimal cost impact, but significant performance enhancement in a huge market.

7. Equipment and Process Planning as Related to Feedstocks and Processes

About half of the biodiesel plants in the United States and Europe have been designed to use clean, high-quality seed oil and methanol. The remainder use recycled restaurant oils and some animal fats. The range of acceptable free fatty acids is from less than 4% to as high as 50%. Most technology providers offer technologies that can handle up to 20% free fatty acids. In this section, we will consider some of the issues involved in using a variety of feedstocks, including different oils and fats, different alcohols, and different catalysts. We will also look at some process variations, particularly the issue of batch versus continuous flow.

Of the facilities that use vegetable oils, most use refined oils. Some facilities could use unrefined oils depending on the technology. Alternative feedstocks require changes to the production process. The important parameter to be considered is the free fatty acid level. Crude soybean oil will usually have a free fatty acid level less than 1.0%. If the oil is refined, the free fatty acid level will approach zero. However, recycled restaurant waste oils will have a free fatty acid level of 1% to as high as 20%, with the most frequent range around 10%. The low end of this range corresponds to a recently changed oil and the high end is an oil that may have been stored for a considerable time before it is processed. Rendered animal fats will have free fatty acids between 5% and 30%, mostly depending on the time of year. In the winter, when animal carcasses cool quickly with little decomposition, the free fatty acid will be low. In hot summers, the free fatty acid can be quite high. Finally, greases from restaurant grease traps and float grease from sewage or wastewater treatment plants can have free fatty acid levels ranging from 40% to 100%.

High free fatty acid feedstocks cannot be processed to biodiesel using the conventional alkaline-catalyzed transesterification. As shown in the reaction below, the alkaline catalyst, sodium hydroxide in this case, reacts with the free fatty acids to form soaps.



These soaps can cause two separate problems. First, the soaps act as an emulsifier to prevent the glycerol from separating from the biodiesel. Second, if the glycerol does separate, then the addition of water during the washing process can also create an emulsion that is hard to break. In either case, the plant may end up with a batch of emulsified product that will require acid treatments to break down before the batch can be reprocessed.

There are a variety of ways the high free fatty acid material can be treated. One technique that is familiar to many in the oil seed processing industry is free fatty acid removal using caustic stripping. This involves adding a sodium hydroxide-water solution of the oil and deliberately making soap. Then, the water-soap solution is separated by centrifugation.

This is frequently used during soybean oil refining to remove the free fatty acids and a product called *soapstock* is produced. Soapstock is generallyconsidered a low-value product but some research has shown that it is possible to convert it to biodiesel. In any case, caustic stripping usually involves removing the free fatty acids and directing them to a separate product stream. An alternative process is to use an acid, such as sulfuric acid, as a catalyst for transesterification but the acid-catalyzed reaction of triglycerides and methanol is very slow, typically taking 2-3 days to reach completion. However, acids are very effective catalysts for the conversion of free fatty acids to methyl esters. This process takes only about an hour at 60 deg C. This gives rise to a two-step approach to processing high free fatty acid feedstocks. First, use an acid catalyst to convert the free fatty acids to esters, and then use an alkaline catalyst to convert the remaining triglycerides to methyl esters. Most plants that process high free fatty acid feeds use some variation of this concept.

When a two-step process is used, water management becomes the technological challenge. Acid esterification of fatty acids into biodiesel creates a byproduct of water in the feedstock mix that creates two problems: (1) it reduces the yield of fatty acids to biodiesel and leaves too many fatty acids behind in the feedstock, and (2) the water will also reduce yields in the transesterification step. The processor needs to design the process so that water of reaction is removed during the acid esterification step and that the material that proceeds into the transesterification step has a low enough water content.

Ethanol

Ethanol is the most common alternative alcohol for producing biodiesel. Other alcohols such as isopropyl and butyl have also been used but to a much smaller extent. The University of Idaho has done most of their process development with ethanol and probably has the largest experience base with this alcohol. Ethanol has the advantage that like soybean oil it is renewable because it is easily made from corn. This allows the argument to be made that the biodiesel is made entirely from renewable feedstocks. Unfortunately, ethanol is more expensive than methanol and about 44% more ethanol is required for the reaction causing a major increase in production cost. The excess ethanol from the reaction is also hard to recover because water and ethanol form an azeotrope so it is hard to return 100% ethanol to the process. Additional processing is required at higher expense. Finally, transesterification with ethanol is more prone to soap formationand thus requires tighter process controls than with methanol.

Other Catalysts

Besides sodium hydroxide, there are several different catalyst options. Sulfuric acid was mentioned above. This and other strong acids can be used for transesterification, but they are very slow and thus not commonly used except for pretreatment of free fatty acids. The acids do have the advantage that they do not make soap with free fatty acids.

Sodium hydroxide for transesterification has the strong advantage that it is inexpensive, about $0.40 - $0.42/lb. Most recipes for biodiesel production specify about 1 lb of

sodium hydroxide to make 100 lb of biodiesel. If free fatty acids are present, it may be necessary to add additional sodium hydroxide to compensate for the loss of catalyst to soap.

Potassium hydroxide is also commonly used in commercial biodiesel production. It is generally observed to be more effective than sodium hydroxide and has the added advantage that when the catalyst is removed from the glycerol at the end of the process, it yields a fertilizer (potash).

Sodium hydroxide is mixed with methanol before the alcohol and catalyst is combined with the feedstock. When these two chemicals are mixed they form a product called sodium methoxide. Water is also formed during the reaction, which tends to inhibit the reaction. Using pure sodium methoxide, produced with a water-free process, can provide a more effective catalyst although at a higher cost. Experience at Iowa State shows that sodium methoxide is at least 5 times more active than sodium hydroxide. An additional advantage of sodium methoxide is that it can be purchased premixed with methanol as a 25% or 30% concentrated solution. These liquid concentrates are more convenient to dispense.

Process Variations – Batch vs. Continuous Flow

Processing biodiesel in batches tends to be favored by small plants. This approach is more flexible as it allows the process parameters to be adjusted for each batch so it is relatively easy to compensate for differences in feedstock characteristics. The equipment needed for batch processing tends to be less expensive since all of the operations can be performed at atmospheric pressure in tanks. The disadvantage of batch processing is that the physical size of the plant tends to scale directly with the capacity of the plant. To double the capacity of the plant requires tanks that are twice as large.

Continuous flow processing is favored by larger plants. It uses utilities and other resources in a continuous manner at a lower peak rate, which usually is less expensive. Continuous flow plants usually operate at high temperatures (at least 65°C) to shorten the processing time. They also tend to avoid gravity separation processes which usually involve long times and large tanks. Centrifugal separators are often used to do separations very quickly while taking very little plant space. However, the cost of the separators is very high. The equipment for continuous flow processing does not usually require a lot of space, and it can be scaled up to provide increased capacity without taking a corresponding increase in space.

Both batch and continuous flow processing can provide a high quality product and successful plants have been developed using both approaches.

8. Inventory and Management Issues

Introduction

This chapter is designed to give you an overview of some of the decisions and determinations you will have to consider in building and operating a biodiesel plant. The following areas will be covered in this presentation:

- Storage requirements
- Transportation needs
- Branding recognition
- Inventory Control
- Contract Issues
- Management philosophy
- Quality

Many of these issues will be addressed in the business plan and will be influenced by the type of biodiesel plant you are building or operating and the markets you will be supplying.

Storage Requirements

Storage requirements are determined by the size of your biodiesel operation and customer requirements. Also the regulations can dictate the number and sizes of your tanks and whether they are above or below ground. Zoning regulations and fire regulations have to be considered when deciding on your storage requirements.

The major areas you should address when looking at the storage requirements are:

- Storage of products and raw materials in tanks
- Type – vertical or horizontal
- Location – above ground or below
- Size – amount of capacity
- Design – material of construction
- Regulations – federal, state, and local
- Heating requirements

If using feedstocks with variable properties, such as yellow grease, more storage will be required so that different feeds can be mixed to standardize the FFA level entering the plant. Since biodiesel is often sold under contract, sufficient finished product storage capacity will be needed to meet contract delivery requirements.

Transportation Needs

Transportation needs will be somewhat determined by your customers for your product, suppliers of your raw materials, and the size of your facility. Some customers can only accept drums, totes, or tank trucks. Small biodiesel facilities may be able to provide fuel only in small volumes best suited to drum, totes, or tank trucks. Other customers have facilities to unload rail cars or access to a pipeline, which are better suited to producing larger volumes of biodiesel. Access to steam to melt railcars or tank trucks of biodiesel may be important for customers receiving shipments by rail cars or tank trucks; even in southern climates as rail cars or tank trucks can freeze in transit. If possible, you should have the resources to switch from one type of transportation to another as needed.

Some transportation needs depend on the volume of product you will be shipping at one time, such as with rail or pipelines. A secondary consideration is location of rail spur or pipeline. Cost is always a factor in determining the best mode of transportation and the frequency of shipments. It will be cheaper to move large volumes infrequently compared to small volumes frequently. The availability of customer storage capacity will influence these decisions.

The topic of own vs. lease and internal vs. outsourcing is mainly a financial decision. Other factors will come into play depending on whether or not you have the traffic to warrant having some one on your payroll or to purchase a tank truck or rail car with all the expenses to maintain it.

Regardless of the form or frequency of transportation, a program needs to be implemented to ensure that the container used to transport the biodiesel fuel is kept clean and free of vegetable oils, dirt, and other contaminants. The ability to clean these containers before use should always be available on site and staff should be trained to inspect and monitor container cleanliness.

Depending on some customer requirements, you may be required to filter the product before it enters the transportation container or when it leaves the container.

Brand Recognition

Brand recognition is important when there are many choices for your product's consumers. . Many times the decision to buy from a company is determined by the recognition of the buyer with all other factors equal. A customer will even pay more for a brand that he recognizes over one he has never heard of, because of perceived quality or familiarity.

Establishing brand recognition can be expensive. It takes a lot of advertising and marketing to make your product or company name a household name that is recognized and can take many years to establish. A quality assurance program will be required to protect your brand and respond to consumer problems in a timely and professional manner. Most problems arise from failures in the chain of custody that result in contamination of the fuel. A liability bond that protects the consumer's equipment is just one part of an entire quality system that provides consumer security.

A quicker method in obtaining brand recognition is to buy someone else's brand name. This can be difficult because many companies do not want to sell their brand name because they are still a viable company and are still using the brand recognition. Also, it can be hard to find a brand name that would be appropriate for your product. The cost of purchasing a brand name can be very expensive, especially if it is a nationally known brand name rather than just regional.

Another way is to partner with a company with a well know brand name. Many times you bring the product and some money, and they bring the brand name. If the right partnership can be formed, this can be a win-win situation for the partners. Biodiesel firms have successfully partnered with petroleum firms in this manner.

The last way to capitalize on brand name recognition is to sell your product to a national company that has a brand name established. They will then use their brand name to promote your product. In return for the added market exposure, they often will ask for a lower price on your product. The other advantage to selling to a national company is that they have the resources to create a new brand name for your product under their company name.

Inventory Control

Why does inventory need to be controlled?
Management often asks the important question, "Why does inventory need to be controlled?" A few of the most common answers are below:

- Cost savings on equipment
- Limited space or tanks available
- Cash flow
- Taxes
- Product Quality

Cost savings on equipment: Inventory has to be stored. This means that you must have tank capacity for your entire inventory, both finish and work in process. Along with the tanks are piping, pumps, valves, heaters, and a host of auxiliary equipment. There are daily costs associated with maintaining excess inventories.

Limited space or tanks available: Real estate and buildings cost money and when you have excess inventory you must have more of both these resources available. If your plant has limited space available for the storage of inventory, then you must minimize the amount of inventory you have on hand.

Cash Flow: When a business is starting out or slow times caused by a recession are happening, then cash is tight. This means cash flow needs to be managed very carefully. Inventory ties up your cash flow and does not produce any profit until it is sold and the

money is collected. Therefore inventory is directly tied to cash flow and when inventory is high, cash flow is low.

Taxes: Income taxes and some other federal and state taxes are assessed on inventory of finish goods. This is another reason to keep inventory low.

Product quality: Holding large quantities of biodiesel products and raw materials on hand can compromise product quality. The longer you have material in storage, the greater the risk of contamination, for example by water. Also the stability can change if the products are held for a long time in the absence of stability additives.

Is inventory an asset or a liability?

The second most important question that management has to find an answer concerning inventory is "Is inventory an asset or a liability?" This question is a difficult one to answer and can differ depending on what your interest are. How would you answer the question "Is it an asset or a liability?"

There are two opposing views, one from a financial prospective and one from that of a manufacturer. In the financial or bankers world, inventory is an asset. This is because they see it as a source of money to repay a loan if it is sold. Accounting practices also list it as an asset.

You, as a manufacturer, should consider it as a liability because it ties up your money that can be used in other parts of the operation. Inventory can become obsolete and therefore cannot be sold for normal price and would be a liability. In many cases this obsolete inventory cannot be sold at all.

In the case of biodiesel, excess inventory in the form of a mixed product may not be what the customer wants and therefore sit for a long time tying up storage tanks and preventing storage of the products in demand. This would be considered a liability because it would affect production.

Another example would be producing biodiesel to a certain set of specifications and having the regulations change making this product undesirable and obsolete. Excess inventory can also become obsolete because of contamination or long-term stability issues.

In the real world –view, it is both an asset and a liability. Storing more inventories than is needed to supply the customer demand or orders on hand can be considered a liability. Enough inventories to supply the customer demand or orders on hand can be considered an asset because it protects the market share and customer base

In the case of biodiesel, the quicker you can sell your inventory the faster you can have the profit or cash from the sale in hand. Therefore you would want to make your product

to fill orders as they come in. But in many cases you must hold on hand a certain amount of inventory to make sure the customer can get product when needed.

Sometimes the amount you keep on hand is dictated by the contract with your customer or by the means of transportation you are using to deliver it to the customer. For example, if you are using a tank truck for transportation, you would want to have on hand at least one tank truck amount in storage when the time to deliver arrives. Not having that amount on hand in tanks means that the delivery could become a late shipment and cause the customer to become dissatisfied. This could cause you to lose your contract; therefore this inventory would be an asset to your operations and future.

It would also be an asset to have a small amount of excess inventory to supply the spot local market that can demand higher prices resulting in higher profits. But too much excess inventory would become a liability because it would tie up cash flow and inventory has carrying costs associated with it.

In summary, too little inventory can be a liability in satisfying customer contracts and future business and therefore be considered as an asset by the manufacturer. Too much inventory is a liability from the cash flow being tied up and chance for loss of product or obsolescence. Somewhere in between having too little inventory and having too much inventory is the place you want to operate and that can be determined by looking at inventory turns and the flow of product from your tanks to the customer.

How is inventory controlled?

To control inventory, various steps are needed to start the process. They are to establish procedures, a tracking system (MRP), setting purchasing limits and controls, conduct a financial analysis, customer considerations–lead-time, and a production or process understanding.

Establish procedures: You should set up standard operating procedures (SOP) for your inventory control. These rules will help others keep the inventory amount to a minimum and make sure you are producing what the customer needs.

Tracking system (MRP): Some type of Material Resource Planning (MRP) system is needed to track your inventory and raw materials used in your operation. This, coupled with sales orders, can give you an indication of the status of your inventory levels.

Purchasing limits and controls: Your procedures or SOP can help set limits on raw material you purchase. You can work with your supplier of raw materials or feedstock to limit the inventory you have on hand at any one time. If you can work out a deal where you can receive your raw materials on a just-in-time basis, you can minimize the money you have tied up in inventory. Consignment is another way to minimize your cost of raw material inventory.

Financial analysis: Conduct a financial analysis of the cost of holding inventory and compare that to the loss of sales if you cannot supply the product. Financial considerations are only one part of the equation in determining the amount of inventory to hold on hand, but it is an important one.

Customer considerations–lead-time: Discussion with your customers about their needs will help define what level of inventory you need to have. Explaining that inventory costs you money and ease of availability comes at a price will help your customers take a look at their real product demands. Market norms can also help determine an estimate of lead times, but you should set your goal for shorter lead times than the industry norms.

Production or Process understanding: Understanding your biodiesel process and the reliability of the process and equipment will dictate the safety stock of finished product and raw materials you need to keep in inventory. Once all risks are evaluated, you can determine a starting point for inventory levels and adjust them as time goes on or conditions change.

What needs to be controlled?

The following items need controlled:

- Raw Materials
- Intermediate products
- Finished products
- Supplies
- Contracts

Raw materials and supplies are purchased, while intermediate and finished products are a result of production and customer demand.

The final area that needs controlled is the contracts, which in most cases dictate the amount of inventory and the determining factors for the inventory levels.

Contracts can be broken down into the following types: supply contracts, raw material contracts, finished product contracts, and other purchase contracts

Contracts will specify the quantity being purchased or sold. This is directly related to the level of inventory in stock. These contracts must contain flexibility if possible on the delivery of the products as well as the quantity being delivered. It is one area that can help limit the amount of excess inventory and spell out procedures being used by the suppliers and customers.

Inventory Control Strategies

There are many management philosophies that can be used in a biodiesel plant and operation. They should be considered by management and used where applicable. A few of these management philosophies are:

- Just in time
- Kanban
- Replenishment
- Safety stock or buffer

Just in time: Just in time is when material needed for production is available right before it is needed and not stocked before hand in any appreciable quantities.

Kanban: This is a visual system to indicate when a raw material or intermediate product used in production need to be produced or procured. For example: when an item is used up, the employee using the last of the item takes the card from the container and passes it to the person in charge of supplying the item. That person then makes the quantity on the card and passes it on to production to be used. This visual card dictates the batch size to be produced.

Replenishment: Replenishment is slightly different than Kanban. In replenishment when an item is used in production, it is replaced at a set time to be produced and only in the quantity that was used in production. So in replenishment time of production of the item is set and the quantity produced is variable, unlike Kanban where the quantity produced is set and time of producing the item is variable.

In a Biodiesel plant with limited variability in feedstock and produces, Kanban or Replenishment would probably work the same and provide the same benefits. When variety or variability occurs, replenishment is a better control system for inventory.

Safety stock or buffer: This is the amount you keep on hand to cover the variability in demand of a product or raw material and to protect against "Murphy's Law", which is "If anything can go wrong, it will".

Contract Issues

The following list is a sampling of contract issues to be concerned with:

- Standard clauses for trucking and rail transportation
- Mediation clause for disputes between supplier and customer
- Quality standard and sampling procedure
- Testing methods used

By agreeing on these issues up front in the contract, it can minimize problems that may arise later on in the relationship between your company and the customer or suppler. In most cases you would want to have your attorney help with the language in the contract and protect your interest.

Management Philosophies

In today's economic climate it is important to strive to be the best among your competitors. Adopting management philosophies that will take your company to better productivity and quality is very important.

This is a list of the most popular management philosophies being used today. Each one can benefit your organization and add profit to the bottom line. One is not necessarily better than another and often parts of each of them can be applicable in your company.

- Lean Manufacturing
- Constraint Management (Theory of Constraints)
- Six Sigma
- Malcolm Baldridge Criteria
- ISO Certification

Your management team should review what each one has to offer and see what would work best in your organization.

Quality

Quality involves testing requirements and customer acceptance of your product. Here is a list of quality topics you need to address:

- ASTM Test Methods
- ISO Certification or BQ 9000
- Policies and procedures
- Quality Manual

ASTM Test Methods: ASTM test methods are used to evaluate the quality of your product.

ISO Certification or BQ 9000: ISO Certification is an international certification for quality accepted around the world. The BQ 9000 is a quality management system requirement for the Biodiesel Industry developed by the National Biodiesel Accreditation Commission on November 12, 2002.

Policies and procedures: Policies and procedures need to be determined for your plant and process. This will help standardize your evaluation and testing of your product and process and help reduce operator error in sampling and testing. It will also spell out what is acceptable for the customer and what is not.

Quality Manual: The quality manual is the place where all your quality procedures and policies are kept. This is available to all employees and the contents are kept up to date and current. All documents are controlled and dated.

Both the ISO 9001 and the BQ 9000 certifications will be discussed in further detail to expose you to the international standard (ISO 9001) and biodiesel industry specific (BQ 9000) options for a quality certification.

ISO certification is becoming more accepted as a requirement for conducting business and can expand your market to those who require this certification.BQ 9000 was developed specifically for the biodiesel industry to help define quality standards that need to be met to insure production and distribution of a quality product. Both ISO certification and BQ 9000 certification processes and requirements are very similar.

ISO 9001 Quality Management System

The following text is based on ISO 9001:2000 and was developed by CIRAS at Iowa State University.

Many of you may recognize the ISO name and may also have preconceived ideas about ISO. The new standard is focused on processes. The documentation requirements have been minimized.

The quality system of ISO 9001:2000 is a model for a quality system for a company whether or not the company becomes certified to the standard.

What is ISO 9001?

It is an international standard for establishing, documenting and maintaining a quality system within an organization.

The current version is ISO 9001:2000; it was approved in December of 2000. This standard has been adopted by over 170 countries world wide as the quality standard to be adopted by business and industry. About 15 percent of Iowa's companies have adopted ISO 9001. In addition to manufacturing, Iowa has seed companies, feed mills, machine shops, parts manufacturers, tool and die shops, paint shops, electronic parts and product manufacture, appliance and farm implement manufacture, farmers and feed additive firms certified to this standard.

What is "ISO"?

ISO stands for the International Organization of Standards and means "equal". The purpose is to promote the development of standards and related world activities and to develop cooperation among member countries in scientific, economic and technological activities. It is recognized by the American National Standards Institute (ANSI).

The International Organization of Standards is located in Geneva, Switzerland. It is an organization that issues standards in many product areas for international commerce. The standards include product and system standards. Standard 9000 was issued in 1987 as the ISO 9000 quality standard.

The U. S. representative to ISO is ANSI. Technical committee 176 of IOS is responsible for issuing and updating the quality standard. The standard is revised on a schedule of every five to six years.

ISO is a Greek word that means, "equal." In an organization, the standard is equal in that all functions of a company are expected to participate in the quality system, except accounting, which is covered by and regulated by other financial and accounting standards. Management is expected to participate in the standard like the other staff and employees do. The standard is equal in the sense that all types of businesses who adopt the standard, adopt the same standard, regardless of size. Also the same standard is used around the world as the international language of quality.

What is the underlying concept of ISO 9001:2000?

It provides guidance to management in the implementation of a quality system or to improve a system. It also will assist organizations in achieving quality improvements.

This is based on the new standard ISO 9001:2000 and is a system that is acceptable on an international basis and a system that is certified by an independent third party – the registrar. Also it provides quality improvements – higher efficiencies, better effectiveness, prevention of defects, and reduced risks.

The Model for the ISO 9001:2000 Quality System

This is the model for the ISO 9001:2000 quality system. The model is focused on processes. The four main elements of the standard are found in almost all business, non-profit. Most businesses, groups and organizations have management, resources to manage, a product or service to provide and some form of measurements to measure success. In addition, these same businesses or groups would also be concerned about their customer base with an interest in customer satisfaction.

This in a "nutshell" is the ISO 9001:2000 quality system.

Will your business have management responsibility? Resource management? Products to produce? Measurements to take? Customers to satisfy? Of course, the answer is yes. The ISO system may be a model for a quality system for your operation.

The ISO Reason to Adopt the Standard?
"…for use where an organization's capability to provide conforming product and/or service needs to be demonstrated."

Reasons to provide evidence of conforming product or service usually relates to a customer(s) who specify ISO 9001:2000 certification as a requirement to sell them product.

For example, the federal government is one customer that does specify ISO 9001:2000 certification for suppliers.

Benefits

The benefits of adopting ISO 9001:2000 are as follows:

- Open access to new markets and protects existing markets.
- Provide consistent direction to employees.
- Increase employee awareness of quality.
- Opportunity for continuous improvement.

Most companies adopt the ISO 9001:2000 quality system because they have to. That is, a customer tells them to adopt the system or lose their business. Many major companies in the automotive, aerospace, appliance and machining industry now require suppliers to adopt the ISO 9001:2000 quality management system. Or a company will adopt the standard because they are afraid of losing business to a competitor who is certified. Federal procurement bids specifications now often specify a company must be certified to ISO 9001:2000.

However, once companies have adopted the standard, are certified to the standard and are actively using the standard they report other benefits. By actively manage we mean the company tries to continuously improve their quality process and product quality. The first benefits reported are usually by the employees. Employees consistently say they have better direction on what they are to do and/or they have better instructions on how to do their job from the documentation established during the ISO 9001:2000 implementation.

But studies such as the McGraw Hill study also show that the two top benefits reported by the quality system have nothing to do with the marketplace. The two top benefits are improved customer satisfaction, the number one benefit reported, and reduced defects.

Payoff?

The payoff in using ISO 9001:2000 has been found to be an average savings-to-cost ratio equal to 1.5. In small companies it is equal to 1.3, and the highest ratio – food, tobacco, textile and wood products sector is equal to 2.3. The source for these statistics is the ISO 9000 Survey '99, McGraw-Hill.

Besides the benefit reported by employees or related to defects or customers, there are monetary benefits. Companies who had implemented and used the quality management system for five years or more achieved the payoffs depicted above.

Process Approach

The process approach is used by the standard to implement a quality system. It can be broken down into two: Process – a series of interrelated or interacting activities which transform inputs into outputs and Process Approach – the identification, management, and interaction of a series of processes within an organization

The manufacture of a product consists of processes. On the top level is the process related to the macro view of the business. The process starts with a customer who wants to purchase your product. This usually triggers a series of events in the business starting with marketing and sales through purchasing procuring needed raw materials and supplies to production where the product is produced to storage to shipping with delivery to the customer. The final processes relate to preparing and sending an invoice to the customer.

In any of the areas, such as marketing there are processes. In marketing and sales, someone will talk to the customers, determine the customer needs and write and order. The order then may be passed to a clerk who enters the order into the factory software management system.

The Model for the ISO 9001:2000 Quality System

In the next topics we will explain what is involved in each of the four main elements of the ISO 9001:2000 quality management system. You will be able to see the system is simply dealing with factors found in almost all business. The one exception is the requirement dealing with product design. Many companies and organizations, of course, do not do this. However, the other requirements fit almost all situations.

Quality Management System

Managements Tasks: Establish, document, implement, and maintain a system. Identify processes, determine criteria for effectiveness, provide resources, and continually improve.

Management Responsibility

Top management takes a leading and visible role in defining, implementing, administering, and improving the quality management system to meet customer requirements.

Management Responsibility- Customer Focus

Top management shall ensure that customer requirements are determined and fulfilled with the aim of enhancing customer satisfaction.

Management has a responsibility to make sure the company understands what the customer wants and then running the business to ensure the requirements are met.

Management must also define and communicate responsibility and authority in the organization. In addition, management must also establish appropriate internal communication practices.

Resource Management Human Resources

Personnel performing work affecting product quality shall be competent on the basis of appropriate education, training, skills, and experience.

The organization is to provide the resources needed to implement and maintain the quality system and continually improve its effectiveness to enhance customer satisfaction.

One important area of resource management is people. The organization should determine the requirements, such as education, training, and experience, for people performing work affecting quality. In addition the company is to determine training needs and then providing the training. Another issue is determining the effectiveness of the training provided.

