

TESC Farmhouse Biodiesel Project

Processor Manual

Thank you (in no particular order) to: David Rack, Sam Stout, and Kolby Bray-Hoagland for starting the Evergreen Biodiesel Project; our faculty and staff, Melissa Barker, E.J. Zita, Dave Muehleisen, Marty Beagle and Michelle Bartlette; The Evergreen State College Clean Energy Committee for their funding; the students of Practice of Sustainable Agriculture Program and the Organic Farm caretakers, for their continuing support; and Energy Systems students Sara Keehfuss, Burke Anderson, Brodie Pettit (the Biodiesel Buccaneers) and Andrew York for their research assistance.

3rd Edition: Revised March 2008

Written and compiled by:
Megan P. Ellis-Treasure and John S. Kemp

Edited By:
Megan P. Ellis-Treasure

The Evergreen Biodiesel Processor Manual

Table of Contents

Introduction	4
Project History	
Current Project	
Emergency Prevention Checklist	5
Safety Procedure	6
Emergency numbers	
Lab Rules	
Emergency Procedures	
Fire	
Chemical spills, on people, clean-up	
Chemical Storage and Transportation	
Chemical Fact Sheets	12
Methyl Alcohol	
Potassium Hydroxide	
Operation Procedure	26
Retrieval, Transit and Measurement	26
Materials	
Methods and Procedures	
Laboratory Tests	27
Materials	
Methods and Procedures	
Quality Tests	
Biodiesel Production and Procedure	29
Transesterification	
Heating	
Draining Glycerin	
Washing	
Filtering	
Quality Tests	
Maintenance Manual	33
Future Improvements and Goals	40
Resources	41
Human Resources	
Emergency Contacts (also see Safety Procedure Manual)	
Biodiesel Resources	
Credits and Bibliography	42

Before you begin; familiarize yourself with the Biodiesel Safety, Chemical Safety, Operation Procedure, and Maintenance Manuals.

INTRODUCTION

The Evergreen Biodiesel Project's mission is to build, refurbish and establish a permanent, safe, and user-friendly bio-diesel processing facility infrastructure. The infrastructure of the Biodiesel Project includes: a processing unit (located on Evergreen's Organic Farm), a collection barrel (located in the basement of the CAB), and a transit barrel. By converting spent vegetable oil into useable biodiesel, the Biodiesel Project supplies Evergreen's Organic Farm tractors with a renewable fuel. In addition, the Biodiesel Project aims to be a model for other schools and state institutions that aspire to produce biodiesel on-site.

The Evergreen State College consumes roughly 3,500 gallons of petroleum diesel fuel annually. Of the various diesel vehicles at Evergreen, the Organic Farm possesses two four-cylinder Kubota tractors. The two tractors consume roughly 10 gallons of diesel fuel per week. On a weekly basis the cafeteria at Evergreen disposes of roughly 20 gallons of spent vegetable oil, at a cost of \$50 per month. By using the spent vegetable oil, the Biodiesel Project will be able to produce roughly 500 gallons of biodiesel annually and fully suffice the Organic Farm's diesel requirements. The 500 gallons of renewable fuel will displace 17 percent of the campus's annual petroleum diesel consumption. In addition, the user-friendly biodiesel infrastructure will be an excellent learning tool for faculty, students and staff in various applications.

In the winter of 2004, David Rack, Sam Stout, and Kolby Bray-Hoagland researched and designed a processing unit. In the spring of 2004, David and Kolby fabricated the various components, utilizing the campus metal shop. In the summer of 2004, Kolby and Sam installed the processing unit and built a fume hood, a filtered collection barrel, and a transit barrel. In the fall of 2004, Kolby and Sam wrote a Safety Manual, Procedure Manual, Maintenance Manual, and other related written aids for the operation and upkeep of the Biodiesel Project. Over the fall, Sam performed test batches in order to determine the quality of the spent oil. In the spring of 2005, the Biodiesel Project became fully operational.ⁱ

The facility was out of operation for a little over a year when the newest team brought it back into production. John Kemp, Megan Ellis-Treasure, and their team began safety-testing the facility in spring of 2007. The team refurbished the main reactor, tested all equipment, performed mini-test batches in the Laboratory, created a new version of the Evergreen Biodiesel Project Operation and Safety Manual, and have produced several full-scale batches of biodiesel.

The Biodiesel Team applied for a grant, Winter 2008, and was awarded funds though the Evergreen Clean Energy Committee to repair and renovate the existing

Biodiesel Facility.ⁱⁱ During winter quarter 2008, Megan and John purchased and installed new heating elements and insulation on the main biodiesel reactor. They are operating the facility and maximizing the turnaround time, energy efficiency and quality of the final product, based on previous research and experience with the equipment.

