



Guide for Establishing and Operating an On-Campus Biodiesel Production System

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Abstract

This guide provides practical considerations and recommendations for establishing and safely operating an on-campus biodiesel system. The guide discusses methanol storage and handling safety issues and provides a detailed list of the equipment, supplies and materials, and procedures used in the Morrisville State College "Biodiesel Production Lab." Methanol handling and use guidelines and a model safety plan are provided.



RENEWABLE ENERGY
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Contents

- Introduction
 - An overview of the Biodiesel Facility and Renewable Energy at MSC
- Suggested Biodiesel Transesterification Procedures:
 - Free Fatty Acid Titration for Base Catalyst Determination
 - Test Batch Procedure
 - 27/3 Conversion Test
- Procedural Manual for Methanol Handling in a Biodiesel Production Facility
 - Procedural Manual for Methanol Handling
 - Worker training with sample test and answer key
- Morrisville State College Site-Specific Biodiesel Safety Plan (and MSDS)
- Building a Small-Scale Biodiesel Production System: Design and Process Specifications
 - Safety Considerations in a Small Biodiesel Production Facility (codes/regulations list)
 - System Overview and Equipment & Supplies Utilized for Biodiesel Production (detailed item and price lists)

Introduction:

Global energy consumption is projected by the United States Energy Information Administration to grow by 56% between 2010 and 2040 (International Energy Outlook, 2013). The expansion of energy demand is for the most part unavoidable, given its source in the persistent growth of the human population and technological advancements made by developing countries. The inevitability of expansion presents a critical issue, however, given that many of the energy sources favored at the current time are finite resources. Fossil fuels such as coal, petroleum, and natural gas must be replaced at some point by fuels that persist indefinitely, in order to prevent mass energy shortages and affiliated issues. Renewable energy sources such as wind, solar and biomass have been suggested as replacements in this sense, and are desirable beyond simply being available indefinitely. Principally, each renewable source presents a drastic reduction in environmental toxicity when compared with current fossil fuel sources.

Implementation of renewable fuels on a large scale thus could conceivably discourage or mitigate the dangerous effects of environmental degradation characterized in recent years. Additionally, several renewable energy sources generate energy from compounds that would otherwise be considered waste. For example, organic waste such as used cooking oil (a.k.a., waste vegetable oil, or WVO) may be effectively converted to biofuels, generating useful energy and avoiding hauling and tipping fees for disposal. While a single renewable energy source will not meet the global energy demand, collectively, renewable energy sources present an environmentally responsible approach to the global energy demand. Small-scale, local efforts, including on-campus biodiesel production, will play a role in the broader effort.

In 2008, Morrisville State College (MSC) established a Renewable Energy Training Center (RETC) devoted to providing education to students and community members in the field of renewable energy

technologies. As part of the RETC program, a production facility was developed to convert waste vegetable oil from campus dining facilities to biodiesel, which could then be utilized as fuel on campus. Such a facility provided students with the unique opportunity to supplement classroom material with the development of technical skills in a “hands-on” capacity. The facility also benefited the greater campus community by transforming campus waste into fuel that could be utilized in campus machinery. The economic and environmental advantages of the system allowed Morrisville State College and its students to establish a unique position at the forefront of sustainability in renewable energy systems.

Unfortunately, operations at the Biodiesel Production Facility were suspended during the 2012-2013 school year due to safety concerns. Initial shortcomings in system design and operation were revealed in light of a fire inspection, and plans were made to begin a retrofitting of the facility during the summer of 2013. Prior to the initiation of the retrofit project, the RETC conducted extensive research regarding biodiesel facility safety standards, in hopes of discovering an operation that would serve as an acceptable model. While conducting research however, the RETC not only had difficulty in locating literature that might serve as a direct model for the facility, but also discovered that several other biodiesel facilities had also been discontinued at other universities in New York. These two facts highlighted a general lack of guidelines and knowledge regarding acceptable practices in designing and operating a biodiesel facility. While numerous sources existed pertaining to very specific aspects of a biodiesel facility, in other words, no guide or model was directly available. By consolidating research from several sources and detailing its own newly retrofitted facility, the RETC hopes to provide a document that might clearly model a safe and acceptable biodiesel facility for adaptation by other institutions and members of the public.

The *Guide for Establishing and Operating an On-Campus Biodiesel Production System* begins by addressing the basic lab procedures utilized for biodiesel production in the RETC facility. Specifically, this section provides the necessary procedures for determining the amount of base catalyst required for the transesterification reaction and the recommended test procedure for biodiesel feedstocks (e.g., waste vegetable oil). The manual then devotes specific attention to methanol and its safety concerns via the *Procedural Manual for Methanol Handling in a Biodiesel Production Facility*. This document attempts to consolidate guidelines from the Methanol Institute based on their pertinence to a biodiesel facility and includes a safety examination, solution guide, and a copy of the RETC facility safety plan, for reference. The examination and solution guide are intended to ascertain the competency of a potential facility operator in safety measures, and highlight critical emergency response information from the rest of the document. The safety plan (Appendix C of the procedural manual; separate section for this report) addresses safety in a broad sense within the facility, providing operational and evacuation protocols, NFPA Code 704 labels for all chemicals in the facility and directions to the nearest medical facility. Institutions are encouraged to mimic aspects of the safety plan in constructing their own plans, require facility operators to read the procedural manual, and require operators to pass the safety test before being allowed in the facility. The safety plan states that each biodiesel facility must have a copy of the relevant Material Safety Data Sheets (MSDS) accessible at all times. Thus, a copy of accurate MSDS for the chemicals encountered in a biodiesel facility is included in the manual, following the safety plan. The RETC strongly recommends adherence to the information expressed on the particular sheets included,

as many other MSDS found during research presented scientifically incorrect information. The final section of the guide presents information that is useful from the perspective of designing a facility. The document entitled *Safety Considerations in Small-Scale Biodiesel Production Facilities* presents research findings regarding applicable safety codes, and general information to consider when constructing a new facility. The final document/section *Equipment & Supplies Utilized for Biodiesel Production* provides an overview of the physical system an extensive list of equipment, materials and supplies. This document is intended to detail the RETC facility and provide a means of estimation in terms of scale and cost for individuals wishing to pursue construction of a similar facility. It should be noted that the RETC intends purely to demonstrate an example of a viable system in these documents. There exist a myriad of components that can be used to construct a biodiesel system and it is recommended that each facility construct its system to address its unique operational goals.

It is the hope of the RETC that this document supports the viability of constructing a biodiesel facility that complies with all recommended safety codes and provides strong benefit to both the operating institution and the environment. If further materials are desired, one is encouraged to consult Dr. Ben Ballard's personal page (<http://people.morrisville.edu/~ballarbd/>) or contact Dr. Ballard directly by email at ballarbd@morrisville.edu. Future updates to these and related documents will be posted on Dr. Ballard's personal webpage. Further information about Morrisville State College academic programs may be found via the Morrisville State College Website, www.morrisville.edu and the RETC website, at www.retc.morrisville.edu.

Works Cited:

"International Energy Outlook 2013." *United States Energy Information Administration*. United States Department of Energy, 25 July 2013. Web. 8 Aug 2013. <<http://www.eia.gov/forecasts/ieo/>>.



Suggested Laboratory Procedure for Small-Scale Biodiesel Production

Free Fatty Acid Titration for Base Catalyst Determination

Test Batch Procedure

27/3 Conversion Test

Morrisville State College

Renewable Energy Training Center

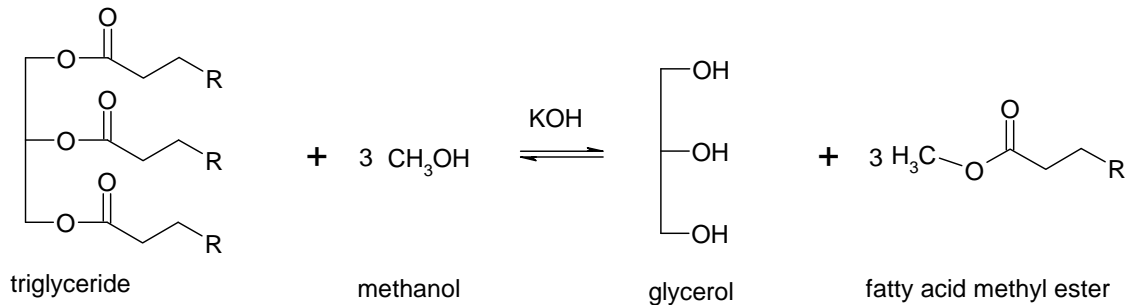
Dr. Ben Ballard, Director

Free Fatty Acid (FFA) Titration of Oil Feedstocks for Biodiesel Production

(Adapted from Walz et al. 2012)

Background:

Biodiesel fuel is made by mixing vegetable oil or animal fat (triglycerides) with methyl alcohol (a.k.a. methanol) in the presence of a basic catalyst (KOH). This produces glycerol (a byproduct) and fatty acid methyl esters (FAME, the biodiesel fuel).



(Image from Walz et al. 2012)

Basic biodiesel recipe for virgin vegetable oil

Catalyst Mixture:

5.28 g of KOH per Liter of oil (recommended by Josh Tickell, known to be too little)

6.87 g of KOH per Liter of oil (recommended by Piedmont Biofuels)

9.0 g of KOH per Liter of oil (recommended by MSC's Biofuels Lab)

9.51 g of KOH per Liter of oil (recommended by Jon Van Gerpen, known to be excess)

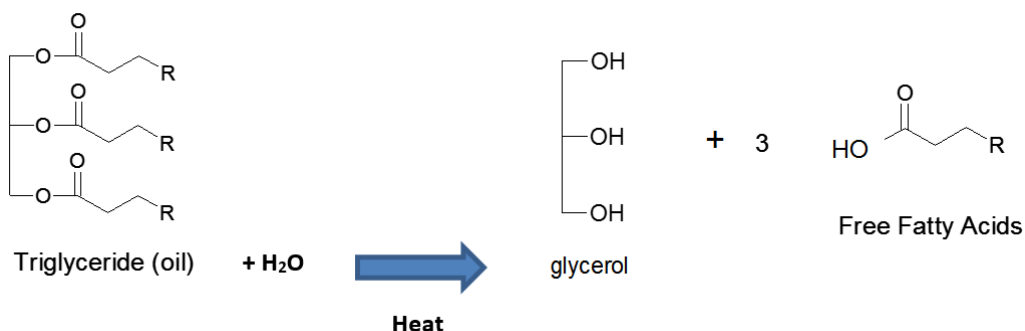
Reaction Mixture: ~1 Liter of methanol/KOH catalyst for every 5 Liters of oil (22% by volume; this is ~2× the stoichiometric quantity required)

Reaction Temp: Recommend between 55 and 60°C (methanol BP = 64.7°C)

Reaction Time: 60 to 120 min at 60°C, depending on feedstock quality (van Gerpen et al.)

Problem:

When vegetable oil is used for cooking purposes (especially for frozen foods), some of the triglyceride oil molecules break down to create free fatty acids (FFAs). The FFAs lower the pH of the oil, and unfortunately will neutralize the basic catalyst (KOH) that is normally added to speed the reaction up. Note that even raw virgin oils will have some FFAs present.



(Image from Walz et al. 2012)

Solution:

By doing a titration test before processing the feedstock into fuel, we can measure the concentration of FFAs in the used cooking oil (or other triglyceride feedstock). We will then add extra KOH to our reaction to account for the neutralization of the FFAs.

Materials:

- volumetric flask
- balance (accuracy of 0.01g)
- stir plate
- ring stand
- buret
- buret holder
- 3-ml plastic pipette
- 150-ml beakers
- graduated cylinder
- distilled H₂O
- KOH (100% purity)
- 0.10% (w/v) KOH solution
- isopropyl alcohol
- phenolphthalein (pH indicator)
- oil or fat

Procedure: Making 0.10% KOH Water Solution:

If there is no pre-mixed KOH/water solution or the old one has become too acidic, it's easy to make a new batch. To test if the batch is too old, check the pH. If it has a pH value of less than 11, it's time to make a new batch.

1. Pour 1 liter of distilled water into a volumetric flask.
2. Place the 1 liter of water into a large jar.
3. Add 1.000 gram of KOH, seal the lid, and shake until dissolved.
4. Transfer the solution to a large glass canning jar (or other suitable container) for storage.
5. Wash and rinse the jars and droppers that you used and set them out to dry.

- Procedure: Determining excess KOH catalyst required by titration
1. Fill a buret with 0.10% KOH solution and record amount of solution in buret: Start volume _____ ml.
 2. Using a graduated cylinder, measure 50 ml isopropyl alcohol (isopropanol), add to 150-ml beaker.
 3. Using a 3-ml plastic pipette, measure 5 ml of oil and mix with the 50 ml of isopropyl alcohol.
 4. Add 10 drops of phenolphthalein indicator. Note that the indicator is colorless in an acidic solution of FFAs.
 5. Using the buret, slowly add 0.10% (w/v) KOH solution, while stirring the alcohol/oil mixture.
 6. Continue to slowly add (single drops) 0.1% KOH solution until the alcohol/oil mixture turns pink and holds color for **10-15 seconds**. At this point, all of the FFA's have been neutralized by the KOH solution. Record the remaining amount of 0.1% KOH in the buret: End volume _____ ml.

7. Subtract the starting KOH solution from remaining end amount and record the volume used:

End _____ - Start _____ = _____ ml of 0.10% KOH ml used.

8. Discard the titration mixture into the approved waste jug labeled for liquid flammables.
9. Rinse your glassware and then place it in the dishwasher. Alternatively, wash your glassware in hot soapy water, then rinse thoroughly and place on a rack to dry.
10. Determine the amount of extra KOH that must be added to the methanol using the following calculations.

Analysis/Calculations:

1. **Convert** the number of milliliters used to titrate the oil into grams of KOH/L by dividing by the quantity of oil used for the titration (i.e., 5.0 ml of oil, in this case):

Example: Titration requiring 10.4 ml of titrate solution would be equivalent to:

$$\begin{aligned} \text{Titration number} &= \frac{10.4 \text{ ml of } 0.10\% \text{ KOH}}{5.0 \text{ ml oil used for titration}} \\ &= 2.1 \text{ g KOH/L } \mathbf{additional} \text{ KOH needed for biodiesel reaction} \end{aligned}$$

$$\text{Titration number} = \frac{\text{_____ ml of } 0.10\% \text{ KOH}}{5.0 \text{ ml oil used for titration}} = \text{_____ g KOH/L}$$

2. **Calculate** amount of KOH needed for reaction using the equation:

$$\mathbf{KOH \text{ for reaction}} = (9.0 \text{ g KOH/L} + \text{Titration Number}) \times \text{Liters to be reacted} = \text{Total g KOH}$$

Note: 9.0 g KOH/L is the amount of catalyst needed for a 1 Liter mini-batch with no free fatty acids present. However, most feedstocks have some FFA present, so we titrate to determine how much more KOH is needed to “neutralize” the FFAs.

Example: You have found that the oil you want to process has a *titration number* of 2.1 g KOH and you would like to use 1000 ml of oil in the reaction. The equation in this instance would be:

$$(9.0 \text{ g KOH/L} + 2.1 \text{ g KOH/L}) \times 1 \text{ L} = \mathbf{11.1 \text{ g KOH}}$$

For a 250-ml (0.25-L) “mini-batch,” you will use the following formula:

$$(9.0 \text{ g KOH/L} + \text{_____ g KOH/L}) \times 0.25 \text{ L} = \text{_____ g KOH} \text{ for a 250 ml mini-batch}$$

***For a 50-gal. (190-L) batch of biodiesel:**

$$(9.0 \text{ g KOH/L} + \text{_____ g KOH/L}) \times 190 \text{ L} = \text{_____ g KOH} \text{ for a 50-gallon batch}$$

*When making a 50-gallon batch, we recommend doing a test batch first (see procedure below) and testing for oil water content first. We also recommend using a 70:30 or 80:20 approach; i.e., complete the transesterification reaction using 70% (or 80%) of the reagents (KOH and methanol), drain the glycerol after allowing it to sit overnight, and then complete the transesterification by adding the remaining 30% (or 20%) of the reagents. While this adds time to complete a batch, the likelihood for a complete, successful conversion and quality biodiesel are well worth the additional reaction steps and time. See additional notes and recommendations in the Test Batch procedure below.

Biodiesel Test Batch or “Mini-Batch”

When using a new (or unknown quality) oil (or fat) feedstock, we highly recommend conducting a test batch of biodiesel using the procedure outlined below to avoid potential issues/failures while making a larger batch (e.g., a 50 gal. batch in the Biodiesel Production Lab). In addition to the titration procedure for Free Fatty Acids (see above), it is highly recommended that the oil feedstock be tested for water content (e.g., Karl Fisher Coulometric Titration or Sandy Brae water test kit). A quality feedstock should have <1% water content (at MSC’s Biodiesel Production Lab, we require <0.5% or 5000 ppm water). If the water content is too high, the oil should be dried before transesterification (e.g., heated to break the oil-water emulsion—water will settle to the bottom where it can be drained off—and/or to evaporate water from the oil). This will minimize the amount of soap that is made during the process and possibly avoid a complete batch failure. After washing the crude biodiesel, fuel quality testing is also recommended. At a minimum, the 3/27 test (see below) should be done on every batch produced. The commercially available pHlip test by CytoCulture International is also a useful test for biodiesel fuel.

Materials:

- warm water bath
- wide mouth pint (0.5-L) glass canning jar
- balance (accuracy of 0.01 g)
- graduated cylinder
- quart (1-L) glass canning jar
- 500-ml separatory funnel

Reagents:

- potassium hydroxide (KOH 100% purity)
- 55 ml methanol (22% by volume; 250 ml oil × 0.22 = 55 ml)
- 250 ml oil or fat

Procedure:

1. Measure approximately 250 ml of oil in a beaker or directly in a pint (0.5-L) glass canning jar, and heat in warm water bath to 60°C (140°F).
2. Calculate the **KOH for reaction** of the oil to be processed using the FFA Titration procedure: _____ g KOH/L.

$$\text{KOH for reaction} = (9.0 \text{ g KOH/L} + \text{Titration Number}) \times \text{Liters to be reacted} = \text{Total g KOH}$$

Note: 9.0 g KOH/L is the amount of catalyst needed for a 1 Liter mini-batch with no free fatty acids present. However, most feedstocks have some FFA present, so we titrate to determine how much more KOH is needed to “neutralize” the FFAs.

3. **Under Hood** - Measure 55 ml of methanol and put into a quart (1-L) glass canning jar (NOT the pint glass canning jar with your oil).
4. **Under Hood** - Weigh KOH catalyst* (#2 above) and carefully add to the methanol. Shake/swirl until the KOH is completely dissolved. *You have now created potassium methoxide**.*
 - ***Important:** Work quickly but carefully to replace cap of catalyst container. KOH will absorb moisture from air and become a solid block if allowed to sit in open container.