Competence, Awareness and Training

- Identify training needs
- Provide training or satisfy need
- Evaluate the effectiveness
- Ensure personnel are aware of importance of their activities
- Maintain records of training, education, skills, and experience

Resource Management Infrastructure & Environment

Provide workspace, utilities, equipment, hardware and software, and supporting services needed to achieve conformity to product requirements.

Work Environment

The organization shall determine and manage the work environment needed to achieve conformity to product requirements.

If competent people are hired, the organization also has the responsibility to determine, provide and maintain the infrastructure and work environment needed to produce a quality product and maintain a quality process.

Resource Management Work Environment

The organization shall determine and manage the work environment needed to achieve conformity to product requirements.

Product Realization

Planning Of Product Realization

- Plan and develop processes needed for product or service realization
- Determine quality objectives required, resources, and inspection
- Provide records/evidence that the realization processes meets requirements

Process for Product Realization

- Review Customer Orders
- Product Design
- Purchasing
- Production Control
- Product Identification and Trace-ability
- Product Handling, Storage and Transportation
- Calibration of Measurement Instruments

Company activities included in product realization including reviewing customer orders to make sure you can provide the product in the quality and time specified; product design of new products; purchasing which includes qualifying suppliers; production control – scheduling the plant and providing appropriate information; product ID; shipping and storage and calibration of gauges, scales and other devices used to take measurements.

Measurement, Analysis and Improvement

- Plan and implement monitoring, measurement, analysis and improvement processes needed to demonstrate conformity of product and quality system
- Continually improve the effectiveness of the quality management system

Measurement, Analysis and Improvement Activities

- Customer Satisfaction
- Internal Audits
- Monitor and Measure Products and Processes

- Control Defective Product
- Continual Improvement

Specific activities include measuring customer satisfaction
Monitor and measuring the product – inspection and test
Handling defective product
Continual improvement to improve the system
Documentation And Records

- Amount of detail of documentation based on organization's process and requirements
- Minimum amount of documentation is better
- The quality management system will identify the need for additional documentation

Documentation Levels

To have a quality management system will require some documentation. The ISO documentation tree depicts one such way of tracking documentation. How much documentation? What kind of documentation? How much detail should I include in the documentation? That is entirely up to you.

The level one document is the quality manual. It is a series of policy statements about your what aspects are contained in your quality system. The policies are broadly stated.

The procedures provide the detail of what, who, where and when. They provide guidance on how to do a process such as purchasing.

Work instructions are familiar to most everyone. The detailed instructions are on how to do specific work tasks.

Regarding ISO 9000, a common misconception is the standard requires a lot of paperwork – documents and records. That is not true! The ISO standard only requires six procedures. All the other processes and areas included in the standard do not require procedures. The six required procedures are:

- Internal auditing
- Corrective action
- Preventative action
- Nonconforming material
- Document control
- Control of quality records

The amount of documentation you have and the amount of detail you have is dependent on several factors. These are:

- Complexity of the process
- Education and skill level or competency of the people – trained people may not need as many work instructions.
- Tasks are repeated often or infrequently – meaning people need to be reminded.

Documents such as work instructions do not have to be written. Documentation can be through written documents, videos, pictures, diagrams or flowcharts.

Records

Records provide the objective evidence that a quality system activity took place. The data found in the various records are some of the facts that can be used to analyze the quality system and determine the need for improvement.

All firms keep records. Record related to employees, finances, inventory, sales and product. Many times firms when adopting the quality standard, discover that the company has many more records than required by the ISO 9001:2000 quality system.
Records provide serve several uses in the ISO systems. One use – records are proof to the registrar, to your internal auditors and to your customer that the quality system is working, that products produced meet the specifications required.

Another use is as a source of data that can be used to improve the system.

Records can take many different forms and do not need to be paper document. Records could be a picture, a video, a form with numbers, a check sheet, emails, or spreadsheets in a computer.

BQ-9000, Quality Management System Requirements for the Biodiesel Industry

Approved by the National Biodiesel Accreditation Commission on November 12, 2002

This requirements document has been prepared by the National Biodiesel Accreditation Commission, an autonomous committee of the National Biodiesel Board, P.O. Box 104898, Jefferson City, MO 65110-4898, for use in a cooperative and voluntary program for the accreditation of producers and marketers of biodiesel. Compliance with these requirements is a minimum requirement of the accreditation process. The existence of this document does not in any respect preclude any entity from producing, purchasing, or using products, processes, or procedures not conforming to this standard. This document is subject to periodic review and revision control and users are cautioned to obtain the latest edition.

BQ-9000 - QUALITY MANAGEMENT SYSTEM REQUIREMENTS FOR THE BIODIESEL INDUSTRY

1 SCOPE

This document specifies requirements for a quality management system where an organization needs to demonstrate its ability to provide product that meets ASTM D 6751, Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distilate Fuels and applicable regulatory requirements, and to address quality assurance through the effective application of the system, including processes for corrective action and the prevention of nonconformity.

The requirements specified herein are applicable to organizations in the Biodiesel Industry, i.e. producers or marketers. Marketers are defined as organizations engaged in the business of the distribution and sale of biodiesel and/or biodiesel blends of B2 or greater. The process control requirements are prescriptive, whilst the remaining clauses are descriptive.

2 TERMS AND DEFINITIONS

For use in this text, the following terms and definitions apply.

Note: The word “shall” indicates mandatory requirements of this document. The word “should” indicates a mandatory requirement with some flexibility allowed in compliance methodology. Those choosing other approaches to satisfy a “should” must be able to show that their approach meets the intent of these requirements.

Biodiesel: a fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats and meeting ASTM D 6751, designated B100.

Blend: a blend of biodiesel with petroleum-based diesel fuel in a specified ratio, designated Bxx, where xx is the volume percent of biodiesel.
Quality Manual: a document that describes the elements of the quality system used to assure that the requirements of this requirements document are met.

Quality System: the organizational structure, responsibilities, procedures, processes and resources necessary to manage quality.

Verification: confirmation by examination and provision of objective evidence that specified requirements have been fulfilled.

3 QUALITY MANAGEMENT SYSTEM REQUIREMENTS

The organization shall establish and maintain a documented quality management system containing provisions which explicitly or by reference, include the requirements contained in Appendix A.

4 BIODIESEL SAMPLING & TESTING PROCESS REQUIREMENTS

'The organization shall establish and maintain documented procedures containing provisions which explicitly or by reference, include the process requirements contained in Appendix B. A record of significant process changes shall be maintained by the organization.

5 BIODIESEL PRODUCT WARRANTY (Applies only to organizations established as marketers)

The organization shall develop and publicize a warranty policy that declares that the product (biodiesel or a biodiesel blend) is "fit for purpose". When used by the end user for the purpose intended, the product warranty covers consequential equipment damage.

6 REFERENCES

6.1 Normative References

The following references contain provisions which, through reference herein, constitute provisions of these requirements. All referenced documents are subject to revision, and all those applying these requirements are required to apply the most recent editions of the references indicated below. (Note: ASTM documents are available from: ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. BQPs are available from the National Biodiesel Board, P.O. Box 104898, Jefferson City, MO 65110-4898.)

ASTM D 664, Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration.

ASTM D 1298, Standard Practice for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.

ASTM D 4057, Standard Practice for Manual Sampling of Petroleum and Petroleum Products.

ASTM D 4176, Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels (VisualInspection Procedures)

ASTM D 6584, Standard Test Method for Determination of Free and Total Glycerine in B-100 Biodiesel Methyl Estersby Gas Chromatography.

ASTM D 6751, Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels.

BQP-01, Field Test Method for Acid Number.

NOTE: The BQP-01 test method may be used as an alternative to ASTM D 664 for determining acid number.

6.2 Informative References

The following reference is included as bibliographic information which may contain material useful in the application of this requirements document. Excerpts from this reference were used in the development of the requirements in Appendix A.

ISO 9001:1994[1)], Quality Systems - Model for quality assurance in design, development, production, installation, and servicing.

[1)] - International Organization for Standardization (ISO). This material is reproduced from ISO 9001:1994 with permission of the American National Standards Institute (ANSI) on behalf of ISO. No part of this material may be copied or reproduced in any form, electronic retrieval system or otherwise or made available on the Internet, a public network, by satellite or otherwise without the prior written consent of the American National Standards Institute, 25 West 43rd Street, New York, NY 10036. All ISO documents are available through ANSI's online electronic standards store at http://webstore.ansi.org.

Appendix A
(mandatory)
Quality Management System Requirements

The organization shall establish and maintain a quality management system containing provisions, which explicitly or by reference, include the requirements contained in this Appendix.

A1. Organizational Elements

A1.1 The quality system shall be documented in a quality manual, which meets the requirements herein including the means to ensure that product, conforms to ASTM D 6751 and any customer specific requirements. The quality manual shall include or make reference to quality system procedures, outline the structure of the documentation used
in the quality system, and shall be a controlled document.

A1.2 A quality policy shall be defined and documented which includes the objectives for and commitment to quality. The quality policy shall be related to the business goals of the organization and the expectations of its customers. The quality policy shall be invoked throughout the organization and understood by all levels of personnel.

A1.3 A quality management representative (QMR) shall be appointed and irrespective of other duties, shall chair management review meetings, ensure that a quality system is established and that it meets the requirements herein, and report on the performance of the quality system. The management review meetings shall be held at specified intervals (at least one each six months) to ensure the quality system is suitable, effective, and continuously improving. The reviews shall confirm the requirements herein are being met and that the organization's quality policy and objectives remain appropriate. The reviews shall include input from internal audits and records shall be kept of the review meetings.

A1.4 The personnel responsible for managing, performing, and verifying work affecting quality shall have their responsibilities and authority defined and documented. This should be accomplished with an organization chart and written job descriptions. Attention shall be given to identify the personnel in the organization that are required to: 1) initiate action to prevent the occurrence of any nonconformities relating to product, process and quality system (and have the authority to stop production, if necessary to correct problems), 2) identify and record any problems relating to the product, process and quality system, 3) initiate, recommend or provide solutions, 4) verify the implementation of solutions, and 5) control further processing or delivery of nonconforming product until the deficiency or unsatisfactory condition has been corrected. Personnel responsible for corrective action shall be promptly notified of processes, which become noncompliant. The resources necessary to implement and maintain the quality system shall be identified and the organization shall ensure such adequate resources are provided.

A1.5 Documented Quality System Procedures (QSPs) shall be prepared and be consistent with the requirements herein, any self-imposed requirements, any customer specific requirements, and any other external requirements. Procedures may make reference to work instructions that define how an activity is performed. Procedures and work instructions are controlled documents and shall be "fit for purpose". In this context, "fit for purpose" means that the scope and detail of the document depends on the complexity of the work, the methods used, and the skills and training needed by personnel involved in carrying out the activity.

A1.6 Quality Planning shall be accomplished through the use of written procedures that describe the process to be employed for determining and documenting how operational quality requirements will be met.

A1.7 The organization shall develop and implement a system for performing internal quality audits. Each element of the quality system shall be audited at specified intervals (at a minimum of once per year) to verify that the organization's operations comply with the requirements stated in its quality manual and to determine the effectiveness of the quality system. Audit frequency should be increased when audit results indicate the increased frequency would be beneficial. Audit personnel shall be trained to conduct audits and when the size of the organization permits, they should be independent of the area/function being audited. Audit results shall be presented to personnel responsible for the audited area/function and cited nonconformities must be resolved in a timely manner (as defined in written procedures). The audit process, nonconformance reports, corrective action plans, and effective corrective action shall be included in internal audit records. Internal quality audits shall be extended to suppliers to the organization that perform services that satisfy quality system requirements.

A2. Operational Elements

A2.1 As stated in clause 4, the organization shall establish and maintain documented procedures containing provisions, which explicitly or by reference, include the process requirements contained in Appendix B. A record of significant process changes shall be maintained by the organization.

A2.2 The organization shall develop written procedures for identifying the product by a suitable means through the production process where the lack of such identification might be confusing. If traceability is a specified requirement (self-imposed or an external requirement), the organization shall develop written procedures describing a method of unique identification of individual product, batches, or lots. This identification shall be recorded as a quality record (see A3.2).

A2.3 Inspection and testing functions associated with the verification that specified product requirements are being met shall be defined in written procedures. Such procedures shall include the types of inspection and testing performed and the records established by same. The organization shall conduct receiving inspection, in-process inspection, and final inspection and testing in accordance with written procedures.

The procedures for final inspection and testing shall require that all specified inspection and tests have been carried out and that the results meet specified requirements. The requirements must, as a minimum, meet those specified in Appendix B. Final inspection and testing procedures shall assure that production lots are not released until all the specified requirements have been completed and the corresponding documentation has been approved.

The organization shall create and maintain records which provide evidence that the product has been inspected and/or tested. These records shall indicate that the product has passed or failed the tests and/or inspections that are required by aforementioned procedures. The records shall also indicate the personnel with the authority to "sign-off" on the release of product. Procedures for control of nonconforming product shall be employed (see A4.1) when a lot (or portion thereof) fails to pass a required inspection or test.

A3. Administrative Elements

A3.1 All documents and data that relate to the quality system shall be controlled per written procedures. Such control shall include, as applicable, documents of external origin (e.g. ASTM standards and customer specifications). Document and data control procedures shall include provisions for: authorized signatures (approval), revision control, and the use of a listing (record) of document locations. The control mechanism shall provide for keeping documents in their most current form and accessible to those requiring their use. Obsolete or out of date documents shall be removed from use and destroyed (unless properly identified and retained for business reasons). The control mechanism shall also include a means of controlling changes to documents which includes review and approval by the party having originally approved the document.

A3.2 Quality records shall be managed such that records relating to the effective implementation and operation of the organization's quality system are controlled. This shall include supplier's records to the extent they relate to the organization's quality system requirements. Records control shall include defining how records are identified, indexed, retained, stored, and disposed. The storage of quality records shall be done in a manner that ensures record integrity until destroyed (following a quality system stated retention period).

A4. Remediation Elements

A4.1 The organization shall develop written procedures that will ensure that product is prevented from unintended use or shipment if it is found to be nonconforming. Controls shall be defined that provide for identification, documentation, evaluation, segregation (when practical), disposition of nonconforming product, and for notification to the functions concerned. Personnel with the authority to review and "sign-off" on the disposition of nonconforming product shall be identified. The review of nonconforming product shall be conducting according to the written procedures. The disposition of nonconforming product may be categorized as: 1) reprocessed to meet specification,

2) use with or without concession, 3) re-classified to another application, or 4) rejected or destroyed. If product is reprocessed, it must be also reinspected to assure it meets specification.

A4.2 Corrective and preventive action shall be managed through the use of written procedures. Where corrective or preventive action is taken to eliminate the root cause of observed or anticipated nonconformances, such actions shall correspond with problems encountered and/or potential risks. The organization shall record changes made to procedures that are a result of corrective and preventive actions taken.

Appendix B
(mandatory)
Sampling & Testing Process Requirements

The organization shall establish and maintain documented procedures containing provisions, which explicitly or by reference, include the process requirements contained in this Appendix. Section B1 is applicable to organizations established as producers, whilst Section B2 is applicable to organizations established as marketers.

B1 Producer Process Requirements

B1.1 Production Lots (see Appendix C)

A biodiesel production lot is a homogeneous production volume of finished biodiesel from one or more sources that is held in a single container where representative samples are taken and analyzed to provide an authentic certificate of analysis (COA) for the specific volume. Each separate lot shall be identified (see A2.2) in a manner that corresponds to that particular volume of fuel. All production lots shall be tested as described herein. Production lots shall be managed so that once the lot is identified, no other product shall be introduced into the lot without reconfirming that it meets specification.

B1.1.1 Sampling

Each production lot shall be sampled by obtaining a tank outlet sample (which represents the product in the lowest level of the tank that will be delivered to the customer), and tank samples at the upper, middle and lower regions of the tank. ASTM D 4057, Standard Guide for the Sampling of Petroleum Products, addresses the issues relative to the sampling of biodiesel. A composite or all-level sample made from the upper, middle, and lower levels shall be created, a portion of which shall be retained for 60 days, or the estimated life of the product, whichever is longer.

B1.1.2 Testing

All production lot outlet samples shall be tested to assure that the customer delivered product shall be free from particulate matter, water, and unreacted material per test procedure, ASTM D 4176 Free Water and Particulate Contamination in Distillate Fuels. If the product is out of specification the appropriate corrective action shall be taken including documentation.

Further, each production lot shall be subjected to full specification testing (see A1.1.2.1) until there is sufficient confidence that the production process consistently produces product, which meets ASTM D 6751. The production of a

minimum of ten consecutive lots that meet the standard provides such a confidence level. Once this has been achieved, production lots may be subjected to reduced specification testing (see A1.1.2.2), except that at least once per quarter, a production lot shall be selected for full specification testing.

If a significant process change occurs (one that could materially alter the composition of the product), full specification testing shall resume until confidence in the production process is re-established. Confidence is re-established with the production of a minimum of three consecutive lots that meet the standard.

NOTE: A significant process change may include; a) the use of different raw materials, b) the use of new or modified equipment, c) refurbishment of existing equipment, d) change in equipment location, e) change in personnel, e) change of source for materials or services, or f) use of equipment that has been inactive for volume production for 30 days or more.

If a biodiesel storage tank (containing a unique lot) has no activity for 30 days, product shall not be shipped from the storage tank until an outlet sample and an all-level sample is taken. Both samples shall be tested for water and sediment per ASTM D 4176, and for Acid Number per ASTM D 664.

If any of the production lot testing fails to meet specification, the production lot shall be isolated and the procedures for the control of nonconforming product shall apply (see A4.1).

B1.1.2.1 Full Specification Testing

Full specification testing shall include testing to each of the limits defined in ASTM D 6751 and the following:

Property	Test Method	Limits	
Relative Gravity, kg/L	ASTM D 1298	range	0.006
Visual appearance	ASTM D 4176 Procedure 2	2	max (outlet sample)

The upper, middle, and lower level tank samples (see B1.1.1) shall be used for the relative gravity test and the composite sample is used for the remainder of the full specification testing.

B1.1.2.2 Reduced Specification Testing

Reduced specification testing shall include testing performed on the composite sample (except as noted) to each of the following limits:

Property	Test Method	Limits
Flash point, °C	per ASTM D 6751	per ASTM D6751
Water and Sediment, volume %	per ASTM D 6751	per ASTM D6751
Cloud point, °C	per ASTM D 6751	per ASTM D6751
Acid number, mg KOH/gm	per ASTM D 6751	per ASTM D6751

Free glycerin, % mass per ASTM D6751	per ASTM D 6751	
Total glycerin, % mass per ASTM D6751	per ASTM D 6751	
Visual appearance max (outlet sample)	ASTM D 4176 Procedure 2	2

B1.1.3 Certificates of Analysis (COA)

A COA shall be generated for each production lot and shall contain a unique lot identification. When full specification testing has been performed on a lot, the COA shall contain a listing of each of the actual results. When reduced specification testing has been performed on a lot, the COA shall contain a listing of each of the actual results of the reduced testing. The remaining specification requirements can be given as “typical”, relying on the results from the previous full specification testing period.

B1.2 Truck and Railcar Standards

The quality system shall address the standards for trucks and railcars that are used for distributing biodiesel. Preferably, trailers and railcars should be dedicated to biodiesel service. If this is not practical, then the quality system shall provide cleanliness specification standards that address material and chemical compatibility issues. Each trailer and railcar compartment shall be inspected to assure the standards have been met before the loading operation begins. Records of such inspections shall be maintained (see A3.2). Contracts with rail and trucking companies will state, explicitly or by reference, the cleanliness standards that must be complied with before hauling biodiesel.

A retain sample shall be taken of all biodiesel shipped from the production lot storage tank. If the customer is supplying the transport, the sample should be taken from the fill line to the transport. If the producer is supplying the transport, the sample should be taken from the outlet of the transport after it has been filled. The sample shall be retained for 60 days, or for the estimated life of the product, whichever is longer.

Trucks and railcars are to be used which are designed to accommodate closure and identification seals. At the end of the loading operation, all inlet valves to the compartments shall be closed and sealed.

B2 Marketer Process Requirements (see Appendix D)

A marketer has two purchase options when marketing biodiesel, 1) the marketer can purchase biodiesel from an NBAC accredited producer and rely on the COA generated by the producer, or 2) the marketer can purchase the biodiesel from a non-accredited producer and have the testing performed to produce a valid COA.

B2.1 Sampling, Inspection and Testing at the Point of Receipt (Receiving Inspection)

All trucks and railcars are to be inspected at the point of receipt from the production facility. The compartment inlets are to be inspected to assure the inlets were properly sealed and the seals are still intact.

B2.1.1 Product received from an NBAC Accredited Producer

Product received from an NBAC accredited producer may bypass the ASTM D 6751 tests required to generate a COA and be off-loaded directly into a distribution tank. The producer generated COA applies to this product.

B2.1.2 Product received from a producer not NBAC accredited

Product received from a producer that is not accredited, shall be quarantined1) and subjected to the required tests to verify that the product meets ASTM D 6751. An all-level or composite sample is taken and tested for Haze at 50 °F (10 °C) per ASTM D 4176 (maximum of 2) and for Acid Number per BQP-01 (maximum of 0.80mg KOH/gm). If the sample passes these tests, the composite sample is then subject to full specification testing (see A1.1.2.1). When the product passes these test requirements, a COA is created and the product is released to the Distribution Tank. A portion of the all-level or composite sample shall be taken and retained for at least 60 day, or for the estimated life of the product, whichever is longer. If the product is out of specification the appropriate corrective action shall be taken including documentation. If the product is released to the Distribution Tank before the product has been confirmed to meet product specification, and testing reveals that the product does not meet specification, the organization shall isolate and (if necessary) recall the product.

1) - Approved product with a COA shall not be commingled with product not yet assigned a COA.

B2.2 Distribution Tanks

All distribution tanks should be dedicated to biodiesel service. If a tank is changed from some other service to biodiesel storage, the tank should be drained dry, cleaned, and then inspected. The inspection shall be documented.

After each receipt of new product into the Distribution Tank, an all-level sample and outlet sample shall be obtained and tested. A portion of the all-level or composite sample is retained2) for at least 60 days, or for the estimated life of the product, whichever is longer. If no activity occurs in this tank within a one month time period, a new outlet sample shall be obtained and tested.

2) - Retained samples (“retains”) shall be kept in an environmentally appropriate location to avoid spoilage of the sample for the period of time being retained.

B2.2.1 Testing

The samples obtained after receipt of new product and those collected on a monthly basis shall be visually inspected for water, sediment, and particulate matter. Additionally, the test method for acid number (per BQP-01) shall be performed. If the product is out of specification the appropriate corrective action shall be taken including documentation.

B2.2.2 Product Distribution Sample

If biodiesel is sold and being shipped as B100 directly from a Distribution Tank, a sample of the product being loaded shall be obtained and retained for at least 60 days or for the estimated life of the product, whichever is longer.

B2.3 Trucks or Tanks Containing Blended Biodiesel (see Appendix E)

During the process of creating a biodiesel blend, the blending operation shall be monitored to assure adequate mixing of the products in the correct proportions. This includes measuring and recording the volumes and lot numbers of both the biodiesel and diesel fuel, which comprise the blend.

All blend tanks should be dedicated to biodiesel blend service. If a tank is changed from some other service to biodiesel blend storage, the tank should be drained dry, cleaned, and then inspected. The inspection shall be documented.

B2.3.1 Sampling

After each product receipt into the diesel fuel tank, an all-level or composite sample should be taken and retained for at least 60 days in case of a dispute about product quality.

The blended fuel shall be sampled to assure the finished fuel is well mixed in a homogeneous product in a manner best suited for the method of blending employed. The appropriate method of sampling and testing shall be determined by the organization. After testing, the sample shall be retained for 60 days, or for the estimated life of the product, whichever is longer.

If no activity occurs in the tank, at least once per month the blend tank shall be sampled to assure water has not been introduced into the tank and that sediment has not developed. For this purpose an outlet sample small be obtained. The all-level or composite sample shall be retained for 60 days, or for the estimated life of the product, whichever is longer.

B2.3.2 Testing

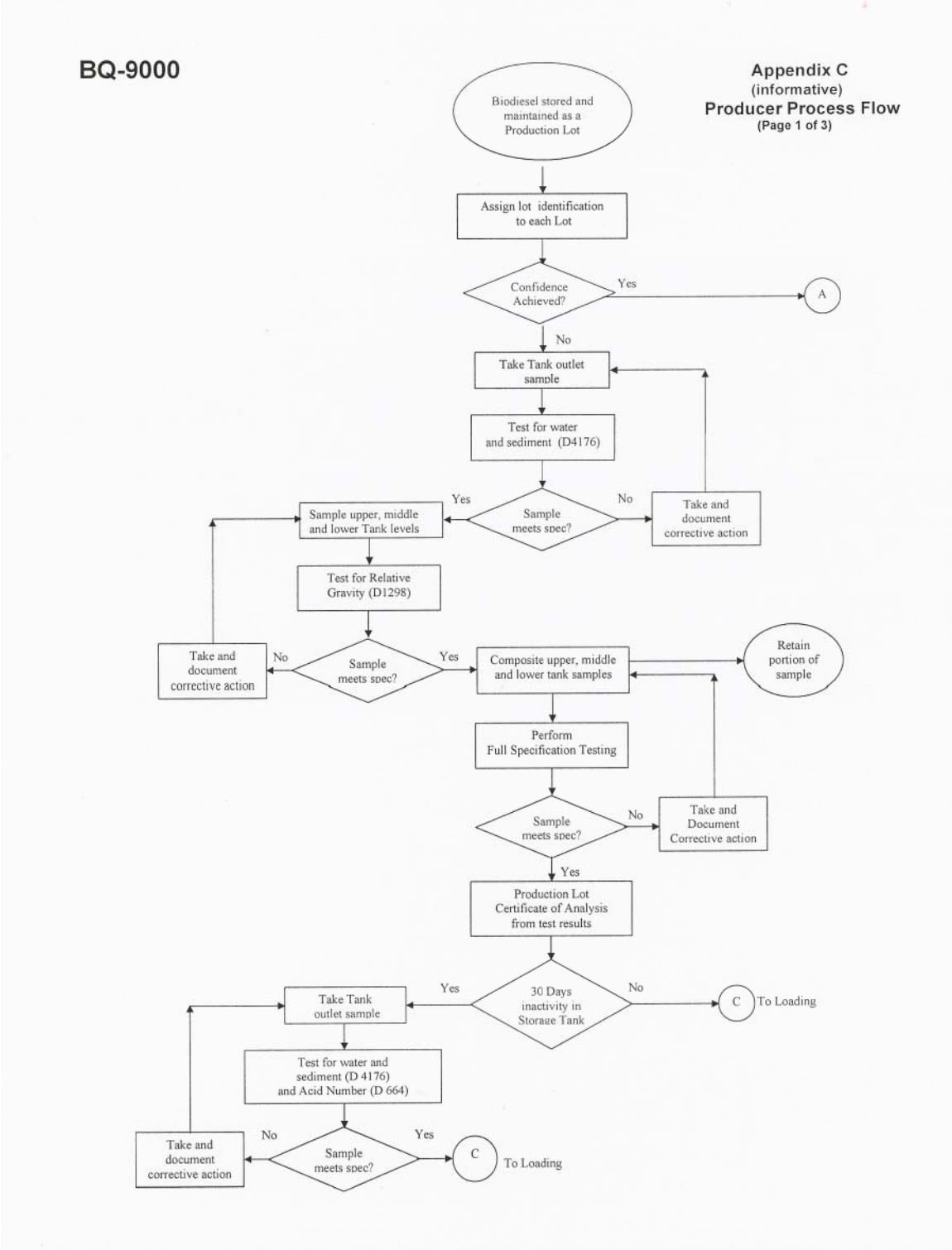
If a diesel fuel tank outlet sample has been taken, it shall be tested for moisture and sediment per D 4176. If moisture or sediment is detected in these samples, corrective action should be taken to remove the contaminants and the action documented.