Emergency Prevention Checklist

- **Read-** Thoroughly read safety manual and MSDS of chemicals.
- **Ventilation-** Make sure the exhaust fan is operating properly when turning the unit on. When in the work area, the fan should remain on **EXCEPT** in the case of a methanol spill.
- **Check Processing Unit-** Carefully look over the processing unit's joints and connections to prevent leaks. Pay particular attention to the connection of the plastic carboy (Catalyst/Reactant vessel) to the ½" steel pipe.
- **Protective Clothing and Attire-** Every person present throughout the production of biodiesel (heating, processing, draining, and washing) must have pants and close-toed shoes. When there is the threat of contact with lye or methanol, participants must wear gloves (Butyl or Nitrile), a protective chemical apron, and goggles.
- **Observe!!!-** Every person present throughout the production of biodiesel must know where the emergency phone is located (the blue pole next to the work room). Participants must know where the fire-extinguishers, first aid kit, wash-station, and spill kits are located before any switch is turned or chemical unsealed (See Safety Map).
- **Wash-** Wash hands and necessary equipment thoroughly after operating or handling.
- **Make Sure-** Make sure the methanol container sits steady when pumping into catalyst carboy. The metal container must be grounded using the alligator to prevent a possible spark.
- **Empty Containers-** Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Close all containers tightly and store properly, even 'empty' containers. Label "MT"
- **Never Operate Alone-** Never operate the biodiesel processor alone. The buddy system is required in order to operate the system at all times.
- **No Smoking or Open Flame-** Make sure that nobody is smoking or has an open flame near or around the doors of the shed

SAFETY PROCEDURE

The following information contains excerpts from TESC Lab Safety Manual.ⁱⁱⁱ Megan Ellis-Treasure modified this Edition March 2008. **Please read the entire Lab Safety Manual and be familiar with it before proceeding.** The Biodiesel Project Operators are responsible for obtaining any additional chemical fact sheets or safety information when operation modifications are made.

(The Lab Safety Manual may be obtained from TESC Lab Stores or by downloading it from:
http://scicomp.evergreen.edu/images/lab_safety_manual.pdf)

General Emergency Procedures:

Know the locations and proper use of each piece of emergency equipment in the biodiesel Production Facility and Lab space. This packet provides the knowledge of the following:

Spill Kits	Exits
Eye Wash	First Aid Kits
Fire Extinguishers	Telephones
Personal Protective Equipment	

If an emergency occurs, the first concern is for the health and safety of people in the area; property damage is secondary.

- Alert co-workers in the area of danger.
- Assess the severity of the emergency.
- Based upon the severity of the emergency, Call for Help.

Telephone Locations

1. The blue emergency phone outside the farm workroom calls Police Services.
2. There is a phone inside the farm workroom that requires dialing 9 for any outside call. Dialing 9 is not required for calling campus extensions.

Extreme Emergency

	McLane Fire Dept	9-911
	TESC Police Services	x6140
M-F, 8 am – 5 pm	Lab Stores	x6489
Poison Center:		0-800-542-6319
Environmental Health and Safety:	Lab II, 1265	x6111
Building Maintenance Problems:	(8 am to 5 pm) Facilities	x6120
	(after hours) Steam Plant	x6318

When reporting an emergency, give:

- Building, room number, or other location
- Nature of the emergency
- The number you are calling from
- Your name

Evacuate the area and keep people from re-entering before help arrives.

IF UNSURE OF THE SEVERITY, CALL POLICE SERVICES ON THE BLUE EMERGENCY PHONE or X6140 FROM INSIDE THE WORK ROOM.

Don't hesitate to ask for immediate help. Your health and safety are important!

Do not attempt to move an unconscious person unless you know the nature of the emergency.

MANDATORY LAB AND STUDIO RULES

These rules apply to all individuals utilizing the science and art labs at The Evergreen State College. Violation of any of the following rules is cause for disciplinary action including forfeiture of laboratory use privileges. Everyone is responsible for complying with the safe practices and rules set forth in this manual in addition to complying with all legal regulations governing laboratory work and handling and disposal of chemicals and hazardous materials.

If any of these rules are unclear, ask the lab staff for clarification.

- Shoes are required in the Biodiesel Facility and all Lab buildings at all times.
- Food and drink are prohibited in Biodiesel Facility and all lab rooms, including gum and chewing tobacco. Do not store food or beverages in the facilities. You or your food may be removed from the lab if this rule is not followed.
- Mouth pipetting is prohibited.
- Eye protection must be worn when doing chemical work and in chemical handling and storage areas. When there is a possibility of violent reaction, goggles, face shield or portable explosion shield must be used. Wearing contact lenses with goggles or face shields is not recommended.
- Closed-toed shoes and long pants or long skirts are required when working with chemicals.

You must limit exposed skin as much as possible. If you wear inappropriate clothing for lab, you will not be allowed to participate. Lab coats and protective gloves as well as goggles, are recommended at all times when handling chemicals.