- ****Important:** Potassium methoxide is extremely corrosive. Always use care when handling methoxide—wear gloves, apron, and goggles/face shield—and **always handle it under the fume hood.**
5. Once oil has reached 60°C (140°F), carefully remove pint (0.5-L) glass canning jar from water bath and place it under the fume hood next to the methoxide jar. Add methoxide to the oil and tightly replace lid of both jars.
 6. Vigorously shake the pint glass canning jar for 60 seconds (the mixture will be cloudy initially and then begin to clear as the methoxide dissolves into the oil) and then place back into warm water bath for 15 minutes.
 7. Remove jar from water bath after 15 minutes. Some glycerol should already be settling out at this point. Shake for an additional 60 seconds. Then place it back into warm water bath for an additional 15 minutes.
 8. Remove jar from water bath after 15 minutes (30 minutes total) and place it in the fume hood.
 9. **Under Hood** – using a funnel, transfer contents of the glass canning jar into a 500-ml separatory funnel, screw on the cap, and let sit overnight.
 10. You should see a separation line between biodiesel and glycerin begin to form within 15-30 minutes of transferring to the separatory funnel if you have good conversion. The following day you can drain the glycerin off the bottom.
 11. Clean up all of you lab glassware: Rinse your glassware and then place it in the dishwasher. Alternatively, wash your glassware in HOT, soapy water, then rinse thoroughly and place on a rack to dry.

27/3 Conversion Test (a.k.a. 3/27)

Explanation:

The 27/3 test can be used as a qualitative assessment of conversion. Due to the insolubility of triglycerides in methanol, any unconverted triglycerides will not be miscible in methanol and thus will precipitate to the bottom of the centrifuge tube. In general, if no precipitate is seen at the bottom of the tube the fuel being tested has been well converted.

Materials:

50-ml centrifuge tube
3-ml disposable pipette with 0.5 ml graduations

Reagents:

- methanol
- biodiesel (methyl esters)

Procedure:

1. Add 3 ml of biodiesel to centrifuge tube.
2. Measure 27 ml of methanol and pour into centrifuge tube (top off at 30 ml mark).
3. Securely place cap on centrifuge tube and invert 2-3 times. **Do not shake.**
4. Hold centrifuge tube up to light source and watch for falling droplets.
5. If possible, place centrifuge in refrigerator.
6. Allow mixture to settle for 10-15 minutes.
7. Inspect tip of centrifuge tube for precipitate.

Analysis:

If no precipitate is visible upon inspection, the fuel has been well converted.

If precipitate is observed, conversion has not been taken to completion.

References/Sources:

Walz, K. et al. 2012. Lab Manual 10-468-122: Introduction to Biodiesel Fuel. Madison Area Technical College. Version 6.0, May 2012.

Van Gerpen et al. 2006. Building a Successful Biodiesel Business: Technology Considerations, Developing the Business, Analytical Methodologies (2nd ed.). Biodiesel Basics (publisher). 277p.



Procedural Manual for Methanol Handling in a Biodiesel Production Facility

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Table of Contents:

INTRODUCTION	1
OVERVIEW OF METHANOL: PROPERTIES AND USE	1
PHYSICAL PROPERTIES OF METHANOL	1
METHANOL USES	1
GENERAL SAFETY CONCERNS	2
GENERAL SAFETY GUIDELINES FOR BIODIESEL PRODUCTION	3
INDIVIDUAL GUIDELINES FOR METHANOL HANDLING	3
INSTITUTION GUIDELINES FOR PURCHASES AND FACILITY SAFETY	4
TANK SYSTEM SAFETY:	5
SAFETY REVIEW PRIOR TO START UP OR FOLLOWING SYSTEM ALTERATIONS	6
RECOMMENDED STEPS IN THE EVENT OF A SPILL	6
METHANOL SPILL KIT CONTENTS	8
METHANOL FIRES	8
FIRST RESPONDER’S SAFETY EQUIPMENT	9
REPORTING AND LEGAL CONSEQUENCES	10
WORKS REFERENCED	11
APPENDIX A: METHANOL HANDLING SAFETY EXAMINATION	A-1
APPENDIX B: METHANOL HANDLING SAFETY EXAMINATION- ANSWER KEY (available upon request)	B-1
APPENDIX C: SAFETY PLAN FOR BIODIESEL PRODUCTION	C-1

Introduction

This document is intended as a compilation of guidelines pertaining to methanol handling and safety, specifically within the context of a small biodiesel production facility. These guidelines have been carefully adopted and summarized from the Methanol Institute's *Methanol Safe Handling Manual* and various other qualified sources, which are fully cited in the *Works Referenced* section of the document. Also included in the document is a specific methanol safety plan compiled for our facility at Morrisville State College, which we expect will provide a useful example of how the guidelines discussed may ultimately be utilized. It is our expectation that this document will both provide a resource for the construction of a facility similar to our own, and serve as an integral training component for individuals working in such an operation. Questions regarding the material in this document may be directed to Dr. Ben Ballard, Director of the Renewable Energy Training Center at Morrisville State College. Dr. Ballard may be reached via email at ballarbd@morrisville.edu or by phone at (315)-684-6780.

Overview of Methanol: Properties and Use

Physical Properties of Methanol

Methanol (CH₃OH) is an organic alcohol that exists as a colorless liquid at standard ambient temperature and pressure (approximately 25°C and 1 atmosphere of pressure). The compound is considered to be polar (given the presence of the R-OH organic functional group) and is 100% miscible in water, two extremely important qualities that govern many of its interactions with other chemicals and the environment. Furthermore, these qualities allow methanol to be an ideal solvent in many cases, and influence the intermolecular forces defining the boiling and freezing points for the compound. A brief table outlining several important physical properties of pure methanol appears in below.

Table 1. Selected Physical Properties of Methanol

Structure	Freezing Point	Boiling Point	Molecular Mass	Specific Gravity	Vapor Pressure
CH ₃ OH	-97.6°C (-143.7°F)	64.6°C (148.3°F)	32.04 g/mol	0.7915 (at 20°C)	12.8 kPa (at 20°C)

Source: The Methanol Institute

Methanol Uses

Methanol is extraordinarily useful in a wide variety of applications. Industrially, the compound is used as a solvent and as a starting point for the chemical synthesis of important compounds such as acetic acid and formaldehyde. In wastewater management, methanol is often utilized in denitrification processes, where nitrates in the wastewater effluent are reacted with methanol to form gaseous nitrogen. After the reaction, the gaseous nitrogen is allowed to escape to the atmosphere, which is desirable because it limits the amount of nitrogen available to plants (such as algae). Limiting available nitrogen in this way reduces eutrophication of water bodies and mitigates other adverse environmental impacts. Additionally, the practice limits the uptake of oxygen from the effluent, which allows the effluent to retain sufficient oxygen to support aquatic animal life and preserve ecology. Finally, methanol is of use in fuel blends, as an

additive to gasoline, and in the production of fuels such as biodiesel. In the latter case, methanol is combined with lye (NaOH or KOH) to form methoxide, an extraordinarily strong base that catalyzes the production of esters (biodiesel) and waste glycerol from fat molecules. The biodiesel product has qualities similar to diesel fuel and is highly desirable given its production from substances normally considered to be waste or renewable in nature.

General Safety Concerns

The Methanol Institute defines five overarching considerations integral to methanol handling, as summarized below.

1. Methanol is both flammable and easily ignited. It burns and may explode in air.
2. Methanol possesses a slightly greater molecular weight than that of air (32 g/mol as compared to 28 g/mol). Thus liquid will pool and vapor may collect near the ground, in confined spaces, and/or in low-lying areas. Methanol will dissipate readily from ventilated locations, but should not be expected to dissipate from enclosed or non-ventilated spaces. Finally, ignited vapor can flash back to its source.
3. Certain circumstances may result in methanol vapor exploding, rather than burning upon ignition.
4. Methanol is a toxin and may cause death in quantities as small as one to two ounces (30 to 60 milliliters), with lesser amounts potentially causing irreversible blindness. Thus, methanol should not be swallowed or breathed in. Additionally, methanol may be absorbed through the skin and other tissues, directly into the bloodstream. It is thus important that vapor or liquid not be permitted to contact an individual's skin under any circumstances.
5. Methanol is totally miscible in water and is flammable even in dilute mixtures (75% water to 25% methanol remains flammable for example). This, coupled with the fact that methanol is a chemical solvent, informs distinct firefighting procedures that must be followed when dealing with methanol.

These five considerations will be closely examined in the following sections, which detail the complexities and required safety procedures for the multiple subsections of a biodiesel production facility. While information is aggregated by pertinence to each aspect or "phase" of production (individual handling, facility management, fire safety, legal, etc...), it is important to recognize that each individual involved in production should be familiar with all elements of the system, even if some of these elements do not directly pertain to the designated tasks of that individual. In other words, while an employee may not be required to participate in legal matters regarding the facility, the employee must still consider the legal guidelines expressed within this document to gain a broad understanding of production and all its elements. Likewise, individuals involved in managing the facility should not neglect to study the safety concerns for methanol handling, even if they will not be directly handling the substance in the facility. Cases may arise in which these individuals must assist other employees who directly handle methanol, or find themselves unintentionally in a situation where they must handle methanol. If all members involved in production are fluent in the safety guidelines outlined in this document, the propensity for accidents across all elements of production is greatly diminished.

General Safety Guidelines for Biodiesel Production

The following guidelines begin to consolidate the aforementioned broad suggestions pertaining to methanol into slightly more specific guidelines for methanol use in the context of biodiesel production.

- Methanol must be stored in a dedicated location protected from heat and other ignition sources. Any electrical systems in proximity to the storage area should be both fully enclosed and explosion proof.
- Methanol should be stored in a sealed container to discourage the absorption of moisture. One should ensure that the container has an allowance for thermal expansion, so that temperature changes do not result in the methanol expanding to rupture the container.
- Store methanol in a bermed, diked or bounded, well-ventilated area capable of containing considerably more than 110% of the volume of the largest methanol storage tank in the area. Note that National Fire Protection Association (NFPA) codes stipulate 110% as an absolute minimum in this regard (NFPA 30 [45]). These considerations protect against what is called a “running fire”.
- If a leak occurs, the methanol pool that results should be completely covered with alcohol-resistant foam. If the storage area is adequately sized (see above), a leak may be also safely diluted- by at least 4 parts water to 1 part methanol.
- When preheating the vegetable oil in the biodiesel production reaction, exercise extreme caution to prevent oil splattering and accidental ignition when adding the reactants (a closed/sealed system for dispensing reagents is recommended).
- Exercise caution when handling methanol, adding hydroxide, mixing hydroxide/methanol and introducing methoxide during the experiment (a closed/sealed system for dispensing reagents is recommended).
- Ensure that the temperature during the reaction does not rise too high, and that agitation is not excessive. Control in these areas limits the possibility of fire and/or explosion. One should be careful in this regard, however, because too low a temperature and rate of agitation will result in the transesterification reaction not going to completion.
- Use a closed reactor, if possible, to reduce the possibility of spills.
- Do not operate any personal electronic item (such as a cell phone or laptop) near the system involving methanol. Sparks generated by these devices can ignite methanol vapor.

Individual Guidelines for Methanol Handling

These guidelines address specific concerns relevant to individuals who will be directly handling methanol in the biodiesel production facility. The guidelines address methods of methanol absorption, protective measures, and pertinent protocols for emergency response.

- Note that methanol may enter the body via inhalation, absorption through the skin, as a result of eye contact, or due to ingestion by eating/drinking.
- Always utilize both skin and eye protection when handling methanol. Utilize safety glasses with side shields or goggles, as well as task appropriate gloves. Additional protection may be needed in some cases.

- Wear chemical resistant clothing or materials (such as rubber boots, gloves etc.) if repeated/prolonged contact with methanol is expected.
- If an individual inhales methanol vapor, remove the individual to fresh air and monitor them for respiratory conditions. Administer CPR or artificial respiration if the individual stops breathing and seek medical attention immediately.
- If an individual's skin comes into contact with methanol, use the emergency eyewash or safety shower to flush the affected area for 15 minutes. Wash with soap and water and seek medical attention if further symptoms of toxicity develop or irritation/pain persists.
- If eye contact with methanol occurs, use the eye wash for at least 15 minutes while holding the eyelid open. Obtain immediate medical attention.
- In the case of ingestion, do not induce vomiting. Get medical attention immediately and ensure the individual remains under close medical care for several days.

Institution Guidelines for Purchases and Facility Safety

These guidelines address safety measures and important considerations that pertain to the management of a biodiesel production facility. Specifically, the guidelines inform required facility rules, equipment standards, design specifications, accessible items required in the case of spills/fire, and process overview suggestions in a managerial context.

- Purchase methanol exclusively from reputable sources. A useful tool to ensure this may be found on the Methanol Institute's website, www.methanol.org, under the "Methanol Source Request" link.
- Consult chemical suppliers concerning the intended use of purchased methanol and the conditions for such use. Consultation should precede any contract commitments.
- Establish and train a local response team to assist in case a spill occurs during the receipt of purchased methanol, its storage, or its transport within the system.
- Store methanol in a dedicated area and clearly label the area as hazardous.
- Ensure appropriate safety measures are available to any individuals working in the area. Ensure that measures to protect against spillage, exposure and ignition are in place as well.
- Install an effective, clearly audible alarm to summon assistance if required.
- Use positive materials identification for gaskets, filters, hose materials, and any similar items.
- Develop and implement procedures to ground the production apparatus, and verify grounding periodically. All equipment near and potentially within the range of methanol vapor must also be grounded. This includes lighting systems, pipe racks, pumps, hoses, and other equipment.
- Bonding (connecting ungrounded objects to grounded objects) should be used to dissipate static electricity when pouring methanol or engaging in other transfer operations.
- Develop and implement procedures to discourage water uptake and water accumulation in the system.
- Replace items such as gaskets, hoses and "O" rings periodically; well before they are expected to fail.
- Ensure that spilled methanol will not enter drains, confined spaces, manholes, aquifers, or the water table.
- Make an eye wash and a shower station accessible to all individuals in the facility.

- Ensure that procedures and equipment are in place for leak detection and any corresponding alarms, onsite emergency response, and offsite emergency response. This may require specialized equipment.
- Pump (rather than pour) methanol whenever possible within the system.
- Ventilation should be considered on a site-specific basis, given the myriad of factors that influence it. However, one should note that all ventilation systems, regardless of location, must prohibit methanol concentrations from reaching or exceeding 200 ppm. This may be possible with natural ventilation but, if mechanical ventilation is required, ensure that spark-proof fans are used. Account for the possibility of leaks when determining ventilation requirements.
- Employ devices to measure gas concentration (electronic monitors or gas detection tubes), as methanol can only be detected by the human sense of smell at lethal concentrations.
- Smoking on the premises is dangerous and must be prohibited.
- Vehicle access to the premises must be strictly controlled.
- Positive pressure may be required in control areas, switch rooms, or smoking rooms (methanol-free areas).
- Storage tank vents leading to the atmosphere should be correctly sized to allow for fire-heated emergency vapor release.
- Use Alcohol-Resistant Film-Forming Foam (AR-AFFF) with a 6% foam proportion (to water) in the event of a methanol fire.
- Make a variety of dry chemical extinguishers available for use on small fires.
- Strategically position hydrants and adequate hoses around the facility.
- Overall, the Methanol Institute Recommends that small spills “should be remediated with sand, earth, or other non-combustible materials, and then the area flushed with water.” Larger spills, in contrast, should be “diluted with water and diked for later disposal.”
- Instances of “hot work” around methanol vapor or storage containers are dangerous and should be carefully monitored. This includes welding, brazing, soldering, cutting, heat treating, grinding, and using power-accentuated tools- among other processes. Implement systems such as prior work authorization and a fire watch, in addition to encouraging safe welding practices, to mitigate the potential for fire.
- Use non-sparking tools if possible.
- For small volume storage tanks, such as those likely present in a biodiesel facility, a “no ignition zone” of 50 feet (minimum) should be enacted around the tank.
- Any radios, telephones, portable instrumentation, computers, calculators, and other electronic equipment should have explosion-proof ratings.
- If a tanker truck or storage tank is involved in a fire, evacuate all individuals to a radius of half (1/2) a mile from the site.
- Visually inspect the system for leaks and spills at least once per shift. Test the condition of tanks, valves, pipes, hoses, dikes, and all safety/fire prevention equipment on a regular basis.

Tank System Safety:

- Large volumes of methanol should be stored with internal floating roof tanks.

- Either pad the vapor space of the tank with an inert gas or equip the tank vents with flame arresters. If using flame arresters note that arresters made from aluminum alloys will be corroded by methanol and thus should not be used. If using an inert gas, dry nitrogen is preferred (do not use CO₂ as this will corrode the tank and increase the acidity of methanol).
- Paint outside tanks with heat reflective paint.
- Control the internal pressure in the tank with pressure relief/vacuum breaker valves. Note that vents ideally should be configured with flame arresters. Pressure relief valves should be sized to a fire case and ideally should be piped to relieve into a flare header.
- If the pressure system described above is configured to relieve to the atmosphere, Process Safety Valves (PSVs) should be configured to breathe through flame arresters.
- Do not use overflow pipes.

Safety Review Prior to Start Up or Following System Alterations

Guidelines in this category specifically refer to steps that should be taken by facility managers prior to initial system start up or system restart following any alterations.

- Prior to resuming work verify all construction tasks are complete and construction activity has ceased.
- Verify that all equipment is in accordance with design specifications.
- Update all process safety information and inform individuals involved in the facility of these changes.
- Review all safety, operating, maintenance, and emergency procedures to ensure that they are adequate.
- Conduct a process hazards review, taking into account system modifications. Make any necessary changes in accordance with review findings.
- Satisfy any requirements for management of changes preformed.
- Train individuals working in the facility with regard to any new procedures or changes to current procedures.
- Maintain a written record of changes to the system and actions taken following these changes (to train individuals, etc.).
- Contact local first responders with a safety plan for the facility and actively seek feedback on the plan. Ensure that any emergency protocols are in place and understood by the first responders.
- Conduct audits of the facility at least every three years. Retain and archive these reports.

Recommended Steps in the Event of a Spill

Despite even the most rigorous safety considerations, the possibility for an accident exists in all operations. The following guidelines govern protocol in the event of a methanol spill within a biodiesel production facility.

- Keep methanol from entering sewers, drains or other confined areas.
- Do not allow methanol to enter rivers, streams or other bodies of water.
- Move any leaking containers to an isolated area outdoors or an isolated, well-ventilated area indoors. Contain the spill in that location.