If multiple level samples are used to assure homogeneity, the specific gravity (D 1298) of each strata of the blended product should be determined. The range of results across the three samples shall be less than 0.006 and be visually examined for water, sediment and particulate matter by D 4176. If the product is out of specification then corrective action shall be taken including documentation.

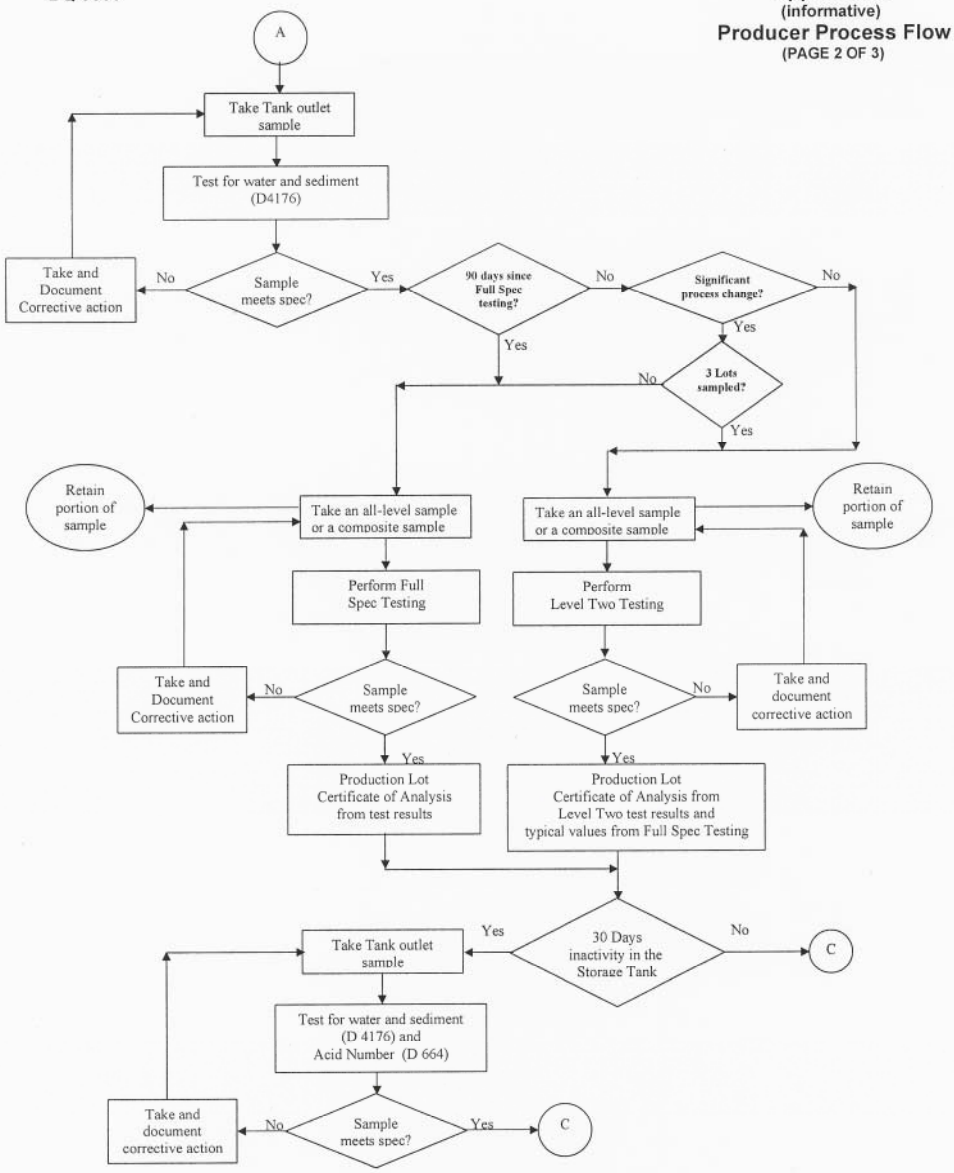
The outlet sample taken from the blend tank (when there is no activity over a thirty-day period) shall be tested for moisture and sediment using D 4176, procedure 2. If out of specification, corrective action with documentation is required.

B2.3.3 Product Distribution

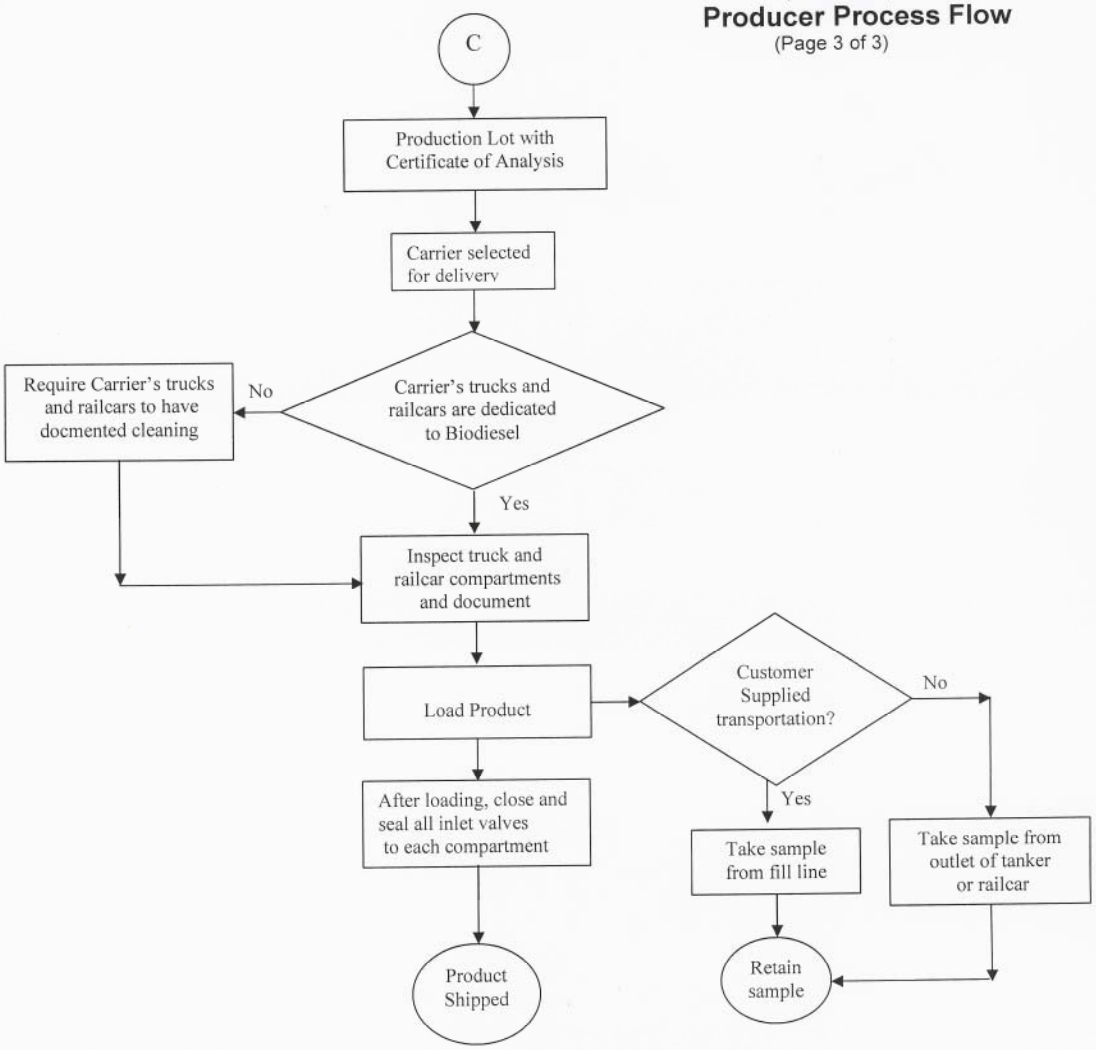
When blended biodiesel is sold and being shipped from a blend tank, a sample of the product being loaded shall be obtained and retained for at least 60 days or for the estimated life of the product, whichever is longer.



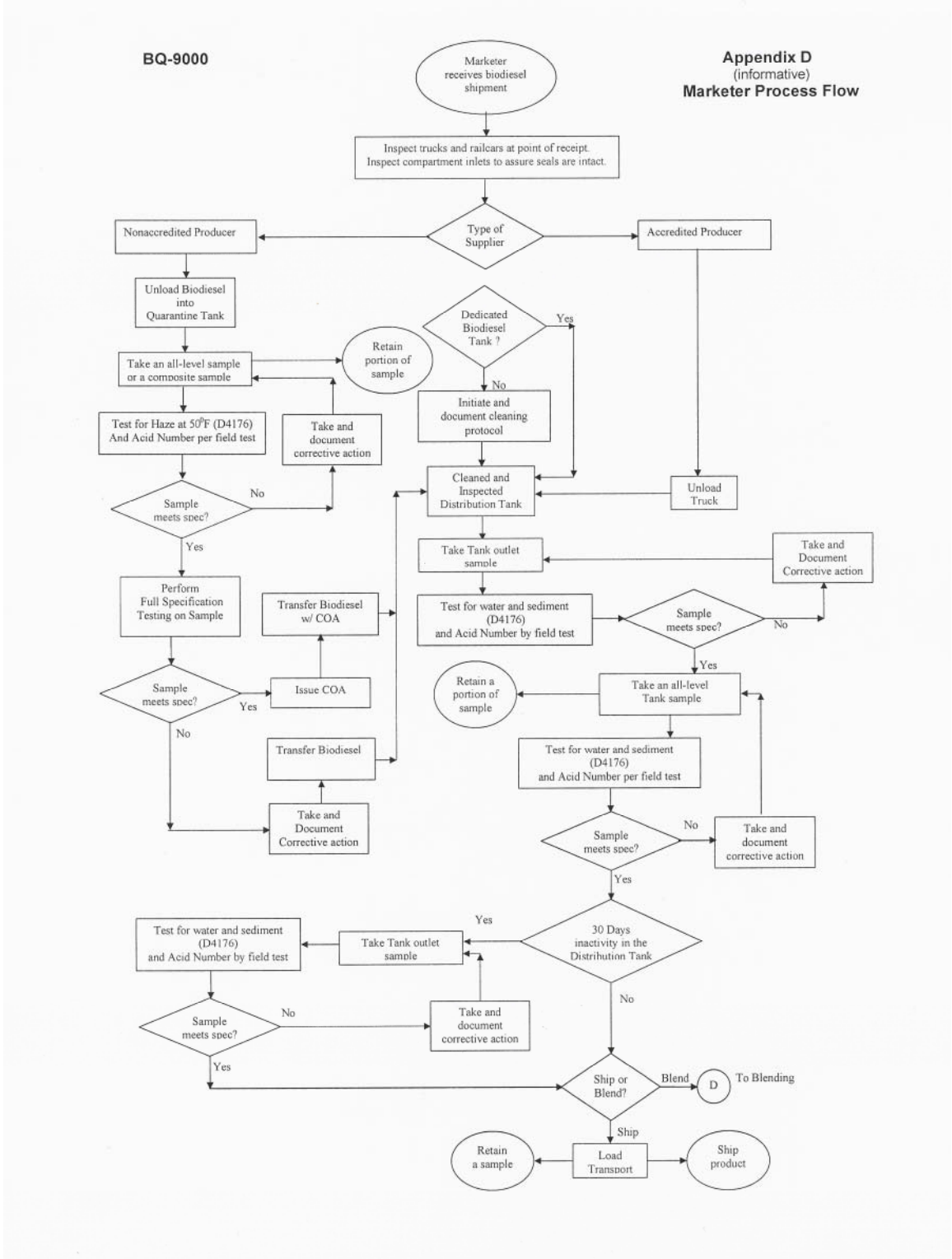
Appendix C
(informative)
Producer Process Flow
(PAGE 2 OF 3)

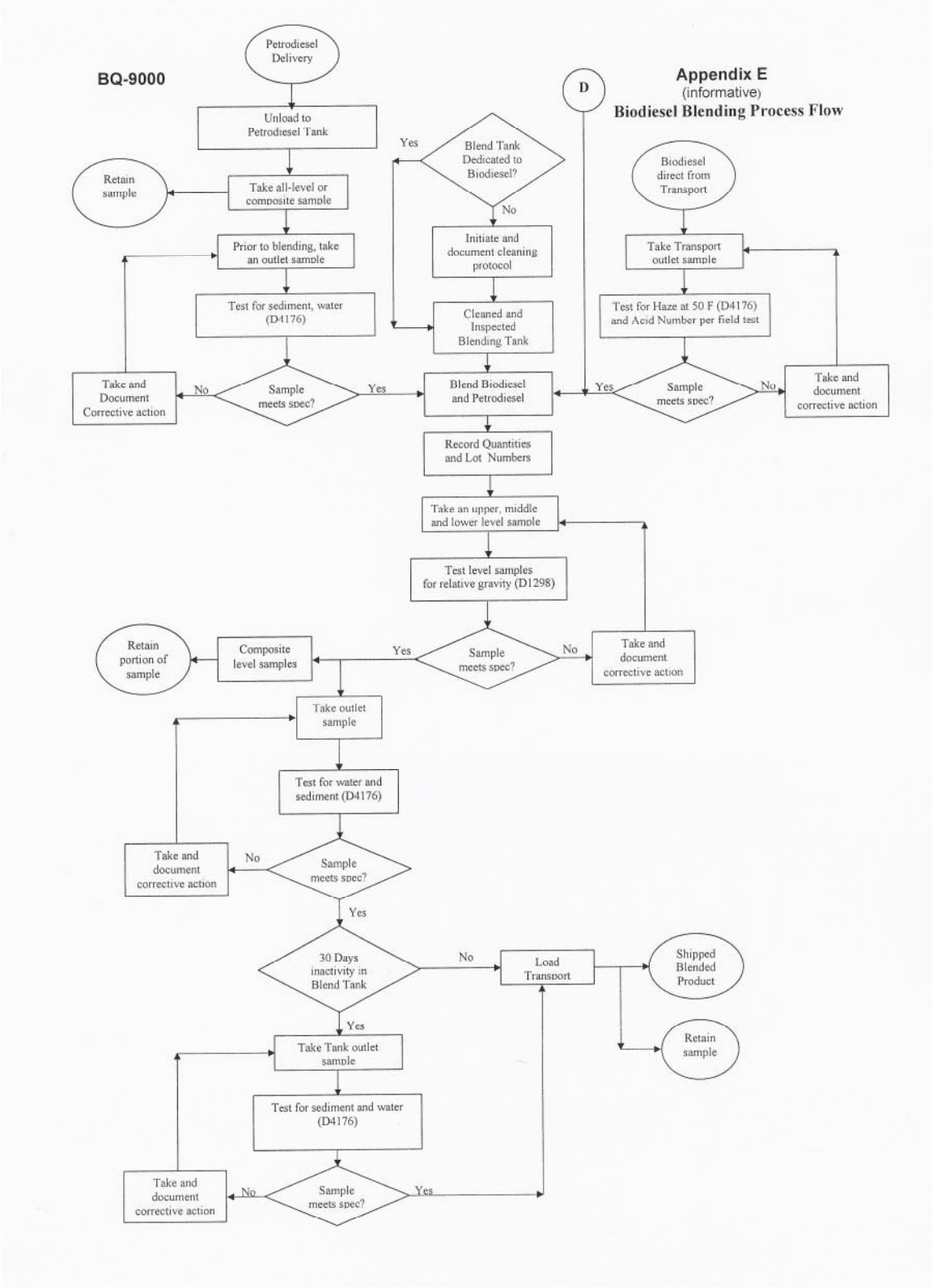


Appendix C
(informative)
Producer Process Flow
(Page 3 of 3)



Appendix D
(informative)
Marketer Process Flow




BQ-9000
Appendix E
(informative)
Biodiesel Blending Process Flow
Petrodiesel Delivery
Unload to Petrodiesel Tank
Retain sample
Take all-level or composite sample
Prior to blending, take an outlet sample
Test for sediment, water (D4176)
Take and Document Corrective action
No
Sample meets spec?
Yes
Blend Tank Dedicated to Biodiesel?
Yes
No
Initiate and document cleaning protocol
Cleaned and Inspected Blending Tank
D
Biodiesel direct from Transport
Take Transport outlet sample
Test for Haze at 50 F (D4176) and Acid Number per field test
Yes
Sample meets spec?
No
Take and document corrective action
Blend Biodiesel and Petrodiesel
Record Quantities and Lot Numbers
Take an upper, middle and lower level sample
Test level samples for relative gravity (D1298)
Retain portion of sample
Composite level samples
Yes
Sample meets spec?
No
Take and document corrective action
Take outlet sample
Test for water and sediment (D4176)
Take and document corrective action
No
Sample meets spec?
Yes
30 Days inactivity in Blend Tank
No
Load Transport
Shipped Blended Product
Retain sample
Yes
Take Tank outlet sample
Test for sediment and water (D4176)
Take and document corrective action
No
Sample meets spec?
Yes

9. Taxation

Introduction

Taxation and Environmental Permitting is one of the basic and most important facets of starting or expanding a business. It involves meeting state and federal requirements associated with operating a business and having a payroll.

Many of the taxes and permitting regulations stated in this chapter will relate to Iowa, because of resources available in preparation of this document.. Although they are listed as an Iowa requirement, they also apply to all states and businesses. By listing these taxes and resources, you may find similar resources available in your own state or country. Please keep this in mind as we discuss these tax and environmental resources.

The following information will be covered:

- General Business Tax Issues
    - Federal and State Taxes
    - Local regulations
- Biodiesel Tax Issues
- Environmental Permits
- Other issues
- Summary

Federal Taxes

There are many federal taxes or requirements you must be aware of and apply toward your type of business structure. They are Employers Identification Number (EIN), Withholding Tax, Social Security Tax, Self-Employment Tax, Personal Income Tax, and Corporate Income Tax.

The first step that must be taken before you collect these taxes is to obtain a Employers Identification Number (EIN). The EIN is issued by the Internal Revenue Services. An application for an EIN can be obtained from the IRS, Form SS-4, and you will receive information on the business liability associated with operating. Included with the EIN that the IRS sends to the business is information on social security withholding, federal income tax, and other applicable federal tax information for your business.

The businesses required to have an EIN are partnerships, corporations, and in some cases sole proprietorships. Sole proprietorships are required to have an EIN if any of the following apply: they pay wages to 1 or more employees, they file any type of federal excise tax return, sell alcoholic beverages, tobacco, firearms, or ammunition, own a truck and transport goods or materials for others on public roads, or pay $6,000 or more

annually to an independent contractor. If the sole proprietorship meets any one of these criteria, then they too have to obtain an EIN.

State Taxes

State taxes include the following taxes: Withholding Tax, Unemployment Tax, Sales Tax, and Property Tax.
Payroll taxes include a host of state and federal taxes. We will talk about the state taxes at this time. Employers in Iowa and most states are required to withhold an estimated income tax payment from each employee's wages. The business must register with state and federal tax collecting agencies and collect both state and federal taxes. Federal payroll taxes include social security and withholding taxes. To receive information about withholding procedures for state and federal tax collecting agencies, ask when registering.

State Income Tax Withholding must be collected by the business if there is a state income tax. The business must withhold an estimate of state income tax payment from the employees' wages. This applies if the business has one or more employees or if the business is a corporation. The business must register with the Iowa Department of Revenue as an Iowa-withholding agent or with the appropriate agency in your state. The business' EIN will be needed for registration and the Iowa Department of Revenue will send you information about state income tax withholding policies.

The Unemployment Tax covers benefits the state offers to employees that lose their jobs. In Iowa, employers must contribute to the unemployment insurance fund for the state. This holds true for most other states. You should obtain a copy of the Employer's Handbook on Unemployment Insurance. The Job Service of Iowa administers the State's unemployment fund.

The Employer's Handbook on Unemployment Insurance can be obtained through Job service of Iowa. It explains Iowa unemployment insurance requirements.

Specific questions on regulations affecting businesses operations can be obtained from the Iowa Department of Economic Developments' CALL ONE Program (1-800-532-1216).

What's next?

Most businesses can start operating once state and federal taxes are satisfied and local regulations are met. However, certain businesses and occupations require permits and/or licenses. Let's look at some of the local requirements and business permits that may be needed.

The State of Iowa requires permits and/or licenses for select businesses and occupations. Engineers, architects, and land surveyors are just a couple of the occupations that the State of Iowa requires licensing for. Commercial feed product sales is an example of a

business that require a special permit/license from the Department of Agriculture and Land Stewardship. Depending on whether or not your biodiesel plant is buying and selling feed, this might be required.

Local Requirements

Don't forget about the local requirements and visit the city clerk's office or county auditor's office to determine what ones might apply to your biodiesel plant. Find information on local permits, licensing requirements, and procedures to follow to obtain the necessary permits and licenses. Many requirements are common, but the regulations vary from place to place.

Zoning Regulations

Check the local zoning regulations to find out what areas are restricted to commercial activities. This is one of the first steps in selecting a site or plant. Also determine if they have any guidelines on regulating activities within the area you will be operating.

Make sure you know the local ordinances, road and bridge limitations, and sewage requirements for your location. Another point to cover is to address the surrounding community and their considerations. This may involve attending a zoning or city council meeting to obtain their input to your project. Local ordinance may have limitations on advertising in specific areas. School and other community sensitive building may have specific requirements to be addressed.

Business Permits

Some places may require a general business permit before operating. In addition special permits may be required for certain businesses and/or operations. Check with your local government to determine if any of these are required. You will have to abide by the local fire codes and have an inspection before starting operation.

Building Permits

Business or construction permits are needed if your business is erecting or remodeling a building. A building inspector from either the county or city will check to make sure local building codes are met before opening. Many times the engineering firm or construction firm will obtain the necessary permits in your business name.

Business Registration

Before you can register your business you have to decide on the organization of the business. It can be a partnership, sole proprietorship, corporation or a coop. There are many different forms of corporations and coops, each with their own tax and registration requirements.

Partnerships need to file a Partnership Certificate with the Secretary of State in the state you register it in. They may require a small fee to cover the registration.

Sole proprietorships need to file a Certificate of Assumed or Fictitious Name at the Recorder's Office in the state the plant is in. Again a small fee may be required.

Corporations and coops involve much more documentations and procedures. If you plan to incorporate a new or existing business, articles of incorporation need to be filed with the Secretary of State. Legal documents are best prepared with a lawyer in most cases. There is usually an initial fee to file plus a fee to register with the county.

Labor Laws

Be aware of both state and federal laws for employees and the workplace. Know about the minimum wage laws and be aware of child labor standards. This information can be found with the department of labor in your state.

Workers' Compensation

Employers are required by the state to provide medical and disability benefits to employees in the case of a possible job-related injury or disease. Employers can provide insurance through a private insurance company or be self-insured. But to be self insured, the employer must be qualified by the state.

Patents and Copyrights

The federal government is the only source to obtain patents for inventions. Trademarks and Copyrights are also obtained through the federal government.

Summary of Federal & State Taxes

To review:

Federal Taxes
Employers Identification Number (EIN)
- Obtained from the IRS
- Used for federal and state tax purposes

Withholding Tax
- Comes from employees wages and held by the employers
- Employee's W-4 Form is used to determine the amount of tax to be withheld

Social Security Tax
- Must be paid by all employers with a net earning of $400 or more

Self-Employment Tax

- Provides social security coverage for self-employed individuals in place of social security tax

Personal Income Tax

- Paid by sole proprietors and members of partnerships on business earnings
- Also paid by corporate shareholders on corporate dividends

Corporate Income Tax

- Paid by corporations except those who qualify as "Subchapter S" corporations according to IRS
- Filed estimate quarterly tax report with IRS

State Taxes

Withholding Tax

- Comes from employees wages and held by the employers just as federal income taxes
- State withholding payments made quarterly to Iowa Department of Revenue and Finance

Unemployment Tax

- Benefits employees who have been laid off
- Paid by the employer
- Collected by the state and federal government

Sales Tax

- Sales tax permits are required for retailers conducting business in Iowa
- Iowa Department of Revenue and Finance provides applications

Property Tax

- Businesses that own property are taxed for the property

Biodiesel Tax Issues

Federal Excise taxes must be paid since biodiesel is a fuel. Also Road or Transportation Taxes must be paid if applicable.

In general, excise taxes are not owed to the federal, state or local agencies until the fuel enters into the customer's tank. If a biodiesel producer has a retail pump on site, they will have to collect and pay all relevant excise taxes. If the producer sells B100 to a second party that distributes (blended or not) to the end customer, then the second party is responsible for the taxes. The IRS has debated making biodiesel producers liable for all taxes, but at this time, the firm that distributes the fuel to the end customer is responsible for collecting and remitting the taxes. Since state or local taxes may be different, the producers need to be aware of local tax regulations and should check with local, state and federal taxing authorities.

Environmental Permits

Environmental Permits must be addressed at the start of the project. This subject will be addressed in more detail in another chapter since it is such an important and complex area.

Other Issues

General taxes, both federal and state, and biodiesel taxes are issues that need addressed in your biodiesel business. Most of these taxes and permits are basic to most business ventures and cover the vast majority of the issues in starting up a biodiesel business.

Still there are other issues that need to be considered and vary from state to state and from country to country. Issues concerning taxes and permits relate to areas like insurance, equipment, fire, liability, product quality, distribution related permits, and weight and measure permits. These all need to be researched in you locality to see which ones apply.

10. Environmental Requirements and Permitting

Introduction

This module reviews the major Federal level environmental laws that are the basis for setting environmental protection requirements across the U.S. These requirements can be implemented in the form of imposing limits to emissions, restricting or banning use of harmful materials, or requiring permits for discharge of pollutants.

Environmental laws are developed by the U.S. Congress, and signed by the President. The responsibility for interpreting and enforcing these laws is delegated to the U.S. Environmental Protection Agency. The EPA is a regulatory agency – an enforcement agency that develops specific regulations, and inspects and applies penalties for violations. It is the leading environmental research and development agency for the U.S.

This module will address only environmental legislation enacted at the Federal level. This is because each state and locality has the authority and responsibility to enact and enforce environmental regulations specific to the local area.

The goals of this module are to

1. Review the major legislation defining environmental regulations in the U.S.;
2. Review the general requirements under the environmental titles; and,
3. Describe the impact of the legislation on biodiesel production and use.