- Hair that is shoulder length or longer must be pulled back. Long, loose sleeves, jewelry, etc. must also be secured to prevent being caught or dragged. Wash hands thoroughly after working in the lab.
- Backpacks and coats should not be stored on lab tables or on the floor. Cubbies are provided for storage of personal items. In order to keep the cubbies clean, no chemicals, glassware, specimens, etc. may be stored in them.
- It is the responsibility of the individual using chemicals or equipment to know the associated hazards of each and to handle them accordingly.
- All chemical containers must be clearly labeled with contents, date, hazards and a HMIS rating label including the MSDS number (see Section IV-B and IV-C). When you transfer chemicals, label the new container with your name and date as well as the above information.

FIRE

PREVENTION

Eliminating the source of ignition can prevent fires. When working with

flammable materials, consider all potential sources of ignition: open flames, sparks, electrical sparks from motors, etc.

GENERAL - WHEN A FIRE OCCURS

Prompt action may prevent small fires from getting out of control. Alert others in the area of the fire and send someone for help. Placing an inverted beaker or a watch glass over the fire can smother small fires in glassware.

If the fire is too large to smother, evacuate the area. Only people trained in fire extinguisher use should attempt to fight the fire.

NEVER ATTEMPT TO FIGHT A FIRE ALONE.

When fighting a fire, put yourself between the fire and the exit to ensure a means of escape. If the fire can't be immediately controlled, call the fire department at 9-911. Pull the alarm located by the exits and stairways in each lab building. Try to contain the fire to the lab area by closing fume hood sashes, windows, and the doors to the lab as you leave.

PEOPLE

If clothing, skin, or hair catches fire, drop to the ground and roll to smother the flames. You may need to help push the person to the ground to prevent them from running and fanning the flames. Safety showers are in or near all lab rooms, and can also be used to put out a fire. Send someone to call for help, 9-911

METALS

Metal fires cannot be extinguished with regular extinguishers. Use a Class D fire extinguisher or sand to smother the fire (CO₂ and dry chemical extinguishers will intensify some types of metal fires). Before starting work with metals such as Sodium, Potassium, or powdered Aluminum or Magnesium, check that there is sand or a Class D fire extinguisher located in your area.

CHEMICAL SPILLS

Consider what to do in the event of a spill before starting a project. Spills may cause serious health and environmental problems if not handled correctly. Familiarity with chemical hazards and the proper spill control measures will help minimize the effects of a chemical spill. Again, the first concern is for the health and safety of the people in the area; property damage is secondary.

CHEMICAL SPILLS, GENERAL PROCEDURES

Immediately alert co-workers in the area of the danger. Assess the severity of the emergency. Consider the possibility of exposure through contact, inhalation, and the increased fire hazard associated with flammable materials. Based upon your best judgment of priorities, and knowledge of the chemical, Call for Help:

	Emergency	
McLane Fire Dept.		9-911
M-F 8am to 5pm	Lab Stores	x6489
Evenings and Weekends	Security	x6140 (0)

If necessary, you may need to pull the fire alarm, and/or evacuate the area and keep people from re-entering before help arrives.

The person spilling the chemical is responsible for contacting lab staff/faculty as soon as the severity of the spill allows. Minor spills not involving human contact should be contained whenever possible. Depending on the hazard and size of the spill, lab staff/faculty will either direct the person responsible to clean up the spill or perform the clean up themselves. Anyone noticing a leak or spill is also responsible for contacting lab staff/faculty to initiate the clean up process.

Spill kits are located in every lab room. These should be found in the lab reconnoiter exercise that accompanies the safety quiz. Before any chemical experiment begins, learn how to use the spill kits: that is, the proper absorbent and the proper neutralizer for the type of spill.

CLEAN-UP PROCEDURE

Methanol:

- Turn off pump, heat strap and fan.
- Open both doors to create a draft and leave the room.
- Notify others in the vicinity.

Methoxide:

- Turn off pump, heat strap and fan.
- Open both doors to create a draft and leave the room.
- Notify others in the vicinity.
- Cover the spilled area with bicarbonate from the caustic spill kit.
- Scoop up with a plastic tool.
- Place into a suitable container for disposal.

Glycerin, Biodiesel, or Oil:

- Apply itty litter to soak up liquid.
- Scoop up with a non-sparking tool.
- Place into a suitable container.

CHEMICAL SPILLS ON PEOPLE

If a chemical is spilled on a person, IMMEDIATELY rinse the exposed area of the body and continue rinsing for 15 minutes. Use an eyewash station, emergency shower, or the sink to rinse the exposed area. Consult the MSDS for information on any delayed bodily reactions.

Notify the person in charge to fill out an Accident Report.

Eyes are extremely susceptible to chemical burns. Prompt and continued rinsing (for 15 minutes) can prevent severe eye damage. If your lab partner has a chemical splashed in

their eye, you should assist them to the eyewash and ensure they rinse for the full 15 minutes, even if it is uncomfortable. Seek medical attention as soon as possible, and bring the MSDS with you to the emergency room or physician's office.