- Only collect liquid with explosion-proof pumps, grounded and bonded containers, and spark resistant tools.
- Surround spills on the ground with mechanical or chemical barriers. These could include sand, vermiculite, zeolite, or absorbent dikes.
- In small spills, cat litter may be used as an effective absorbent.
- Do not allow methanol vapor to flow into confined spaces such as sumps, manholes, and utility tunnels. The vapor may settle and reach flammable concentrations under such conditions. If vapor is suspected to have entered these spaces, check for explosive atmospheres prior to re-entry.
- AR-AFFF (alcohol-resistant aqueous film-forming foam) may be applied to a spill for vapor suppression.
- If methanol is spilled indoors, ventilation should occur to reduce vapor concentration to <200ppm before individuals are allowed back into the building.
- Ignition sources should be removed to 100-200 meters from the spill area.
- If a spill occurs outdoors, isolate the area 100-200 meters in radius from the spill site and stay upwind of the release plume. Expand the area to 800 meters if a tanker truck or rail car is involved.
- Diversion channels or pathways may be needed in the event of a pipeline spill, to direct methanol as desired.
- Methanol lost to natural bodies of water cannot practically be recovered.
- Only individuals trained under OSHA Hazardous Waste Operations and Emergency Response protocol, contained in section 1910.120 (HAZWOPER) of Title 29 of the Code of Federal Regulations, may participate in spill control and cleanup operations.
 - For large spills (where explosive concentrations are assumed), “Level A” protective clothing must be worn and supplied-air respiratory protection must be provided.
 - For smaller spills “Level B” protective clothing may be used, with supplied-air respiratory protection also provided.
- The goal of remediation should be to recover as much pure methanol and methanol-saturated absorbent materials as possible. This allows reuse and treatment to recover methanol.
- Confirm the compatibility of all radios utilized in the recovery process, as well as the safety of such devices (and the explosive proof nature of any cellular phones utilized).

The Methanol Institute recommends the following steps to mitigate issues in the event of methanol spillage.

1. Stop or reduce the rate of methanol release from its container. Proceed with this step only in the event that it can be completed safely.
2. Evacuate the premises if noxious vapors are present. Sound a vapor release alarm and notify a supervisor or emergency coordinator.
3. Remove all sources of ignition to a safe “standoff” distance from the point of methanol release and any pools of methanol that have formed.
4. Evacuate any individual without proper protective equipment and forbid reentry until the area is remediated.
5. Do not walk through any spilled methanol pools. Avoid skin contact or inhalation.

6. Remain upwind of the facility and avoid any low lying areas that may have accumulated methanol vapor.
7. Immediately call the fire department in the event of a large spill or fire.

Note that site control zones should be specified in the event of a spill. Zones may be defined most readily by a method employing three concentric circles. The smallest of these zones, the Exclusion Zone (EZ) consists of the “hot zone”, within which the spill is contained. The second zone, deemed the Containment Reduction Zone (CRZ), should contain a single point of entry and exit to the EZ and a decontamination corridor for the individuals and machines used in the hot zone. Finally, the outermost Support Zone (SZ) should be used to contain response equipment, and a communications center. It should be noted that the EZ and CRZ must be restricted to authorized personnel only.

Methanol Spill Kit Contents

Each biodiesel production facility must have methanol spill kits accessible to employees in the event of an accidental methanol spill. The number of kits present in a given facility will depend largely upon the size of the facility, but it should be noted that erring on the side of having too many kits is preferred over erring in having too few kits. Kit locations should be clearly labeled and the kits themselves should be easily accessible from all areas of the facility. Kits should include:

- Multiple types and sizes of sorbent materials. These may include vermiculite or activated carbon, and sorbent pads.
- A plastic, non-sparking shovel to facilitate the distribution of sorbent materials.
- Yellow caution tape or some other barrier to isolate any spill areas.
- A drum or container to hold any collected waste materials
- Emergency communication devices (explosion-proof mobile phones or two-way radios).

Methanol Fires

Despite all protective measures, the possibility of a methanol fire must always be considered in biodiesel production facilities. The following guidelines, suggestions, and protocols attempt to ensure that in the unfortunate event of such a fire, property damage and human injury are minimized.

In general, all fires (regardless of type) share the important tendency to begin small and then grow larger as time progresses. Thus, regardless of the type of fire encountered, it is vital that fire protection measures attempt to contain, control, and extinguish the fire while it is still small- rather than waiting until a later point in time. In order for response to occur in this manner, it is integral that any plan for fire response contain provisions emphasizing early detection of the fire, immediate response to the outbreak of fire, and appropriate action in these responses.

While all fire response plans should contain these general provisions, it is important to realize that many of the specific details present in plans for methanol will be considerably different from plans for more common gasoline, diesel, and jet fuel fires. These differences occur because methanol fires have

substantially different characteristics than “common fires” do. A brief list of these differences is summarized as follows:

- Methanol fires produce less heat than “common” fires.
- Methanol fires transfer less heat to the surroundings than “common fires”. Thus flames in a methanol fire are non-luminous.
- Methanol fires are very difficult to see, as flames are nearly invisible to the naked eye in daylight and smoke evolution is extremely limited.
- Methanol fires can be ignited even in unexpected circumstances. This occurs because flammability limits are 6 vol% to 36 vol% in air for methanol.
- Methanol fires are extremely difficult to extinguish with water.
- Methanol fires may continue to burn with up to 75 vol% water (i.e., 25% methanol, 75% water).

Thus, several unique procedures with regard to methanol fires must be considered to account for these differences. A summary of important changes is as follows:

- Either vapor detection or thermal imaging must be used to locate the source of methanol fires.
- Small fires may be approached with handheld extinguishers. Thermal imaging should be used, however, so that the fire may be precisely located and its characteristics deduced. In absence of imaging equipment, individuals may approach the fire too closely and be injured.
- Use only high temperature, alcohol compatible foam to fight methanol fires, specifically alcohol-resistant aqueous film-forming foam (AR-AFFF). Apply the foam from a substantial distance and continue to apply the foam long after the fire appears to be out (to prevent the fire from restarting). Note that foam must be alcohol compatible (AR-AFFF) or it will not function.
- Water may be used only on small methanol fires, and only in the form of a fog or fire droplet water spray. There must also be sufficient space to increase the volume of the methanol-water solution by four (the mixture should be, at minimum, *4 parts water to 1 part methanol*). If such space is not present, the water may cause the fire to spread and generate additional damage.
- Plastics and synthetic fabrics may soften or rapidly degrade when they contact methanol. On account of this, the use of such materials in fire response should be carefully considered and corrected for.
- It is important to note that using SCBA breathing equipment with a conventional turnout does not protect against methanol. One must rather use SCBA with a level “B” chemical resistant suit.

First Responder’s Safety Equipment

As noted, first responders must possess specialized equipment and training to properly combat fires involving methanol. The following list details many of these unique items. However, one must note that such a list is not necessarily exhaustive. Dialogue with first responders must occur prior to operation of any facility involving methanol, such that a complete list of required materials may be evolved in accordance with the fire safety and spill protocols detailed above.

- Chemical splash goggles and face shields.
- Butyl or nitrile gloves.

- Rubber boots.
- Thermal Imaging Equipment.
- Chemical-resistant coveralls.
- An apparatus for supplying breathing air (required). Do not use air-purifying respirators with organic vapor cartridges.
- Multiple fire extinguishers (note that AR-AFFF is integral to any operation).
- Industrial first aid kits.
- Full body showers and eye-wash stations should be accessible to any contaminated personnel. Note that these stations should be capable of delivering fifteen minutes of continuous water.
- Portable water for washing and drinking.
- An emergency transport vehicle.

Reporting and Legal Consequences

In the case of any fire or methanol spill of sufficient size, federal, state, and local regulations may apply regarding reporting and/or legal consequences. These guidelines should be considered along with any additional requirements from site-specific operating entities, to ensure that proper protocols are followed and recovery is made possible.

- As required by the United States Emergency Planning and Community Right-To-Know Act (EPCRA), immediate notification of a spill to the Federal National Response Center, the State Emergency Response Commissions, and the Local Emergency Planning Committees is required if **over 755 gallons** of methanol are spilled (5000 pounds, 2858 liters).
- An investigation should be conducted so that causes of release may be identified and the response effort improved.
- Legal fines, penalties, or requests for additional documentation may result- depending on the severity of the spill.
- In the event of even a small spill, the on-site Emergency Response Coordinator (ERC) possesses primary responsibility. This individual should ensure that correct protocols are followed including the implementation of corrective measures, notification of authorities, and completion of follow up reports. Any spills, fires, injuries, illnesses, and property damage must be reported to the ERC.
 - If outside responders are required, the ERC should transfer command to the lead agency's Incident Command (IC), who will then direct response.

Works Referenced

- "Methanol." *Chemicals in the Environment*. U.S. Environmental Protection Agency, Aug. 1994. Web. 18 June 2013. <http://www.epa.gov/chemfact/f_methan.txt>.
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- "Methanol Safe Handling Manual." *The Methanol Institute*. The Methanol Institute, 2011. Web. 18 June 2013. <<http://methanol.org/Health-And-Safety/Safety-Resources/Health---Safety/Methanol-Safe-Handling-Manual-English.aspx>>.
- "Physical Properties of Pure Methanol." *The Methanol Institute*. The Methanol Institute, 2011. Web. 18 June 2013. <<http://www.methanol.org/Technical-Information/Resources/Technical-Information/Physical-Properties-of-Pure-Methanol.aspx>>.

Appendix A: Methanol Handling Safety Examination

The following examination provides an opportunity for individuals involved in a biodiesel production facility to evaluate their knowledge of safety protocols, particularly as they pertain to methanol handling and emergency response. It is recommended that all individuals involved in the facility (including those who work directly with methanol and those who are in managerial positions) complete the examination prior to their involvement in production. Additionally, it is highly recommended that all first responders and emergency personnel also complete the examination following the completion of their training in methanol spill/fire response protocols. This examination contains 20 questions sourced from the material expressed in the preceding *Procedural Manual for Methanol Handling in a Biodiesel Production Facility*, and is intended to be completed within 30 minutes. Given the critical nature of the material covered in the examination, only a score of 18 (90%) or higher shall be considered adequate or “passing”. In the event that an individual does not achieve such a score, further study and re-evaluation is recommended prior to involvement in biodiesel production (to ensure facility and personal safety). An answer key with explanations may be found in Appendix B of this document.

Answer key (Appendix B) is available by request: contact Dr. Ben Ballard at ballarbd@morrisville.edu

Name: _____

Date: ____/____/____

METHANOL HANDLING SAFETY EXAMINATION

Directions: For each of the 20 questions that follow, choose the letter (A-D) corresponding to the most correct answer choice.

Exam Time: 30 Minutes

Required Score: 18/20 (90%)

- 1) Methanol is considered to be a/an _____ compound.
 - a) Ionic
 - b) Nonpolar
 - c) Polar
 - d) Organometallic

- 2) Which of the following is NOT true regarding methanol?
 - a) Methanol may burn in air but cannot burn in water.
 - b) Methanol is easily ignited.
 - c) Methanol may explode in air.
 - d) Ignited methanol vapor may “flash back” to its source.

- 3) Select the terms that best complete the following statement: *Methanol vapor is _____ than air and will collect near the _____ if unventilated.*
 - a) heavier; ceiling
 - b) heavier; floor
 - c) lighter; ceiling
 - d) lighter; floor

- 4) Which is true concerning the toxicity of methanol?
 - a) While ingestion is not recommended, methanol is a relatively non-toxic compound.
 - b) If 20 ounces (about 600 milliliters) of methanol are ingested, temporary blindness will likely result.
 - c) If 20 ounces (about 600 milliliters) of methanol are ingested, permanent blindness will likely result.
 - d) If 20 ounces (about 600 milliliters) of methanol is ingested, death will likely result.

- 5) Which of the following statements is true regarding methanol absorption?
 - a) Methanol absorption is possible via breathing vapor, skin contact and eye contact.
 - b) Methanol absorption is possible via breathing vapor or skin contact. Eye contact is relatively safe.
 - c) Methanol absorption is possible via breathing vapor or eye contact. Skin contact is relatively safe.
 - d) Methanol absorption is only possible via swallowing the compound. Breathing vapor, eye contact, and skin contact are relatively safe.

- 6) Select the terms that best complete the following statement: *Methanol is _____ in water and generally _____ in water as well.*
 - a) miscible; flammable
 - b) miscible; not flammable
 - c) not miscible; flammable
 - d) not miscible; not flammable

- 7) Select the choice that correctly identifies all of the items below that are NOT safe to operate near methanol.
- I. Explosion-Proof Radio II. Cell Phone III. Computer
IV. Conventional Electric Wiring V. Spark Proof Fans
- a) All of the above (I-V)
b) II, III, and IV
c) I, IV, and V
d) III and IV
- 8) Select the choice below that correctly identifies all the REQUIRED safety equipment for working with methanol under casual conditions (a rather brief timeframe and low vapor concentration)
- I. Standard Safety Glasses II. Safety Glasses with Side Shields (or Goggles) III. Appropriate Gloves
- a) I
b) II
c) I, III
d) II, III
- 9) Which of the following situations reflects INCORRECT safety protocol?
- a) An individual inhales methanol vapor. They are removed to fresh air and monitored closely. If the individual stops breathing, CPR or artificial respiration is performed and medical attention is sought.
- b) An individual's skin comes into contact with methanol. Soap and water are immediately used to wash the area in the safety shower/eyewash station for 15 minutes. Medical attention is sought if irritation or pain persists.
- c) An individual's eye comes into contact with methanol. The eyewash is used for 15 minutes while holding the eyelid open. Immediate medical attention is sought.
- d) An individual ingests methanol. Vomiting is immediately induced and the individual is given water to drink before returning to work. If the individual feels ill, medical attention is sought.
- 10) Which of the following statements concerning methanol ventilation is FALSE?
- a) Methanol vapor will avoid confined spaces and low lying areas.
b) In some instances, a mechanical system may be required to disperse methanol.
c) Spark-proof fans should be used in any mechanical ventilation system.
d) It is best to employ devices measuring methanol concentration, to ensure safety in biodiesel facilities.
- 11) Which protocol(s) are recommended when dealing with a leaking methanol container?
- I. Removal of the container to an isolated area outdoors or to an isolated, well-ventilated area indoors
II. Dilution of any spilled methanol with an equal volume of water
III. Removal of all ignition sources near the container to a safe "standoff distance"
- a) III only
b) I and II
c) I and III
d) II and III
- 12) Which of the following should be placed in a methanol spill kit?
- a) Multiple types and sizes of sorbent materials.
b) Organic vapor cartridges for breathing assistance
c) Water for extinguishing large methanol spills
d) All of the above

- 13) Which of the following practices is/are considered dangerous in a facility containing methanol?
- Smoking
 - Welding
 - Both a and b
 - Neither a nor b
- 14) Methanol fires are characterized by which of the following (I-IV)?
- | | |
|---|-----------------------------|
| I. Production of less heat than “common fires” | II. Luminous flames |
| III. Ability to be easily extinguished by water | IV. Limited smoke evolution |
- I and II
 - I only
 - II and III
 - I and IV
- 15) Assume you are provided with four methanol-water mixtures, corresponding to the answer choices listed below. Select the mixture with the highest percent water (by volume) that remains flammable.
- 25% water (by volume)
 - 50% water (by volume)
 - 75% water (by volume)
 - 85% water (by volume)
- 16) Due to the flammability of methanol and water mixtures, safety protocols recommend dilution to a minimum of ____ parts water to 1 part methanol when extinguishing a fire.
- 1
 - 2
 - 4
 - 5
- 17) Select the choice that best completes the following statement: ____ *should be applied to large methanol fires.*
- Alcohol-Resistant Aqueous Film-Forming Foam (AR-AFFF)
 - Water
 - Standard Aqueous Film-Forming Foam (AFFF)
 - a and b
- 18) Training in methanol safety protocols and development of a site-specific safety plan should involve which of the following groups of individuals?
- Facility employees
 - Facility management officials
 - Local emergency personal
 - All of the above
- 19) Which of the following statements regarding temperature and level of agitation in biodiesel production is correct?
- Temperature and level of agitation during the biodiesel reaction do not influence the rate of reaction or safety considerations.
 - If the temperature and level of agitation during the reaction are too high, safety concerns arise. If the temperature and level of agitation during the reaction are too low, the reaction will not reach completion.
 - If the level of agitation during the reaction is too high, safety concerns arise. If the level of agitation is too low, the reaction will not reach completion. The temperature during the reaction does not influence reaction rates or safety considerations.

- d) If the temperature during the reaction is too high, safety concerns arise. If the temperature is too low, the reaction will not reach completion. The level of agitation during the reaction does not influence reaction rate or safety considerations.
- 20) Regarding ventilation in methanol facilities, which of the following statements is most accurate?
- a) Mechanical ventilation is required in all methanol facilities.
 - b) Ventilation considerations for a facility depend only on the size of the facility.
 - c) Ventilation should prohibit methanol concentrations from exceeding 200 ppm in a given facility.
 - d) Ventilation should prohibit methanol concentrations from exceeding 2.00% in a given facility.



Appendix C: Safety Plan for Biodiesel Production

Lab Safety Plan

Emergency Contacts,
Response Plan, MSDS, & Lab
Procedures

Biodiesel Production Lab

Aquaculture Center CHP Building

Morrisville State College

Dr. Ben Ballard (X-6780)

Questions/Contact Information:

Dr. Ben Ballard (Renewable Energy Professor)

- office: 315-684-6780
- mobile:

Mr. Seth Carsten, Instructional Support Associate

- office: (315)-684-6423

Craig Fisher (Campus Environmental Health & Safety Officer)

- office: 315-684-6450
- mobile:

Spill Emergency/Safety Information:

Dr. Ballard, Mr. Carsten, Mr. Fisher, and

University Police: 684-6410

Medical Emergency Call:

University Police 684-6410



Safety Plan for Biodiesel Production

The Renewable Energy Training Center at Morrisville State College

Updated: September 2013

Introduction

Despite implementation of even the most rigorous safety precautions at a biodiesel production facility, the possibility for emergency situations does remain. Thus, in order to best mitigate damage and personal harm as a result of these emergencies, it is necessary that each facility have a site-specific safety plan detailing response protocols to a wide variety of situations. The following document provides such a plan for the Biodiesel Production Lab facility at the Morrisville State College. The document addresses general facility rules and safety protocols, in addition to detailing the steps that should be taken if substances are contacted, spilled, or ignited in the facility. Also included are NFPA labels for chemicals that may be encountered in the production facility and directions to the nearest medical center in case of an emergency. Note that a copy of this safety plan, a document entailing production procedures, the appropriate Material Safety Data Sheets, directions to the nearest hospital, and any additional pertinent safety publications such as the *Procedural Manual for Methanol Handling* must be available in the production facility at all times.