Environmental law is a complex and rapidly changing area. In addition, detailed requirements and interpretations can vary by locale. This module is an introduction to major acts and acronyms. Work with specialists as you develop your plans and responses to the requirements that must be met by your own facility.

Environmental requirements vary by location across the U.S. This is because there are levels of requirements, beginning at the Federal level, then at the State level, and, finally, there may be locally specific requirements. State and/or local requirements may be more restrictive than Federal requirements, but they cannot be less restrictive. In the cases where permits are required, review and enforcement is usually at the State or local level.

Resource Conservation and Recovery Act (RCRA)

RCRA addresses solid and hazardous waste management activities, including waste management and underground storage tanks. The framework is a “cradle-to-grave” system governing hazardous waste from generation to disposal.

Facilities that generate hazardous waste are subject to accumulation (amount present), manifesting (tracking), and record keeping standards. The facilities must have a permit

either from the EPA or the delegated state agency. Various provisions of RCRA are delegated to state agencies in 46 of the states.

Important regulatory requirements under RCRA include:

- Identification of solid and hazardous wastes
- Standards for generators of hazardous wastes
- Land disposal restrictions
- Used motor oil storage and disposal regulations
- Emission standards for tanks and containers
- Underground storage tank design and release detection standards
- Design and operating standards for boilers and industrial furnaces that burn fuel containing hazardous wastes

EPA publishes a detailed listing of materials and specific chemicals that fall under the "P", "U", "K", "F" and "D" categories. The categories are defined as:

- Commercial products designated "P" or "U"
- Hazardous wastes from specific industries "K"
- Hazardous wastes from non-specific sources "F"
- Materials that exhibit hazardous characteristics: ignitibility, corrosivity, reactivity, or toxicity "D"

In the case of biodiesel production, methanol and base and/or acid catalysts are listed materials.

The key issue in working under RCRA, however, is the designation "waste". Raw materials in storage are not waste. Materials recovered as a part of the process, such as methanol are not waste, unless so designated. Recovered co-products, such as glycerol, are not waste if they are to be used elsewhere in processing or sold to another entity. A material must be designated as "waste", to fall under RCRA.

However, the operation cannot stockpile materials to avoid RCRA. There must be a "reasonable expectation" of use within the facility within a reasonable period of time (generally six months), or the facility could be cited as an unlicensed waste disposal or holding operation.

There is an incentive to keep generation of hazardous waste materials to a minimum, both for plant safety and for RCRA reporting. The extent of required reporting and the requirements for detail in managing these materials grows in proportion to the amount generated.

Waste generators are designated on the basis of the amount of hazardous waste generated. The amounts are further broken down as hazardous and acutely hazardous. Each category of generator has specified limits to the amount of hazardous material allowed on the property. The categories are:

- Conditionally Exempt – no more than 220 lbs. of hazardous waste (HW) and no more than 2.2 lbs of acutely hazardous waste (AHW) per month. There is a maximum of 2,200 lbs HW on the property.
- Small Quantity Generator (SQG) – produce between 220 and 2,200 lb HW and no more than 2.2 lb AHW per month.
- Large Quantity Generator (LQG) – produce more than 2,200 HW or more than 2.2 lb AHW per month.

There are a number of operating and reporting requirements for generators. The requirements vary somewhat in proportion to the quantity of waste generated. These requirements include:

- Inventory – Identify all HW on-site, pounds generated per month, maximum accumulated.
- State and EPA ID number (Conditionally exempt not required to have EPA ID).
- Accumulation limits – Specific rules for each level generator.
- Labeling – RCRA HW labels for LQG and SQG; DoT labels for Conditionally Exempt
- Inspection – Storage areas weekly, tanks daily; spill and emergency prevention/detection equipment for LQG and SQG.
- Transport – detailed instructions regarding packaging, manifests, exception reports, holding times, approved treatment/disposal facility (TSD).

The following requirements apply to LQG, with lesser requirements for smaller generators.

- Waste minimization – certify program in place; annual reports (LQG)
- Training – employees trained in handling and procedures
- Emergency response – plans and incident reporting
- Reporting – exception reports, quarterly reports, periodic survey
- Record keeping – manifests for 3 years, exception reports for 3 years, analyses for 3 years, inspection logs, biennial reports, land disposal restrictions

Hazardous materials training is required under OSHA provisions. MSDS materials are required in the workplace. There are a number of professionally developed training materials available to meet these requirements for training and re-certification. This is not only good practice – it is the law. The characteristics that define a hazardous material are:

- Ignitable – flash point < 140 °F
- Corrosive – pH > 12.5 or < 2
- Reactive – rapid or violent reaction when exposed to heat, pressure, water, or other materials.
- Toxic – determined by acute and chronic response levels; carcinogens, teratogens, blood or kidney pathogens.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

CERCLA is also known and the Superfund Act. The EPA currently has about 1300 active Superfund cleanup sites. The Superfund Act authorizes EPA to respond to releases of hazardous substances. The Act requires reporting of releases to National Response Center. Reportable quantities are listed in 40 CFR §302.4

The National Oil and Hazardous Substances Pollution Contingency Plan NCP) (40 CFR Part 300) provides for permanent clean-ups of pollutants.

Emergency Planning and Community Right-to-Know Act (EPCRA)

EPCRA is designed to improve community access to information about chemical hazards present in the community. The Act also is intended to facilitate the development of chemical emergency response plans by State and local governments. To implement EPCRA, Congress required each state to appoint a State Emergency Response Commission (SERC). The SERCs were required to divide their states into Emergency Planning Districts and name a Local Emergency Planning Committee (LEPC) for each district.

Companies are required to notify SERC and LEPC of the presence of "extremely hazardous substances", if they are in excess of the planning threshold quantity. Companies are also required to notify SERC and LEPC in event of release exceeding the reportable quantity of a CERCLA hazardous substance or an EPCRA extremely hazardous substance.

A facility having OSHA hazardous chemicals in excess of threshold amounts submit to SECR, LEPC and fire department copies of MSDSs and chemical inventory forms. Facilities in SIC Codes 20 – 39, with > 10 employees, that manufacture or use more than the threshold amounts of TRI chemicals, submit annual toxic chemical release report (Form R).

TRI chemicals are chemicals listed in the Toxic Release Inventory. The Toxic Release Inventory is a list of chemicals subject to reporting requirements under Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA). The current TRI list contains 582 individually listed chemicals and 30 chemical categories. The list is published in EPA-260-B-01-001, which may be downloaded from the Internet.

Clean Water Act

The Federal Water Pollution Control Act Amendments of 1972, as amended in 1977 is commonly known as the Clean Water Act (CWA). The Act established the basic structure for regulating discharges of pollutants into the waters of the U.S. It gave the EPA the authority to implement pollution control programs such as setting wastewater standards

for industry. The CWA also set water quality standards for all contaminants in surface waters. The CWA made it unlawful to discharge any pollutants from a point source into navigable waters, unless a permit was obtained.

The CWA is designed to restore and maintain the chemical and physical integrity of the nation's surface waters. To accomplish thisit provides for regulation of several categories of pollutants. The National Pollutant Discharge Elimination System (NPDES) controls direct discharges into navigable waters. Pollutant categories included are:

- Point source discharges from pipes or sewers;
- Storm water discharges; and,
- Discharges to public treatment works (pretreatment requirements).

In practice, essentially all surface, running waters are considered navigable.

The CWA distinguishes among "priority" pollutants and toxic pollutants. Also considered are "conventional" pollutants – BOD, suspended solids, fecal coliform, oil and grease, and pH. Some materials are considered "non-conventional" pollutants.

Safe Drinking Water Act

This act requires the EPA to sets standards for drinking water quality. It also provides for Underground Injection Control (UIC) permits to regulate five categories of injection wells. The Wellhead Protection Program is designed to protect areas adjacent to water wells from contamination by pollutants that could enter the water supply through the well bore.

Toxic Substances Control Act (TSCA)

The EPA has authority to regulate chemical imports and production to control unreasonable risks. Chemicals deemed to present unreasonable risks are entered into an inventory list. Non-inventory materials must be described in terms of health and environmental effects prior to import or manufacture.

The EPA can require health and environmental testing before import or manufacture of specified chemicals. Also, the EPA can ban or limit chemicals that pose unreasonable risks. They currently include: asbestos, CFCs and PCBs.

Clean Air Act (CAA)

The CAA sets emission standards for fixed operations in terms of "criteria pollutants" and specific chemical emissions. Of direct importance to the biodiesel community, the CAA has been the basis for increasingly strict vehicle emission standards that have, in fact, created the market niches the biodiesel addresses. The CAA is divided into a number of Titles that address specific areas of clean air concerns. The Titles are described below.

Title I, CAA: Establishes national ambient air quality standards (NAAQSs) to limit "criteria pollutants" (CO, Pb, NO_2, PM, O_3, and SO_2). The Title also establishes new source performance standards (NSPSs) requiring best available technology for pollutant control. Very important for the chemical industry, the Title establishes the National Emission Standards for Hazardous Air Pollutants (NESHAPs), which provides the authority for monitoring and permitting much of the chemical industry and a list of hazardous air pollutants (HAPs).

Title II, CAA: Provides for emissions regulation for mobile sources: cars, trucks, buses, rail, boats, and airplanes. This Title is the basis for requiring measures such as reformulated gasoline, vapor recovery nozzles, catalytic converters, and low sulfur diesel fuel. The California Air Resources Board (CARB) is applying the strictest standards in the nation under this Title.

This Title is driving the liquid fuels industry in the U.S. The emissions standards and the progressive tightening of these standards have enormous impact on liquid fuels. They are the basis for the entry of biodiesel into the liquid fuel stream.

EPA has compiled a database on biodiesel emissions under the Biodiedel Emissions Analysis Program. The draft report will be ready in early 2003. Also, there is health effect information for biodiesel emissions. Biodiesel has been approved under Tier I and Tier II requirements

Title III, CAA: There are a number of very specific provisions that pertain to chemical process operations under Title III. They are covered in 40 CFR Parts 60,61, and 63. The Act directed EPA to develop a list of sources for the 189 HAPs and a schedule for developing emission standards. The standards will be based on "maximum achievable control technology" (MACT). Importantly, permitting of existing and new sources will be based on MACT.

Title IV, CAA: Establishes a SO_2 emission reduction program to reduce acid rain. This rationale is a part of the "green power" effort for electrical power generation and a factor in the vehicle emissions programs.

Title V, CAA: Establishes a single permit program for all "major sources". The states are developing their programs with EPA guidance. Once approved, permits will be issued and monitored by the State.

Title VI, CAA: Requires phase-out of manufacture of ozone depleting chemicals and restriction of their distribution. This is part of the U.S. enactment of the Montreal Protocol.

Oil Pollution Control Act

This Act set up a trust fund to strengthen EPA's ability to respond to large oil spills and for aboveground storage incidents. The Act requires development of Area Contingency Plans for spill response. It is not clear if/how biodiesel facilities will be affected, because some agencies treat fats and oils like petroleum, and others do not. Since there have been serious spills associated with the oleochemical industry, biodiesel producers should design their facilities in accordance with best practices for containment and mitigation of spills.

Energy Policy Act (EPAct)

EPAct establishes alternative fuel goals for vehicles to replace petroleum with renewably derived fuels. The January 11, 2001 ruling gives biodiesel fuel use credit for fleets, *in lieu* of purchase of alternatively fueled vehicles.

11. EPA Registration

In recent years, regulators and policy-makers have become concerned about the potential impact of exhaust emissions on human health. The Environmental Protection Agency (EPA) has promulgated strict regulations for the amount of carbon monoxide, unburned hydrocarbons, oxides of nitrogen and particulate matter that an engine is allowed to emit. This has resulted in large reductions in the amount of these compounds entering our atmosphere. In addition, the EPA enforces ambient air standards across the country and holds those regions that are not in compliance with these standards responsible for developing plans to correct the non-compliance. As an additional safeguard, the EPA requires that producers of fuels and fuel additives (F/FA) intended for use in motor vehicles register their products. The authorization for this registration process is provided in sections 211(b) and 211(e) of the Clean Air Act and the F/FA regulations are sometimes referred to as the 211 regulations. The regulations are described in detail in 40 CFR Part 79.

Fuels that are not sold into on-road markets are exempt from 40 CFR Part 79. These include fuels sold as heating oil, farming, construction, marine, power generation, and other off-road uses. To qualify for this exemption, a biodiesel producer can never provide biodiesel to anyone using it in a licensed vehicle used on-road all or part of the time. Cooperatives or producers using biodiesel in their own vehicles must register their fuels.

All motor vehicle fuel and fuel additive manufacturers are required to register each product they sell, offer for sale, or introduce into commerce, with the EPA. This registration must include the following [derived from 40 CFR 79.11 and 79.33]:

a) The commercial identifying name of each additive that will or may be used in a designated fuel.
b) The name of the additive manufacturer of each additive named.
c) The range of concentration of each additive named, as follows:
    a. In the case of an additive that has been or is being used in the designated fuel, the range during any 3-month or longer period prior to the date of submission.
    b. In the case of an additive which has not been used in the designated fuel, the expected or estimated range.
d) The purpose in-use of each additive named;
e) The description (or identification in the case of a generally accepted method) of a suitable analytical technique (if one is known) that can be used to detect the presence of each named additive in the designated fuel and/or to measure its concentration therein;
f) Such other data and information as are given below:
    a. Hydrocarbon composition (aromatic content, olefin content, saturate content), with the methods of analysis identified;
    b. Polynuclear organic material content, sulfur content, and trace element content, with the methods of analysis identified;
    c. Distillation temperatures (90 percent point, end point);

d. Cetane number or cetane index;
e. Mechanism of action of each additive reported;
f. Reactions between the additives and motor vehicle diesel fuel;
g. Identification and measurement of the emission products of such additives when used in motor vehicle diesel fuel;
h. Effects of such additives on all emissions;
i. Toxicity and any other public health and welfare effect of the emission products of such additives.

g) Assurances that the fuel manufacturer will notify EPA if any information changes.
h) Assurances that the manufacturer will not advertise that registration constitutes endorsement of their product by EPA.
i) Assurances that the fuel used is substantially similar to fuels used for certification of motor vehicles after 1974. (Does not increase emissions)
j) The manufacturer shall submit, or shall reference prior submissions, all of the test data and other information required in Subpart F (Tier 1, 2 and 3 testing).

The requirement given in j) is the most substantive and requires testing that can cost millions of dollars. These requirements can be organized into three tiers as shown in Figure 1. from http://www.epa.gov/otaq/regs/fuels/additive/spring94.pdf

Testing Requirements

Tier 1 is the first step of data collection. It starts with a comprehensive literature review of the publications that have investigated the health effects of the exhaust from engines fueled with the fuel to be registered.

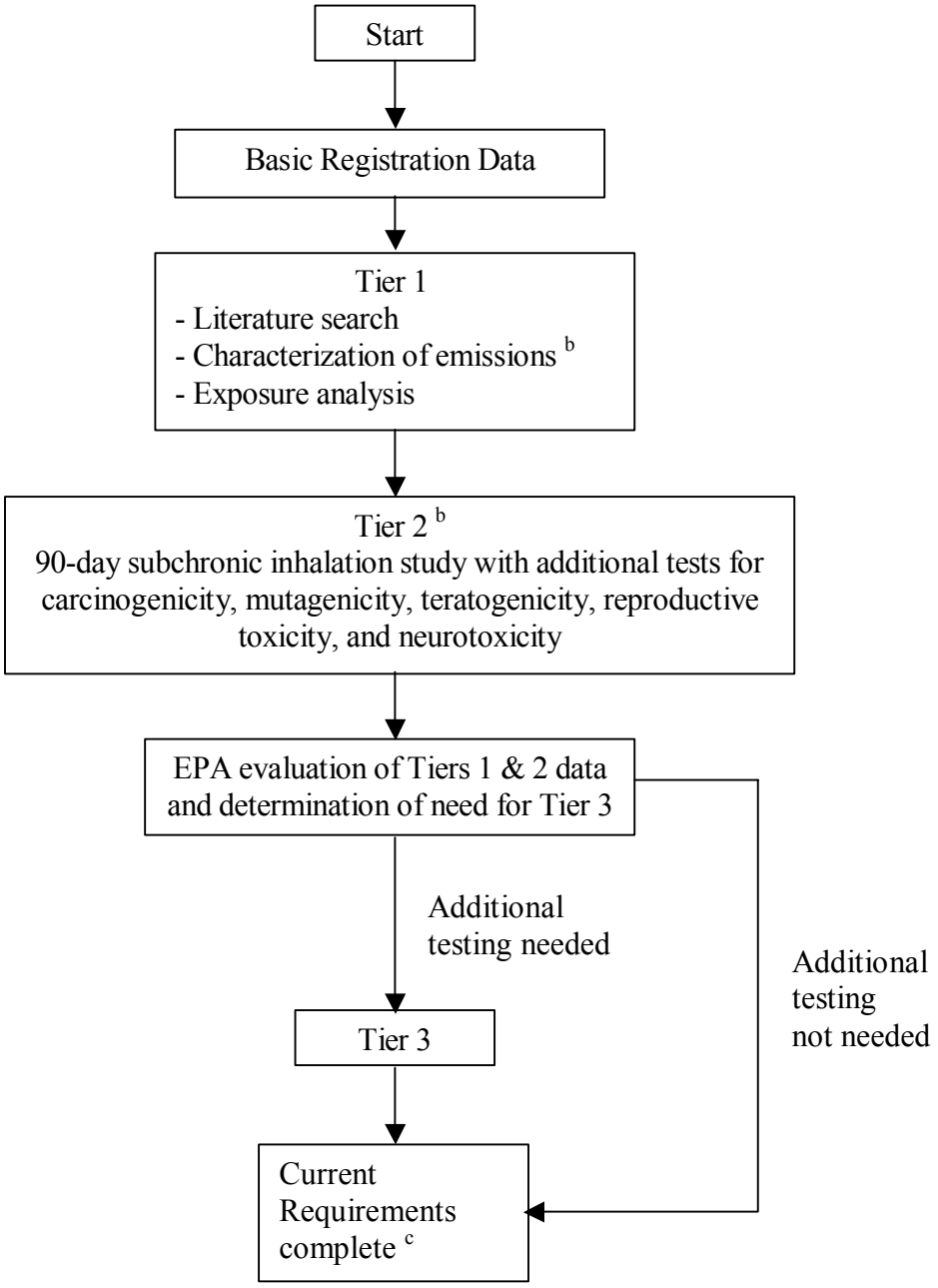
The second step of Tier 1 is an emissions characterization. This requires testing of engines following a protocol that goes well beyond the usual emissions certification test. The protocol requires speciation of hydrocarbon emissions (identification of individual chemical compounds), measurement of the amounts of the polynuclear aromatic hydrocarbons (PAHs) and nitro-PAHs.

Tier I data in the public domain (generated outside of the National Biodiesel Board) can be referenced so long as the engine, testing methods and other criteria involved in the test meet the EPA's standards. Anyone pursuing a Tier I data should check with EPA in person and read the 40CFR79 regulations to determine what is appropriate to submit.

To date, a complete body of emission data that meets Tier I criteria have not been conducted independently from NBB and are not available for reference. For example, DOE's Northwest Regional Biomass Energy Program submitted Tier I data to the EPA but the data were rejected because the wrong engine was used in the test.

Tier 2 consists of a test of laboratory rats that are exposed for 90 days to the exhaust of engines fueled with the fuel (subchronic exposure). After 90 days, the rats are dissected and examined for evidence of carcinogenicity (tendency to cause cancer), mutagenicity

Figure 1. Overview of Evaluation Tiers [a]



[a] This chart shows the general requirements for most F/FAs, and do not take into account any special provisions which may apply.
[b] Required unless adequate data exist.
[c] EPA retains the authority to require additional testing if new concerns arise.

(tendency to cause genetic mutations-conducted on diesel particulate extract), teratogenicity (tendency to cause fetal abnormalities), reproductive toxicity (inability to reproduce), and neurotoxicity (nervous system problems).

The NBB is the only organization to date to submit Tier II data to the EPA. Only members of NBB can access this data for registration purposes. All other manufacturers will need to either join NBB for their coverage, or conduct their own independent tests.

Tier 3 is additional testing that EPA may require after the results of Tier 1 and Tier 2 testing have been submitted. If EPA believes that additional testing is needed to confirm the results of Tier 1 and Tier 2, or if new testing is justified, they can require it as part of Tier 3.

Special Provisions

The cost of the testing to satisfy Tier 1, 2, and 3 is very large. The National Biodiesel Board has stated that their total cost was $2.2 million. In recognition of the high potential costs for this testing, the EPA included several provisions intended to ease the burden of the program. These provisions include the ability for manufacturers to group together and share costs and waivers for small businesses. A manufacturer may make use of jointly submitted testing and analysis for a product that conforms to the same grouping criteria as the tested product. However, previous submitters (NBB in this case) are entitled to reimbursement for an appropriate portion of its costs incurred to report the information.

The grouping below is not solely intended for the evaluation of shared costs and waivers, but also dictates the testing required by the manufacturer. The grouping system established by the EPA divides the candidate fuels into 3 groups: baseline fuels, non-baseline fuels, and atypical fuels. These fuels are defined as follows:

Baseline fuels – satisfy all of the following criteria.

1) Contains no elements other than carbon, hydrogen, oxygen, nitrogen, and/or sulfur.
2) Contain less than 1.0% oxygen by weight.
3) Contain less than 0.05% sulfur by weight.
4) Possess the characteristics of diesel fuel as specified by ASTM standard D 975-93.
5) Derived only from conventional petroleum, heavy oil deposits, coal, tar sands, and/or oil sands.

Non-baseline fuels – These fuels satisfy the criteria for the baseline fuel except that they contain more than 1% oxygen and may be derived from sources that are not fossil-based.

Atypical fuels – The definition of atypical fuel is that it contains elements other than carbon, hydrogen, oxygen, nitrogen, and/or sulfur. However, EPA also indicates that

fuels that do not fall into the baseline or non-baseline categories should also be considered to be atypical.

Biodiesel only contains carbon, hydrogen, and oxygen, so it satisfied requirement 1). However, B100 contains about 11% oxygen so 2) is not satisfied and B100 cannot be considered to be baseline. Further, while B100 does have a sulfur content of less than 0.05%, it does not conform to ASTM D 975 and is not derived from conventional petroleum or the other sources listed.

The non-baseline category would appear to be a better fit for biodiesel. It allows the fuel to contain more than 1% oxygen and to be from other than fossil sources. In fact, biodiesel (B100) is specifically identified as a non-baseline fuel in one area of the Code of Federal Regulations [40 CFR 79.56(e)(4)(ii)(B*)(2)(iv)(A)*], so it would appear that it was the intent of the original writers of the regulations that there is a biodiesel group that is considered as a non-baseline group. However, the EPA has subsequently determined that B100 does not qualify as non-baseline since it does not satisfy some of the parameters specified in ASTM D975. The ASTM standard for diesel fuel oils specifies the requirements for diesel fuel shown in Table 11-1.

Table 11-1. Requirements for Diesel Fuel Oils (ASTM D975-97)

Property	Grade LS #1	Grade LS #2	Grade No. 1-D	Grade No. 2-D	Grade No. 4-D
Flash point °C, min	38	52	38	52	55
Water and sediment, % vol, max.	0.05	0.05	0.05	0.05	0.50
Distillation temp., °C, 90%					
Min.	--	282	--	282	--
Max.	288	338	288	338	--
Kinematic Viscosity, mm^2/s at 40°C					
Min.	1.3	1.9	1.3	1.9	5.5
Max.	2.4	4.1	2.4	4.1	24.0
Ramsbottom carbon residue, on 10%, %mass, max.	0.15	0.35	0.15	0.35	--
Ash, % mass, max.	0.01	0.01	0.01	0.01	0.10
Sulfur, % mass, max	0.05	0.05	0.50	0.50	2.00
Copper strip corrosion, Max 3 hours at 50°C	No. 3	No. 3	No. 3	No. 3	--
Cetane Number, min.	40	40	40	40	30
One of the following Properties must be met:					
(1) cetane index	40	40	--	--	--
(2) Aromaticity, % vol, max	35	35	--	--	--
Cloud point, °C, max.	Determined by local climate				

Excluding biodiesel from consideration as a non-baseline fuel based on the differences from ASTM D 975 is a decision that is likely to be challenged. The areas where biodiesel does not conform with D 975, such as the 90% distillation temperature, are primarily included in the standard to allow distinctions to be made between different grades of diesel fuel such as No. 1 and No. 2. They are not relevant to the question of whether a fuel is suitable for use in a diesel engine. The only property in D 975 that pertains to the suitability of the fuel is the cetane number and biodiesel easily meets the minimum value of 40 given in the standard.

Due to the deviations with D 975, the EPA has categorized biodiesel as an *atypical* fuel. While biodiesel does not satisfy the primary requirement of atypical fuels, which is that it should contain elements other than carbon, hydrogen, oxygen, nitrogen, and/or sulfur, the EPA considers fuels to be atypical if they do not fit in the baseline or non-baseline categories [40 CFR 79.56 (e)(2)(iii)].

Small Business Provisions

To further ease the impact of the testing costs on small producers, the F/FA regulations state that fuel manufacturers of baseline and non-baseline fuels with annual sales of less than $50 million, only need to submit the basic registration data. These companies are not required to submit Tier 1 and Tier 2 data. However, since EPA does not consider biodiesel to be a non-baseline fuel, small biodiesel producers are not eligible for this exemption.

Small producers of atypical fuels can also qualify for an exemption but the limiting size is only $10 million. These producers are also still required to submit Tier 1 data although Tier 2 can be waived. Collecting Tier 1 data can still be quite expensive, requiring between $100,000 and $250,000.

National Biodiesel Board Health Effects Data

The National Biodiesel Board (NBB), using funds from the National Soybean Checkoff Program, has sponsored a program to develop Tier 1 data. NBB and the Department of Energy co-sponsored a program to develop Tier 2 data. This test program has been described in a number of publications [1-4].

The EPA has accepted the NBB data and registered several new biodiesel producers. These producers are considered to be part of NBB's group, and with NBB's permission, are allowed to use its data.

The EPA regulations recognize that groups that submit Health Effects data are entitled to reimbursement from groups that submit later requests that reference the earlier data. Before the EPA will consider the later registration requests, the group must submit documentation that the original submitter has been notified and reimbursement has been arranged. The entitlement to compensation remains in effect for 15 years following the original submission. Any person who violates the registration requirements is subject to a

civil penalty set up by the EPA, which may be up to $25,000 per violation plus the monetary savings that may have resulted from the violation. Each day of a continuing offense is a separate violation.

The NBB has made their Health Effects data available to all their members at no charge. Non-members must pay $100,000 plus twice the volume dues paid by NBB members on gallons produced for access to the data.

NBB Membership

The National Biodiesel Board is a trade association that has been formed to promote the common business interests of its members and to promote the use of biodiesel as a fuel that meets ASTM standards.

The National Biodiesel Board has two classes of Voting Director membership:

1) Feedstock producers or feedstock producer organizations;
2) Biodiesel processors or biodiesel marketers.