In the event the spill contaminates clothing, remove all contaminated clothing and rinse the exposed area for 15 minutes. Extra clothing is available at Lab Stores.

If the exposure is severe, someone in the area must call 9-911 to get paramedics on the scene.

Be sure to continue rinsing the exposed areas until directed to stop by the paramedics.

In the case of minor exposures: rinse affected areas for a minimum of 15 minutes, seek medical attention, and bring the MSDS with you.

FLAMMABLE MATERIALS

If flammable materials have been spilled, immediately eliminate all sources of ignition.

Unplug all electrical devices, extinguish open flames, etc. Absorb the material quickly with the appropriate spill absorbent, and call Lab Stores.

CHEMICAL STORAGE

Incompatible chemicals are chemicals that have potential for a violent reaction with each other (examples of specific incompatible chemicals are listed in Appendix 6).

Hazardous chemicals (for storage definition) are chemicals with any HMIS category rating greater than 2.

General Guidelines:

- Date all chemicals when received and opened.
- Inventory annually, checking dates, condition, and amounts. Check particularly for ethers and peroxide forming materials, and discard within one year of opening.
- Avoid storing hazardous chemicals above eye level.
- Do not store chemical containers on the floor.
- Open shelves must have lips or doors to prevent bottles from slipping off.
- Any chemicals left unattended for ANY length of time must be stored in a closed container and properly labeled with name, date, program, chemical name(s), and concentration.
- Keep incompatible chemicals separated.
- Select an appropriate container (see Section IX-B and Appendix 7).
- Store away from heat and direct sunlight.
- Segregate bottles of chemicals in plastic tubs to contain any spill and maintain separation.
- For temporary storage, non-hazardous chemicals should be stored at the rear of a counter or in the center of an island.
- Hazardous chemicals are to be stored in a fume hood or vented cabinet.

TRANSPORTING CHEMICALS

The level of care and protection needed to transport a chemical must match the potential hazards of the chemical. This requires knowledge of the hazards associated with the chemical in transport and knowledge of protective measures.

All chemicals must be placed in secondary containment while in transport. Acid buckets and plastic tubs are available from Lab Stores.

Transport incompatible chemicals separately; place incompatible chemicals in separate carriers. All concentrated acids and bases must be carried in acid carriers. Use care when crossing the thresholds between the lab buildings. It is recommended to use the connecting basement level between Lab I and Lab II to avoid thresholds, extra doors, uneven surfaces and inclement weather.

Do not ride the elevator when transporting volatile chemicals. Label the cart "Do not ride with this elevator," send the cart up the elevator, and walk up the stairs to meet it. If the elevator breaks down, you do not want to be trapped in a small space with volatile and hazardous chemicals.

CHEMICAL FACT SHEETS^{iv}

METHYL ALCOHOL

MSDS Number: **M2015** * * * * * *Effective Date: 08/10/04* * * * * * *Supersedes: 11/12/01*

MSDS MATERIAL SAFETY DATA SHEET

CHEMTREC: 800-424-9300 (USA)
703-527-3887(Outside USA and Canada)
CANUTEC: 613-996-6666

From: Mallinckrodt Baker, Inc
222 Red School Lane

Phillipsburg, NJ 08865

NOTE: Use CHEMTREC and CANUTEC
phone numbers only in the event
of a chemical emergency.

Emergency Telephone Number: 908-859-2151

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

M A L L I N C K R O D T

J. T. B A K E R

METHYL ALCOHOL

1. Product Identification

Synonyms: Wood alcohol; methanol; carbinol

CAS No.: 67-56-1

Molecular Weight: 32.04

Chemical Formula: CH₃OH

Product Codes:

J.T. Baker: 5217, 5370, 5794, 5811, 5842, 5869, 9049, 9063, 9065, 9066, 9067, 9069, 9070, 9071, 9073, 9075, 9076, 9077, 9091, 9093, 9096, 9097, 9098, 9263, 9822, 9830, V654

Mallinckrodt: 3004, 3006, 3016, 3017, 3018, 3024, 3041, 3701, 4295, 5160, 8814, H080, H488, H603, H985, V079, V571

2. Composition/Information on Ingredients

Ingredient -----	CAS No -----	Percent -----	Hazardous -----
Methyl Alcohol	67-56-1	100%	Yes

3. Hazards Identification

Emergency Overview

POISON! DANGER! VAPOR HARMFUL. MAY BE FATAL OR CAUSE BLINDNESS IF SWALLOWED. HARMFUL IF INHALED OR ABSORBED THROUGH SKIN. CANNOT BE MADE

<http://content.msdsonline.com/dataentrypdfs/MKH48810.htm> (1 of 7) [3/10/2006 1:23:55 AM]

METHYL ALCOHOL

NONPOISONOUS. FLAMMABLE LIQUID AND VAPOR. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM AND LIVER.

SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)

Flammability Rating: 3 - Severe (Flammable)

Reactivity Rating: 1 - Slight

Contact Rating: 3 - Severe (Life)

Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER

Storage Color Code: Red (Flammable)

Potential Health Effects

Inhalation:

A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Once absorbed into the body, it is very slowly eliminated. Symptoms of overexposure may include headache, drowsiness, nausea, vomiting, blurred vision, blindness, coma, and death. A person may get better but then worse again up to 30 hours later.

Ingestion:

Toxic. Symptoms parallel inhalation. Can intoxicate and cause blindness. Usual fatal dose: 100-125 milliliters.

Skin Contact:

Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure.

Eye Contact:

Irritant. Continued exposure may cause eye lesions.

Chronic Exposure:

Marked impairment of vision has been reported. Repeated or prolonged exposure may cause skin irritation.

Aggravation of Pre-existing Conditions:

Persons with pre-existing skin disorders or eye problems or impaired liver or kidney function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Ingestion:

Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Skin Contact:

Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:

Flash point: 12C (54F) CC

Autoignition temperature: 464C (867F)

Flammable limits in air % by volume:

lel: 6.0; uel: 36

Flammable Liquid and Vapor!

Explosion:

Above flash point, vapor-air mixtures are explosive within flammable limits noted above. Moderate explosion hazard and dangerous fire hazard when exposed to heat, sparks or flames. Sensitive to static discharge.

Fire Extinguishing Media:

Use alcohol foam, dry chemical or carbon dioxide. (Water may be ineffective.)

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Use water spray to blanket fire, cool fire exposed containers, and to flush non-ignited spills or vapors away from fire. Vapors can flow along surfaces to distant ignition source and flash back.

6. Accidental Release Measures

Ventilate area of leak or spill. Remove all sources of ignition. Wear appropriate personal protective equipment as specified in Section 8. 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 (e. g., vermiculite, dry sand, earth), 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. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker SOLUSORB® solvent adsorbent is recommended for spills of this product.

7. 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 (vapors, liquid); observe all warnings and precautions listed for the product. Do Not attempt to clean empty containers since residue is difficult to remove. Do not pressurize, cut, weld, braze, solder, drill, grind or expose such containers to heat, sparks, flame, static electricity or other sources of ignition: they may explode and cause injury or death.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

For Methyl Alcohol:

METHYL ALCOHOL

- OSHA Permissible Exposure Limit (PEL):

200 ppm (TWA)

- ACGIH Threshold Limit Value (TLV):

200 ppm (TWA), 250 ppm (STEL) skin

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details. Use explosion-proof equipment.

Personal Respirators (NIOSH Approved):

If the exposure limit is exceeded and engineering controls are not feasible, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus. Breathing air quality must meet the requirements of the OSHA respiratory protection standard (29CFR1910.134). This substance has poor warning properties.

Skin Protection:

Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure.

Eye Protection:

Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:

Clear, colorless liquid.

Odor:

Characteristic odor.

Solubility:

Miscible in water.

Specific Gravity:

0.8

pH:

No information found.

% Volatiles by volume @ 21C (70F):

100

Boiling Point:

64.5C (147F)

Melting Point:

-98C (-144F)

Vapor Density (Air=1):

1.1

Vapor Pressure (mm Hg):

97 @ 20C (68F)

Evaporation Rate (BuAc=1):

5.9

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

METHYL ALCOHOL

May form carbon dioxide, carbon monoxide, and formaldehyde when heated to decomposition.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

Strong oxidizing agents such as nitrates, perchlorates or sulfuric acid. Will attack some forms of plastics, rubber, and coatings. May react with metallic aluminum and generate hydrogen gas.

Conditions to Avoid:

Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Methyl Alcohol (Methanol) Oral rat LD50: 5628 mg/kg; inhalation rat LC50: 64000 ppm/4H; skin rabbit LD50: 15800 mg/kg; Irritation data-standard Draize test: skin, rabbit: 20mg/24 hr. Moderate; eye, rabbit: 100 mg/24 hr. Moderate. Investigated as a mutagen, reproductive effector.

-----\Cancer Lists\-----

Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Methyl Alcohol (67-56-1)	No	No	None

12. Ecological Information

Environmental Fate:

When released into the soil, this material is expected to readily biodegrade. When released into the soil, this material is expected to leach into groundwater. When released into the soil, this material is expected to quickly evaporate. When released into the water, this material is expected to have a half-life between 1 and 10 days. When released into water, this material is expected to readily biodegrade. When released into the air, this material is expected to exist in the aerosol phase with a short half-life. When released into the air, this material is expected to be readily degraded by reaction with photochemically produced hydroxyl radicals. When released into air, this material is expected to have a half-life between 10 and 30 days. When released into the air, this material is expected to be readily removed from the atmosphere by wet deposition.

Environmental Toxicity:

This material is expected to be slightly toxic to aquatic life.

13. Disposal Considerations

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.