Facility Information and Contacts

Facility Location:

Aquaculture Center at Morrisville State College, Eaton Street, Morrisville NY, 13408

Facility Management:

Dr. Ben Ballard, Director of the Renewable Energy Training Center

Office: 103 Shannon Hall, Phone: (315)-684-6780, Mobile Phone: (315)-440-2411

Mr. Seth Carsten, Instructional Support Associate

Office: 102 Aquaculture Center, Phone: (315)-684-6423

Mr. Craig Fisher, Environmental Health and Safety Officer

Office: Johnson Service Building, Phone: (315)-684-6450, Mobile Phone: (845)-807-8722

School of Agriculture, Sustainability, Business and Entrepreneurship Main Office

Office: 103 Marshall Hall, Phone: (315)-684-6083

Emergency Contacts:

Morrisville State College University Police: Emergency Phone: (315)-684-6410 (if on a campus phone, simply dial 6410)

Morrisville Fire Department: ALWAYS CALL UNIVERSITY POLICE FOR ANY CAMPUS EMERGENCY: 684-6410. Fire Department General Phone: (315)-684-3214

General Production Stipulations

- No individual shall be permitted to operate the biodiesel production apparatus without comprehensive safety training, satisfactory performance on the Methanol Safety Examination, and the permission of Dr. Ben Ballard, Director of the Renewable Energy Training Center (RETC).
- All guidelines expressed in pertinent Renewable Energy Training Center publications such as the *Procedural Manual for Methanol Handling in a Biodiesel Production Facility* and the *Biodiesel Lab Procedures Handbook* must be strictly followed, in all phases of production.
- Mr. Carsten must be notified prior to the start of biodiesel production. If Mr. Carsten is unavailable, the operator must notify another member of the Aquaculture Center staff who is present at the given time (e.g., Mr. Ryan Diehl).
- Following biodiesel production, the facility must be cleaned in accordance with RETC protocols and Mr. Carsten must be notified. If Mr. Carsten is unavailable, the operator must again notify another member of the Aquaculture Center staff.
- Safety Goggles and gloves must be worn at all times during production.
- All chemical reagents (Methanol, Potassium Hydroxide) and products (Biodiesel) must be labeled according to NFPA Code 704 protocol. Completed labels are attached to this plan.
- When adding potassium hydroxide (KOH), the operator should wear a dust mask, respirator or face shield, as instructed during training.
- Smoking and the operation of cell phones (or other electronic devices) is prohibited near production and storage areas.
- During production, the operator must remain on-site. The facility may not be left unattended for any reason.
- Prior to system operation, the apparatus must be checked for leaks, in accordance with training.
- Failure to adhere to the any RETC protocols may be cause for dismissal from the production facility.

FIRST AID: Methanol (CH₃OH), Potassium Hydroxide (KOH), Biodiesel and Potassium Methoxide (KCH₃O) Contact Protocols*

- *If vapor is inhaled:* Remove the individual to fresh air and give oxygen if breathing is difficult. If breathing has ceased, get medical attention immediately. Administer CPR and artificial respiration (using a respiratory medical device- do not use mouth to mouth resuscitation).
- *If skin contact occurs:* Use the emergency eyewash or safety shower to flush the affected area for 15 minutes. Wash with soap and water and seek medical attention, especially if further symptoms of toxicity develop or irritation/pain persists. Remove and dispose of contaminated clothing while flushing the affected area.
- *If eye contact occurs:* Immediately flush eyes thoroughly with water for at least 15 minutes. Occasionally lift the upper and lower eyelids while flushing the eyes. Obtain immediate medical attention.
- *If any of the above substances are ingested:* Do not induce vomiting. Get medical attention immediately and ensure the individual remains under close medical care for several days.

*While the four compounds listed have different chemical and physical properties, consideration of their respective Material Safety Data Sheets informs recommended first aid measures that are identical across all four compounds. It is for this reason that contact protocols have been consolidated as above.

Methanol and Biodiesel Spill Response Protocol

In the event of a spill during production, the following steps should be taken.

1. Stop or reduce the rate of methanol/biodiesel release from its container. Proceed with this step only in the event that it can be completed safely.
2. If the combustible gas detector alarm sounds or if noxious vapors are present, sound the vapor release alarm and evacuate the premises and notify Mr. Carsten (or another Aquaculture Center staff member) immediately. This individual must then notify Dr. Ballard.
3. Remove all sources of ignition to a safe “standoff” distance from the point of methanol/biodiesel release and any pools of methanol/biodiesel that have formed.
4. Evacuate any individual without proper protective equipment and forbid reentry until the area is remediated.
5. Do not walk through any spilled methanol or biodiesel pools. Avoid skin contact or inhalation.
6. Remain upwind of the facility and avoid any low lying areas that may have accumulated methanol vapor.
7. In the event of a large spill or fire, Morrisville State College Police must be immediately contacted by dialing (315)-684-6410 (simply dial 6410 if using a campus phone). Campus police will contact the fire department as necessary. Craig Fisher, Environmental Health and Safety Officer, should also be informed of the spill. Operators should use the phone located in the Aquaculture Center office. If this phone is unavailable a cell phone may be utilized, as long as the operator is a safe distance (ideally 100-200 meters) from the facility. When contacting police, individuals *must* mention the presence of methanol and biodiesel at the facility.

8. Proceed as directed by Mr. Carsten, Dr. Ballard, Mr. Fisher, or the fire department. If the spill is relatively minor, treatment with absorbent materials and disposal may be adequate (these materials may be found in the spill kit). For major spills, response zones as discussed in the *Procedural Manual for Methanol Handling in a Biodiesel Production Facility* may be required.
9. Note that biodiesel (especially “crude”, unwashed biodiesel) from the facility should be treated like methanol (in handling and such endeavors) due to possible presence of methanol impurities.

Fire Response Protocol

In the event of a fire, the following steps should be taken.


1. Sound the vapor release/fire alarm. This will notify the Aquaculture staff of the developing situation.
2. In the event of a small fire, apply dry chemical compound or AR-AFFF to the fire immediately. Remain a safe distance from the fire at all times and follow training guidelines for correct application of the fire suppressant.
3. If it is possible to do so without risking personal harm, remove any containers and possible ignition sources to a safe distance.
4. In the event of a large fire that presents an imminent threat to personal safety, evacuation should occur immediately. In this case, the garage door should be manually closed during evacuation, if possible.
5. In the event of a fire, it should be noted that immediate action is required (either fighting the fire if it is small or evacuating if it is large). Thus, while the operator must sound the vapor release/fire alarm to notify staff of the emergency, the operator should proceed in fighting the fire/evacuating rather than attempting to further notify staff (as is protocol in a simple spill). When the alarm is sounded, staff will approach the facility and then may be told to contact the University Police. *Staff should exercise due caution when approaching the facility.*
6. Upon assessment of the situation, staff will contact Morrisville State College University Police immediately by dialing (315)-684-6410 (or simply 6410 if on a campus phone). Staff must then notify Mr. Craig Fisher or Dr. Ben Ballard, who will serve as the Emergency Response Coordinator. When notifying U. Police, staff *must* mention the presence of methanol and biodiesel at the facility.
7. In the event of a large fire, all individuals should be evacuated not only from the biodiesel facility, but also from the entire Aquaculture Center.

*Disclaimer: The above information is intended to provide response **guidelines**. Site-specific and situation specific considerations should be made when applying these guidelines to other situations and facilities. The safety protocol may not take the place of advice from a doctor or trained emergency responder.*

NFPA 704: Code for Hazardous Materials Identification

Methanol (CH₃OH)
Methyl Alcohol, Wood Alcohol

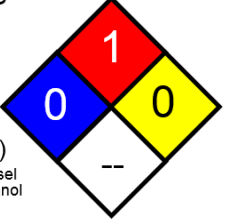
CAS Number: 67-56-1
Molar Mass: 34.04 g/mole
Density: 0.790 g/cm³
Boiling Point: 64.7°C (148.5°F)
Precautions: Flammable liquid and vapor. Harmful if inhaled. May be fatal or cause blindness if swallowed.



RETC: Biodiesel Production Laboratory

Biodiesel
Methyl Soyate

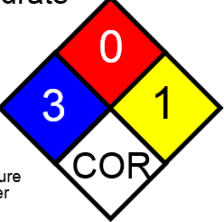
CAS Number: 67784-80-9
Molar Mass: 296.5 g/mole
Density: 0.88 g/cm³
Boiling Point: 315-350°C (599-662°F)
Precautions: Combustible Liquid. Crude biodiesel may contain methanol (see methanol precautions)



RETC: Biodiesel Production Laboratory

Potassium Hydroxide (KOH)
Lye, Potassium Hydrate

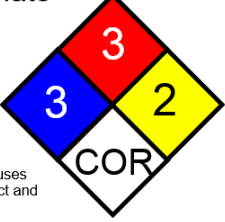
CAS Number: 1310-58-3
Molar Mass: 56.1 g/mole
Density: 2.04 g/cm³
Boiling Point: 1320°C (2408°F)
Precautions: Causes severe burns by all exposure routes. Harmful if swallowed. Water reactive.



RETC: Biodiesel Production Laboratory

Potassium Methoxide
Potassium Methylate

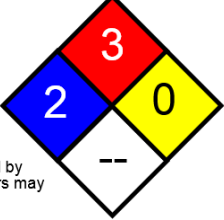
CAS Number: 865-33-8
Molar Mass: 70.13 g/mole
Density: 0.95 g/cm³
Boiling Point: 48.1°C (>118.6°F)
Precautions: Highly flammable. Very corrosive: causes burns. Toxic by inhalation, skin contact and injection. Reacts violently with water.



RETC: Biodiesel Production Laboratory

Isopropyl Alcohol (C₃H₈O)
2-Propanol

CAS Number: 67-63-0
Molar Mass: 60.1 g/mole
Density: 0.785 g/cm³
Boiling Point: 82.5°C (180.5°F)
Precautions: Volatile, flammable liquid. Harmful by inhalation and if swallowed. Vapors may form explosive mixtures with air.

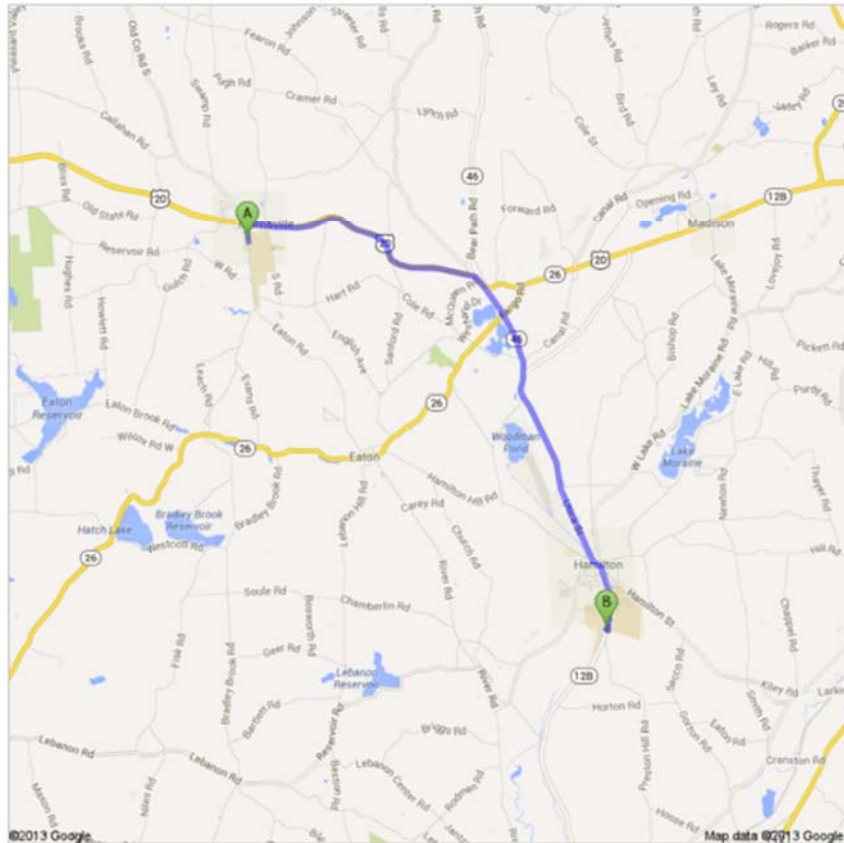


RETC: Biodiesel Production Laboratory





Directions to Nearest Hospital (Community Memorial)



Directions to Community Memorial Hospital: Madison Barbara M
 150 Broad St, Hamilton, NY 13346
 9.6 mi – about 15 mins



A Morrisville State College
 80 Eaton St, Morrisville, NY 13408

1. Head **north** on **Eaton St** toward **Maple Ave E** go 0.3 mi
total 0.3 mi
 About 50 secs
-  2. Turn **right** onto **US-20 E/Main St**
 Continue to follow **US-20 E** go 3.9 mi
total 4.2 mi
 About 5 mins
-  3. Slight **right** onto **NY-46 S** go 1.4 mi
total 5.6 mi
 About 3 mins
-  4. Continue **straight** onto **New York 12B S** go 3.1 mi
total 8.7 mi
 About 4 mins
-  5. Slight **right** onto **Broad St**
 Destination will be on the right go 1.0 mi
total 9.6 mi
 About 2 mins

B Community Memorial Hospital: Madison Barbara M
 150 Broad St, Hamilton, NY 13346

Appendix: Biodiesel Production Lab Safety Sheets

**Includes example Material Safety Data Sheets for
biodiesel and commonly used chemicals used in
biodiesel production.**

SAFETY SHEET

Methanol (CH₃OH)

Methyl Alcohol, Wood Alcohol

CAS Number: 67-56-1

Molar Mass: 34.04 g/mole

Density: 0.790 g/cm³

Boiling Point: 64.7°C (148.5°F)

Precautions: Flammable liquid and vapor. Harmful if inhaled. May be fatal or cause blindness if swallowed.



RETC: Biodiesel Production Laboratory

Very flammable liquid and vapor. In case of fire, use water fog dry chemical carbon dioxide or alcohol foam. Water may be ineffective. Flame is also colorless/difficult to see (thermal imaging camera should be used by fire responders).

May be harmful if inhaled or absorbed through the skin. Prolonged or repeated contact may dry the skin and cause irritation and burns. Harmful or fatal if swallowed. May cause blindness. May affect the central nervous system causing dizziness, headache, nausea, or visual impairment.

FIRST AID:

In case of contact: flush eyes or skin with water. Call a physician if irritation develops and persists.

If inhaled, remove to fresh air. If not breathing, give artificial respiration.

If swallowed: DO NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to unconscious person. Call a physician.

Note: **Glycerol** produced in the transesterification process contains a substantial amount of **methanol**. While glycerol itself is quite harmless, this tainted glycerol should be treated with the same precautions as methanol.

Crude (unwashed) biodiesel also contains **methanol** and should be treated with the same precautions as methanol.

Material Safety Data Sheet
Instant FAME/Instant Anaerobe Methods
Methanol

SECTION 1 – CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MSDS Name: Methanol
MSDS Preparation Date: 06/19/2009
Synonyms or Generic ID for Methanol: Carbinol; Methyl alcohol; Methyl hydroxide; Monohydroxymethane; Wood alcohol; Wood naptha; Wood spirits; Columbian spirits; Methanol.
Chemical Family: Methanol Family
Formula: CH₃OH
Molecular Weight: N/A
PIN (UN#/ NA#): UN1230
Company Identification:
 Microbial ID.
 125 Sandy Drive
 Newark, DE 19713
For Information, call: (800)276-8068, (302)737-4297
For Domestic CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

SECTION 2 – COMPOSITION, INFORMATION ON INGREDIENTS

67-56-1	Methanol	<99%	200-659-6	Irritant, Flammable
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NFPA Rating: (estimated) Health: 1; Flammability: 3; Instability: 0

State: Liquid	Appearance: colorless	Odor: Alcohol-like, weak odor
Boiling Point: 64.7°C@760mmHg	pH: Not available	Specific Gravity: 7910g/cm ³ @20°C
Vapor Pressure (mm Hg): 128mmHg @20°C	Vapor Density (AIR=1): 1.11	
Flash Point: 12°C	Solubility in Water: miscible	

SECTION 3 – HAZARDS IDENTIFICATION

Appearance: Colorless liquid, Flash Point: 12°C, 53.6°F.

Danger! Poison! May be fatal or cause blindness if swallowed. Vapor harmful. **Flammable liquid and vapor.** Harmful if swallowed, inhaled, or absorbed through the skin. Causes eye, skin, and respiratory tract irritation. May cause central nervous system depression. Cannot be made non-poisonous.

Target Organs: Eyes, nervous system, optic nerve.

Potential Health Effects

Eye: May cause painful sensitization to light. Methanol is a mild to moderate eye irritant. Inhalation, ingestion or skin absorption of methanol can cause significant disturbance in vision, including blindness.

Skin: Causes moderate skin irritation. May be absorbed through the skin in harmful amounts. Prolonged and or repeated contact may cause defatting of skin and dermatitis. Methanol can be absorbed through the skin, producing systemic effects that include visual disturbances.

Ingestion: May be fatal or cause blindness if swallowed. Aspiration hazard. Cannot be made non-poisonous. May cause gastrointestinal irritation with nausea, vomiting and diarrhea. May cause systematic toxicity with acidosis. May cause central nervous system depression, characterized by excitement, followed by headache, dizziness, drowsiness, and nausea. Advanced stages may cause collapse, unconsciousness, coma, and possible death due to failed respiratory failure. May cause cardiopulmonary system effects.

Material Safety Data Sheet
Instant FAME/Instant Anaerobe Methods
Methanol

Inhalation: Methanol is toxic and can very readily form extremely high vapor concentrations at room temperature. Inhalation is the most common route of occupational exposure. At first, methanol causes CNS depression with nausea, headache, vomiting, dizziness and incoordination. A time period with no obvious symptoms follows (typically 8-24 hrs). This latent period is followed by metabolic acidosis and severe visual effects which may include reduced reactivity and/or increased sensitivity to light, blurred, double and/or snowy vision, and blindness. Depending on the severity of exposure and the promptness of treatment, survivors may recover completely or may have permanent blindness, vision disturbances and/or nervous system effects.

Chronic: Prolonged or repeated skin contact may cause dermatitis. Chronic exposure may cause effects similar to those of acute exposure. Methanol is only very slowly eliminated from the body. Because of this slow elimination, methanol should be regarded as a cumulative poison. Though a single exposure may cause no effect, daily exposures may result in the accumulation of a harmful amount. Methanol has produced fetotoxicity in rats and teratogenicity in mice exposed by inhalation to high concentrations that did not produce significant maternal toxicity.