The board also has non-voting associate memberships available to individuals and organizations that do not fall into one of the categories for voting membership.

The NBB charges annual dues that depend on whether you are in the feedstock class or the biodiesel processor/marketer class. The dues for a feedstock producer or feedstock producer organization are currently $10,000/year. Several organizations can split the dues but they only receive one Voting Director position. Dues for a Biodiesel processor or marketer are a minimum of $5,000/year but primarily depend on annual sales. Table 11-2 shows how the actual dues are calculated from the sales volume.

The annual dues are billed at the start of each fiscal year (October 1). The volume dues must be paid quarterly based on quarterly sales reports submitted to NBB. NBB may audit a member's books to confirm that they are correctly reporting their volumes.

Table 11-2. Voting Director; Biodiesel Producer/Marketer - Volume Dues

Volume produced or marketed (gallons/yr)	Volume dues
0 to 1,000,000	$0.01/ gallon ($5,000 minimum annual dues)
1,000,001 to 5,000,000	$0.0075/gallon
5,000,001 to 10,000,000	$0.0050/gallon
10,000,001 to 15,000,000	$0.0025/gallon
Amounts over 15,000,000	$0.0010/gallon

Sample Calculation:
Suppose a processor sells 65 million gallons of biodiesel.

$10,000 + $30,000 + $25,000 + $12,500
+ $50,000 = $127,500 annual dues

NBB Fuel Accreditation

NBB has initiated a fuel accreditation program, known as BQ9000, which will allow fuel producers to claim that they are an "accredited" producer. This is intended to ensure that biodiesel producers follow good business practices and provide fuel that meets the ASTM standard. While guidelines for the accreditation process are still under development, they involve ISO 9000 – type inspections (paid for by producer) and periodic fuel testing. The latest guidelines can be obtained by contacting NBB through [www.biodiesel.org].

References

1. Koo-Oshima, S., N. Hahn, and J. Van Gerpen, "Comprehensive Health and Environmental Effects of Biodiesel as an Alternative Fuel," presented at the Fall meeting of the Society for Risk Analysis, Paris, France, Oct. 11-14, 1998.

2. Sharp, C.A., S.A. Howell, J. Jobe, "The Effect of Biodiesel Fuels on Transient Emissions from Modern Diesel Engines, Part I Regulated Emissions and Performance," Society of Automotive Engineers Paper No. 2000-01-1967, 2000.

3. Sharp, C.A., S.A. Howell, J. Jobe, "The Effect of Biodiesel Fuels on Transient Emissions from Modern Diesel Engines, Part II Unregulated Emissions and Chemical Characterization," Society of Automotive Engineers Paper No. 2000-01-1968, 2000.

4. Finch, G.L., et al., "Effects of Subchronic Inhalation Exposure of Rats to Emissions from Diesel Engine Burning Soybean Oil-Derived Biodiesel Fuel," submitted to Toxicological Sciences, Dec., 2001.

12. Workplace Safety Issues

Introduction

Workplace Safety is one of the most important areas that a company can address. Safety of your workforce and employees is important to the future success of your biodiesel business. In most biodiesel plants there will be more than 10,000 pounds of a hazardous chemical on site (usually methanol) that brings the plant under federal regulations 29 CFR 1910.119 Process Safety Management of Highly Hazardous Materials. This requires specific programs on:

- Employee participation
- Process safety information
- Process hazardous analysis
- Written operating procedures
- Documented operator training
- Contractor safety training and screening
- Having a Mechanical Integrity Program
- Having a Management of Change Program
- Incident Investigation and Emergency Planning and Response

Risk Communication

Risk communication involves the following rules. These are known as the Seven Cardinal Rules of Risk Communication, issued by the U.S. Environmental Protection Agency.

- Accept and involve employees
- Plan carefully and evaluate your efforts
- Listen to concerns
- Be honest and open
- Coordinate and collaborate with other credible sources
- Meet the needs of the media
- Speak clearly and with compassion

Accept and involve employees: Communicate any and all possible risks to employees and people involved.

Plan carefully and evaluate your efforts: Always be careful and improve procedures to keep the workplace safe.
Listen to concerns: Encourage employees to voice concerns and make comments.

Be honest and open: This will encourage employees to speak up about concerns.

Coordinate and collaborate with other credible sources: Talk to manufactures or anyone else who is involved with the workplace or can help you to improve the workplace.

Meet the needs of the media: If an unfortunate situation should occur, use the media as your resource to prevent and stop possible disasters through communication and education.

Speak clearly and with compassion: When dealing with risk communication, keep in mind the emotions and sensitivity that people may have due to the nature of the topic.

Source: Seven Cardinal Rules of Risk Communication. Pamphlet drafted by Vincent T. Covello and Frederick H. Allen. U.S. Environmental Protection Agency, Washington, D.C., April 1988, OPA-87-020.

Influencing Factors on Risk Perception

When addressing the influencing factors on risk perception from A Primer on Health Risk Communication Principles and Practices, U.S. Department of Health and Human Services, the following seven factors come to mind:

- Risks perceived vs. comparison of risks
- Voluntary vs. imposed
- Under individual's control vs. controlled by others
- Natural vs. manmade
- Statistical vs. catastrophic
- Generated by a trusted source vs. generated from new source
- Familiar project vs. new project

People are influenced by many different factors. These factors do not necessarily have to be statistical. Just as every individual is different, every person's perception of risk and the magnitude of risk are different. Here are some influencing factors that should be considered when addressing risk communication to effectively explain the risk to your personnel.

When looking at the last three influencing factors, keep in mind you are dealing with perception of the employees and community. If you think the risk is minimal, but your audience believes otherwise, listen to their point of view before you try and impose yours. Then discuss your differences and try to find a middle ground and meet them half way.

Source: A Primer on Health Risk Communication Principles and Practices. Prepared by M. Lum, and T. Tinker. Washington, D.C.: U.S. Department of Health and Human Services, Public Health Service, Agency fro Toxic Substances and Disease Registry. 1994, Adapted from Acceptable Risk.

Questions to Ask

This is a topic we all wrestle with when discussing safety with our employees. Here is a list of questions you should consider when discussing safety from the source Communicating with the Public, Rutgers Center for Environmental Communications:

- Why am I communicating?
- Who am I speaking to?
- What does my audience want to know?
- What do I want to get across?
- How will this be communicated?
- How will I listen?
- How will I respond?
- Who will carry out the plans? When?
- What problems or barriers has our team planned for?
- Have we succeeded?

So, you may be asking yourself right now, "How do I communicate risks to my personnel?" Here are some suggested questions to ask according to the Chess, Hance, and Rutgers Center for Environmental Communications' book (Communicating with the Public: 10 Questions Environmental Managers should Ask).

After you have asked yourself these questions and determined your answers, you are ready to communicate with your personnel. These questions will also help you plan your meeting and how you plan to proceed when faced with some of the audiences' questions and reactions to your information.

Workers' Right to Know

Workers have a right to know what they are working with and the possible harms and in many time that information comes from Material Safety Data Sheets. Originally it was intended for a select group of chemical manufactures, but in 1987, it was extended to all business regardless of size or classification.

Worker's Right to know is a federal standard and cannot be overturned by state laws and local laws. This has become a more important topic in today's workforce. They want to be informed about the risk and safety issues that are present in their workplace. It is easier for them to accept some risk if they know about it up front when they start the job.

Translation to the Workplace

Workers are protected by Hazardous Communication Standard (HCS). HCS protects any worker exposed to hazardous chemicals and other hazards include in HCS.

- Hazards covered: HCS is not limited to hazardous chemicals and physical hazards (flammability or explosions). HCS also include health hazards.

- Right to know hazards and precautions: Employees have the right to know of hazards they will be associated with at the workplace and what precautions to use when dealing with hazardous chemical, physical hazards, and health hazards.

- Information shared: Sharing information with employees will prevent injury and illnesses due to hazards.

- Employers' responsibility: Employers, manufacturers, and importers are responsible for informing and training workers about workplace hazards.

- Employee protection programs: Once information is shared between employer and employees, development of employee protection programs is highly recommended.

Hazardous Communication Standard (HCS)

OSHA has provided a simple summary of the HCS in a pamphlet entitled "Chemical Hazard Communication," OSHA Publication Number 3084. A copy may be obtained from your local OSHA Area Office, or by contacting the OSHA Publications Office at (202) 693-1888.

Some employers prefer to begin to become familiar with the rule's requirements by reading this pamphlet.

HCS Mandates

Obtain a copy of the rule: This can be obtained from OSHA.

Read and understand the requirements: This will entail reading the rule and make sure you understand the requirements. You may have to call OSHA to obtain clarification of any questions you may come up with after reading the rule.

Assign responsibility for the tasks: This will make sure that someone is responsible to see that you meet the HCS mandates. Many times this will be your safety person or manager. They will have to conduct a hazard assessment, in which each chemical used in the workplace will have a hazard assessment conducted on it by the employer.

Inventory of chemicals: A list of chemicals used in the workplace must be made available to employees.

Labeling: Employers must adopt a labeling program for each chemical used in the workplace and make sure it is used and all chemicals are labeled.

Obtain Material Safety Data Sheets (MSDS) for each chemical: This includes your raw materials, maintenance chemical supplies, office chemicals, and any other place chemicals are used or stored. You can obtain these MSDS from the supplier where you bought the chemicals. Also read the MSDS and make sure that you know what safety procedures are needed when handling these chemicals or in case of a spill or contact with an employee.

Prepare a written program: Employers are required to provide a written program describing the HCS. This written program must be available to all employees. Make sure to incorporate it into your safety manual.

Make MSDS available to workers: MSDS must be made readily available for employees. It is required that employers have an MSDS for each and every chemical used in the workplace.

Conduct training of the workers: Employees are to be trained about MSDS and HCS. Employers are required to demonstrate that employees have been trained.

Establish procedures to maintain the current program: These procedures should also be in the safety manual and make a person responsible for maintaining the program and all documentation.

Establish procedures to evaluate effectiveness of program: This will provide feedback on how effective your program is being conducted and accepted by the workers.

Summary - HCS Mandates

The following list covers a brief explanation of the HCS mandates in summary fashion:

- Hazard assessment: Each chemical used in the workplace will have a hazard assessment conducted on it by the employer.
- Inventory of chemicals: A chemical list of chemicals used in the workplace must be made available to employees.
- Material Safety Data Sheets (MSDS): MSDS must be made readily available for employees. It is required that employers have a MSDS for each and every chemical used in the workplace.
- Labeling: Employers must adopt a labeling program for each chemical used in the workplace.
- Training: Employees are to be trained about MSDS and HCS. Employers are required to demonstrate that employees have been trained.
- Written Program: Employers are required to provide a written program describing the HCS. This written program must be available to all employees.

HCS Hazards

These are some of the common HCS hazards found in the workplace. Evaluate your plant for each of these and look for additional ones that might be specific to your industry.

- Chemical
- Explosion and fire
- Oxygen deficiency
- Noise
- Ionizing radiation
- Safety hazards
- Electrical hazards
- Heat stress
- Cold exposure
- Biological hazards

OSHA's Purpose

This is the mission statement for OSHA:

- Occupational Safety and Health Administration (OSHA)
- OSHA's mission is to "assure so far as possible every working man and woman in the Nation [has] safe and healthful working conditions"

  Source: OSHA website, http://www.osha.gov

Lab Safety, MSDS, and Right-to-Know

The following are the regulation authorities that dictate lab safety, MSDS, and Right to Know:

- Lab Safety - OSHA regulations and NRC recommendations
- MSDS and OSHA Hazard Communication Standard
- Community Right-to-Know (EPCRA)

The OSHA Occupational Exposure covers lab safety for Hazardous Chemicals in Laboratories Standard (Title 29, Code of Federal Regulations, Section 1910.1450). In the appendix of that section, noted as non-mandatory but widely accepted, reference is made to the National Research Council publication **Prudent Practices for Handling Hazardous Chemicals in Laboratories** concerning chemical hygiene in laboratories.

The terms "chemical hygiene" and "lab safety" are essentially interchangeable.
The manufacturers provide Material Safety Data Sheets (MSDS) when they ship chemicals. They contain information that allows users to be aware of the physical properties and possible hazards associated with the use a chemical. They are required under the OSHA Hazard Communication Standard (Title 29, Code of Federal Regulations, Section 1910.1200).

Just as the OSHA HCS requires employers to keep their employees informed, Right-to-Know requires users and producers of chemicals to keep the public informed of possible hazards. It is required under the Emergency Planning and Community Right-to-Know Act (EPCRA).

Lab Safety - OSHA Occupational Exposure to Hazardous Chemicals Standard

Four points that cover the Hazardous Chemical Standard are:

- Also called the Lab Safety Standard
- Applies to all employers engaged in laboratory use of hazardous chemicals
- Exists as a section of the OSHA standards
- Eight specific requirements

OSHA definition of hazardous chemical: Hazardous chemical means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees.

OSHA standards as covered in other sections of 29CFR1910, obviously still apply, unless they are superceded by more specific requirements of this standard. This definition does not apply to uses of hazardous chemicals outside of the laboratory.

Specific Requirements of the OSHA Lab Safety Standard

PEL - For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified.

Employee exposure - Employers shall perform initial and periodic monitoring of PELs if there is reason to believe that exposure limits routinely exceed the action level. Employees must be notified of monitoring results.

Respirators - Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment.

Medical consultation - The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention performed by or under the direct supervision of a licensed physician. This attention shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

Records - The employer shall retain a written record of the physician’s opinion concerning the exposure.

Information and training - The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.

Hazard identification - Hazards shall be labeled, and the MSDS shall be made available to employees.

Chemical hygiene plan - A chemical hygiene plan (lab safety manual) is required to be developed specifically for each lab. Among its contents should be general safety considerations, standard procedures involving the use of hazards, requirements for adequate ventilation, and designation of personnel responsible for the implementation of the plan. The National Research Council (NRC) provides recommendations for the preparation of a hygiene plan.

Lab Safety - NRC Recommendations

The National Research Council (NRC) publishes Prudent Practices for Handling Hazardous Chemicals in Laboratories.

Listed as a non-mandatory recommendation in the OSHA Lab Safety Standard is a publication by the National Research Council.

Prudent Practices for Handling Hazardous Chemicals in Laboratories is cited because of its wide distribution and acceptance and because of its preparation by members of the laboratory community through the sponsorship of the National Research Council. However, none of the recommendations given here will modify any requirements of the lab safety standard. It deals with both safety and chemical hazards while the laboratory standard is concerned primarily with chemical hazards.

An outline of its contents is included in the OSHA Lab Safety Standard appendix.

Recommendations of the NRC

Exposures - It is prudent to minimize all chemical exposures. Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted, rather than specific guidelines for particular chemicals. As a rule, skin contact with chemicals should be avoided.

Avoid underestimation of risk - For work with substances, which present special hazards, special precautions should be taken. One should assume that any mixture will be more toxic than its most toxic component and that all substances of unknown toxicity are toxic.

Ventilation - The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices.

Chemical hygiene plan - A mandatory chemical hygiene plan (lab safety manual) designed to minimize exposures is needed. It should be a regular, continuing effort, not merely a standby or short-term activity. Full-time laboratory workers should follow its recommendations, not only in academic teaching laboratories, but in the private sector also.

PEL and TLV - The Permissible Exposure Limits (PEL) of OSHA and the Threshold Limit Values (TLV) of the American Conference of Governmental Industrial Hygienists should not be exceeded.

Responsibility - The Chief Executive Officer has ultimate responsibility for chemical hygiene within the institution and must, with other administrators, provide continuing support for institutional chemical hygiene. The Chemical Hygiene Officer works with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices. The Laboratory Supervisor has overall responsibility for chemical hygiene in the laboratory. The laboratory worker is responsible for developing good personal chemical hygiene habits.

Design - The lab facility should be designed to function as a lab, with adequate ventilation, storage space, lab sinks, safety shower, and eyewash, in addition to appropriate fire safety apparatus.

Maintenance - The facility should be kept clean and well maintained.

Usage - Work conducted and its scale must be appropriate to the physical facilities available.

The chemical hygiene plan (lab safety manual) should contain procedures covering the following topics:

Chemical procurement and storage - Before a substance is received, those who will be involved with the chemical should know information on proper handling, storage, and disposal. Chemical inventories should be separated into compatible groups and appropriate storage provided.

Housekeeping, Maintenance, and Inspections - Formal housekeeping and chemical hygiene inspections should be held semiannually; informal inspections should be continual. Safety equipment should be inspected regularly. (e.g., every 3-6 months).

Medical Program - Regular medical surveillance should be established to the extent required by regulations. Personnel trained in first aid should be available during working hours and an emergency room with medical personnel should be nearby.

Protective Apparel and Equipment - Protective apparel compatible with the required degree of protection for substances being handled, an easily accessible drench-type safety

shower, an eyewash fountain, fire extinguisher, respiratory protection, fire alarm and telephone for emergency use should be available nearby.

Records - Accident and medical records should be kept. Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations. Inventory and usage records for high-risk substances should be kept.

Signs and Labels - Emergency telephone numbers, location signs for safety showers, eyewash stations, and exits should be posted. Identity labels showing contents should be on all containers (including waste receptacles).

Spills and Accidents - A written emergency plan and spill control policy should be established and communicated to all personnel. All accidents or near accidents should be carefully analyzed.

Information and Training Program - Assure that all individuals at risk are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs.

Waste Disposal Program - The waste disposal program should specify how waste is to be collected, segregated, stored, and transported and include consideration of what materials can be incinerated.
Some general procedures for working with chemicals:

- Avoid chemical contact with skin and eyes
- No food or drink in lab
- Wear personal protective equipment (PPE)
- Use a ventilation hood when necessary
- Don't work alone

The chemical hygiene plan should also contain the obligatory list of common dos and don'ts:

- Keep the work area clean
- Don't use damaged glassware
- Confine long hair and loose clothing
- Plan work well before beginning
- Pay attention to what you and others are doing
- Follow standard procedures carefully when using toxins or allergens

Material Safety Data Sheets (MSDS)

MSDS sheets are required by OSHA Hazard Communication Standard, to be provided by the chemical supplier, must be made available to employees, and must contain certain basic information. The following section talks about MSDA Sheets and what are some of the requirements pertaining to them.

Information Required in MSDS

Material manufacturer and identification - Name and address of manufacturer, name of chemical, Chemical Abstract Service number, date MSDS prepared

Hazardous ingredients - Lists the product ingredients that are hazardous

Physical and chemical data - Boiling point, freezing point, solubility, etc

Fire and explosion data - Flash point, recommended extinguishing media, special protective equipment needed

Reactivity data - Chemical compatibility information, product stability over time, light sensitivity

Health hazard - Threshold Limit Value (TLV) is the recommended maximum exposure concentration. Respiratory or contact hazard information, exposure symptoms, and carcinogen

Precautions for safe handling and use - Disposal information, special procedures for spills or leaks

Control measures - Personal Protective Equipment (PPE) recommended

Community Right-to-Know (EPCRA)

The community right to know was established in the Emergency Planning and Community Right-to-Know Act (1986). It regulates property owners and businesses that are involved with hazardous chemicals and has five basic reporting requirements

EPCRA Requirements

The five basic reporting requirements are: Create emergency planning, Emergency release reporting, Submission of MSDS, Submission of chemical inventory forms, and Submission of toxic chemical release forms.

Emergency planning - Required if an Extremely Hazardous Substance (EHS) becomes present at the facility in excess of a Threshold Planning Quantity (TPQ). If TPQ is exceeded, the State Emergency Response Commission (SERC) must be notified and an emergency response coordinator must be appointed at the facility.

Emergency release reporting - If a Reportable Quantity (RQ), as determined by the EPA, of an EHS is released, the operator must report it to the SERC.

Submission of MSDS and submission of inventory - If a Threshold Reporting Quantity (TRQ), as determined by the EPA, becomes present at the facility, the operator must give a copy of the MSDS and chemical inventory forms to the SERC. TRQ of most hazards is 10,000 lbs. TRQ of an EHS is 500 lbs.

Submission of toxic chemical release forms - Operators that manufacture or process 25,000 lbs or otherwise use 10,000 lbs of a toxic chemical in year are subject to this requirement. They must submit to the EPA an estimate of the quantity of toxic chemicals released into the environment or transported offsite.

Summary

This section provided an overview of lab safety - OSHA regulations and NRC recommendations. OSHA regulations requiring full disclosure to employees (MSDS and OSHA Hazard Communication Standard) and Community Right-to-Know (EPCRA) Regulations requiring public reporting were presented briefly.

Other Work Place Safety Issues

The following is a list of other work place safety issues you should address:

- Safety and Health Programs
- Personal Protective Equipment
- Flammable and Combustible Materials
- Hand and Portable Powered Tools
- Lock-out/Tag-out Procedures
- Confined Spaces
- Electrical
- Walking-Working Surfaces
- Hazard Communication
- Ergonomics
- Industrial Hygiene

Acknowledgements

- Source: A Primer on Health Risk Communication Principles and Practices. Prepared by M. Lum, and T. Tinker. Washington, D.C.: U.S. Department of Health and Human Services, Public Health Service, Agency fro Toxic Substances and Disease Registry. 1994, Adapted from Acceptable Risk.
- Source: Seven Cardinal Rules of Risk Communication. Pamphlet drafted by Vincent T. Covello and Frederick H. Allen. U.S. Environmental Protection Agency, Washington, D.C., April 1988, OPA-87-020.

- Source: Communicating with the Public: 10 Questions Environmental Managers should Ask by Chess, Hance, and Rutgers Center for Environmental Communications.

13. Government Incentive Programs

As discussed elsewhere, biodiesel is currently too expensive to compete directly with diesel fuel, except in those cases where environmental or other advantages justify the added cost. In Europe, biodiesel has been greatly aided by the fact that it is not taxed like petroleum-based fuels. In the United States, a number of state and federal programs have been developed to help make biodiesel more competitive to allow the industry to develop. Other programs are currently in the discussion phase. These programs are justified for many reasons such as: reducing imports of foreign oil, rural economic development, and environmental improvement. This section will review some of the current and proposed programs.

Commodity Credit Corp.

Starting in 2000, the Federal Government authorized the U.S. Department of Agriculture through the Commodity Credit Corporation (CCC), to make direct payments to producers of ethanol and biodiesel to offset part of their cost to buy commodities to produce these fuels. The current authorization level is $150 million per year through 2006. The program is described in the following at http://www.fsa.usda.gov/daco/bio_daco.htm

The CCC program will pay biodiesel producers for 40% of the cost of purchasing soybeans (or other oil seeds such as corn, grain sorghum, sunflower seeds, rapeseed, canola, cottonseed, and others), if the beans are processed to produce biodiesel. In the case of soybeans, the producer can still sell the soybean meal and the 40% CCC payment may actually be greater than the value of the oil in the beans. Current versions of the CCC program also include greases from rendered animal fats and recycled restaurant frying oils. However, the subsidy rate on these products depends on their price relative to soybean oil.

The original CCC program only applied to increases in production over the previous year. To continue to take advantage of the subsidy, a biodiesel producer had to continually grow and increase their production level. The current program allows partial payments on existing production (50% for base production in FY 2003, 30% in FY 2004, and 15% in FY 2005). When the producer reaches a production level of 65 million gallons/year, the subsidy drops to 28.6% of the commodity price.

Example 1: Suppose as a biodiesel producer you produce 1000 gallons of biodiesel. The CCC assumes that one bushel of soybeans can produce 1.4 gallons of biodiesel. Thus, to produce the 1000 gallons of biodiesel, you must have purchased 1000/1.4 = 714.3 bushels of soybeans. If soybeans were selling for $5.59/bushel, these beans cost you $3,992.90. The CCC will return to you 40% of this cost or $1,597. Now if these beans weighed 57 lb/bushel and contained 18% oil, they should yield 7,328.7 lbs of oil. At 22.59 cents per pound, this oil was worth $1,656. So, the payment from the CCC was roughly equivalent to the value of the oil. You still have the meal from the 714.3 bushels of soybeans, which would be (assume 5% moisture loss) 714.3 x 57 x 0.82 x 0.95 / 2000

= 15.9 tons. At $165/ton, this meal is worth $2,617. So, the value of the meal and the subsidy $1,597 + $2,617 = $4,214 is more than the original cost of the soybeans.

Example 2: Suppose you produced 1000 gallons of biodiesel from yellow grease. The CCC figures that if you had produced this biodiesel from soybean oil it would have taken 714.3 bushels and at the current price of beans, that would have cost $3,992.90, and you would have expected a check for 40% of that or $1,597 (see example 1). However, since yellow grease was only selling for 10 cents/lb when soybean oil was at 22.59 cents/lb, they will decrease the size of the payment by the ratio of the two prices: 0.10/0.2259 = 0.443, which means the amount of the CCC payment would be 0.443 x $1,597 = $707. Now to produce 1000 gallons of biodiesel from yellow grease requires about 7,725 lb of grease (assumes 5% loss during processing). At 10 cents/lb, this would cost $772.50. Again, the CCC payment almost entirely pays for the cost of the feedstock.

For both of these cases, it should be remembered that this program was only funded for a total of $150 million for each year and the program applies to both biodiesel and ethanol producers. Producers are required to submit estimates of their production levels and then based on the total estimated production, the amount that each producer is eligible to receive is prorated so that the total payments do not exceed the funding level.

No producer can receive more than 5% of the total $150 million, or more than $7,500,000. At the current subsidy rate, $1.59/gallon in the example above, a producer would exhaust the subsidy after producing about 4.7 million gallons of biodiesel, a relatively small plant. Producers are cautioned against basing the economics of their plant on the CCC program. The subsidy is reduced every year on existing production and the program may not be renewed after 2006.

EPACT

The Energy Policy Act (EPACT) is Federal legislation to reduce the consumption of petroleum-based fuels for transportation. It is administered by the Department of Energy and primarily focuses on replacing petroleum-based fuels with alternative non-petroleum fuels. It originated in 1992 with very aggressive goals of replacing 10% of petroleum-based motor fuels by 2000, and 30% by 2010. Its actual progress to date has lagged these goals by a considerable amount. The primary strategy for increasing the use of alternatively fueled vehicles has been to require state and federal fleets to purchase these vehicles. Alternative fuel providers have also been required to purchase alternative fuel vehicles and starting in 2002, some municipal and private fleets are provided with purchasing guidelines. Although these fleets have provided a market for thousands of new alternative fuel vehicles, and all of the major automakers have alternative fuel models available, they only consumer about 1-2% of the total fuel supply. Even when ethanol (E10) is included the total alternative fuel consumption is only about 3% of the supply.

Biodiesel was not originally included in the list of EPACT-defined alternative fuels, but B100 was quickly added. However B20 has a special exemption and is handled on a pro-

rated basis. Essentially, five conventional diesel-powered heavy-duty vehicles fueled with B20 can be counted as one alternative fuel vehicle. The regulations require that the vehicles must actually be fueled with B20 or a higher blend and consumption equal to 450 gallons is considered to be equal to one vehicle. More information about the EPACT program is available at http://www.ott.doe.gov/epact/.