14. Transport Information

Domestic (Land, D.O.T.)

METHYL ALCOHOL

Proper Shipping Name: METHANOL
Hazard Class: 3
UN/NA: UN1230
Packing Group: II
Information reported for product/size: 358LB

International (Water, I.M.O.)

Proper Shipping Name: METHANOL
Hazard Class: 3, 6.1
UN/NA: UN1230
Packing Group: II
Information reported for product/size: 358LB

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\-----
Ingredient TSCA EC Japan Australia

Methyl Alcohol (67-56-1) Yes Yes Yes Yes

-----\Chemical Inventory Status - Part 2\-----
Ingredient Korea DSL NDSL Phil.

Methyl Alcohol (67-56-1) Yes Yes No Yes

-----\Federal, State & International Regulations - Part 1\-----
Ingredient -SARA 302- -SARA 313-
RQ TPQ List Chemical Catg.

Methyl Alcohol (67-56-1) No No Yes No

-----\Federal, State & International Regulations - Part 2\-----
Ingredient CERCLA -RCRA- -TSCA-
261.33 8(d)

Methyl Alcohol (67-56-1) 5000 U154 No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: Yes Pressure: No
Reactivity: No (Pure / Liquid)

Australian Hazchem Code: 2PE
Poison Schedule: S6
WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **1** Flammability: **3** Reactivity: **0**

Label Hazard Warning:

POISON! DANGER! VAPOR HARMFUL. MAY BE FATAL OR CAUSE BLINDNESS IF SWALLOWED. HARMFUL IF INHALED OR ABSORBED THROUGH SKIN. CANNOT BE MADE NONPOISONOUS. FLAMMABLE LIQUID AND VAPOR. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM AND LIVER.

Label Precautions:

Avoid breathing vapor.
Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling.
Keep container closed.
Use only with adequate ventilation.
Keep away from heat, sparks and flame.

Label First Aid:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. In all cases get medical attention immediately.

Product Use:

Laboratory Reagent.

Revision Information:

No Changes.

Disclaimer:

Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.

Prepared by: Environmental Health & Safety

Phone Number: (314) 654-1600 (U.S.A.)

MSDS Material Safety Data Sheet	24 Hour Emergency Telephone: 908-859-2151 CHEMTREC: 1-800-424-9300
	National Response in Canada CANUTEC: 613-996-6666
From: Mallinckrodt Baker, Inc. 222 Red School Lane Phillipsburg, NJ 08865	Outside U.S. and Canada Chemtrec: 703-527-3887
 	NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

POTASSIUM HYDROXIDE

1. Product Identification

Synonyms: Caustic potash; potassium hydrate
CAS No.: 1310-58-3
Molecular Weight: 56.11
Chemical Formula: KOH
Product Codes:
J.T. Baker: 3140, 3141, 3146, 3150, 3152, 5685
Mallinckrodt: 6964, 6976, 6984, 7704, 7815

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Potassium Hydroxide	1310-58-3	85 - 90%	Yes
Water	7732-18-5	10 - 15%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! CORROSIVE. CAUSES SEVERE BURNS TO SKIN, EYES, RESPIRATORY TRACT, AND GASTROINTESTINAL TRACT. MATERIAL IS EXTREMELY DESTRUCTIVE TO ALL BODY TISSUES. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED.

SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 2 - Moderate
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White Stripe (Store Separately)

Potential Health Effects

Inhalation:

Severe irritant. Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on the severity of exposure. Symptoms may include coughing, sneezing, damage to the nasal or respiratory tract. High concentrations can cause lung damage.

Ingestion:

Toxic! Swallowing may cause severe burns of mouth, throat and stomach. Other symptoms may include vomiting, diarrhea. Severe scarring of tissue and death may result. Estimated lethal dose: 5 grams.

Skin Contact:

Corrosive! Contact with skin can cause irritation or severe burns and scarring with greater exposures.

Eye Contact:

Highly Corrosive! Causes irritation of eyes with tearing, redness, swelling. Greater exposures cause severe burns with possible blindness resulting.

Chronic Exposure:

Prolonged contact with dilute solutions or dust of potassium hydroxide has a destructive effect on tissue.

Aggravation of Pre-existing Conditions:

Persons with pre-existing skin disorders or eye problems or impaired respiratory function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

Ingestion:

If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Skin Contact:

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

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:

Not combustible, but contact with water or moisture may generate enough heat to ignite combustibles.

Explosion:

Can react with chemically reactive metals such as aluminum, zinc, magnesium, copper, etc. to release

hydrogen gas which can form explosive mixtures with air.

Fire Extinguishing Media:

Use any means suitable for extinguishing surrounding fire.

Special Information:

Solution process causes formation of corrosive mists. Hot or molten material can react violently with water.

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Keep unnecessary and unprotected people away from area of spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust. Do not flush caustic residues to the sewer. Residues from spills can be diluted with water, neutralized with dilute acid such as acetic, hydrochloric or sulfuric. Absorb neutralized caustic residue on clay, vermiculite or other inert substance and package in a suitable container for disposal.