SECTION 4 – FIRST AID MEASURES

Eyes: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical aid.

Skin: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid immediately. Wash clothing before reuse.

Ingestion: Potential for aspiration if swallowed. Get medical aid immediately. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If vomiting occurs naturally, have victim lean forward.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.

Notes to Physician: Effects may be delayed.

Antidote: Ethanol may inhibit methanol metabolism.

SECTION 5 – FIRE FIGHTING MEASURES

General Information: Ethanol may inhibit methanol metabolism. As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Use water spray to keep fire-exposed containers cool. Water may be ineffective. Material is lighter than water and a fire may be spread by the use of water. Vapors are heavier than air and may travel to a source of ignition and flash back. Vapors can spread along the ground and collect in low or confined areas.

Extinguishing Media: For small fires, use dry chemical, carbon dioxide, water spray or alcohol-resistant foam. Water may be ineffective. For large fires, use water spray, fog or alcohol-resistant foam. Do NOT use straight streams of water.

Flash Point: 12 deg C (53.60 deg F)

Autoignition Temperature: 455 deg C (851.00 deg F)

Explosion Limits, Lower: 6.0 vol %

Upper: 31.00 vol %

NFPA Rating: (estimated) Health: 1; Flammability: 3; Instability: 0

SECTION 6 – ACCIDENTAL RELEASE MEASURES

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks: Use water spray to disperse the gas/vapor. Remove all sources of ignition. Absorb spill using an absorbent, non-combustible material such as earth, sand, or vermiculite. Do not use combustible materials such as sawdust. Use a spark-proof tool. Provide ventilation. A vapor suppressing foam may be used to reduce vapors. Water spray may reduce vapor but may not prevent ignition in closed spaces.

Material Safety Data Sheet
Instant FAME/Instant Anaerobe Methods
Methanol

SECTION 7-HANDLING AND STORAGE

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Ground and bond containers when transferring material. Use spark-proof tools and explosion proof equipment. Avoid contact with eyes, skin, and clothing. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Keep container tightly closed. Do not ingest or inhale. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames. Use only with adequate ventilation. Keep away from heat, sparks and flame. Avoid use in confined spaces.

Storage: Keep away from heat, sparks, and flame. Keep away from sources of ignition. Store in a cool, dry, well-ventilated area away from incompatible substances. Flammables-area. Keep containers tightly closed.

SECTION 8 – EXPOSURE CONTROL/ PERSONAL PROTECTION

Engineering Controls: Use explosion-proof ventilation equipment. Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.

Chemical Name	ACGIH	NIOSH	OSHA – Final PELs
Methanol	200 ppm TWA; 250 ppm STEL; Skin - potential significant contribution to overall exposure by the cutaneous route	200 ppm TWA; 260 mg/m ³ TWA 6000 ppm IDLH	200 ppm TWA; 260 mg/m ³ TWA

OSHA Vacated PELs: Methanol: 200 ppm TWA; 260 mg/m³ TWA

Personal Protective Equipment

Eyes: Wear chemical splash goggles.

Skin: Wear butyl rubber gloves, apron, and/or clothing.

Clothing: Wear appropriate protective clothing to prevent skin exposure.

Respirators: Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Physical State: Clear liquid

Appearance: clear, colorless - APHA: 10 max

Odor: alcohol-like - weak odor

pH: Not available.

Vapor Pressure: 128 mm Hg @ 20 deg C

Vapor Density: 1.11 (Air=1)

Evaporation Rate:5.2 (Ether=1)

Viscosity: 0.55 cP 20 deg C

Boiling Point: 64.7 deg C @ 760 mmHg

Freezing/Melting Point:-98 deg C

Decomposition Temperature:Not available.

Solubility: miscible

Specific Gravity/Density:.7910 g/cm³ @ 20°C

Molecular Formula:CH₄O

Molecular Weight:32.04

Material Safety Data Sheet
Instant FAME/Instant Anaerobe Methods
Methanol

SECTION 10 – STABILITY AND REACTIVITY

Chemical Stability: Stable under normal temperatures and pressures.

Conditions to Avoid: High temperatures, ignition sources, confined spaces.

Incompatibilities with Other Materials: Oxidizing agents, reducing agents, acids, alkali metals, potassium, sodium, metals as powders (e.g. hafnium, rane nickel), acid anhydrides, acid chlorides, powdered aluminum, powdered magnesium.

Hazardous Decomposition Products: Carbon monoxide, irritating and toxic fumes and gases, carbon dioxide, formaldehyde.

Hazardous Polymerization: Will not occur.

SECTION 11 – TOXICOLOGICAL INFORMATION

RTECS#:

CAS# 67-56-1: PC1400000

LD50/LC50:

CAS# 67-56-1:

Draize test, rabbit, eye: 40 mg Moderate;

Draize test, rabbit, eye: 100 mg/24H Moderate;

Draize test, rabbit, skin: 20 mg/24H Moderate;

Inhalation, rabbit: LC50 = 81000 mg/m³/14H;

Inhalation, rat: LC50 = 64000 ppm/4H;

Oral, mouse: LD50 = 7300 mg/kg;

Oral, rabbit: LD50 = 14200 mg/kg;

Oral, rat: LD50 = 5600 mg/kg;

Skin, rabbit: LD50 = 15800 mg/kg;

Human LDLo Oral: 143 mg/kg; Human LDLo Oral: 428 mg/kg; Human TClO Inhalation; 300 ppm caused visual field changes & headache; Monkey LDLo Skin: 393 mg/kg. Methanol is significantly less toxic to most experimental animals than humans, because most animal species metabolize methanol differently. Non-primate species do not ordinarily show symptoms of metabolic acidosis or the visual effects which have been observed in primates and humans.

Carcinogenicity:

CAS# 67-56-1: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

Epidemiology: No information found

Teratogenicity: There is no human information available. Methanol is considered to be a potential developmental hazard based on animal data. In animal experiments, methanol has caused fetotoxic or teratogenic effects without maternal toxicity.

Reproductive Effects: See actual entry in RTECS for complete information.

Mutagenicity: See actual entry in RTECS for complete information.

Neurotoxicity: ACGIH cites neuropathy, vision and CNS under TLV basis.

SECTION 12 – ECOLOGICAL INFORMATION

Ecotoxicity: Fish: Fathead Minnow: 29.4 g/L; 96 Hr; LC50 (unspecified)Fish: Goldfish: 250 ppm; 11 Hr; resulted in deathFish: Rainbow trout: 8000 mg/L; 48 Hr; LC50 (unspecified)Fish: Rainbow trout: LC50 = 13-68 mg/L; 96 Hr.; 12 degrees CFish: Fathead Minnow: LC50 = 29400 mg/L; 96 Hr.; 25 degrees C, pH 7.63Fish: Rainbow trout: LC50 = 8000 mg/L; 48 Hr.; UnspecifiedBacteria: Phytobacterium phosphoreum: EC50 = 51,000-320,000 mg/L; 30 minutes; Microtox test No data available.

Environmental: Dangerous to aquatic life in high concentrations. Aquatic toxicity rating: TLM 96>1000 ppm. May be dangerous if it enters water intakes. Methyl alcohol is expected to biodegrade in soil and water very rapidly. This product will show high soil mobility and will be degraded from the ambient atmosphere by the reaction with photochemically produced hydroxyl radicals with an estimated half-life of 17.8 days. Bioconcentration factor for fish (golden ide) < 10. Based on a log Kow of -0.77, the BCF value for methanol can be estimated to be 0.2.

Physical: No information available.

Other: No information available.

Material Safety Data Sheet
Instant FAME/Instant Anaerobe Methods
Methanol

SECTION 13 – DISPOSAL CONSIDERATIONS

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.

RCRA P-Series: None listed.

RCRA U-Series:

CAS# 67-56-1: waste number U154 (Ignitable waste).

SECTION 14 – TRANSPORT INFORMATION

	US DOT	CANADA TDG
Shipping Name:	Methanol	Methanol
Hazard Class:	3	3
UN Number:	UN1230	UN1230
Packing Group:	II	II
Additional Information		Flash Point 12°C

SECTION 15 – REGULATORY INFORMATION

US FEDERAL

TSCA

CAS# 67-56-1 is listed on the TSCA inventory.

Health & Safety Reporting List

None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules

None of the chemicals in this product are under a Chemical Test Rule.

Section 12b

None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

CERCLA Hazardous Substances and corresponding RQs

CAS# 67-56-1: 5000 lb final RQ; 2270 kg final RQ

SARA Section 302 Extremely Hazardous Substances

None of the chemicals in this product have a TPQ.

SARA Codes

CAS # 67-56-1: immediate, fire.

Section 313

This material contains Methanol (CAS# 67-56-1, > 99%), which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

Clean Air Act:

CAS# 67-56-1 is listed as a hazardous air pollutant (HAP).

This material does not contain any Class 1 Ozone depleters.

This material does not contain any Class 2 Ozone depleters.

Clean Water Act:

None of the chemicals in this product are listed as Hazardous Substances under the CWA.

None of the chemicals in this product are listed as Priority Pollutants under the CWA.

None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 67-56-1 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

Material Safety Data Sheet
Instant FAME/Instant Anaerobe Methods
Methanol

California Prop 65

California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:

T F

Risk Phrases:

R 11 Highly flammable.

R 23/24/25 Toxic by inhalation, in contact with skin and if swallowed.

R 39/23/24/25 Toxic : danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.

Safety Phrases:

S 16 Keep away from sources of ignition - No smoking.

S 36/37 Wear suitable protective clothing and gloves.

S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

S 7 Keep container tightly closed.

WGK (Water Danger/Protection)

CAS# 67-56-1: 1

Canada - DSL/NDSL

CAS# 67-56-1 is listed on Canada's DSL List.

Canada - WHMIS

This product has a WHMIS classification of B2, D1B, D2B.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

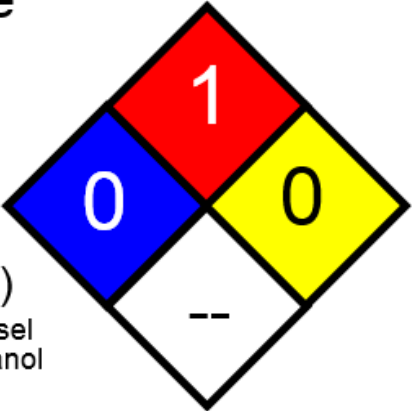
Canadian Ingredient Disclosure List

CAS# 67-56-1 is listed on the Canadian Ingredient Disclosure List.

SECTION 16 – Other Information

This Material Safety Data Sheet has been prepared in accordance with 29 CFR 1910.1200 and contains information believed to be accurate and complete at the date of preparation. The statements contained herein are offered for informational purposes only and are based upon technical data. MIDI Inc. believes them to be accurate but does not purport to be all-inclusive. The above-stated product is intended for use only by persons having the necessary technical skills and facilities for handling the product at their discretion and risk. Since conditions and manner of use are outside our control, we (MIDI Inc.) make no warranty of merchantability or any such warranty, express or implied with respect to information and we assume no liability resulting from the above product or its use. Users should make their own investigations to determine suitability of information and product for their particular purposes.

SAFETY SHEET

<h2>Biodiesel Methyl Soyate</h2>	
CAS Number:	67784-80-9
Molar Mass:	296.5 g/mole
Density:	0.88 g/cm ³
Boiling Point:	315-350°C (599-662°F)
Precautions:	Combustible Liquid. Crude biodiesel may contain methanol (see methanol precautions)
	
<i>RETC: Biodiesel Production Laboratory</i>	

FIRST AID:

In case of eye contact: Rinse immediately with cool water. Remove contact lenses (if applicable), then flush eyes with water for at least 15 minutes. If symptoms or irritation occur, call a physician.

In case of skin contact: Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. If symptoms or irritation occur, call a physician.

If swallowed: Do Not induce vomiting and do not give liquids. Immediately call a physician.

If inhaled: If affected, move person to fresh air. If symptoms or irritation occur with any exposure, call a physician.

Note: **Crude (unwashed) biodiesel** will contain **methanol** and should be treated with the same precautions as methanol. See the Methanol Safety Sheet.



MATERIAL SAFETY DATA SHEET

SECTION 1 – PRODUCT IDENTIFICATION

Common Name: Biodiesel
Chemical Name: Fatty Acid Methyl Ester
Formula: C14-C24 Methyl Esters
Chemical Family: CAS No. 67784-80-9

SECTION 2 – INGREDIENTS AND HAZARDOUS CLASSIFICATION

Typical Composition:

Alkyl C14-C24 Methyl Esters	OSHA PEL	ACGH/TLV	Percent
	none	none	99

This product contains no hazardous materials.
SARA Title III, Section 313: Not Listed

SECTION 3 – PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point: >400° F
Vapor Pressure (mm Hg): <5 mm Hg @ 72° F
Evaporation Rate: less than .005 versus (Butyl Acetate = 1)
Solubility in Water: insoluble
Appearance and Odor: light to dark yellow clear liquid / light musty odor

SECTION 4 - FIRE AND EXPLOSION HAZARD DATA

Flash Point (method used): 321° F PMCC
Flammable Limits: N/A
HMIS Rating: Health: 0 Fire: 1 Reactivity: 0
Extinguishing Media: Use water spray, dry chemical, foam or carbon dioxide.
Special Fire Fighting Procedures: Treat as oil fire.
Unusual Fire and Explosion hazards: Rags soaked with any solvent present a fire hazard and should be stored in an approved UL listed covered container.

SECTION 5 – REACTIVITY DATA

Reactivity: Stable

Conditions to Avoid: Non Known

Incompatibility (materials to avoid): Strong oxidizing agents

Hazardous Decomposition or By-products: Carbon monoxide, carbon dioxide

Hazardous Polymerization: Will not occur

SECTION 6 – HEALTH HAZARD DATA

Emergency First Aid Procedures:

Ingestion: Rinse mouth with water, contact physician

Eyes: Rinse with water 15 minutes, contact physician

Skin: Rinse with soap and water

SECTION 7 – PRECAUTIONS FOR SAFE HANDLING AND USE

Steps to be taken in case material is released or spilled:

Avoid uncontrolled releases. Contain spilled material. Transfer to secure containers. Use absorbent material if necessary.

Disposal; Dispose of according to Federal, state and/or local regulations

Precautions to be Taken in Handling and Storing: Avoid open flames

Other Precautions: None

SECTION 8 – CONTROL MEASURES

Respiratory Protection: None required

Ventilation: mechanical

Protective Gloves: Rubber

Eye Protection: Safety glasses / splash goggles

Other Protective Clothing or Equipment: None required

SECTION 9 – TRANSPORTATION

DOT Code: N/A

DOT Shipping Name: Fatty acid esters

Other Regulatory: Listed in TSCA inventory

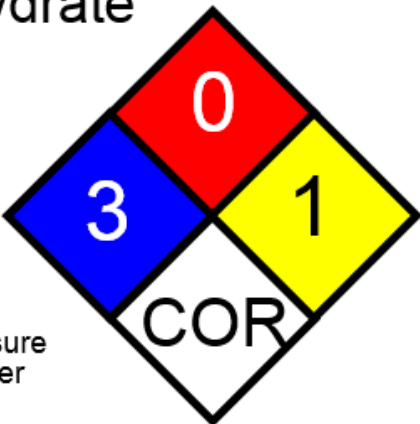
The information provided is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability, or suitability for an intended use, or any other warranty, expressed or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes.

BIODIESEL INDUSTRIES, INC.

111 SAGUARO LANE, MARATHON, FL 33050 • 305-743-3942 • FAX 305-743-3943

ON-LINE AT [HTTP://WWW.PIPELINE.TO/BIODIESEL](http://www.pipeline.to/biodiesel) • EMAIL RTEALL@AOL.COM

SAFETY SHEET

Potassium Hydroxide (KOH) Lye, Potassium Hydrate	
CAS Number: 1310-58-3	
Molar Mass: 56.1 g/mole	
Density: 2.04 g/cm ³	
Boiling Point: 1320°C (2408°F)	
Precautions: Causes severe burns by all exposure routes. Harmful if swallowed. Water reactive.	
<i>RETC: Biodiesel Production Laboratory</i>	

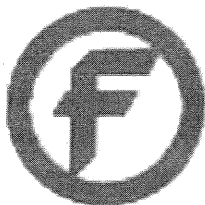
Extremely corrosive. Harmful or fatal if swallowed. Can cause severe burns or blindness upon contact with skin or eyes. Always protect face, eyes, and other portions of body. Always wear safety glasses/goggles when using this product.

FIRST AID: Immediately Call Poison Center, Physician or Emergency Room (on campus, call Campus Police X-6410)

In case of eye contact: Rinse immediately with cool water. Remove contact lenses (if applicable), then flush eyes with water for at least 20 minutes.

If Swallowed: Rapidly rinse mouth. Then drink a glassful of milk or water. DO NOT induce vomiting.

In case of skin contact: Remove affected clothing. Flush with cold water for 15 minutes.



Material Safety Data Sheet

Creation Date 02-Nov-2009

Revision Date 02-Nov-2009

Revision Number 1

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name	Potassium Hydroxide
Cat No.	P246-3; P250-1; P250-3; P250-10; P250-50; P250-500; P251-3; P251-50; P251-500; P258-12; P258-50; P258-50LC; P258-212
Synonyms	Potassium hydrate; Lye; Caustic potash
Recommended Use	Laboratory chemicals
Company Fisher Scientific One Reagent Lane Fair Lawn, NJ 07410 Tel: (201) 796-7100	Emergency Telephone Number CHEMTREC®, Inside the USA: 800-424-9300 CHEMTREC®, Outside the USA: 703-527-3887

2. HAZARDS IDENTIFICATION

DANGER!

Emergency Overview

Causes severe burns by all exposure routes. Harmful if swallowed. Water reactive.

Appearance Light yellow

Physical State Solid

Odor odorless

Target Organs Eyes, Respiratory system, Skin, Gastrointestinal tract (GI)

Potential Health Effects

Acute Effects

Principle Routes of Exposure

Eyes

Causes severe burns. May cause blindness or permanent eye damage.

Skin

Causes severe burns. May be harmful in contact with skin. Repeated exposure may cause skin dryness or cracking.

Inhalation

Causes severe burns. May be harmful if inhaled.

Ingestion

Harmful if swallowed. Causes severe burns.

Chronic Effects

Tumorigenic effects have been reported in experimental animals.. Mutagenic effects have occurred in experimental animals..

See Section 11 for additional Toxicological information.

Aggravated Medical Conditions Preexisting eye disorders. Skin disorders.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Haz/Non-haz

Component	CAS-No	Weight %
Potassium hydroxide	1310-58-3	100.0

4. FIRST AID MEASURES

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.