Federal Fuel Tax Reduction

Legislation was proposed in 2001 to reduce the Federal fuel excise tax on biodiesel. Diesel fuel is currently subject to a Federal excise tax of 22.5 cents/gallon. States generally add a similar amount. Senators Hutchinson and Dayton introduced S. 1058 that would have reduced this tax by 1.5 cents per percent of biodiesel made from vegetable oil up to 2% and 1 cent per percent of biodiesel up to 20%. So, a 2% blend of biodiesel could receive a tax reduction of $0.03, which would correspond to a cost reduction of $1.50/gallon for the biodiesel. A 20% blend would receive a reduction of $0.20 and correspond to a cost reduction of $1.00/gallon of biodiesel. To make up for the reduction in tax income to the Highway Trust Fund caused by this subsidy, an equivalent amount of funds would be transferred from the Commodity Credit Corporation program to the Highway Trust Fund. This legislation did not pass in 2001 but has been reintroduced each year since

A separate bill has introduced a tax incentive for animal fat and recycled grease biodiesel. Those fuels could receive 0.5 cents income tax credit per 1 percent biodiesel in a fuel. This exemption is less popular because the blender needs to have an income tax bill to deduct the credits from.

At the time of this writing, the U.S. Senate has passed a version of the Federal Energy Bill that contains a reduction in the federal diesel fuel excise tax of 1-cent per percentage point of biodiesel blended with diesel fuel, up to 20%. At the present time, the bill is in Conference with the House.

B02 in Minnesota

The State of Minnesota currently has a statewide mandate in place that will require the use of 2% biodiesel in all diesel fuel sold in the state for use in internal combustion engines (with a few exceptions). This mandate is due to take effect June 30, 2005 and could be implemented earlier if there is a Federal reduction in fuel taxes of 2 cents or more per gallon on a 2 % blend. The law includes a reimbursement program for distributors who make capital expenditures to adapt or add equipment in order to comply with the mandate, if the mandate is repealed within 8 years of becoming effective. This could make repeal of the law very expensive for the State if repeal is ever considered.

Renewable fuel standard

The same legislation mentioned above, the Senate's version of the Federal Energy Bill, contains a Renewable Fuels Standard that would increase the nation's consumption of

renewable fuels to 5 billion gallons by 2012. Again, this law is currently in Conference Committee with the House and its final status is not known.

These laws would mandate that a certain fraction of our national fuel supply must consist of renewable fuels such as ethanol and biodiesel. One previous example is from Senators Daschle and Lugar (S.690 - 2001) and specified that motor fuels would have to contain 0.6% renewable fuels in 2002 and 1.5% in 2011. Another proposal (S.1006 and H.R.2423 – 2001) would have required renewable fuels to amount to 3% in 2001 and 5% in 2016. Senate file 517 was passed during April 2002 and would establish a renewable standard equal to 5 billion gallons of fuel by 2012 and this is the language in the current bill. Whether a renewable fuel standard will become law and, if it does, the measures it will provide for enforcement, are not yet clear.

14. Biodiesel Transportation and Storage

This chapter will discuss biodiesel transportation and storage and address the following list of areas that need to be considered when determining your storage and transportation.

Key property considerations
  - Storage temperature
  - Oxidative stability
  - Solvency
  - Material compatibility
- Storage
  - Temperature
  - Stability
  - General
- Handling
- Transportation
- Blending
- Regulations

Key Property Considerations

There are several key properties that need to be considered in the transportation and storage of biodiesel. These properties include exposure temperature, oxidative stability, fuel solvency, and material compatibility. Exposure temperature refers to the temperature at which the biodiesel is being stored or transported. Oxidative stability concerns the ability of the biodiesel to be stored for extended periods without degradation. Fuel solvency refers to the solvent properties of the biodiesel. The interaction of the biodiesel with materials of construction for storage tanks, seals, and gaskets is the material compatibility. Each of these properties will be discussed in more detail and within the context of storage.

Ambient Temperature

All types of diesel fuels can gel at low temperatures. The temperature required to induce gelling (freezing) in biodiesel is generally higher than that of conventional diesel fuel and depends on the composition of the biodiesel. In particular, saturated methyl esters will have higher freezing points than unsaturated methyl esters. The composition of the biodiesel is, of course, dictated by the oil feedstock used for its production.

Oxidative Stability

As with gelling, all diesel fuels have the potential for oxidative stability issues. Oxidative stability concerns the degradation of diesel fuel due to reaction of the fuel with oxygen. As such, the reactivity of the fuel is important. This reactivity can be related to the presence of C=C (olefinic) bonds in the fuel with increased content of the C=C bonds

correlated to decreased oxidative stability of the diesel fuel. The increase in instability of a given diesel fuel molecule is generally directly proportional to the increase in the number of C=C bonds in the molecule (i.e., a molecule containing two C=C bonds has half the stability of a molecule containing one C=C bond). The oxidative stability of a diesel fuel can be estimated using the iodine number (ASTM D 1510). The longer-term stability of a diesel fuel can be evaluated using an accelerated stability test (ASTM D 2274). Oxidative degradation of diesel fuel is manifest by higher acid numbers, increased viscosity, and the formation of gums and sediments.

Fuel Solvency

While biodiesel is only a mild solvent, it does have higher solvency properties than diesel fuel. Due to this property, residual sediments in diesel storage tanks or vehicle fuel tanks can be solvated by biodiesel. The solvent properties of biodiesel are mitigated by the use of biodiesel in blends with diesel fuel. Typically, 20% or less blends of biodiesel in diesel will nearly completely dilute the solvency effect. However, this solvency effect should be considered if pure biodiesel is stored in a tank that was previously used for standard diesel.

When switching a vehicle or fleet to biodiesel, it is often recommended that fuel filters be changed several times after the switch to ensure there will be no operational problems.

Material Compatibility

The material compatibility is also an important property to consider with biodiesel. It is best to use stainless steel or aluminum equipment in the processing of biodiesel. Oxidation and sediment production in either biodiesel or diesel can be initiated by contact with brass, bronze, copper, lead, tin and zinc. Biodiesel can have compatibility issues with some polymers. Shown in Table 1 is compatibility of biodiesel with a number of polymers relative to the polymer's compatibility with standard diesel. Biodiesel is compatible with the seals, gaskets and adhesives commonly used today. However, there may be issues with pre-1993 seals, gaskets and adhesives.

Biodiesel Material Compatibility Table

Polymer	Relative to Standard Diesel
Fluorosilicon	Hardness little change, swell +7%
Nitrile	Hardness –20%, swell +18%
Nylon 6/6	Little Change
Polypropylene	Hardness –10%, swell +8-15%
Polyurethane	Hardness little change, swell +6%
Polyvinyl	Much worse
Teflon	Little change
Tygon	Worse
Viton A401-C	Little change
Viton GFLT	Little change

This table lists some polymer materials and their compatibility with standard diesel, which should also hold true for biodiesel.

Biodiesel Material Compatibility: Storage – Temperature

When storing biodiesel, the temperature that is experienced by the biodiesel must be closely monitored so as to avoid the formation of crystals. These crystals are formed by the solidification (freezing) of the biodiesel. Crystal formation is undesirable since the crystals can plug fuel lines and fuel filters. To avoid the formation of crystals, biodiesel should be stored at a temperature at least 15˚F higher than the pour point of the fuel. For most pure biodiesel storage temperatures of 45-50˚F are generally adequate.

Even in most cold climates, underground storage of pure biodiesel commonly provides the necessary storage temperature to prevent crystal formation. If pure biodiesel is stored above ground in cold climates, the storage system needs to include additional features such as insulation, agitation capability, and/or heating capability.

Blends of biodiesel with standard diesel can frequently be stored at lower temperatures. These blends still need to be stored at least 15˚F above pour point temperature for the blend. The formation of crystals is reversible as heating of the biodiesel can be used to melt the crystals. Alternatively, the crystals can be filtered from the biodiesel.

Storage – Stability

Stability of the biodiesel is an important attribute if the biodiesel is to be stored for a prolonged period. Poor stability can lead to increasing acid numbers, increasing fuel viscosity, and the formation of gums and sediments. Information about the stability of the stored biodiesel can be achieved by monitoring the acid number and viscosity. Storage stability of biodiesel has not been extensively examined relative to its composition. Therefore, the current best practice involves not storing biodiesel or biodiesel blends for more than six months.

Using antioxidants can enhance the stability of stored diesel fuels. Examples of acceptable antioxidants include t-butyl hydroquinone (TBHQ), Tenox 21, and tocopherol. Water contamination must be minimized in the stored fuel as it can lead to biological growth in the fuel. If water contamination occurs, using biocides can mitigate biological growth.

Storage – General

When selecting tanks for the storage of biodiesel several factors should be considered. Acceptable materials of construction for biodiesel storage tanks include aluminum, steel, Teflon and fluorinated polyethylene or polypropylene.

Tanks that have been used for diesel fuel storage are frequently contaminated with water and this water can be absorbed by biodiesel. If the tanks to be used have been previously used for the storage of standard diesel fuels, the tanks should be cleaned prior to use for biodiesel storage. Tanks should be selected to minimize the possibility of water contamination, as well as minimizing air contact, which will diminish oxidation and uptake of moisture. You should also familiarize yourself with local regulations on fuel storage, which may influence your decisions.

Handling

Several factors should be considered when handling biodiesel. While biodiesel contains no hazardous materials, it should still be stored and used in well-ventilated areas. Storage of biodiesel should not be near heat, spark, or flames sources. If stored in drums, proper drum handling procedures should be followed, which includes no drum puncturing, dragging, or sliding. It is recommended that PVC-coated gloves as well as safety glasses or goggles should be used when handling biodiesel. You should acquire an MSDS sheet on biodiesel and become familiar with its contents and ensure that your staff is familiar with it as well.

Transportation

When transporting biodiesel, the transportation vessels should be clean and dry. In addition, the vessels must conform to the same materials of construction used in storage. Seals, gaskets, and adhesives present in the transfer systems should comply with the compatible materials discussed above. Due to its pour point, pure biodiesel is difficult to ship in cold weather. Methods to transport biodiesel in cold weather include hot biodiesel in tank cars that are rapidly delivered, solidified biodiesel in tank cars that are equipped with steam coils, 20% biodiesel blends with winterized diesel, and 50% biodiesel blends with kerosene (diesel No. 1), which has a pour point of 0˚F.

Blending

Biodiesel is commonly used in blends with standard diesel fuel. As discussed above, use of biodiesel blends can improve the thermal tolerance of the fuel by decreasing the pour point. Therefore, blending may be considered at the biodiesel manufacturing site prior to storage. Several blending techniques can be employed. Biodiesel has a higher specific gravity than diesel fuel (0.88 versus 0.85), so blending is often achieved by splashing the biodiesel on the top of diesel. This blending technique is known as *splash blending*.

Alternatively, agitated blending can be used. Agitated blending uses direct mechanical agitation or blending induced by pumping the biodiesel/diesel fuel mixture back and forth into a tank truck. While water contamination is undesirable due to the potential to promote biological growth in stored blends, biodiesel/diesel fuel blends will not separate upon exposure to water but can be detrimental to storage stability.

Blending biodiesel into chilled diesel fuel causes crystals of biodiesel to form and could cause gelling if the diesel fuel is cold enough. These crystals of saturated biodiesel are difficult to manage, as they will remain in the fuel until the fuel temperature is raised high enough to melt them. Other approaches include filtering the crystals out. At this time, there are no easy solutions to this problem.

Regulations

Various regulations have to be met with respect to a biodiesel plant. The Clean Water Act and the Oil Pollution Act cover environmental Protection Agency (EPA) regulations. They outline various requirements you have to meet in order to comply with the regulations.

In addition to regulations, various permits have to be obtained. For below ground tanks they are handled by the DNR, which is authorized by the EPA to enforce the federal regulations in the state in this area. The below ground tanks are governed by permits issued by the fire marshal in the state, county or city.

EPA's Emergency Response Program

One of the EPA requirements is to comply with the Emergency Response Program, which is defined by the Clean Water Act, Oil Pollution Act, and other hazardous substance laws.

There are separate regulations covering the implementation of the Emergency Response Program contained within the three following regulations:

- National Contingency Plan
- Oil Pollution Prevention
- Discharge of Oil
- Other Hazardous Regulations

Oil Pollution Prevention Regulation

Oil Pollution Prevention Regulation was written to ensure effective responses to oil discharges. The final rule was amended on July 17, 2002 and there are two major types of requirements: Spill Prevention Control and Countermeasure (SPCC) and Facility Response Plan (FRP).

The Oil Pollution Act (OPA) was signed into law in August 1990, largely in response to rising public concern following the Exxon Valdez incident. The OPA improved the nation's ability to prevent and respond to oil spills by establishing provisions that expand the federal government's ability, and provide the money and resources necessary, to respond to oil spills. The OPA also created the national Oil Spill Liability Trust Fund, which is available to provide up to one billion dollars per spill incident.

In addition, the OPA provided new requirements for contingency planning both by government and industry. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) has been expanded in a three-tiered approach: the Federal government is required to direct all public and private response efforts for certain types of spill events; Area Committees - composed of federal, state, and local government officials - must develop detailed, location-specific Area Contingency Plans; and owners or operators of vessels and certain facilities that pose a serious threat to the environment must prepare their own facility response plans.

Finally, the OPA increased penalties for regulatory noncompliance, broadened the response and enforcement authorities of the Federal government, and preserved State authority to establish law governing oil spill prevention and response.

Spill Prevention Control and Countermeasure (SPCC)

The SPCC plan should clearly address the following three areas:

- Operating procedures that prevent oil spills;
- Control measures installed to prevent a spill from reaching navigable waters;
- Countermeasures to contain, clean up, and mitigate the effects of an oil spill that reaches navigable waters.

In July 2002, EPA published a new Spill Prevention Control and Countermeasure (SPCC) rule at Title 40 of the Code of Federal Regulations, Part 112, (40 CFR 112) incorporating revisions proposed in 1991, 1993, and 1997. This rule became effective on August 16, 2002.
As a cornerstone of EPA's strategy to prevent oil spills from reaching our nation's waters, the Agency requires that certain facilities develop and implement oil spill prevention, control, and countermeasure, or SPCC plans. Unlike oil spill contingency plans that typically address spill cleanup measures after a spill has occurred, SPCC plans ensure that facilities put in place containment and other countermeasures that would prevent oil spills that could reach navigable waters. Under EPA's Oil Pollution Prevention regulation, facilities must detail and implement spill prevention and control measures in their SPCC plans. A spill contingency plan is required as part of the SPCC plan if a facility is unable to provide secondary containment (e.g., berms surrounding the oil storage tank).

Each SPCC plan, while unique to the facility it covers, must include certain elements. To ensure that facilities comply with the spill prevention regulations, EPA periodically conducts on-site facility inspections. EPA also requires that facilities submit their SPCC plans for review after having 2 discharges (over 42 gallons) in any 12-month period.

A copy of the entire SPCC Plan must be maintained at the facility if the facility is normally attended for at least four hours per day. Otherwise, it must be kept at the nearest field office. The SPCC plan must be available to EPA for on-site review and inspection during normal working hours.

SPCC July 17, 2002 Final Rule Highlights

A few of the highlights of the SPCC July 17, 2002 Final Rule that would be of interest to biodiesel producers are listed below. Keep in mind that many of the other rules might apply to your facility and you should read them all and determine which ones apply to you.

Highlights:

- Exempts buried storage tanks
- Exempts portions of certain facilities or any facility used exclusively for wastewater treatment.
- Establishes a minimum container size of 55 gallons
- Establishes an above ground storage capacity threshold of greater than 1,320 gallons and removes the 660 gallon threshold

Who Must Prepare Facility Response Plans?

Facilities that could cause "substantial harm" to the environment are required to prepare and submit Facility Response Plans. Under the Oil Pollution Prevention regulations, EPA provides two methods by which a facility may be identified as posing substantial harm:

- Through a self-selection process; or
- By a determination of the Regional Administrator.

EPA has established criteria to aid facilities in the self-selection process to determine whether they qualify as substantial harm facilities.

In evaluating whether a particular facility may cause substantial harm, the EPA Regional Administrator may consider factors similar to the self-selection criteria, as well as other factors, including type of transfer operations at a facility, the facility's oil storage capacity, lack of secondary containment, proximity to environmentally sensitive areas or drinking-water intakes, and/or the facility's spill history. The EPA Regional Administrator will notify the facility if EPA determines that the facility poses a threat of substantial harm.

What is a Substantial Harm Facility?

Section 112.20 of the Oil Pollution Prevention regulation lists specific criteria to help owners and operators to evaluate whether their facilities pose substantial harm. Under the rule, a facility falls under the "substantial harm" category if it meets at least one of the following criteria:

- The facility has a total oil storage capacity greater than or equal to 42,000 gallons and performs over-water oil transfers to or from vessels; or

- The facility has a total oil storage capacity greater than or equal to one million gallons, and meets one of the following conditions:
    - The facility does not have secondary containment for each aboveground storage area; or
    - The facility is located such that a discharge could cause "injury" to an environmentally sensitive area; or
    - The facility is located such that a discharge would shut down a public drinking water intake; or
    - The facility has had, in the past five years, a reportable spill greater than or equal to 10,000 gallons.

The rule provides more detailed information to help owners/operators interpret these criteria to determine whether their facility should be regarded as a substantial harm facility. If the self-selection process does indicate that a facility poses a threat of substantial harm to the environment, the owner/operator is required to prepare and submit a facility response plan to the appropriate EPA Regional Administrator.

Significant & Substantial Harm

Section 112.20 also requires EPA to identify a subset of substantial harm facilities that could cause significant and substantial harm to the environment upon a release of oil. EPA bases its determinations on factors similar to the criteria to determine substantial harm, as well as the age of tanks, proximity to navigable waters, and spill frequency. Facilities are notified in writing of their status as posing significant and substantial harm. Once notified, the facility must submit its Facility Response Plan to EPA for review and approval.

Vegetable Oils and Animal Fats

Under the Clean Water Act, as amended by the Oil Pollution Act of 1990, vegetable oils and animal fats are considered oils. This summary provides information on EPA's decision to deny a petition of several agricultural trade organizations to allow facilities that store vegetable oils or animal fats to use different and less stringent response methods in planning for spills of these oils under the Facility Response Plan (FRP) rule (40 CFR 112.20-.21; July 1, 1994). The FRP rule requires certain facilities, whose discharge could cause significant environmental harm, to prepare and implement response plans. The EPA FRP rule already provides greater flexibility to vegetable oil or animal fat facilities in the development of these plans than what is required for petroleum facilities.

Based on information provided by industry, only a small number (approximately 50 to 100) of vegetable oil or animal fat storage facilities are required to prepare FRP's under the rule. These facilities meet the rule's substantial harm criteria due to their potential to impact sensitive areas, including drinking water intakes, or due to certain facility characteristics.

The EPA has considered the physical, chemical, biological, and other properties and environmental effects of petroleum oils, vegetable oils, and animal fats, which are the criteria now to be evaluated under the Edible Oil Regulatory Reform Act. EPA finds that petroleum oils, vegetable oils, and animal fats share common physical properties and produce similar environmental effects. Like petroleum oils, vegetable oils and animal fats and their constituents can:

- Cause devastating physical effects, such as coating animals and plants with oil and suffocating them by oxygen depletion
- Be toxic and form toxic products
- Destroy future and existing food supplies, breeding animals, and habitats
- Produce rancid odors
- Foul shorelines, clog water treatment plants, and catch fire when ignition sources are present
- Form products that linger in the environment for many years.

The petitioners did not demonstrate that spills of animal fats and vegetable oils are free of adverse impacts on the environment. Scientific research and experience with actual spills have shown that spills of animal fats and vegetable oils kill or injure fish, birds, mammals, and other species and produce other undesirable effects. Waterfowl and other birds, mammals, and fish that get coated with animal fats or vegetable oils could die of hypothermia, dehydration and diarrhea, or starvation. They can also sink and drown or fall victim to predators. Fish and other aquatic organisms may suffocate because of the depletion of oxygen caused by spilled animal fats and vegetable oils in water. Whether these oils are “toxic” to wildlife or kill wildlife indirectly through other processes is not the issue. Spills of animal fats and vegetable oils have the same or similar devastating impacts on the aquatic environment as petroleum oils.

Resource Websites

- http://www.epa.gov/oilspill/contacts.htm
- http://www.epa.gov/oilspill/vegoil.htm
- http://www.state.ia.us/dnr/organiza/epd/

15. Feedstock Acquisition

Introduction

This course module will review the categories of feedstock available for the production of biodiesel and a number of key feedstock decisions that affect the business structure, technology options and operations of a biodiesel plant.

The instructional goals for this module are:

1. Understand the advantages and disadvantages of combining a biodiesel plant with a commodity processing facility such as an oilseed crush facility or a rendering operation.
2. Review the categories of feedstock available.
3. Examine the advantages and disadvantages of single feedstock versus multiple feedstock operations.

The decision to couple a biodiesel plant with a new or existing processing facility defines the primary feedstock early in the business planning process. Operating a biodiesel facility in conjunction with a processing facility offers a measure of stability for the sourcing of raw materials and may lead to opportunities to take advantage of a number of financing and/or tax incentives for producers/processors. Also, the processor may be able to justify an internal transfer price for the feedstock that is lower than the posted market price. In essence, deferring profits to the biodiesel product or transferring costs to another product in the overall operation.
The categories of feedstock chosen and the decision to use single or multiple feedstock affect the expected pricing of the raw materials and also impact the choices of technologies to be used in the plant. Election of multiple or lower quality feedstock will lead to additional process steps to prepare some of the inputs for the biodiesel production or to manage process co-products.
Many potential biodiesel feedstocks are traded commodities. This may allow the operation to benefit from trading on the futures and spot markets for securing raw materials at below-market prices. Since the raw materials costs are as much as 70% to 85% of the finished product cost, advantageous pricing of the raw materials is a key to the ultimate profitability for the operation.

A raw material producer can gain a number of advantages by the addition of a biodiesel plant to a new or existing facility. The incremental investment for a biodiesel operation is relatively small, compared with the cost of an oilseed refinery or a rendering plant.
A key person in a feedstock purchasing facility is the commodity trader for the organization. A significant factor in the profitability for the plant will be the skills exercised in developing both long term feedstock contracts and utilization of the fats and oils spot markets and futures markets.

The decision to purchase the majority of the feedstock will affect the plant infrastructure. As noted, a single processor of a seasonal feedstock will have to either provide storage

for year-round operation or plan for purchase of supplies in the off-season. The purchaser option will lessen total storage requirements, but will increase transportation expenses. Determining the best balance between these factors requires analysis of the available suppliers for the fats and oils needed, transport costs, and storage requirements.

The use of multiple suppliers and multiple feedstocks will require additional care in the characterization of each new batch of raw material and in monitoring of the products. There can be considerable variation among suppliers and from batch to batch from the same supplier. This is particularly true of tallows and greases during the summer months.

Vegetable Oils: Vegetable oils suitable for producing biodiesel include the commodity oils: palm, soybean, corn, canola, sunflower and rapeseed. Some oils, such as olive and peanut oils, can be used for biodiesel, but their prices are generally too high. Coconut oil can be used for biodiesel, but the fatty acid composition is such that the pour point and cloud point properties are very poor. Cottonseed oil can be used also, but it is a primary feedstock for the margarine industry. Mustard oil from some very high yield varieties is under consideration by DOE.

A key factor in the decision to use vegetable oils for biodiesel feedstock is the fact that these oils are premium food products. This means that the pricing of all vegetable oils is somewhat higher than other triglyceride (TG) sources.

Vegetable oils have the advantage that whether they are partially or fully refined, they have a low free fatty acid content and typically have very low concentrations of most process contaminants, including water. The fatty acid profiles of most temperate climate vegetable oils allow the esters to meet cloud point and pour point requirements without need for winterization. The polyunsaturate content desirable for most premium food oils can lower the cetane number of the biodiesel and may contribute to a lower storage stability for the product.

Futures trading for the plant's oil supply can offer opportunities to lower the average cost of the vegetable oil feedstock. Also, off-specification oils from regional processors may be suitable for use in biodiesel production, although not available in large quantities.

Rendered Products: The primary animal fats considered for biodiesel are beef tallow (inedible grade) and inedible grade pork lard. Because of the palmitic and stearic acid content, biodiesel from these sources may need to be winterized or blended to meet pour point and cloud point specifications.

Poultry fat has not been explored extensively for biodiesel, but it has the potential to be a significant feedstock. Fish oils could be used for biodiesel, but they tend to be priced at a premium. In addition, fish oils are highly unsaturated which may lead to stability problems unless these fatty acids are removed for the specialty health markets. Animal fats tend to have higher free fatty acid contents than vegetable oils because they have been cooked (rendered) once in their preparation.

Rendered products from the meat processing facility (integrated meat packers and renderers) will almost always be from a single source: beef, pork, chicken, mutton, etc. There may be some variation in quality of the product, although the product will meet the standards for which it is labeled. Most fats produced by beef or pork meat packers are considered edible fats, and command slightly higher prices in the market place. Other products produced by renderers include protein, bone, blood and feather meal.

Independent renderers are not integrated with a meat packing operation and often accept a wider variety of animal products from different sources. Their fats and greases are considered inedible for humans and largely used as enhancements in animal feed for their calorie content. Independent renderers typically accepted recycled fryer greases and process these (occasionally with other greases from their rendering operation) into a product sold as "yellow grease."

Because of its lower price, yellow grease is frequently considered for biodiesel production. Yellow grease has a rather high (maximum of 15 percent) free fatty acid content. The original materials are a mix of vegetable and animal fats and oils. The compositions will vary over time and among sources.

The fatty acid profile is one of the most important elements in determining biodiesel properties, so both edible and inedible sources can be used. The price, however, guides biodiesel producers towards the inedible materials – the inedible grades are generally about $ 0.03 per pound cheaper.

The free fatty acid contents tend to be the highest in the summer and the lowest in the winter. The feedstocks used to make the grease products can vary greatly, even from a single plant. The result is variability in the product grease.

There are several low-value crude sources of fats and oils that require pre-processing before use in any esterification process. These include trap grease, brown grease, and soapstock. These sources are commonly associated with water, proteins, polysaccharides, and mineral matter. The addition of appropriate pre-processing capabilities may be economical, since these materials commonly constitute a disposal cost, rather than a product value to the processors.

The quality measures and standards for the all of the rendered products are discussed in more detail in the "Alternative Feedstocks" module.

Single or Multiple Feedstocks: There are advantages to using a single feedstock. The processing is inherently simpler because feedstock variability is limited. There does not have to be multiple tankage for feedstock storage or product storage. If the biodiesel producer is taking advantage of some of the tax or subsidy incentives, accounting for raw materials and products is simpler. Some process technologies are optimized for use with a single feedstock, typically soybean oil.

Multiple feedstocks allow more flexibility in minimizing feedstock costs by "playing the market" to acquire the lowest cost materials available. However, multiple sources will require strict quality control for the raw materials, as well as the final product. The process will have to be more complicated, with provision for one or more pre-treatment steps available to ensure suitable feed to the primary esterification unit.

Some of the impacts of multiple feedstocks have on the business involve feedstock cost flexibility, higher capital and operating costs, product performance, public perception (including color and odor acceptance), public acceptance (some customers prefer some feedstocks over others) sulfur removal, and glycerin quality. In fact, one of the key issues to consider is what type of glycerin coproducts are desired and how the selection of feedstocks can impact that objective. This in turn may influence any blending strategy that is used to control product characteristics.

Summary

The choice of the feedstock for a biodiesel plant determines these key factors for the biodiesel plant:

- The average raw material cost,
- The availability of raw materials (sources and timing),
- The process technology most suitable for the plant, and,
- Access to certain, feedstock specific, tax and/or subsidy advantages.

The financial and tax incentives associated with biodiesel production are a rapidly developing area of legislation. The impacts of the legislation vary quickly in time and location. While these impacts are important to the ultimate profitability of any operation, it is imperative to evaluate the profitability of any venture without reliance on these incentives. Strokes of a pen both implement and abolish these incentives.

16. Alternative Feedstocks

Introduction

This course module describes several categories of biodiesel feedstocks from the point of view of their chemical and physical properties. The key properties reviewed are the fatty acid profiles for vegetable oil resources, and the free fatty acid content, non-triglyceride content, and grade specifications for tallows and greases.

The fatty acid profile of the feedstock determines the physical properties and performance properties of the biodiesel product. This is further described in the Analytical Module entitled "Property Prediction". Other physical and chemical properties of the raw materials, such as the amount of free fatty acids and the MIU (moisture, insolubles, and unsaponifiables) content, affect the steps necessary to prepare the feedstocks for the esterification reaction used to produce biodiesel.

The instructional goals for this module are:

1. Become familiar with the similarities and differences in composition among the various feedstock materials for biodiesel production.
2. Learn the terminology used to describe different sources of fats and oils and their properties, and to understand the differences in specifications applied to these sources.
3. Compare the different feedstocks on the basis of their physical properties and chemical compositions.

Feedstock Categories

Vegetable oils are recovered from plant seeds by a series of physical processing steps. The typical vegetable oil recovery process begins with crushing the seed to break the cell membranes retaining the oil and to partially expel the oil from the seed meal. The seed meal may be further extracted using a solvent, such as hexane, to recover additional oil from the meal. The recovered oils may then be treated to remove non-oil components, reduce color and odor, and to remove free fatty acids. The treatment process is termed "refining". The degree of refining employed is determined by the ultimate use for the oil.

Tallows and fish oils are recovered from animal sources by a process called "rendering". Essentially, the rendering process is a controlled cooking of animal tissues and bones to separate the fats, proteins, water, and bones. The fat (lipid) products are not water-soluble and rise to the surface, where they are skimmed off. The skimmed fats are further refined, deodorized, bleached and dried to produce tallow (meltable solids), fats (semi-solid) or oils (liquid). Beef and pork lipids form tallows, chicken lipids are fats, and fish lipids are typically oils. The differences in physical state arise because of the fatty acid profiles (compositions) characteristic of each source.

Greases are recovered using a similar rendering process, but they may derive from a number of sources. Greases, fats and oils (FOG) have somewhat have different measures of quality, compared to vegetable oil standards. They include the percent free fatty acids, MIU (moisture, insolubles, and unsaponifiables) and the titer (melting point) of the material.

There are a number of waste materials associated with fats and oils processing that contain significant quantities of fatty acid (lipid) material. These materials are expensive to dispose of because of their high BOD (biological oxygen demand). They can, however, provide a low quality feedstock for the production of biodiesel, if they are pre-treated before the esterification process. Three of these materials are described in this module.

Key Physical and Chemical Properties of Biodiesel Feedstocks

Fats and oils are composed of a specific category of organic compounds called "triacylglycerols", or "triglycerides". A triglyceride (TG) molecule is made up of three fatty acid units attached to a three-carbon backbone. The biodiesel reaction uses an alcohol, such as methanol, to split the TG molecule into a single molecule of glycerol (glycerine) and three molecules of fatty acid esters. For example, if the alcohol is methanol, the esters will be called fatty acid methyl esters (FAME).

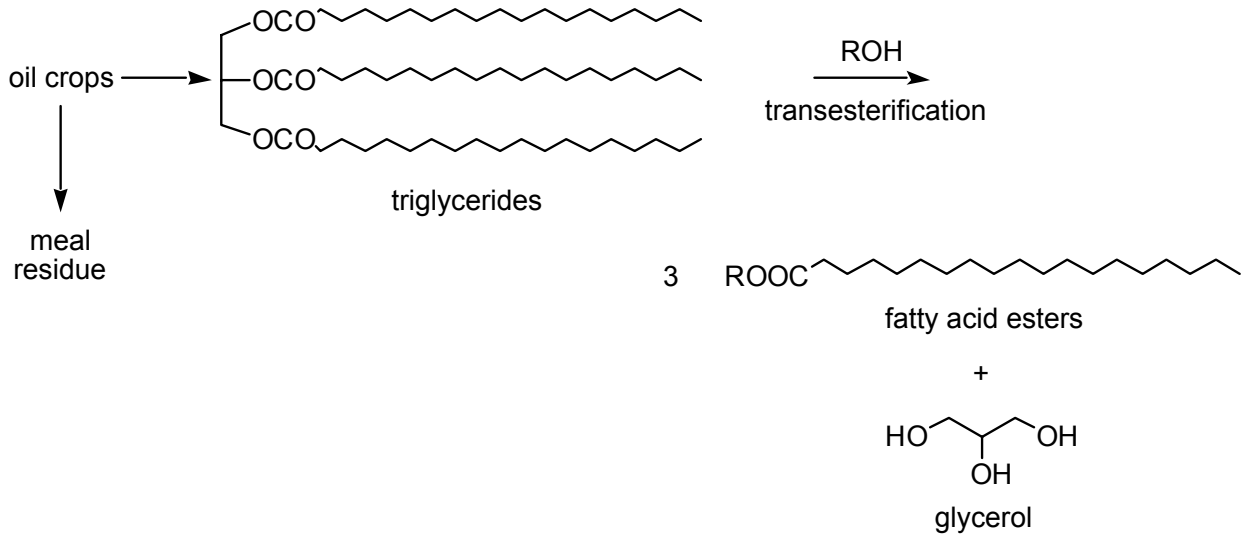


Figure 16-1. Biodiesel Reaction

The fatty acids present and their relative amounts depend upon the source of the fat or oil. There is a relatively small variation in composition in fats and oils from the same source material. The fatty acid profile of any source can be determined using gas or liquid chromatography. More importantly, the fatty acid profile can be used to predict both physical and performance properties of the biodiesel product. (Refer to the Analytical Methods Module "Property Prediction".)

Free fatty acids (FFA) can be formed during the recovery process for the fats and oils, or when there is water present to break the glyceride–fatty acid bond. FFAs require different

processes than triglycerides, but can be made into biodiesel. Hence, the FFA content is a significant measure of feedstock quality, because it indicates the degree of processing required. FFA content is reported as percent FFA.

The free fatty acid percentage of a fat or oil is measured by the acid number. The acid number is the number of milligrams of KOH required to saponify the free fatty acids in one gram of fat or oil. The assumption is made that the FFAs present are oleic acid. This results in the relation that one unit of acid number = 0.503% FFA.

Specific gravity is a measure of the density (grams per milliliter) of the fat or oil. The specific gravity (sp. gr.) is reported as a ratio of the density of the sample at a specified temperature to the density of water at a specified temperature. For example, sp. gr. 25/25 means that the temperature of the sample and the water is 25°C. There are a number of different "standard" temperatures used in the industry, so it is very important to note the temperatures associated with any data reported, or standards used. In the U.S., the typical temperature standard is 25/25°C.

The refractive index of a liquid is the ratio of the velocity of light in a vacuum to the velocity of light in the liquid. In spite of the esoteric definition, the refractive index is easily measured. It is useful in identifying substances and in determining the purity of a material. In the case of fats and oils, the refractive index is a quick measure of the degree of unsaturation in the fatty acids present. For biodiesel, this measure is important because the degree of unsaturation affects the viscosity, pour point, cloud point and cetane number of the product.

The iodine number is a direct chemical measure of the degree of unsaturation present in a triglyceride or the derivative esters or fatty acids. The iodine number is defined as the number of grams of iodine reacted with 100 grams of triglyceride. The reactant source for the iodine is iodine monochloride or iodine monobromide. The iodine number and refractive index for a given material are related by the general expression:
$n_D = a + b\ I$, where a and b are empirical constants that depend on the triglyceride.

Saponification is the reaction of a fat or oil with an alkali hydroxide (NaOH, KOH, etc.) to form glycerol and fatty acid salts. The saponification number is the number of milligrams of potassium hydroxide (KOH) required to saponify one gram of fat or oil. The saponification number is a crude indicator of the average molecular weight of the oil.

Titer is a measure of the solidification temperature of a tallow or grease. The titer is used as a measure of quality and to distinguish between inedible tallow and inedible grease. A material with a titer less than 40°C is classified as a grease, and a material with a titer above 40°C is a tallow.

MIU is a combined measure of the percentage of moisture (M), insoluble impurities (I), and unsaponifiable matter (U) present in the tallow or grease. The I and U components indicate the presence of a variety of possible non-triglyceride materials that can serve as contaminants for the biodiesel product and can reduce product yields. The moisture value

is particularly important, because moisture can lead to the production of free fatty acids, instead of esters in the reaction system.

Color is measured by comparison with a set of permanent color standards. The sample must be liquid when making the comparison. The color blocks and comparator are purchased items (The Tintometer Company).

Vegetable Oil Sources for Biodiesel Production

Palm oil is the largest volume triglyceride resource in the world. As the name indicates, palm oil is a seed oil derived from the oil palm tree. Palm kernel oil is derived from the seed kernel, while palm oil is recovered from the seed pulp. Palm oil is a material of interest for biodiesel production. Palm oil is characterized by high (32 – 40 %) palmitic acid and high (38 – 52 %) oleic acid contents. The oil is semi-solid at room temperatures. The ester product has to be winterized to meet pour point and cloud point standards in temperate regions.

Soybean oil is recovered as a co-product from the production of soybean meal, a high protein food and feed material. This temperate seed oil has received the greatest attention as a source for biodiesel in the U.S. The fatty acid profile of soybean oil yields an ester product that requires minimal winterization. There is an extensive infrastructure in the U.S. for the recovery and refining of soybean oils.

There are two types of soybean oil available. The majority of the soybean oil is extracted oil, which means that the oil was recovered from the meal using a solvent extraction process. There are a number of smaller facilities that specialize in expeller pressed oils and meals. Both types of oil can be used to make biodiesel.

Rapeseed oil is the primary feedstock used in Europe for the production of biodiesel. The European variety of rape is a low erucic acid, edible oil. Industrial rapeseed is high in erucic acid (C 22:1), which is used in a variety of high performance lubricants, corrosion inhibitors, and other products, as well as biodiesel. The primary source of industrial rapeseed oil in the U.S. is the Northwest, where it has been tested extensively as a source for biodiesel. Canola oil is a low erucic acid oil derived from the rape family that can be used for biodiesel, but it commands a premium price as an edible oil.

Corn oil is recovered as a co-product from a corn wet milling operation. The properties of corn oil are very similar to those of soybean oil, but the oil is typically priced $0.02 to $0.03 per pound higher than soybean oil.

Other oils that can be used for biodiesel production include cottonseed oil, sunflower oil, and peanut oil. The DOE is sponsoring the development of an oilseed mustard variety that has very high oil yields per acre as a new source for biodiesel.

Table 16-1 shows typical values for the fatty acid compositions of common vegetable oils that have been used for biodiesel production. The numbers describing each acid indicate

the number of carbon atoms in the acid chain, followed by the number of unsaturated carbon-carbon bonds in the chain. For example 16:0 is palmitic acid, with 16 carbon atoms and no unsaturated bonds. Oleic acid (18:1) has 18 carbon atoms and one unsaturated bond.

Table 16-1: Fatty Acid Percentages in Commodity Vegetable Oils

Fatty Acid	Palm	Soybean	Industrial Rapeseed	Corn
Palmitic 16:0	32 - 45	7 - 11	1 - 3	8 - 12
Stearic 18:0	2 - 7	2 - 6	0.4 – 3.5	2 - 5
Oleic 18:1	38 - 52	15 - 33	12 - 24	19 - 49
Linoleic 18:2	5 - 11	43 - 56	12 -16	34 - 62
Linolenic 18:3	-	5 - 11	7 - 10	-
Erucic 22:1	-	-	40 - 55	-

Rendered Products as Sources for Biodiesel Production

Tallows and greases are triglyceride materials that are recovered using a rendering process. The rendering process is a large-scale cooking of animal processing residues or used cooking oils in water. The fats and oils rise to the surface and are recovered.

Because of the fatty acid profiles of most animal fats, the rendering products are generally semi-solid or solid at room temperature. Beef and pork tallows are always solid at room temperature. Chicken fats are semi-solid. The rendered cooking oils may be semi-solid, depending on what other materials were processed with them. Table 16-2 shows typical fatty acid profiles for the three primary sources of animal fats in the U.S.

The nature of the rendering operation does not lend itself to making highly consistent products. The input stream is too variable. The specifications used to characterize tallows and greases reflect the inherent variability of the materials. The specifications are in terms of limits, rather than ranges, as shown in Table 16-3.

The decision to use tallows and greases in a biodiesel facility is a commitment to careful monitoring of each new lot of feed material. Also, these materials will require the addition of pre-processing equipment to ensure that the feedstock quality to the esterification process is suitable for the technology in use in the facility.

Table 16-2: Fatty Acid Percentages in Selected Animal Fats and Oils

Acid	Beef	Pork	Chicken
Myristic 14:0	1.4 – 6.3	0.5 – 2.5	1
Palmitic 16:0	20 - 37	20 - 32	25
Palmitoleic 16:1	0.7 – 8.8	1.7 - 5	8
Stearic 18:0	6 - 40	5 - 24	6
Oleic 18:1	26 - 50	35 - 62	41
Linoleic 18:2	0.5 - 5	3 - 16	18

Table 16-3: Grade Specifications for Tallows and Greases

Analysis	Yellow Grease	Brown Grease	Inedible Tallow
Min. Titer	36.0 ºC	38.0 ºC	40.0 ºC
Max FFA	15%	50%	15%
Max Color	37	none	33
Max MIU	2 %	2 %	2 %
Sp. Gr.	-	-	0.86 – 0.87
Iodine #	-	-	35 - 48

Low Quality Sources for Biodiesel Production

Trap grease materials are typically recovered from the bottoms of commercial frying systems and from grease traps installed as a part of the water discharge system. These materials are highly variable in composition, but will have significant quantities of water and non-lipid materials associated with them. They require dewatering, filtering, grit removal, and may also require deodorization and bleaching prior to use.

Soapstock is a large volume, low value material produced as a part of the oil refining process. The oil is treated with an alkali solution to convert the free fatty acids into a soap suspension that is decanted and discarded. A typical composition of soapstock is:

Glycerides	12%
Phosphoglycerides	8%
Free fatty acids	10%
Water	45%
Other	25%

Spent bleaching clay also is a waste product of the oil refining process. Activated clays are contacted with the oil as an adsorbent to remove coloring agents from the oil. The clays can contain from 20% to 50% by weight oil that can be recoverable. A danger in working with spent clays is that the materials are pyrophoric and must be handled appropriately.

Summary: Feedstock Choices and Biodiesel

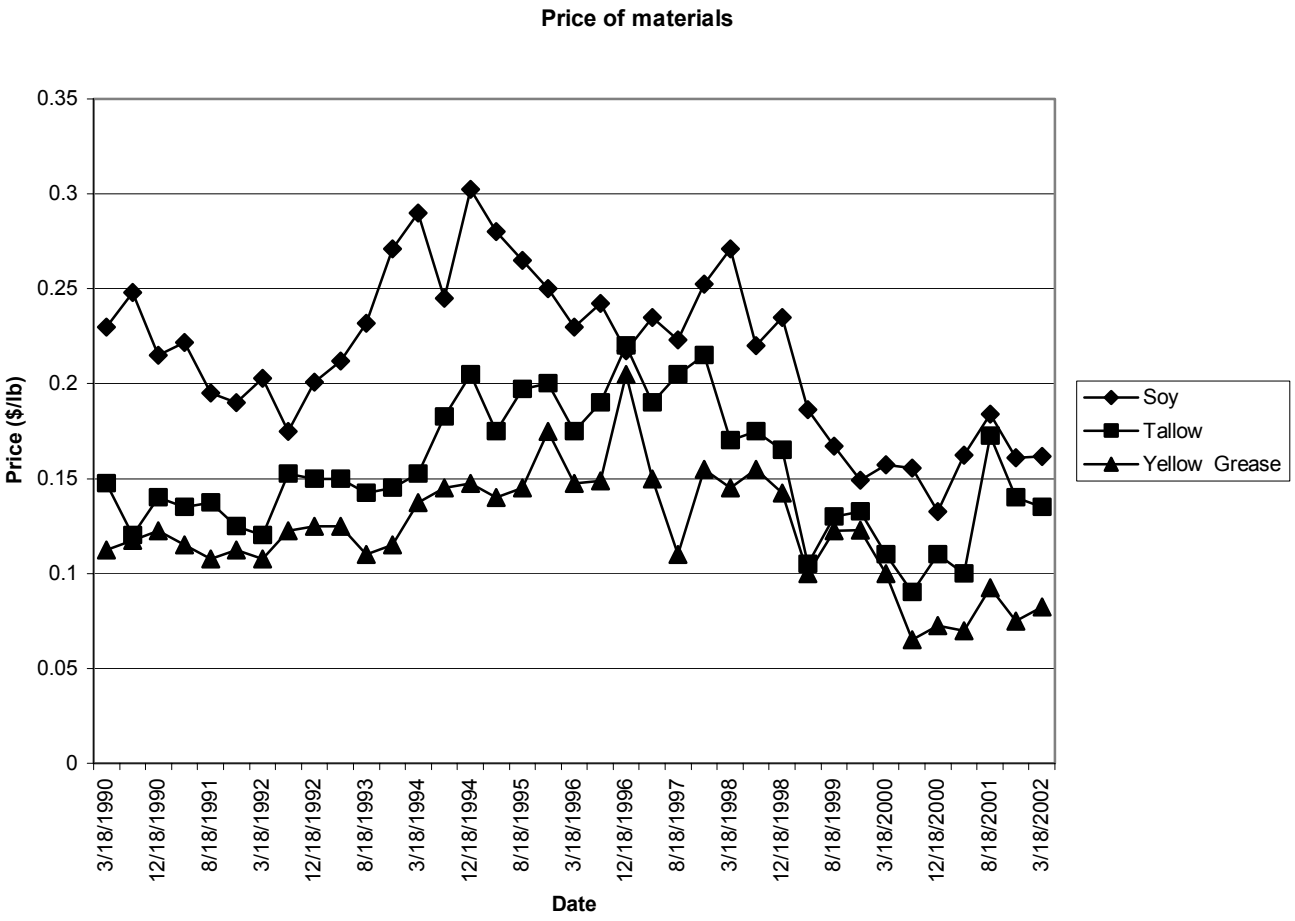
The two most important factors in feedstock selection for any biodiesel operation are the cost of the material(s) to be used and the quality (particularly the free fatty acid content) of the materials. The cost of the TG material used to make biodiesel is typically 70% to 85% of the total production cost of the product. Hence, there is a significant pressure to use the lowest cost TG source possible.

In general, rendered products are consistently lower in cost than vegetable oils. Because of its massive production and refining infrastructure, soybean oil tends to be the lowest cost vegetable oil available in the U.S. Figure 15-2 illustrates the relative pricing of soybean oil, inedible tallow, and inedible yellow grease over the period from 1990 to 2001. Typically, soybean oil costs about $0.05 to $0.07 per pound more than tallow, and tallow is $0.03 to $0.05 per pound more than yellow grease.

The choice of feedstock also affects biodiesel's properties and the overall process scheme used to produce the product. Key properties that are affected by the fatty acid profile of the raw material include the pour point and cloud point (measure of cold weather performance), the cetane number, viscosity, and storage stability. In general, the greater the fraction of saturated fatty acids, the poorer the cold weather performance. Typically, the greater the number of polyunsaturates, the lower the cetane number and the poorer the storage stability.

Free fatty acids present in a feedstock at less than 0.5% require additional pre-treatment before the material can be used in a typical base-catalyzed biodiesel process. This means that use of all rendered products requires pre-treatment to either remove the free fatty acids, or to convert them into fatty acid esters before entering the standard esterification process step. Because of the inherent variability of the rendered products, there must be careful monitoring of the raw material, as well as the final product.

Figure 16-2: Comparison of Soybean Oil, Tallow and Yellow Grease Prices



17. Glycerol

Glycerol is a byproduct of the transesterification process that produces biodiesel. It is also known as glycerin, glycerine, and 1,2,3-propane-triol. It will be produced by a biodiesel plant at about 10% of the biodiesel production level. It is often referred to as a high-value co-product but suitable markets have been hard to find.

Glycerol is a very common industrial chemical with a multitude of uses. Jungermann makes the following comments about uses for glycerol:

> "Glycerine in is a versatile chemical. It is found in baby care products and in embalming fluids used by morticians, in glues that hold things together and in explosives to blow them apart; in throat lozenges and in suppositories." [Chapter 1 of Glycerine – A Key Cosmetic Ingredient, Edited by E. Jungermann and N.O.V. Sonntag, Marcel Dekker, Inc., New York, 1991.]

Principle uses include: food products, cosmetics, toiletries, toothpaste, explosives, drugs, animal feed, plasticizers, tobacco, and emulsifiers.

The glycerol produced by transesterification is only about 50% pure. It contains a significant amount of contaminants including methanol, soap, and catalyst. It is relatively easy to raise the purity level of the crude glycerol to 80%-90%. This can be accomplished by adding hydrochloric acid to the crude glycerol until the pH is acidic (around 4.5). This splits the soaps into fatty acids and salt. The fatty acids will rise to the top of the glycerol where they can be removed. Then, the methanol can be removed by evaporation to yield 80%-90% purity glycerol. The actual level will depend on the purity of the original oil because contaminants tend to concentrate in the glycerol.

Prices for pure glycerol have varied from $0.50 to $1.50/lb over the past several years. At the higher price in this range, each gallon of biodiesel will be accompanied by an amount of glycerol worth about $1.10. Clearly, the disposition of the glycerol is an important element of biodiesel profitability. However, it needs to be pointed out that these prices are based on glycerol that is at least 99.7% pure. To take the partially refined glycerol described above to this level of purity requires either vacuum distillation or ion exchange refining. Vacuum distillation is capital intensive and probably not practical for small biodiesel plant operators. Ion exchange columns involve less capital but generate large volumes of wastewater during regeneration so they will involve additional wastewater treatment costs for large operators.

Current annual production of glycerol in the United States is about 300 million pounds per year [Jungermann and Sonntagg, op. cit.]. If biodiesel production in the U.S. reaches 200 million gallons per year, a relatively modest goal that would use only 8% of the U.S. production of soybean oil, the amount of additional glycerol produced from this source would be equal to 50% of the current glycerol production. The impact of this additional glycerol on prices is unclear but it is likely that if new uses for glycerol are not found, the

glycerol price will drop to a level that is consistent with its value as a burner fuel, which is about 5 cents/lb.

The selection of feedstock can affect glycerin coproduct values. Color and odor bodies are not acceptable in most grades of glycerin. One of the key tradeoffs in selecting a feedstock is to consider how it will impact the quality of the crude glycerin produced.

There are color and odor standards for glycerin. Rendered feedstocks and off-spec vegetable oils can lend undesirable color and odor bodies to the glycerin. These can be treated at the front end of the process with some feedstock pretreatment or treated at the back in of the process with more intensive glycerin refining. If nothing is done to remove these contaminants, the value of the glycerin will be discounted and the sales price will be reduced.

Other contaminants also impact the value of the glycerin. Some glycerin buyers will not purchase glycerin with potassium salts present. There may also be limits on water and methanol.

Some glycerin is Kosher, which is a desirable grade of glycerin often used for food and pharmaceutical products. It commands a higher price than other glycerin grades. Most Kosher glycerin is produced from seed oils. Mixing feedstocks is not permitted.

As the amount of biodiesel production expands world wide, the supply of glycerin/glycerol will expand. There are many growing uses for glycerol but the market is sensitive to imbalances between supply and demand. This could cause periods as long as several years, in which glycerin prices become depressed. In fact, there is some concern within the industry that a major glut could occur in future years. The supply of glycerin produced from biodiesel could double or triple U.S. glycerin supplies. Biodiesel producers should consider developing a plan for making some type of marketable product from the glycerin. For example, glycerin could be produced in the first five years, and then the facility could be modified to produce a new glycerin based product. This could reduce any risk to coproduct values that low glycerin prices could cause.

Glycerol Standards

There are a wide variety of standards for glycerol. There are standards for crude glycerol, such as those shown in Table 17-1. Standards for high quality glycerol are usually based on the United States Pharmacopeia (USP) or one of the European equivalents (British Pharmacopeia, etc.). Individual companies may sell USP grade glycerol with high quality specifications than are actually required by the USP specification. USP specifications are listed in Table 17-2 and the British Standard Specifications for 3 grades of glycerol are provided in Table 17-3. Finally, Table 17-4 shows an example of a commercial USP product from Proctor and Gamble Corp.

Table 17-1. Crude Glycerol Specifications

	Soap lye crude glycerol[a]	Hydrolyser crude glycerol[b]
Glycerol (% wt) min	80.0	88.0
Ash (%wt), max	10.0	1.0
MONG[c] (%wt), max	2.5	1.5
Water (% wt), Karl Fisher, max	10.0	--
Propane 1,3 diol (%wt), max	0.5	0.5
Arsenic as As (ppm)	2.0	2.0
Sugars (max)	Nil	Nil

[a]Soap lye crude glycerol is prepared by evaporation of the purified lyes obtained from the manufacture of soap.
[b]Hydrolyser crude glycerol is prepared by evaporation of the sweet waters obtained from the hydrolysis of fats under pressure or in the presence of catalysts.
[c] MONG = matter organic non-glycerol
Source: Woollatt, E., *The Manufacture of Soaps, Other Detergents and Glyerine*, Ellis Horwood, Ltd., Chichester, UK, 1985. Originally British Standard Specifications.