Inhalation Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Immediate medical attention is required.

Ingestion Do not induce vomiting. Call a physician or Poison Control Center immediately.

Notes to Physician Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Flash Point Method Not applicable
No information available.

Autoignition Temperature No information available.

Explosion Limits

Upper No data available

Lower No data available

Suitable Extinguishing Media Substance is nonflammable; use agent most appropriate to extinguish surrounding fire..

Unsuitable Extinguishing Media Carbon dioxide (CO2).

Hazardous Combustion Products No information available.

Sensitivity to mechanical impact No information available.

Sensitivity to static discharge No information available.

Specific Hazards Arising from the Chemical
Water reactive. Contact with metals may evolve flammable hydrogen gas. Thermal decomposition can lead to release of irritating gases and vapors.

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA **Health 3** **Flammability 0** **Instability 1** **Physical hazards N/A**

6. ACCIDENTAL RELEASE MEASURES

- Personal Precautions** Use personal protective equipment. Evacuate personnel to safe areas. Ensure adequate ventilation. Avoid dust formation. Do not get in eyes, on skin, or on clothing.
- Environmental Precautions** Should not be released into the environment.
- Methods for Containment and Clean Up** Sweep up or vacuum up spillage and collect in suitable container for disposal. Avoid dust formation.

7. HANDLING AND STORAGE

- Handling** Use only under a chemical fume hood. Ensure adequate ventilation. Avoid dust formation. Do not breathe dust. Do not get in eyes, on skin, or on clothing.
- Storage** Keep containers tightly closed in a dry, cool and well-ventilated place. Protect from moisture. Corrosives area.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Measures Use only under a chemical fume hood. Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH
Potassium hydroxide	Ceiling: 2 mg/m ³	(Vacated) Ceiling: 2 mg/m ³	Ceiling: 2 mg/m ³

Component	Quebec	Mexico OEL (TWA)	Ontario TWAEV
Potassium hydroxide	Ceiling: 2 mg/m ³		CEV: 2 mg/m ³

NIOSH IDLH: Immediately Dangerous to Life or Health

Personal Protective Equipment

Eye/face Protection

Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166

Skin and body protection

Wear appropriate protective gloves and clothing to prevent skin exposure

Respiratory Protection

Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced

9. PHYSICAL AND CHEMICAL PROPERTIES

- Physical State** Solid
- Appearance** Light yellow
- Odor** odorless
- Odor Threshold** No information available.
- pH** 13.5 (0.1M)
- Vapor Pressure** No information available.
- Vapor Density** No information available.
- Viscosity** No information available.

9. PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point/Range	1320°C / 2408°F
Melting Point/Range	360°C / 680°F
Decomposition temperature °C	No information available.
Flash Point	Not applicable
Evaporation Rate	No information available.
Specific Gravity	2.04
Solubility	Soluble in water
log Pow	No data available
Molecular Weight	56.1
Molecular Formula	KOH

10. STABILITY AND REACTIVITY

Stability	Moisture sensitive. Air sensitive. Absorbs moisture from air and becomes liquid.
Conditions to Avoid	Avoid dust formation. Incompatible products. Excess heat. Exposure to moist air or water.
Incompatible Materials	Water, Metals, Acids
Hazardous Decomposition Products	Oxides of potassium
Hazardous Polymerization	Hazardous polymerization does not occur
Hazardous Reactions .	None under normal processing.

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Potassium hydroxide	214 mg/kg (Rat)	Not listed	Not listed

Irritation	Causes severe burns by all exposure routes
Toxicologically Synergistic Products	No information available.
Chronic Toxicity	
Carcinogenicity	There are no known carcinogenic chemicals in this product
Sensitization	No information available.
Mutagenic Effects	Mutagenic effects have occurred in experimental animals.

Reproductive Effects	No information available.
Developmental Effects	No information available.
Teratogenicity	No information available.
Other Adverse Effects	Tumorigenic effects have been reported in experimental animals.. See actual entry in RTECS for complete information.
Endocrine Disruptor Information	No information available

12. ECOLOGICAL INFORMATION

Ecotoxicity

Do not empty into drains.

Persistence and Degradability No information available

Bioaccumulation/ Accumulation No information available

Mobility

Component	log Pow
Potassium hydroxide	0.65
	0.83

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification

14. TRANSPORT INFORMATION

DOT

UN-No	UN1813
Proper Shipping Name	Potassium hydroxide, solid
Hazard Class	8
Packing Group	II

TDG

UN-No	UN1813
Proper Shipping Name	POTASSIUM HYDROXIDE, SOLID
Hazard Class	8
Packing Group	II

IATA

UN-No	UN1813
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14. TRANSPORT INFORMATION

Proper Shipping Name POTASSIUM HYDROXIDE, SOLID
 Hazard Class 8
 Packing Group II

IMDG/IMO

UN-No UN1813
 Proper Shipping Name POTASSIUM HYDROXIDE, SOLID
 Hazard Class 8
 Packing Group II

15. REGULATORY INFORMATION

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	CHINA	KECL
Potassium hydroxide	X	X	-	215-181-3	-		X	X	X	X	KE-29139 X

Legend:

- X - Listed
- E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
- F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
- N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
- P - Indicates a commenced PMN substance
- R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
- S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
- T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
- XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B)).
- Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
- Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313
 Not applicable

SARA 311/312 Hazardous Categorization

Acute Health Hazard No
 Chronic Health Hazard No
 Fire Hazard No
 Sudden Release of Pressure Hazard No
 Reactive Hazard No

Clean Water Act

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Potassium hydroxide	X	1000 lb	-	-

Clean Air Act
Not applicable

OSHA
Not applicable

CERCLA
This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Potassium hydroxide	1000 lb	-

California Proposition 65
This product does not contain any Proposition 65 chemicals.

State Right-to-Know

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Potassium hydroxide	X	X	X	-	X

U.S. Department of Transportation

Reportable Quantity (RQ): Y
DOT Marine Pollutant N
DOT Severe Marine Pollutant N

U.S. Department of Homeland Security

This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

WHMIS Hazard Class

E Corrosive material
D1B Toxic materials



16. OTHER INFORMATION

Prepared By Regulatory Affairs
Thermo Fisher Scientific
Tel: (412) 490-8929

Creation Date 02-Nov-2009

Print Date 02-Nov-2009

Revision Summary "****", and red text indicates revision

REVIEWED

DATE: May 22/2012



Disclaimer

The information provided on this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text.

End of MSDS

SAFETY SHEET

Potassium Methoxide

Potassium Methylate

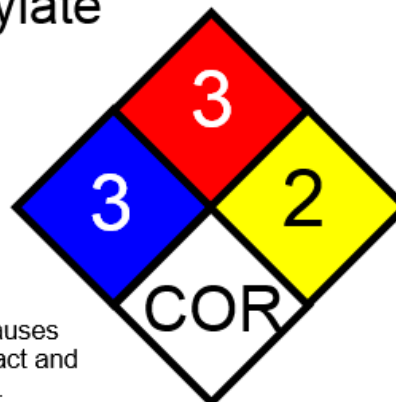
CAS Number: 865-33-8

Molar Mass: 70.13 g/mole

Density: 0.95 g/cm³

Boiling Point: 48.1°C (>118.6°F)

Precautions: Highly flammable. Very corrosive: causes burns. Toxic by inhalation, skin contact and injection. Reacts violently with water.



RETC: Biodiesel Production Laboratory

Very flammable liquid and vapor. Extremely corrosive. Harmful or fatal if swallowed. Can cause severe burns or blindness upon contact with skin or eyes. Always protect face, eyes, and other portions of body. Always wear safety glasses/goggles/face shield when using this product.

FIRST AID: Immediately Call Poison Center, Physician or Emergency Room (Campus Police on Campus X-6410). Show the MSDS/safety data sheet to the doctor in attendance.

If inhaled: If breathed in, move person into fresh air. If not breathing give artificial respiration. Consult a physician.

In case of skin contact: Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Consult a physician.

In case of eye contact: Rinse thoroughly with plenty of water for at least 15 minutes and immediately call a POISON CENTER or doctor/physician. Remove contact lenses, if present and continue rinsing.

If swallowed: Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Potassium methoxide

Product Number : 292788
Brand : Aldrich

Supplier : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone : +1 800-325-5832
Fax : +1 800-325-5052
Emergency Phone # (For both supplier and manufacturer) : (314) 776-6555

Preparation Information : Sigma-Aldrich Corporation
Product Safety - Americas Region
1-800-521-8956

2. HAZARDS IDENTIFICATION**Emergency Overview****OSHA Hazards**

Unstable Reactive, Corrosive

GHS Classification

Self-heating substances (Category 1)

Skin corrosion (Category 1B)

Serious eye damage (Category 1)

GHS Label elements, including precautionary statements

Pictogram



Signal word

Danger

Hazard statement(s)

H251

Self-heating: may catch fire.

H314

Causes severe skin burns and eye damage.

Precautionary statement(s)

P235 + P410

Keep cool. Protect from sunlight.

P280

Wear protective gloves/ protective clothing/ eye protection/ face protection.

P305 + P351 + P338

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

P310

Immediately call a POISON CENTER or doctor/ physician.

Other hazards

Reacts violently with water.

HMIS Classification**Health hazard:** 3**Flammability:** 3**Physical hazards:** 2**NFPA Rating**

Health hazard: 3
Fire: 0
Reactivity Hazard: 2

Potential Health Effects

Inhalation May be harmful if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.
Skin May be harmful if absorbed through skin. Causes skin burns.
Eyes Causes eye burns.
Ingestion May be harmful if swallowed.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Synonyms : Potassium methylate

Formula : CH₃KO

Molecular Weight : 70.13 g/mol

Component	Concentration
Potassium methoxide	
CAS-No. 865-33-8	<= 100 %
EC-No. 212-736-1	
Index-No. 603-040-00-2	

4. FIRST AID MEASURES

General advice

Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact

Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Consult a physician.

In case of eye contact

Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician. Continue rinsing eyes during transport to hospital.

If swallowed

Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIREFIGHTING MEASURES

Conditions of flammability

Not flammable or combustible.

Suitable extinguishing media

Dry powder

Special protective equipment for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

Hazardous combustion products

Hazardous decomposition products formed under fire conditions. - Carbon oxides, Potassium oxides

6. ACCIDENTAL RELEASE MEASURES

Personal precautions

Use personal protective equipment. Avoid dust formation. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas. Avoid breathing dust.

Environmental precautions

Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

Methods and materials for containment and cleaning up

Sweep up and shovel. Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13). Do not flush with water. Keep in suitable, closed containers for disposal.

7. HANDLING AND STORAGE

Precautions for safe handling

Avoid formation of dust and aerosols.

Provide appropriate exhaust ventilation at places where dust is formed. Keep away from sources of ignition - No smoking.

Conditions for safe storage

Keep container tightly closed in a dry and well-ventilated place.

Never allow product to get in contact with water during storage.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Contains no substances with occupational exposure limit values.

Personal protective equipment

Respiratory protection

Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact

Material: Nitrile rubber

Minimum layer thickness: 0.11 mm

Break through time: 480 min

Material tested: Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Splash contact

Material: Nitrile rubber

Minimum layer thickness: 0.11 mm

Break through time: 480 min

Material tested: Dermatril® (KCL 740 / Aldrich Z677272, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Eye protection

Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection

Complete suit protecting against chemicals, Flame retardant protective clothing, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Form	solid
Colour	no data available

Safety data

pH	no data available
Melting point/freezing point	no data available
Boiling point	no data available
Flash point	11 °C (52 °F) - closed cup
Ignition temperature	no data available
Auto-ignition temperature	The substance or mixture is classified as self heating with the category 1.
Lower explosion limit	no data available
Upper explosion limit	no data available
Vapour pressure	no data available
Density	0.950 g/cm ³
Water solubility	no data available
Partition coefficient: n-octanol/water	no data available
Relative vapour density	no data available
Odour	no data available
Odour Threshold	no data available
Evaporation rate	no data available

10. STABILITY AND REACTIVITY

Chemical stability

Stable under recommended storage conditions.

Possibility of hazardous reactions

Reacts violently with water.

Conditions to avoid

Exposure to moisture.

Materials to avoid

acids, Water, Oxidizing agents, Oxygen

Hazardous decomposition products

Hazardous decomposition products formed under fire conditions. - Carbon oxides, Potassium oxides
Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Oral LD50

no data available

Inhalation LC50

no data available

Dermal LD50
no data available

Other information on acute toxicity
no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitisation
no data available

Germ cell mutagenicity
no data available

Carcinogenicity

- IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
- ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
- NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
- OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity

no data available

Teratogenicity

no data available

Specific target organ toxicity - single exposure (Globally Harmonized System)

no data available

Specific target organ toxicity - repeated exposure (Globally Harmonized System)

no data available

Aspiration hazard

no data available

Potential health effects

- | | |
|-------------------|---|
| Inhalation | May be harmful if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract. |
| Ingestion | May be harmful if swallowed. |
| Skin | May be harmful if absorbed through skin. Causes skin burns. |
| Eyes | Causes eye burns. |

Signs and Symptoms of Exposure

Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin., Cough, Shortness of breath, Headache, Nausea

Synergistic effects

no data available

Additional Information

RTECS: Not available

12. ECOLOGICAL INFORMATION

Toxicity

no data available

Persistence and degradability

no data available

Bioaccumulative potential

no data available

Mobility in soil

no data available

PBT and vPvB assessment

no data available

Other adverse effects

no data available

13. DISPOSAL CONSIDERATIONS**Product**

Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging

Dispose of as unused product.

14. TRANSPORT INFORMATION**DOT (US)**

UN number: 3206 Class: 4.2 (8) Packing group: II
Proper shipping name: Alkali metal alcoholates, self-heating, corrosive, n.o.s. (Potassium methoxide)
Reportable Quantity (RQ):
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG

UN number: 3206 Class: 4.2 (8) Packing group: II EMS-No: F-A, S-J
Proper shipping name: ALKALI METAL ALCOHOLATES, SELF-HEATING, CORROSIVE, N.O.S. (Potassium methoxide)
Marine pollutant: No

IATA

UN number: 3206 Class: 4.2 (8) Packing group: II
Proper shipping name: Alkali metal alcoholates, self-heating, corrosive, n.o.s. (Potassium methoxide)

15. REGULATORY INFORMATION**OSHA Hazards**

Unstable Reactive, Corrosive

SARA 302 Components

SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components

SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards

Reactivity Hazard, Acute Health Hazard

Massachusetts Right To Know Components

No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components

CAS-No.

Revision Date

Potassium methoxide

865-33-8

New Jersey Right To Know Components

Potassium methoxide

CAS-No.
865-33-8

Revision Date

California Prop. 65 Components

This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Further information

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SAFETY SHEET

Isopropyl Alcohol (C₃H₈O) 2-Propanol

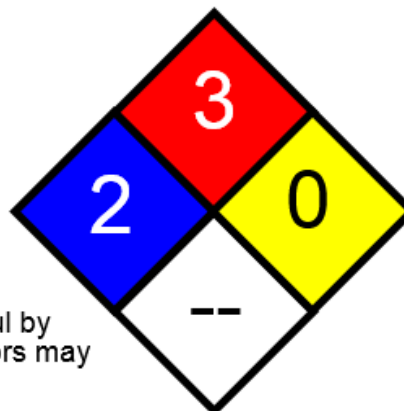
CAS Number: 67-63-0

Molar Mass: 60.1 g/mole

Density: 0.785 g/cm³

Boiling Point: 82.5°C (180.5°F)

Precautions: Volatile, flammable liquid. Harmful by inhalation and if swallowed. Vapors may form explosive mixtures with air.



RETC: Biodiesel Production Laboratory

Flammable liquid and vapor.

FIRST AID:

General: Move out of dangerous area. Consult a physician. Show MSDS/safety data sheet to the doctor in attendance.

If inhaled: If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact: Wash off with soap and plenty of water.

In case of eye contact: Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed: Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

Material Safety Data Sheet Isopropyl Alcohol

PRODUCT & COMPANY IDENTIFICATION

In case of Emergency call CHEMTREC 1-800-424-9300

Supplier	Simchem Corporation, 311 Sarasota Center Blvd., P.O. Box 697, Osprey, Florida, 34229-0697 (941) 377-9935 Fax (941) 377-9539
CAS Number	67-63-0
Synonyms	Isopropanol; sec-propyl alcohol; sec-propanol; dimethylcarbinol
Formula	(CH ₃) ₂ CHOH

TRANSPORTATION DATA

US Department of Transportation – 49 CFR	
Proper Shipping Name	Isopropanol
UN Number	UN1219
Hazard Class	3
Packing Group	II
Labels	Flammable Liquid

PHYSICAL/CHEMICAL DATA

Appearance	Clear, colorless liquid
Odor	Rubbing alcohol
Boiling Point	82° C
Melting Point	-89° C
Vapor Pressure	44 @ 25° C (mm Hg)
Vapor Density (Air = 1)	2.1
Specific Gravity	0.79 @ 20° C / 4° C
Solubility in Water	Miscible in water
Volatile by Volume	100% @ 21° C
Evaporation Rate	2.83 (BuAc = 1)

REACTIVITY DATA

Stability	Stable
Incompatibility	Heat, flame, strong oxidizers, acetaldehyde, acids, chlorine, ethylene oxide, isocyanates.
Hazardous Decomposition Products	Carbon dioxide and carbon monoxide may form when heated to decomposition.
Conditions to Avoid	Heat, flame, ignition sources and incompatibles.
Hazardous Polymerization	Will not occur.

FIRE AND EXPLOSION HAZARD DATA

Flash Point	12° C
Auto Ignition Temperature	399° C
Flammable Limits	LEL: 2.0 UEL: 12.7
Fire Extinguishing Spray	Water spray, dry chemical, alcohol foam, or carbon dioxide. Water spray may be used to keep fire exposed containers cool, dilute spills and nonflammable mixtures, protect personnel attempting to stop leak and disperse vapors.
Explosion	Above flash point, vapor air mixtures are explosive within flammable limits noted above. Contact with strong oxidizers may cause fire or explosion. Vapors can flow along surfaces to distant ignition source and flash back. Sensitive to static discharge.
Special Information	In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full face piece operated in the pressure demand for other positive pressure mode.

PRECAUTIONS FOR SAFE HANDLING & USE

to be Taken in Case Material is Spilled or Released	Ventilate area of leak or spill. Remove all sources of ignition. Wear appropriate personal protective equipment as specified on section 5. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible Use non-sparking tools and equipment. Collect liquid in an appropriate container or absorb with an inert material and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! If a leak or spill has not ignited, use water spray to disperse the vapors, to protect personnel attempting to stop leak, and to flush spills away from exposures.
Disposal Method	Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.
Handling and Storage	Protect against physical damage. Store in a cool, dry well-ventilated location, away from any area where the fire hazard may be acute. Outside or detached storage is preferred. Separate from incompatibles. Containers should be bonded and grounded for transfers to avoid static sparks. Storage and use areas should be No Smoking areas. Use non-sparking type tools and equipment, including explosion proof ventilation. Containers of this material may be hazardous when empty since they retain product residues.