Table 17-2. USP Specifications for Glycerol (USP, v. 24, 2000)

Purity: Contains not less than 99.0 percent and not more than 101.0 percent, by assay.
Color: When viewed downward against a white surface in a 50-ml color-comparison tube, is not darker than the color of a standard made by diluting 0.40 ml of ferric chloride CS with water to 50 ml and similarly viewed in a color-comparison tube of the same diameter as that containing the glycerol.
Specific gravity: not less than 1.249
Residue on ignition: Heat 50 g in an open, shallow 100-ml porcelain dish until it ignites, and allow it to burn without further application of heart in a place free from drafts. Cool, moisten the residue with 0.5 ml of sulfuric acid, and ignite to constant weight; the weight of the residue should not exceed 5 mg (0.01%).
Water: not more than 5.0%
Chloride: A 7.0-g portion shows no more chloride than corresponds to 0.10 ml of 0.020N hydrochloric acid (0.001%).
Sulfate: A 10-g portion shows no more sulfate than corresponds to 0.20 ml of 0.020 N sulfuric acid (about 0.002%).
Heavy metals: Mix 4.0 g with 2 ml of 0.1 N hydrochloric acid, and dilute with water to 25 ml; the limit is 5 ppm.
Chlorinated Compounds: Following specified reactions with morpholine, nitric acid and silver nitrate, the turbidity should not be greater than that of a blank to which 0.20 ml of 0.020 N hydrochloric acid has been added (0.003% of Cl).
Organic volatile impurities: Use gas chromatograph to identify 5 organic volatile impurities. Levels not to exceed: benzene, 2 µg/g; chloroform, 60 µg/g; 1,4-dioxane, 380 µg/g; methylene chloride, 600 µg/g; trichloroethylene, 80 µg/g.
Fatty acids and esters: Mix 50 g with 50 ml of freshly boiled water and 5 ml 0.5 N sodium hydroxide, boil the mixture for 5 minutes, cool, add phenolphthalein, and titrate the excess alkali with 0.5 N hydrochloric acid. Perform a blank determination. No more than 1 ml of 0.5 N sodium hydroxide should be consumed.

Table 17-3. British Specifications for Refined Glycerols

	BS 2623:1979 Technical grade glycerol	BS 2624:1979 Dynamite grade glycerol	BS 2625:1979 Chemically pure glycerol
Glycerol (% wt)	>99.0	>99.0	>99.0
Relative density (20º/20º)	1.261 < density < 1.264		
Sulfated ash, %	<0.010	< 0.010	<0.010
Acidity or alkalinity, milliequivalents/100 g.	< 0.32	< 0.32	< 0.064
Saponification equivalent, milliequivalents/100 g.	--	< 0.64	< 0.64
Heavy metals, ppm	--	--	< 5.0
Lead, ppm	--	--	< 1.0
Iron, ppm	< 2.0	--	--
Arsenic, ppm	--	--	< 2.0
Chlorides as %NaCl	< 0.010	< 0.010	No turbidity in standard test
Organic Chlorides	--	--	Turbidity not greater than standard
Reducing Substances (silver test)	--	Not darker than standard	Not darker than standard
Color, Lovibond	< 5.0 Y and 1.2 R	As technical grade	--
Sugars	--	--	Nil
Odor and taste	Free from abnormal odor when tested as described in BS 5711	Shall not emit an acrid odor when tested as described in BS 5711	Free from odor in test described. Shall taste sweet and be free from any burnt flavor.

Source: Woollatt, E., *The Manufacture of Soaps, Other Detergents and Glyerine*, Ellis Horwood, Ltd., Chichester, UK, 1985. Originally British Standard Specifications.

Table 17-4. Proctor and Gamble Glycerol Specification[a]

Chemical Properties	Superol[b] Glycerol
Glycerol (Bosart and Snoddy Table)	99.7% min (99.9)
Specific Gravity, 25º/25º	1.2613
Assay (percent glycerol on anhydrous basis)	99.0 – 101.0
Moisture	0.3% max
Color, APHA Pt-Co (Hazen) scale	10.0 max (6.0)
Residue on Ignition	0.007% or 70 ppm max
Chlorides (as chlorine)	0.001% or 10 ppm max
Sulfates	0.002% or 20 ppm max
Heavy metals (As Pb)	0.0005% or 5 ppm max
Chlorinated Compounds (as Cl)	0.003% or 30 ppm max
Fatty acids and esters	Not more than 0.3 ml of 0.5 N NaOH is reacted with 50 g of glycerol
Identification by IR	Passes test as glycerol
Identity by GC	Passes test as glycerol
Diethylene Glycol (DEG) & related compounds	DEG impurity 0.1% Max Individual impurity 0.1% max Sum of all impurities 1.0% max
Organic Volatile Compounds	Chloroform, 60 ppm max 1,4-dioxane, 380 ppm max Methylene chloride, 600 ppm max Trichloroethylene, 80 ppm max
Readily Carbonizable Substances Test	Passes – current FCC
CAS Number	56-81-5

[a]http://www.pgchemicals.com/content/pdf/01_about_pg/chemicals/SpecificationSheets/AmericaSpecifications/Glycerine/Glycerine-Superol,Star,Moon_12.PDF

[b] Trademark name for P&G refined glycerol, available as Kosher, non-Kosher, or Kosher for non-food applications.

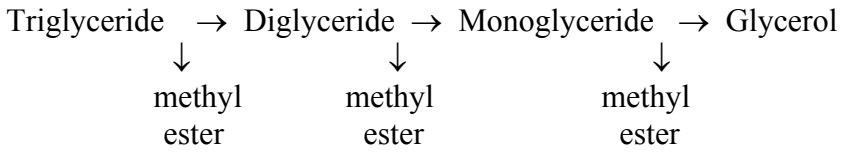
18. Product Quality

ASTM standards

The best current measure for biodiesel quality in the United States is the ASTM standard, ASTM D 6751: *Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels.* This standard specifies the properties required for a fuel to be used in an engine without problems. Even if fuel is to be blended with diesel fuel, most people in the industry expect that the biodiesel blending stock will meet the standard before being blended. While some properties in the standard, such as cetane number and density, reflect the properties of the chemical compounds that make up biodiesel, other properties provide indications of the quality of the production process. This discussion will focus on the most important issues for assuring product quality for biodiesel.

Completion of reaction

The most important issue during biodiesel production is the completeness of the transesterification reaction. The basic chemical process that occurs during the reaction is indicated by the following sequence of events:



The triglycerides are converted to diglycerides, which in turn are converted to monoglycerides, and then to glycerol. Each step produces a molecule of methyl ester or biodiesel. If the reaction is incomplete, then there will be triglycerides, diglycerides, and monoglycerides left in the reaction mixture. Each of these compounds still contains a glycerol molecule that has not been released. These compounds are referred to as *bound glycerol*. When the bound glycerol is added to the free glycerol, we get the *total glycerol*. The ASTM specification requires that the total glycerol be less than 0.24% of the final biodiesel product. The ASTM method requires that the Total Glycerol be measured using a gas chromatographic method described in ASTM D 6584. Other methods can be used such as a High Performance Liquid Chromatograph (HPLC) or a chemical procedure such as that described in American Oil Chemists' Society official method Ca 14-56. All of these techniques require a fairly high level of training and some laboratory equipment.

Free Glycerol

Free glycerol refers to the amount of glycerol that is left in the finished biodiesel. Glycerol is insoluble in biodiesel so almost all of the glycerol is easily removed by settling or centrifugation. Some glycerol may remain either as suspended droplets or a very small amount that is dissolved in the biodiesel, and is known as free glycerol. Most of this glycerol should be removed during the water washing process. Water-washed fuel

is generally very low in free glycerol, especially if hot water is used for washing. Distilled biodiesel tends to have a greater problem with free glycerol due to glycerol carry-over during distillation. Fuel with excessive free glycerol will usually have a problem with glycerol settling out in storage tanks, creating a very viscous mixture that can plug fuel filters and cause combustion problems in the engine.

Residual Alcohol and Residual Catalyst

Since methanol (and ethanol) and the alkaline catalysts are more soluble in the polar glycerol phase, most will be removed when the glycerol is separated from the biodiesel. However, the biodiesel may still contain 2%-3% methanol after the separation, which may constitute as much as 40% of the excess methanol from the reaction. Most plants will recover this methanol by heating the biodiesel. Any methanol remaining after this heating process should be removed by the water washing process. Therefore, the residual alcohol level in the biodiesel should be very low. The allowable alcohol level is specified in European biodiesel standards (give number), but is not included in the ASTM standard. Tests have shown that even as little as 1% methanol in the biodiesel can lower the flashpoint of the biodiesel from 170°C to less than 40°C. Therefore, by including a flashpoint specification of 130°C, the ASTM standard limits the amount of alcohol to a very low level (<0.1%). Residual alcohol left in the biodiesel will not affect its use in the engine. The amount is too small to negatively impact the fuel's performance. However, lowering the flashpoint presents a potential safety hazard, as the fuel may need to be treated like gasoline, which also has a low flashpoint, than diesel fuel.

Most of the residual catalyst is removed with the glycerol. Like the alcohol, remaining catalyst should be removed during the water washing. Although a value for residual catalyst is not included in the ASTM standard, it will be limited by the specification on sulfated ash. Excessive ash in the fuel can lead to engine deposits and high abrasive wear levels.

Water and Sediment

Water and sediment contamination are basically housekeeping issues for biodiesel. Water can be present in two forms, either as dissolved water or as suspended water droplets. While biodiesel is generally considered to be insoluble in water, it actually takes up considerably more water than diesel fuel. Biodiesel can contain as much as 1500 ppm of dissolved water while diesel fuel usually only takes up about 50 ppm. The standards for diesel fuel (ASTM D 975) and biodiesel (ASTM D 6751) both limit the amount of water to 500 ppm. For petroleum-based diesel fuel, this actually allows a small amount of suspended water. However, biodiesel must be kept dry. This is a challenge because many diesel storage tanks have water on the bottom due to condensation. Suspended water is a problem in fuel injection equipment because it contributes to the corrosion of the closely fitting parts in the fuel injection system. Sediment may consist of suspended rust and dirt particles or it may originate from the fuel as insoluble compounds formed during fuel oxidation.

Some biodiesel users have noted that switching from petroleum-based diesel fuel to biodiesel may cause an increase in sediment that comes from deposits on the walls of fuel tanks that had previously contained diesel fuel. Because its solvent properties are different from diesel fuel, biodiesel may loosen sediments and cause fuel filter plugging during the transition period.

Storage Stability

Storage stability refers to the ability of the fuel to resist chemical changes during long-term storage. These changes usually consist of oxidation due to contact with oxygen from the air. The changes can be catalyzed by the presence of certain metals and light. If water is present, hydrolysis can also occur. The chemical changes in the fuel associated with oxidation usually produce hydroperoxides, which can, in turn, produce short chain fatty acids and aldehydes. Under the right conditions, the hydroperoxides can also polymerize. So, oxidation is usually denoted by an increase in the acid value and viscosity of the fuel. Often these changes are accompanied by a darkening of the biodiesel color from yellow to brown and the development of a "paint" smell.

When water is present, the esters can hydrolyze to long chain free fatty acids that also cause the acid value to increase.

There is currently no generally accepted method for measuring the stability of biodiesel. The techniques generally used for petroleum-based fuels, such as ASTM D 2274, have been shown to be incompatible with biodiesel. Other procedures, such as the Oil Stability Index or the Rancimat apparatus, which are widely used in the fats and oils industry, seem to be more appropriate for use with biodiesel. However, the engine industry has no experience with these tests and acceptable values are not known. Also, the validity of accelerated testing methods has not been established or correlated to actual engine problems.

Additives such as BHT and TBHQ (t-butylhydroquinone) are common in the food industry and have been found to enhance the storage stability of biodiesel. Biodiesel produced from soybean oil usually has a high level of vitamin E (tocopherol) and this acts as an antioxidant, providing considerable protection against oxidation. Any fuel that will be stored for more than 6 months, whether it is diesel fuel or biodiesel, should be treated with an antioxidant additive.

Equipment and expertise requirements for quality control

All biodiesel production facilities should be equipped with a laboratory so that the quality of the final biodiesel product can be monitored. It is also important to monitor the quality of the feedstocks.

One strategy used by many producers is to draw a sample of the oil (or alcohol) from each delivery and use that sample to produce biodiesel in the laboratory. This test can be

fairly rapid (1 or 2 hours) and can indicate whether serious problems are likely in the plant.

To monitor the completeness of the reaction according to the Total Glycerol level specified in ASTM D 6751 requires the use of a Gas Chromatograph and a skilled operator. Large producers will find that having this equipment on-site is necessary. Commercial laboratories (i.e. Williams Laboratory Services) are available that can analyze the samples but the cost is $100-$150/test and the time required may be several days. Smaller producers will need to use a more robust production process involving extra methanol and probably multiple reaction steps. Then the product quality can be monitored through periodic testing by an outside laboratory.

Measuring feedstock quality can usually be limited to acid value and water content. These are not too expensive ($500 for the acid value equipment and $5,000 for the water measurement equipment) and can be operated by less experienced technicians.

19. Making a Profit

Introduction

In making a profit in business today, businesses have to be more efficient, make a quality product, and be better than the competition. It is not as easy as cutting cost like it was in the nineties--you have to manage smarter and involve your workforce in the profit equation.

There are some basic areas I would like to cover to address how I think businesses should strive to improve in today's corporate climate. One group of governing principles is what I will call Generally Accepted Business Principles. This is only a partial list but is given to help you think about some of the more important ones.

The other area I will share with you is my Six Steps to Success. These are a collection of observed improvement areas that were arrived with working with new business startups and their successes and failures.

Use Generally Accepted Business Principles

Do your homework or research before you start your biodiesel business: You need to find out as much as you can about the biodiesel industry and what it take to manufacture biodiesel. This includes finding out the cost of construction, design, and all facets of entering the industry.

Look at the financing: Determine the cost of starting a biodiesel business or adding it onto you current business. This should include not only the cost, but also where the money is going to come from.

Understand the markets: This is one of the most important areas to address, because it will allow you to assess the profit potential of the business and what is needed to penetrate the market.

Meet all regulations and permit requirements: You must make sure you understand what the regulations apply to a biodiesel business and what permits are required. Your state and local agencies can be a good resource for this information.

Write and use a business plan: By writing a business plan you will be forced to put your whole business plan on paper and make decisions about the eleven areas that a business plan addresses. This will help to solidify your plans and find what else you might need to start your biodiesel business. Once completed, you should follow the plan like a road map and update it as your situation changes.

Do your homework or research before you start your business

This topic can be summed up in the following four bullets:

- Read about biodiesel and its processes
- Talk to the experts in the industry
- Visit someone already in the biodiesel industry and ask questions
- Understand why you want to go into this business

In your research you should receive a full understanding of biodiesel manufacturing and all the possible process variations. This will entail talking to experts in the biodiesel industry and researchers. The Internet is another source of information, but talking to the experts is a more reliable source.

Visiting someone already in the biodiesel business can be a valuable resource. You can learn from the problems they had and what they found the most difficult part of entering the biodiesel business was for them. Keep in mind that every business is different and no two are the same. Also you might run into some who will not want to share information because you will be a competitor.

Understand why you want to go into the biodiesel business. Know your motives for picking this business over another. Ask yourself the difficult question, "will it be worth the money and trouble?"

Look at the financing

Determine how much money or capital is needed to start a biodiesel business. This will take compiling all the costs associated with the project. This is the same information you will need for your business plan.

Understand the pricing structure for the biodiesel industry and the selling price of the products. This should include the current and proposed legislation on incentive and tax credits.

Spend time researching all the available resources for financing and money. This will help offset some of the financial cost of starting the business and involve the state and local community in the process.

Find a local or regional bank that funds loans to startup businesses and develop a relationship with them. You will want a bank that has some experience with commercial or value added loans. They can be a valuable resource on funding opportunities and provide you with help in developing a budget and financial statements.

Last, but not least, review the financial status of you, your group or your existing company and determine if the resources are available at this time to enter into a new business. The more solid you are financially, the easier you will be able to borrow money and the higher potential for success you can expect.

Understand the Markets

When attempting to understand the markets of biodiesel, you have to understand the local, regional, national and global market for biodiesel; determine what are the markets for the byproducts from manufacturing; how are you going to find your customers; and look at the future markets. These are the areas you have to address.

When looking at markets, make sure to investigate the local, regional, national and global markets. You might find that one or more of them are already saturated with suppliers and you may not want to try to enter that market at this time.

The marketing of your byproducts is becoming more important to making a profit in value added agriculture industries like biodiesel and ethanol. Many times the sale of byproducts makes the difference between losing money or breaking even and making a profit. Find those market for your byproducts and determine what design changes in your plant will make a byproduct that will satisfy the market.

Spend some time determining how you are going to market your products and what distribution channels you will be using. Are you going to sell to wholesalers, the end user, or both?

Take out your crystal ball and look into the future at what you expect the market to evolve to. Read about the trends and forecast for the biodiesel market and what legislative bills are on the horizon that might affect the purchasing of biodiesel.

Meet all regulations and permit requirements

The regulations and permits associated with your business could be different from state to state and in other countries. Find out what is applicable to your location and required by the local community.

You will have to involve a lawyer sometime in the business planning process. Make sure you address all the legal questions that might arise from your research. The legal and tax aspects of the type of business structure you use has to be addressed very early on.

Make sure you meet the environmental regulations of your state and local community. Consider the disposal of byproducts that you cannot sell. Make sure you obtain all the permits necessary for operations and address the regulation in the design of the plant.

Establish a dialog with your local community and state officials right in the beginning of your planning process. If you keep them informed of your plans and progress, they will be willing to help you out in areas of zoning, tax forgiveness and financing.

Write and use a Business Plan

The business plan should consist of eleven separate sections, each one beginning on a new page.

1. Request Page
2. Table of Contents
3. Executive Summary
4. Business Description
5. Management
6. Market Analysis
7. Marketing Plan
8. Product of Services
9. Manufacturing Plan
10. Financial Data
11. Supporting Documents

A business plan may be a document written to persuade a lender or lenders to provide capital for your venture. A business plan is an essential management tool for your business. A business plan may serve as the implementation plan for a strategic plan. The business plan outline in this handout applies to an entrepreneur or a businessperson seeking money for a new business startup or a business expansion.

Six Steps to Success
These are my six steps to success:

- Entrepreneurial Spirit
- Productivity
- Quality
- Management
- Innovation
- Employees

This list changes from time to time. But it represents what I think can help a business succeed from my experiences working with existing business and new business startups.

Entrepreneurial Spirit

Instill this spirit in your organization: The entrepreneurial spirit is what makes a good company great. The entrepreneurial spirit has to start at the top of the organization and trickle down to the rest of the employees. You want your management team to think like an entrepreneur.

Reward success and failures: If you expect great ideas from your management and employees, you have to reward them for successful ideas. You should also reward them

for the failures as long as they are few and they learn from the mistakes. If a person does not make a mistake or wrong decision every now and then, then they are not trying new innovative ideas or suggestions. You want to foster trying new ideas without fear of reprisals.

Everyone in your business should act as if it was their own company: Every one in your company should think of the company as if it was their own and how they would improve it if they could. They should believe that spending or wasting a dollar of company's money is like taking a dollar out of their pocket, because in the long run it is the same.

Know your limitations: Know your limitations and don't try to be everything. There will be areas where you will have to bring in expertise to help the business out or hire the skills needed to be successful.

Foster "thinking outside the box": Fostering "thinking outside the box" is another way of expressing entrepreneurial spirit. You should never hear anyone give a reason for doing a task as "we have always done it this way". They should know why the task should be done and what benefit it is to the company.

Productivity

Productivity and technology (a form of productivity improvement) are ways to improve bottom line profits. Throughput is a way of measuring profitability and productivity. Throughput is the rate at which the system generates money through sales. Another way of stating it is throughput equals the revenue from selling your product minus raw materials. In the case of biodiesel, throughput is the dollars received from the sale of biodiesel minus the cost of the raw materials. This is the money you have to pay your operating expenses including labor and what is left over is profit. This management philosophy is called constraints management or Theory of Constraints.

Minimize waste or non-value added work is a measurement of time used to make your product. Any operation that you do in order to produce your product, you should be asking the question, "Does this add value to the finished product?" Most companies find out that there is only 10% value added work used to produce a product and the other 90% is waste. This management philosophy is called Lean Manufacturing.

You should manage for productivity by using management philosophies that promote increased productivity. Many times the productivity is reduced by the management policies or beliefs of the business. Ask the question "Why?" five times when someone responds to a question on a policy or reason for doing something to get to the root reason or cause.

If you don't see improvement in the profit of the company when a suggestion is made or a change takes place, then question why you need to do it. All improvements should lead to improved "bottom line" results. Keep in mind the goal of all companies is to make money now and in the future. Ask the stakeholders if you don't believe me.

Reduction of inventory increases cash flow and throughput and maintains maximum flexibility in production.

Quality

You can insure quality in your product and manufacturing process by writing manufacturing procedures with quality in mind. Also use visual means to help the operator know if a product is within specifications or not. For example, have a vial of what the in process biodiesel product should look like every step along the way. This way the operator can compare an in process sample with the standard and have a quick initial indication that the product might be in spec.

Design quality into your biodiesel plant by making it difficult for the operator to make a mistake. One easy way to help reduce contamination is using back flow prevention devices. Another way of reducing the possibility of adding the wrong material to the manufacturing process is to color code the pipes for the raw materials.

Implement ISO 9000 procedures in you operation. Even if you don't get ISO certified, you should be compliant. This is an easy way to adopt quality procedures and processes in your company and use a method that is tried and proven and accepted in the industry.

Many times I have heard that quality is in the eyes of the customer. Whether the quality is real or perceived it makes sense to know what is the market standard and the customer is used to. Quality demanded by the customer varies by market and geographical location. Make sure you know what markets would accept the quality of your biodiesel and byproducts.

Management

Make sure the persons who fill the management roles in your company have the right skills and knowledge you are looking for. Also make sure they share the same management philosophies. Having the right person for the job is one of the most important decisions you have to make. Management can make the company run smoothly or not.

Once you have a manager in a position, continually evaluate them to see that they are meeting your need for that position. Make sure that the evaluation of them is conducted by the superiors as well as their peers and subordinates.

Keep management small and delegate responsibility downward. In many manufacturing operations today, there is only one level of management and the employees make most of their own production decisions.

Utilize the individual strengths of your management team and don't be afraid of creating job descriptions that maximize the knowledge and experiences of the managers.

Sometimes the traditional job titles will not fit the job responsibilities your management team members have.

Share the profits of the company with your management and employees. A bonus system or profit sharing is a few ways to tie performance to personal profit or pay.

Innovation

How often have we heard "don't re-invent the wheel"? I am proposing that you do re-invent the wheel, or at least see if there is a better way. Too often we do something because it has been done a certain way for as long as we can remember. Today in the competitive climate we operate in, it is the company that "re-invents a better wheel" or finds a better way to produce a product that ends up making the profit.

Don't be satisfied with current technology; always be seeking out new technology or research. Talk to the experts and find out where the technology is heading or what is on the horizon.

Devote some of your manpower and resources to developing new technology and conduct your own research. This can challenge the employee's innovative thinking and increase their understanding of the process at the same time.

Protect your technology if it is new and innovative. Patents are one means of protection and trade secrets are another.

The final suggestion under innovation is to use innovation in your management of the company. There are new innovative management philosophies being used by companies today. The traditional management style is yielding to the more participative and innovative style of management of the employees and business. Theory of Constraints, Six Sigma, Lean Manufacturing are a few management tools that innovative managers are exploring and picking the best of each to form the style that works best for them.

Employees

Under the topic of employees, I would list the following suggestions to help you succeed in today's business climate:

- Treat them fairly and consistently
- Involve them in the business decision process
- Communicate the business well-being and performance, including the finances
- Consider them a resource, not a cost
- Empower them to make decisions
- Create a win-win situation and share the profits

Most of these suggestions are self-explanatory, although few companies take advantage of them. The more you involve your employees in the business and delegate responsibility to them, the more likely they will feel a part of the company. The more they feel involved in the decision making process of the company the more they will be willing to help it succeed, especially if they can share in the profits or have a steady and rewarding job.

Communications is the key to any successful relationship with the employees. They are the most valuable resource a company can have and the return on investment in training and development them will pay off in the future.

Summary

In today's business world, we must operate a smarter business and embrace technology to be competitive on a global scale. We must use technology to our advantage, not only in the manufacturing process, but also in the whole business including management. Employees are one of our best assets.

Laboratory 1

BUSINESS PLAN DISCUSSION SHEET

The class will be divided into six groups of five. Each group will be assigned one of the following business models and will develop answers to specific questions relating to a business plan for that model. After each of the sessions listed below, the class will convene as a group and report the answers reached by each group.

1. Large soybean processor with solvent-extracted oil wants to add biodiesel to its product line.
2. Small soybean processor with expeller-extracted oil wants to add biodiesel to its product line.
3. Dead stock rendering plant wants to add biodiesel to its product line.
4. Restaurant waste processor wants to add biodiesel to its product line.
5. Purchasing oil or grease to produce biodiesel.
6. Purchasing methyl esters from suppliers and acting as a broker.

Session 1: Business Description

- Type of business entity? Proprietorship, Partnership, Corporation, Subchapter S, C Type, Coop, or LLC
- Type of biodiesel process to be used?
- Feedstock (soybean oil, recycled oil, dead stock renderings, purchased oil….)
- Type of process
- Products to be produced or sold (B20, B100, B2-5…)

Site Location considerations

- Proximity of feedstock
- Transportation issues
- Utilities
- Workforce availability
- Environmental permits
- Rural vs.uUrban issues
- Other considerations

What type of management team is required?

- Identify key personnel
- Technical expertise
- Project management
- Organizational chart
- Ownership's relationship to the operations

Session 2: Market Analysis and Plan

Market decisions

- Who are your customers?
- What is the competition?
- What is the market size and what trends are present?
- Pricing of product?
- National vs. local distribution?
- Potential byproduct markets?

Product to be produced

- Products to be produced or sold (B20, B100, B2-5…)
- Byproducts to be produced?
- Quantity or size of plant?
- Competitor considerations?
- What regulatory requirements will you need to meet?
- What customer service will you provide?
- How will you provide delivery?

Session 3: Manufacturing/Production

Manufacturing Plan

- What equipment is needed?
- Manufacturing process advantages over alternatives
- Timeline?
- Staffing
- How much inventory will be needed?
- How will you maintain quality?
- Where will you get raw material, how will you evaluate quality and how will you store it?
- Environmental issues in and around plant?

Session 4: Financial Considerations

Financial Plan

- Sources of funding (grants, loans, investors…)
- Time needed to secure finances
- Margins
- Economy of scale
- Financial considerations of raw material sources
- Financial considerations for the customer chosen

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ORGANIZATION.

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
July 2004	Subcontract	August 2002 to January 2004

4. TITLE AND SUBTITLE
Business Management for Biodiesel Producers

5a. CONTRACT NUMBER
DE-AC36-99-GO10337

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Jon Van Gerpen

5d. PROJECT NUMBER
NREL/SR-510-36242

5e. TASK NUMBER
BB044630

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Iowa State University
2207 Pearsen Hall
Ames, Iowa

8. PERFORMING ORGANIZATION REPORT NUMBER
ACO-2-31056-01

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80401-3393

10. SPONSOR/MONITOR'S ACRONYM(S)
NREL

11. SPONSORING/MONITORING AGENCY REPORT NUMBER
NREL/SR-510-36242

12. DISTRIBUTION AVAILABILITY STATEMENT
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

13. SUPPLEMENTARY NOTES
NREL Technical Monitor: K. Shaine Tyson

14. ABSTRACT *(Maximum 200 Words)*
The material in this book is intended to provide the reader with information about the biodiesel and liquid fuels industry, biodiesel start-up issues, legal and regulatory issues, and operational concerns.

15. SUBJECT TERMS
biodiesel; production; business

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
Unclassified	Unclassified	Unclassified	UL		19b. TELEPONE NUMBER (*Include area code)*

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18