HEALTH HAZARD DATA

Potential Health Effects:

Inhalation	Inhalation of vapors irritates the respiratory tract. Exposure to high concentrations has a narcotic effect, producing symptoms of dizziness, drowsiness, headache, staggering, unconsciousness and possibly death.
Ingestion	Ingestion can cause drowsiness, unconsciousness, and death. Gastrointestinal pain, cramps, nausea, vomiting, and diarrhea may also result. The single lethal dose for a human adult = about 250 mls (8 ounces).
Skin Contact	May cause skin irritation with redness and pain. May be absorbed through the skin with possible systemic effects.
Eye Contact	Vapors cause eye irritation. Splashes caused severe irritation, possible corneal burns and eye damage.

First Aid Measures:

Inhalation	In case of Inhalation, remove to fresh air. In not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion	Give large amounts of water to drink. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact	Immediately flush skin with plenty of water for at least 15 minutes. Call a physician if irritation develops.
Eye Contact	Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Personal Protective Equipment:

Skin Protection	Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact. Neoprene and nitrile rubber are recommended materials.
Eye Protection	Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

ADDITIONAL INFORMATION

Always comply with all applicable international, federal, state and local regulations regarding the transportation, storage, use and disposal of this chemical.

Due to the changing nature of regulatory requirements, the regulatory information listed in Section X this document should not be considered all-inclusive or authoritative. International, Federal, State Local regulations should be consulted to determine with all required reporting requirements.

The information in this MSDS was obtained from sources, which we believe are reliable. However, the information is provided without any warranty, express or implied, regarding its correctness. The conditions or methods of handling, storage, use, and disposal of the product are beyond our control and may be beyond our knowledge. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of the product. This MSDS was prepared and is to be used only for this product. If the product is used as a component in another product, MSDS information may not be applicable.



Safety Considerations in Small-Scale Biodiesel Production Facilities

Renewable Energy Training Center at Morrisville State College

Hani Shayya, Research Assistant

Dr. Ben Ballard, Director

Summer 2013

Introduction

The Renewable Energy Training Center (RETC) at Morrisville State College operates a “Biodiesel Production Lab” within its Aquaculture Center facility that is dedicated to the small-scale production of biodiesel fuel from waste vegetable oil feedstock. The biodiesel production system is notable as it affords unique benefits to the campus community in two distinct respects. Principally, the system facilitates education regarding alternative fuels to students in the Renewable Energy and related programs. Students are provided with hands-on training in operating the system, which reinforces several pertinent aspects of the classroom curriculum. Additionally, the system benefits the greater campus community by generating biofuel for use in college-owned machinery, from dining facility waste. Economically and environmentally, the system allows Morrisville State College and its students to fill a unique niche at the forefront of sustainability in renewable energy systems.

During the 2012-2013 school year, however, safety concerns at the facility caused the biodiesel production system to temporarily suspend operations. Correspondingly, a renovation of the system was implemented in summer 2013, with biodiesel production planned to resume in fall 2013 with a viable and safe operation for the students of the college and local community at large. This document was compiled to facilitate the renovation process by consolidating fire and environmental safety guidelines for biodiesel production systems, as outlined by government agencies and experts in the field of biodiesel technology. We hope that this document, in tandem with other RETC publications, will provide a framework for the renovation process and subsequent system operation and serve a similar function at other institutions. Additionally, it is hoped that the document will constitute a valuable resource to environmental health and safety officers and fire safety officials who may be unfamiliar with the subtleties of biodiesel production, validating the facility’s safety and commitment to current industry recommendations. As a final note, the document presents research findings on safety via a “notes” format. The notes format is utilized to encourage broad understanding of the topic in a rapid manner. If additional detail beyond what is provided in the document is desired, it is recommended that the reader consult other RETC publications such as the *Methanol Safe Handling Manual*, or the list of references that follows this document.

Research Notes:

NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION: BIODIESEL FACT SHEET

Brewing Practices:

- Ensure proper ventilation for the brewing area; consult the local fire marshal for suggestions and details.
- Ensure the biodiesel system is completely closed.
- Wear safety goggles, chemical resistant gloves, and a chemical resistant apron when working with chemicals.
- Prohibit (unsupervised) children and animals from entering the facility.
- Ensure that a functional fire extinguisher and spill kit are on site.
- Follow correct safety protocols for chemical and biodiesel storage.
 - Do not store chemicals near heat or ignition sources.
 - Store chemicals in “secondary confinement” (ex. a small container within a large one).
 - Store chemicals in High Density Polyethylene (HDPE) or other compatible containers.
 - Label all containers and include a date, if necessary.

Pertinent Rule and Regulations:

- NFPA Code 30 prohibits a facility from storing over 25 gallons of methanol. The provision also appears in NYS Building Code Chapter 3 and the Fire Protection Code of NYS Chapter 34. (See *Allowable Methanol Storage Capacities*, this statement seems inconsistent).
- Fire permits may be required. The *local fire marshal should be consulted* in this respect.
- Electrical wiring is required to meet local codes, and should be approved by a certified electrician. Note that explosion proof fixtures and equipment are recommended.
- If commercial sale of biodiesel is intended, an industrial zoning permit may be necessary.
- Building permits may be required depending on specific NYS County regulations.
- A State Pollution Discharge Elimination System (SPDES) Permit or National Pollution Discharge Elimination System (NPDES) Permit may be required depending on the amount of wastewater produced by the facility.
- If wastewater is discharged to a sewer system, that local system should be contacted first.
- Environmental Conservation Law Part 596: Hazardous Substance Bulk Storage Regulations may apply in some cases to biodiesel facilities. Such cases occur if one possess an aboveground storage tank containing a hazardous substance (or mixture with a hazardous substance) with a 185 gallon or larger capacity, an underground tank containing a hazardous substance (or mixture) of any capacity, or a non-stationary tank used to store 1,000 kg or more of a hazardous substance for 90 consecutive days or more.
- Part 595 of Environmental Conservation Law (regarding methanol and sodium hydroxide) requires reporting to the DEC in the following cases
 - Methanol: A release of 5000+ lbs. or greater than 1lb land to water.
 - Sodium hydroxide: A release of 1000+ lbs. or 100lbs. land to water.
- To report an accidental release of methanol or sodium hydroxide, contact the NYS Spills Hotline (1-800-457-7362).

- In accordance with Part 596 of Environmental Conservation Law, if biodiesel contains more than 1% (by volume or weight) methanol or sodium hydroxide, it must be considered a mixture and is subject to bulk chemical storage regulations.
- Mixing homebrewed biodiesel with petroleum diesel (in any quantity) may require prior registration with the DEC due to Part 612 of Environmental Conservation Law: Registration of Petroleum Storage Facilities.
- Note that legal concerns may be directed to the Division of Environmental Remediation (518-402-9543)
- Air Quality Regulations do not apply to biodiesel manufacture for domestic use. If equipment is operated in excess of 300 hours per year however, the DEC's 6 NYCRR Part 236 provides multiple regulations for emission control, monitoring, repair, reporting and record keeping. In this case, the DEC will require access to the facility to verify regulation compliance.
- Selling biodiesel results in Tax Law applications. Under Article 12-A of NYS Tax Law, registration with the NYS Department of Taxation and Finance and payment of appropriate excise, sales and petroleum business taxes are required.
- The US Environmental Protection Agency (EPA) requires registration if one manufactures and sells/transfers home-brewed biodiesel motor fuel (40 CFR 79.56).

PENN STATE UNIVERSITY: BIODIESEL SAFETY AND BEST MANAGEMENT PRACTICES

- Glycerol by-product and raw biodiesel (from which methanol has not yet been recovered) should be treated as if methanol (flammable and toxic).
- It seems that the MSC facility is small enough to be exempt from most regulations in PA, but we should verify for NY. (See NYS DEC codes).
- When working with NaOH/KOH use gloves and safety goggles for methanol but also use a dust mask/respirator and wear long pants, shoes.
- Be careful with oily rags, keep in an airtight metal container, bucket of water or in evacuated plastic bags (squeeze out free liquid and store safely).
- Authors suggest using "inexpensive modular metal buildings."
- Be careful with "make-up air" which should be allowed to flow when fluids are added, to prevent pressure differences (consider venting practices in this regard).
- Remain aware of transport regulations in NYS (labeling, etc.).
- Devise a methodology for removing methanol from glycerol, if one is not currently in place. This will make safety easier in the long run.
- Define local guidelines for methanol in wash water and disposal, if using a water wash system.

US ENVIRONMENTAL PROTECTION AGENCY: BIODIESEL PRODUCTION AND FIRE SAFETY

- Flash Point: The minimum temperature at which enough vapors are given off from a liquid surface to form an ignitable mixture with air.
- Flammable Liquid: A liquid with a flash point below 100°F. Sub-Classes include IA, IB, and IC.
- Combustible Liquid: A liquid with a flash point above 100°F. Sub-Classes include II, III-A and III-B.
- B100 Biodiesel: A class III-B liquid with a flash point of 266°F. While the liquid is relatively safe in and of itself. Concerns arise when considering its production, however.

- Store chemicals in approved containers (compatible). For example, methanol, a IB flammable liquid, must be stored in a grounded metal container.
- Material Safety Data Sheets should be consulted when questions pertaining to chemicals arise.
- Containers should be labeled to clearly indicate contents. Additionally, NFPA chemical hazard labels should be applied to containers as well.
- Indoors production processes should have vents to a safe location outside.
- Electrical Systems and Equipment must be reviewed for rating in hazardous areas.
- Basic safety should allow for fire extinguishers to be present in the facility, sprinklers/suppression systems to exist, and for clear/unobstructed egress from processing/storage areas to be possible.

Works Referenced:

Allen, Jason. "Biodiesel Production and Fire Safety." United States Environmental Protection Agency. Web. 1 July 2013. <epa.gov/region4/clean_energy/Day%20%20-%20ALLEN.pdf>.

"Biodiesel Fact Sheet." *Renewable Energy*. New York State Department of Environmental Conservation, 2013. Web. 1 July 2013. <<http://www.dec.ny.gov/energy/42154.html>>.

Biodiesel Safety and Best Management Practices for Small-Scale Noncommercial Use and Production. N.p.: Penn State University College of Agricultural Sciences, 2008. Web. 1 July 2013. <<http://pubs.cas.psu.edu/freepubs/pdfs/agrs103.pdf>>.



Equipment & Supplies Utilized for Biodiesel Production

Renewable Energy Training Center at Morrisville State College

Updated: September 30, 2013, by Dr. Benjamin Ballard and Hani Shayya

Introduction

The Renewable Energy Training Center (RETC) at Morrisville State College operates a “Biodiesel Production Lab” within its Aquaculture Center facility that is dedicated to the small-scale production of biodiesel fuel from waste vegetable oil feedstock. The biodiesel production system is notable as it affords unique benefits to the campus community in two distinct respects. Principally, the system facilitates education regarding alternative fuels to students in the Renewable Energy and related programs. Students are provided with hands-on training in operating the system, which reinforces several pertinent aspects of the classroom curriculum. Additionally, the system benefits the greater campus community by generating biofuel for use in college-owned machinery, from dining facility waste. Economically and environmentally, the system allows Morrisville State College and its students to fill a unique niche at the forefront of sustainability in renewable energy systems.

While the benefits outlined above are likely to encourage the implementation of biodiesel production facilities at other academic institutions, encouragement may be partially counteracted by the challenges of constructing a facility in a safe and cost-efficient manner. **The cost of a biodiesel processor is only a small portion of the total cost of a production facility that will meet institutional and code requirements.** The RETC hopes to address these challenges by providing detailed descriptions of our experiences in constructing and operating a production facility. The following document lists the equipment and supplies utilized in our facility, along with pertinent specifications and manufacturer information. It should be noted that the document is in no way intended to be an endorsement by the RETC of specific products or manufacturers. There currently exist a myriad of products developed for use in biodiesel production and thus, it is highly recommended that equipment be considered on a site-specific basis. This document is merely intended to indicate the types of products that will inevitably appear in any production facility, which will afford an estimate of production scale and cost for planning purposes. Additionally, please consider that some of the listed prices are estimates, and also that shipping costs were not included when calculating approximate prices. Shipping costs may be substantial on large items, however, so considerations should be given to this fact. As a final note, please consider that this document does not reflect the changes that may be necessary to prepare a room to house a biodiesel system. For example, the walls of a room may have to be reinforced with fire-rated sheetrock or the electrical wiring altered before production can safely occur. These changes will require additional expenditure beyond what is expressed in this document. Further information based on our experiences and research may be obtained by consulting other RETC publications on biodiesel, visiting our website at www.retc.morrisville.edu, or contacting Dr. Ben Ballard (ballarbd@morrisville.edu).

Biodiesel Production System Overview

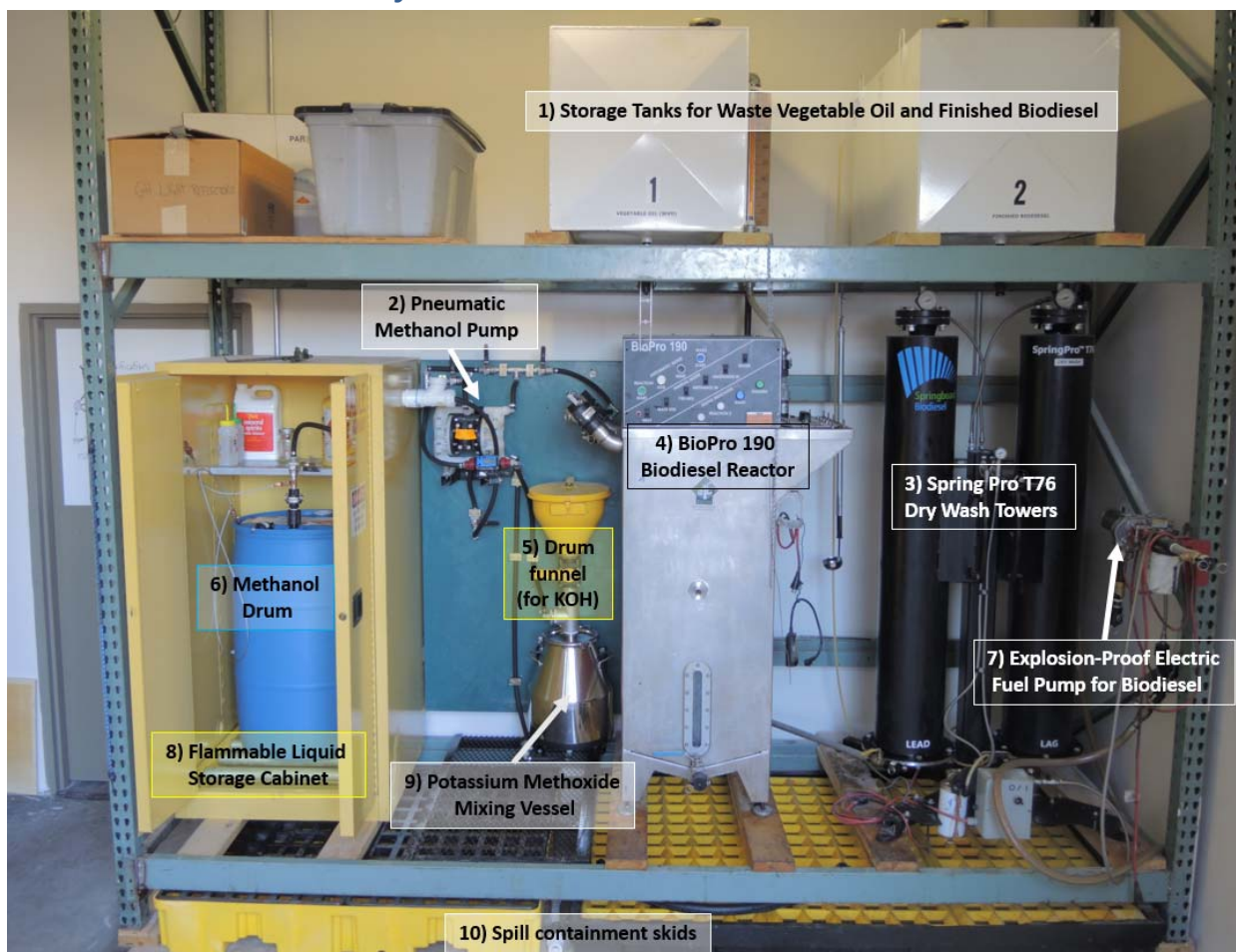





Figure 1. Morrisville State College biodiesel production system. This system produces 50-gallon batches of biodiesel using waste vegetable oil (WVO)/fryer oil from campus dining facilities as the primary feedstock. Note that the exhaust pipe for the flammables cabinet has not yet been installed in this photo.

The Morrisville State College biodiesel production system (Figure 1) has undergone numerous configurations and modifications over the past 5-6 years. The most recent modifications were made to address fire code/safety concerns associated with methanol storage and handling. The BioPro 190 includes built-in methanol and methoxide tanks. However, after several years of use, we found the mixing and dispensing system was inadequate. Local fire code also required a closed system for dispensing and transferring methanol; therefore, we added a separate, external methanol/methoxide vessel with a pneumatic pump. Additional details of the system and “Biodiesel Production Lab” facility components, including PPE and consumables, are provided in the tables below.

Reactor Vessels and Wash Systems

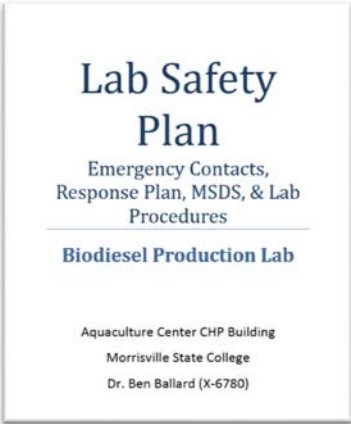



	<p>BioPro 190 Biodiesel Reactor Purpose: biodiesel processor; this is an “all-in-one” reactor for batch biodiesel processing Manufacturer: Springboard Biodiesel Approximate Price: \$9,995 Quantity Used: 1 Total Approximate Price: \$9,995</p> <p><i>Note: In addition to fire code concerns related to methanol handling, the MSC BioPro 190 developed several issues/problems after several years of use, including methoxide mixing and pumping issues, which were addressed by building a separate methanol/methoxide vessel and pumping system (see below). According to the manufacturer (Springboard Biodiesel), most of the issues that we experienced with our BioPro have been addressed with the current model. However, fire code may require a closed system for dispensing methanol into the processor (see our solution below).</i></p>
	<p>Spring Pro T76 Dry Wash Towers Purpose: Cleans/washes crude biodiesel, making finished fuel (avoids water use and disposal issues associated with water washing) Manufacturer: Springboard Biodiesel Approximate Price: \$4,985 Quantity Used:1 Total Approximate Price: \$4,985</p>
	<p>Sodium Methoxide Mixing Vessel (8 gallons)* Purpose: this is an alternative to the built in methanol/methoxide tanks in the BioPro. Manufacturer: Brewhaus (kettle vessel with 2”NPT lid only) Approximate Price: \$170 Quantity Used: 1 Stainless steel mesh basket (mounted internally to hold KOH flakes): \$30 (purchased separately) Custom welding/modification: \$110 (local welding shop added bung on bottom of vessel and a cradle to hold the SS mesh basket) Total Approximate Price: \$310 Note: additional plumbing parts are required to complete the methanol/methoxide system (see the methanol transfer system below). <i>*Also see BioPro 190 above and Fig. 1 for notes about this option.</i></p>

Storage Units




	<p>Flammable Liquid Storage Cabinet (55 gallon capacity) Purpose: methanol, isopropanol storage Manufacturer: Justrite Approximate Price: \$1,574 Quantity Used: 3* Total Approximate Price: \$4,722 <i>*Note: we store up to 3 drums of methanol on site (shipping cost is more economical when purchasing more than one drum at a time, but it does require additional storage cabinet cost)</i></p>
	<p>PPE and Supplies Cabinet (Bin & Drawer Cabinet) Manufacturer: Durham Approximate Price: \$900 Quantity Used: 1 Total Approximate Price: \$900</p>
	<p>Storage Tanks for Waste Vegetable Oil and Finished Biodiesel Purpose: Stationary holding tanks for WVO and finished biodiesel (permit gravity dispensing of biodiesel fuel and WVO into the processor) Manufacturer: Better Built, Daws Manufacturing Company Approximate Price: \$390 Quantity Used: 2 Total Approximate Price: \$780</p>
	<p>250 Gallon Biodiesel/Fuel Oil Storage Tank Purpose: Dedicated biodiesel boiler fuel tank Manufacturer: Granby Industries (Model: 204203) Approximate Price: \$500 (estimate) Quantity Used: 1 Total Approximate Price: \$500</p>
	<p>Spill Containment Units for 250 Gallon Tanks Purpose: Spill containment for dedicated biodiesel boiler fuel tank Manufacturer: Tank Tub (Oil Storage Solutions) Approximate Price: \$650 Quantity Used: 1 Total Approximate Price: \$650</p>
	<p>Oily Waste Can (6 gallons) Purpose: temporary storage of oily rags (WVO and/or biodiesel) Manufacturer: Justrite Approximate Price: \$50 Quantity Used: 1 Total Approximate Price: \$50</p>

	<p>Safety Disposal Can – Flammable Liquids (2 gallons) Purpose: temporary storage of flammable liquid waste (e.g., isopropanol from titrations) Manufacturer: Justrite (model: 12751) Approximate Price: \$175 Quantity Used: 1 Total Approximate Price: \$175</p>
	<p>Corrosive Storage Cabinet for Dry Reagents (45 gallon capacity) Purpose: Storage of Acids or Bases (stored in separate cabinets) Manufacturer: Eagle Manufacturing Approximate Price: \$1,470 Quantity Used: 1 Total Approximate Price: \$1,470</p>
	<p>“Bench-Scale” Corrosive Storage Cabinet Purpose: Storage of Acids or Bases (stored in separate cabinets) Manufacturer: SciMatCo Approximate Price: \$564 Quantity Used: 1 Total Approximate Price: \$564</p>
	<p>Spill Pallet Ramp Purpose: Ramp for loading drums onto spill skids Manufacturer: Eagle Manufacturing Approximate Price: \$227 Quantity Used: 1 Total Approximate Price: \$227</p>
	<p>Waste Glycerol Storage Drums (with drum funnel*) Purpose: temporary storage of glycerol and/or “junk” WVO Manufacturer: N/A Approximate Price: \$50 (estimate) Quantity Used: 2 Total Approximate Price: \$100 (+\$50 for one Eagle drum funnel*)</p>



Safety Equipment

	<p>Lab Safety Notebook with Emergency Contacts, Response Plan, MSDS, and Lab Procedures</p>
	<p>Eyewash Station Purpose: on-site safety Manufacturer: Bradley Corporation Approximate Price: \$459 Quantity Used: 1 Total Approximate Price: \$459</p>
	<p>ABC Multi-Purpose Dry Chemical Extinguisher (10 lbs) Purpose: on-site safety Manufacturer: Amerex Approximate Price: \$52 Quantity Used: 1 Total Approximate Price: \$52</p>
	<p>Combustible Gas Detector Purpose: on-site monitoring for methanol vapors Manufacturer: McMaster-Carr (TIF8800X) Approximate Price: \$210 Quantity Used: 1 Total Approximate Price: \$210</p>
	<p>Thermal Imaging Camera Purpose: Emergency/fire response for facilities using methanol. Manufacturer: Wahl (Heat Spy HSI300) Approximate Price: \$4,500* Quantity Used: 1 Total Approximate Price: \$4,500 *Note: local Emergency Response/Fire Dept. may already have a suitable device.</p>

Spill Containment/Response


	<p>Universal Absorbent Pads Purpose: cleaning up WVO/biodiesel drip or small spills; used extensively throughout the lab, WVO pickup, etc. Manufacturer: Pig® Approximate Price: \$98 per 100-pk Quantity Used: 1-2 pack/year Total Approximate Price: \$98-196</p>
	<p>Spill Response Supplies/Media: Universal Absorbent Pillows (\$66/24-pk) THERMOROCK Medium Grade Vermiculite (\$10/cu.ft.) Zeolite Floorsweep - ZEO10 (\$33/5 gal.)</p>
	<p>Non-Sparking Plastic Emergency Shovel Purpose: spill cleanup Manufacturer: Remco Products Approximate Price: \$30 Quantity Used: 1 Total Approximate Price: \$30</p>
	<p>Spill Containment Pallets Purpose: spill containment under methanol tank, processor, dry wash, transfer tanks, glycerol drums, etc. Manufacturer: Eagle Approximate Prices and Quantities: (1) 4 Drum Inline Skid- \$430 (1) 4 Drum Containment Pallet- \$460 (1) 2 Drum Containment Pallet- \$180 Total Approximate Price: \$1,070</p>

Personal Protective Equipment (PPE)


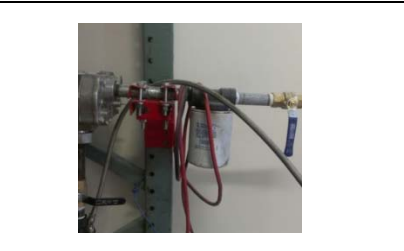
	<p>Safety Glasses/Dust Goggles Manufacturer: DeWalt, Elvex, etc. Approximate Price: \$5-15 Quantity Used: 2-5 Total Approximate Price: \$10-75</p>
	<p>Disposable Nitrile Gloves Purpose: general lab use, including WVO handling Manufacturer: Condor, etc. Approximate Price: \$12-17 per pack of 100 Quantity Used: 2-4 packs/yr. Total Approximate Price: \$24-68/yr. *Additional heavy-weight chemical resist gloves are also recommended for handling corrosives.</p>

	<p>Face Shields Manufacturer: 3M Approximate Price: \$36 Quantity Used: 2 Total Approximate Price: \$72</p>
	<p>Chemical Splash/Impact Resistant Goggles Manufacturer: Condor, 3M, UVEX, etc. Approximate Price: \$5-15 Quantity Used: 2-5 Total Approximate Price: \$10-75</p>
	<p>Lab Coats (example) Manufacturer: Condor Approximate Price: \$50 Quantity Used: 5+ Total Approximate Price: \$250+</p>
	<p>Disposable Coveralls Manufacturer: Dupont Approximate Price: \$94 per pack of 25 Quantity Used: 1 pack* Total Approximate Price: \$94 *Typically, aprons/lab coats are worn, but these are an alternative that we have on hand.</p>
	<p>Lab Aprons (example) Manufacturer: Dupont Approximate Price: \$75 per 24 pk. Quantity Used: 1 pk. Total Approximate Price: \$75</p>
	<p>Respirator and Cartridges Purpose: reduce inhalation exposure (e.g., KOH dust); Note: not suitable for methanol vapors!; also a respirator requires a fit test for each user. Manufacturer: 3M Approximate Respirator Price: \$212 Quantity Used: 1 Approximate Cartridge Price: \$34/pack of 2 Quantity Used: 1 pack Total Approximate Price: \$246</p>

Ventilation Systems

	<p>Explosion Proof Fan Unit Purpose: Provide ventilation in biodiesel production facility (vent prior to entering, and during lab use) Manufacturer: Leader Approximate Price:\$699 Quantity Used: 1 Total Approximate Price: \$699* *Excludes installation cost, wire, switches</p>
	<p>Fume Hood (we're awaiting a repurposed unit) Purpose: exhaust fumes/vapors from lab tests (titration and 3/27 test)</p>

WVO and Biodiesel Transfer Systems





	<p>Flexible Impeller* Pump for Waste Vegetable Oil Manufacturer: Dayton (3ACC1) Approximate Price: \$700 Quantity Used: 1 Total Approximate Price: \$700** * Neoprene impeller recommended for WVO/biodiesel, NOT nitrile! **Excludes cost of hoses and fittings (+\$200-\$300); we recommend cam-lock style fitting for hoses (e.g., Banjo cam-lock couplers, see methanol system table)</p>
	<p>Explosion-Proof Electric Fuel Pump for Biodiesel Manufacturer: GPI, Standard equipment on the BioPro 190. Approximate Price: N/A Quantity Used: 1 Total Approximate Price: N/A <i>Note: We have rarely use this pump after we installed the "finished biodiesel" tank elevated above the processor, since we can gravity dispense the fuel.</i></p>

Methanol Pumping/Transfer/Mixing System*

*Note that the BioPro 190 includes built-in methanol and methoxide tanks, so this may not be necessary for some installations. However, after several years of use, we found the mixing and dispensing system was inadequate. Local fire code also required a closed system for dispensing and transferring methanol; therefore, we added a separate, external system with a pneumatic pump to dispense, mix and transfer methanol/methoxide.

	<p>Pneumatic Pump (Methanol Compatible) Purpose: an “explosion-proof” method of transferring methanol/methoxide to reactor vessels Manufacturer: All-Flo (Model: KT-05-P25) Approximate Price:\$1,118 Quantity Used: 1 Total Approximate Price: \$1,118</p>
	<p>30-Gallon Air Compressor (2HP, 155 PSI) Manufacturer: Kobalt Approximate Price: \$460 Quantity Used:1 Total Approximate Price: \$460</p>
	<p>Compressed Air Dryer Purpose: Extend the life of the pneumatic pump Manufacturer: Central Pneumatic Industrial Approximate Price: \$400 Quantity Used: 1 Total Approximate Price: \$400</p>
	<p>BANJO Cam-lock Couplers Purpose: Used extensively throughout the system to transfer liquids (WVO, methanol/methoxide, biodiesel) Manufacturer: Banjo (Purchased through Grainger) Approximate Price: \$4-\$10 ea. Quantity Used: 20-30+ Total Approximate Price: \$200-300</p>
	<p>Flowmeter, Turbine (1/2” FNPT) Purpose: methanol compatible meter for accurate dispensing Manufacturer: GPI (purchased through Grainger) Approximate Price: \$908 Quantity Used: 1 Total Approximate Price: \$908</p>
	<p>Suction tube (1” FNPT) Purpose: methanol dispensing from 55-gal.drum Manufacturer: Dayton (purchased through Grainger) Approximate Price: \$25-30 Quantity Used: 1 Total Approximate Price: \$25-30</p>

	<p>Santoprene Tubing (1/2" inside diameter, 50ft.) Purpose: transferring methanol, methoxide Manufacturer: Grainger Approximate Price: \$108 (50 ft. roll) Quantity Used: 1 (with plenty to spare/future repairs) Total Approximate Price: \$108 *please note that either Kynar or Santoprene tubing may be utilized in the facility</p>
	<p>Kynar Tubing (1/2" Inner Diameter, 25ft.) Manufacturer: Cole-Parmer Approximate Price: \$168 Quantity Used: (1 if Santoprene not used) Total Approximate Price: (\$168) *please note that either Kynar or Santoprene tubing may be utilized in the facility</p>
	<p>THOGUS Adapter, 1/2" Barb, Purpose: methanol-compatible barbed-NPT fittings for connecting Kynar or Santoprene tubing Manufacturer: Thogus Approximate Price: \$19 per pack of 5 Quantity Used: 3 packs Total Approximate Price: \$57</p>
	<p>Elbow, Thread to Barb, 1/2" Purpose: methanol-compatible barbed-NPT fittings for connecting Kynar or Santoprene tubing Manufacturer: Eldon James (purchased through Grainger) Approximate Price: \$25 Quantity Used: 2 Total Approximate Price: \$50</p>
	<p>Stainless Steel Ball Valve, FNPT- 1/2" Purpose: manifold for methanol/methoxide transfer Manufacturer/supplier: Grainger Approximate Price: \$41 Quantity Used: 6 Total Approximate Price: \$246</p>
	<p>Swing Check Valve, 1/2" NPT, 316 Stainless Steel Purpose: methanol/methoxide transfer plumbing Manufacturer: Grainger Approximate Price: \$90 Quantity Used: 2 Total Approximate Price: \$180</p>

	<p>1/2" 304 Stainless Steel, Nipples, T's Purpose: methanol/methoxide transfer plumbing Manufacturer: Grainger Approximate Price: \$15 Quantity Used: 3-6 Total Approximate Price: \$45-90</p>
	<p>Beta Clamp Assembly, Single, 1/2 In Pipe Purpose: mounting methanol/methoxide transfer plumbing to green board Manufacturer: ZSI (purchased from Grainger) Approximate Price: \$4 Quantity Used: 14 Total Approximate Price: \$56</p>
	<p>Safety drum funnel, NPT 2" Purpose: funnel for KOH addition into methoxide tank Manufacturer: Justrite Approximate Price: \$310* Quantity Used: 1 Total Approximate Price: \$310* *Note: we had this funnel on hand, and repurposed it for this system; other alternatives may be better suited/more economical for the purpose.</p>
	<p>Polypropylene Ball Valve, FNPT, 2" Purpose: port for KOH addition into methoxide tank Manufacturer: Banjo (purchased through Grainger) Approximate Price: \$50 Quantity Used: 1 Total Approximate Price: \$50</p>

Laboratory Equipment & Supplies



Digital Balance

Purpose: Measuring KOH for biodiesel Manufacturer: Adam Equipment (Model: WBW-9a)

Approximate Price: \$190

Quantity Used: 1

Total Approximate Price: \$190



Titration Apparatus*

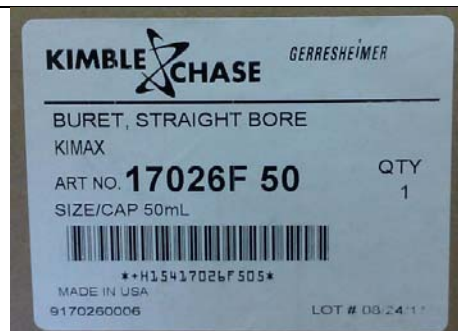
Purpose: titration of WVO for free fatty acids to determine quantity of KOH catalyst required for a batch of biodiesel

Manufacturer: Fisher Scientific, etc.

Total Approximate Price: \$350-450

*Requires: mechanical stirrer, magnetic stir bar, 50-ml buret, buret clamp, ring stand, 150-ml beaker(s), 50-ml graduated cylinder (Nalgene, shatterproof), disposable pipettes, chemical dispensing bottles and eye dropper.

Reagents: KOH solution, phenolphthalein indicator (see Chemical Reagents table below)



KIMBLE CHASE GERRESHEIMER

BURET, STRAIGHT BORE

KIMAX

ART NO. **17026F 50**

QTY
1

SIZE/CAP 50mL



**H15417026F505*

MADE IN USA
917026006

LOT # 08/24/17



Aquamax Coulometric Karl Fischer Titrator

Purpose: determining water content of WVO and finished biodiesel

Manufacturer: GR Scientific (Aquamax)

Approximate Price: \$6500

Quantity Used: 1

Total Approximate Price: \$6500 + reagents

*Note: a cost-effective alternative to KF titration is the **Sandy Brae water test kit**

(<http://www.sandybrae.com/watertest.htm>, ~\$325 for deluxe kit, plus extra reagents)



KF titration reagents: Hydranal Coulomat CG and Hydranal Coulomat AG-H



3/27 Biodiesel test supplies

Purpose: The 3/27 test can be used as a qualitative assessment of conversion of oil to biodiesel.

Total Approximate Price: \$75





Supplies include: 50-ml centrifuge tube, 3-ml disposable pipette with 0.5 ml graduations, methanol dispensing bottle, centrifuge/test tube rack



3-ml disposable pipettes with 0.5 ml graduations

50-ml centrifuge tubes

Chemical Reagents for Biodiesel Production

	<p>Methanol (55 gallon drum) Purpose: Primary reagent/ingredient for making biodiesel; also used for fuel testing (3/27 test) Manufacturer: Pharmco-Aaper Approximate Price: \$150 (with state contract)</p>
	<p>Isopropyl Alcohol: 99% Purity (5 gallons) Purpose: Solvent for testing oil and biodiesel (titrations) Manufacturer: Pharmco-Aaper Approximate Price: \$42 (with state contract)</p>
	<p>Potassium Hydroxide (3 kg bottle) Purpose: Primary reagent/ingredient for making biodiesel Manufacturer: Fisher Scientific Approximate Price: \$135 per case of 4 Quantity Used: ~2.5 kg per 50-gal. batch</p>
	<p>Phenolphthalein indicator 0.1% (w/v) in 50% isopropanol Purpose: used in free fatty acid determination (titration) Manufacturer: Ricca Chemical Company Approximate Price:</p>

We perform additional feedstock and biodiesel fuel quality test procedures in the Biofuels Lab, located on the main campus. Because these additional tests are not required for biodiesel production, the lab equipment, materials and supplies for those procedures have not been included here. For further information, please contact Dr. Ben Ballard (ballarbd@morrisville.edu).

Photo credit (external sources):

- The following photos were obtained from the Graingers.com website: lab coat, apron, face shield, safety goggles, flexible impeller pump, non-sparking shovel
- The air compressor photo was obtained from the Lowe.com website.