US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRACIT®-2 or BuCAIM® caustic neutralizers are recommended for spills of solutions of this product.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Protect from moisture. Addition to water releases heat which can result in violent boiling and spattering. Always add slowly and in small amounts. Never use hot water. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

- OSHA Permissible Exposure Limit (PEL):

2 mg/m³ Ceiling

- ACGIH Threshold Limit Value (TLV):

2 mg/m³ Ceiling

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):

If the exposure limit is exceeded and engineering controls are not feasible, a half facepiece particulate respirator (NIOSH type N95 or better filters) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece particulate respirator (NIOSH type N100 filters) may be worn up to 50 times the

exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure.

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.

9. Physical and Chemical Properties

Appearance:

White deliquescent solid

Odor:

Odorless.

Solubility:

52.8% in water @ 20C (68F)

Specific Gravity:

2.04

pH:

13.5 (0.1 molar solution)

% Volatiles by volume @ 21C (70F):

0

Boiling Point:

1320C (2408F)

Melting Point:

360C (680F)

Vapor Density (Air=1):

No information found.

Vapor Pressure (mm Hg):

1.0 @ 714C (1317F)

Evaporation Rate (BuAc=1):

No information found.

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

Carbon monoxide when reacting with carbohydrates, and hydrogen gas when reacting with aluminum, zinc and tin. Thermal oxidation can produce toxic fumes of potassium oxide (K₂O).

Hazardous Polymerization:

Will not occur.

Incompatibilities:

Contact with water, acids, flammable liquids and organic halogen compounds, especially trichloroethylene, may cause fire or explosion. Contact with nitromethane and other similar nitro compounds cause formation of shock sensitive salts. Contact with metals such as aluminum, tin and zinc causes formation of flammable hydrogen gas.

Conditions to Avoid:

Heat, moisture, incompatibles.

11. Toxicological Information

For potassium hydroxide: Oral rat LD50: 273 mg/kg; Investigated as a mutagen. Skin Irritation Data (std Draize, 50 mg/24 H): Human, Severe; Rabbit, Severe. Eye Irritation Data(Rabbit, non-std test, 1 mg/24 H, rinse): Moderate.

Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Potassium Hydroxide (1310-58-3)	No	No	None
Water (7732-18-5)	No	No	None

12. Ecological Information

Environmental Fate:

No information found.

Environmental Toxicity:

Potassium Hydroxide: TLm: 80 ppm/Mosquito fish/ 24 hr./ Fresh water

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to 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.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: POTASSIUM HYDROXIDE, SOLID

Hazard Class: 8

UN/NA: UN1813

Packing Group: II

Information reported for product/size: 110LB

International (Water, I.M.O.)

Proper Shipping Name: POTASSIUM HYDROXIDE, SOLID

Hazard Class: 8

UN/NA: UN1813

Packing Group: II

Information reported for product/size: 110LB

International (Air, I.C.A.O.)

Proper Shipping Name: POTASSIUM HYDROXIDE, SOLID
Hazard Class: 8
UN/NA: UN1813
Packing Group: II
Information reported for product/size: 110LB

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\-----
Ingredient TSCA EC Japan Australia

Potassium Hydroxide (1310-58-3) Yes Yes Yes Yes
Water (7732-18-5) Yes Yes Yes Yes

-----\Chemical Inventory Status - Part 2\-----
Ingredient Korea --Canada-- DSL NDSL Phil.

Potassium Hydroxide (1310-58-3) Yes Yes No Yes
Water (7732-18-5) Yes Yes No Yes

-----\Federal, State & International Regulations - Part 1\-----
-SARA 302- -----SARA 313-----
Ingredient RQ TPQ List Chemical Catg.

Potassium Hydroxide (1310-58-3) No No No No
Water (7732-18-5) No No No No

-----\Federal, State & International Regulations - Part 2\-----
Ingredient CERCLA -RCRA- -TSCA-
----- 261.33 8 (d)

Potassium Hydroxide (1310-58-3) 1000 No No
Water (7732-18-5) No No No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: Yes (Mixture / Solid)

Australian Hazchem Code: 2R

Poison Schedule: S6

WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 3 Flammability: 0 Reactivity: 1

Label Hazard Warning:

POISON! DANGER! CORROSIVE. CAUSES SEVERE BURNS TO SKIN, EYES, RESPIRATORY

TRACT, AND GASTROINTESTINAL TRACT. MATERIAL IS EXTREMELY DESTRUCTIVE TO ALL BODY TISSUES. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED.

Label Precautions:

Do not get in eyes, on skin, or on clothing.
Do not breathe dust.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.

Label First Aid:

If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If inhaled, remove to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen. In all cases get medical attention immediately.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 3.

Disclaimer:

Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.

Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

OPERATION PROCEDURE

RETREVAL, TRANSIT AND MEASUREMENT

In Biodiesel Facility:

Always wear gloves, protective eyewear and appropriate clothing

If cleaning, wear dust mask

Close all valves

Make sure the work area is tidy

Materials are underlined

Retrieval and transit:

Requires 2 people

1. Place empty 55-gal metal transit barrel, dolly, lid and clamp, pump, some rags, degreaser bottle, and board (for ramp) onto the truck. Make sure that each item is secure with bungee cords and straps.
2. Drive to the loading dock of the CAB.
3. Once in the CAB, back the truck up onto the hydraulic lift until the rear bumper almost touches the rubber bumper on the wall. The control for the lift is to the right of the roll-up door. Raise or lower the bed of the truck so that is level with the floor. Use the board to span the small gap between the truck and the dock, if required. *Note: You need to park close, but be careful not to get the truck bumper too near or it will catch on the loading dock and damage the truck.
4. Place the transit barrel onto the dolly and roll the barrel/dolly to the WVO grease trap. Place the pump's tubing into the transit barrel.
5. Place the other tube into grease trap barrel, holding the end of the tube just under the surface of the WVO. *Note: there is water on the bottom of the grease trap. Do not collect the water.
6. Fill the barrel only 2/3 - 3/4 of the way full. Place the lid on barrel and move on the dolly to the back of the truck, securing all equipment. Clean up all spills. Return to Farm.
7. Back the truck up to the front door of the Biodiesel Shed.
8. Slide storage barrel into the doorway. Pump WVO, through strainer in lid, from transit barrel into storage barrel. Cover with lid and slide into a safe place for storage, against the wall.

Measuring WVO:

Requires 1-2 people

9. WVO will be measured and pumped into reactor in preparation for heating at this time. WVO is currently measured by pumping it from blue storage barrel in to white measuring barrel, through a screen (this allows for removal of more sediment). The WVO can be measured in 5-gallon increments.
10. Once desired amount of WVO is measured in white barrel, move the barrel over to the reactor and place the plastic tube into the whole in the reactor lid. Pump

- WVO from white barrel into reactor. *Note: You can tip the barrel and prop it on your foot to transfer the remaining WVO.
11. Clean up any spilled WVO before proceeding to the next step.

LABORATORY TESTS

Suggested list of Lab Stores items:

Lab space request and Equipment request forms
Beakers (500 – 1000 ml)
3+ Blenders or other mixing device
Graduated Cylinders (500 ml)
Separation Funnel
Weighing paper
Scoop for Lye

In Lab Space:

Always wear gloves
Wear protective eyewear
Make sure work area is tidy and all materials are cleaned

Test Batches:

Requires 2-3 people

1. Mix WVO for a representative sample. Collect about 1 gal of WVO in a 5 gal container.
2. Transport WVO, Methanol and Lye to the Lab on campus (you may already have Methanol and Lye in the Lab).
3. Make labels for all sample batches.
4. Measure WVO: In the lab; Measure out 1500 ml of WVO and place 500 ml in each of the 3 blenders.
5. Measure Methanol and Lye: Have one or two people measure the methanol while another carefully measures the lye onto weighing paper on the scale. *Note: once methanol is uncapped all work must be done under chemical hood. Proper protection must be worn at all times when handling lye and methanol. Lye and methanol absorb water from the atmosphere when not in a sealed container. Develop good lab technique to accurately measure and combine ingredients quickly and safely.
6. For 500 ml of WVO 100 ml of methanol is required for transesterification. Begin testing with 5 grams of lye per liter of WVO. *Note: We ended up using 15 grams/liter of lye to get good separation. See lab notes for more details.
7. Add lye and methanol to a container that can be capped, vented and gently shaken to dissolve lye quickly.
8. Transesterification: Once lye is completely dissolved, add potassium methoxide to the WVO in blender(s) and process on lowest speed for 7 to 10 minutes.
9. After processing, switch off blenders and pour mixture into 600 ml beaker or Separation Funnel. Allow mixture to settle for 24 hours.

10. Drain Glycerine: Once biodiesel and glycerin have separated make some observations; how much glycerin and biodiesel formed? What is the clarity of the biodiesel? Any information you can record at this point is valuable.
*Note: if you don't see 2 distinct layers, increase the amount of lye by .25 grams and try again. If you see two layers, continue to step 11.
11. Option A) Washing: Wash the biodiesel by pouring some off the top of your 600ml settling beaker into a test tube filling it less than half way. Fill the rest of the test tube with 1/3 volume of DI H₂O. Put a cork in test tube or seal tightly with your hand and invert 10 times. Each time the test tube is inverted watch the air in the tube float to the surface, and then continue.
12. Option B) Washing: drain glycerine from the bottom of the Separation Funnel and add water using a misting spray (this allows for mixing). *Note: Only add 1/3 water of WVO in volume (3 part WVO, 1 part H₂O).
13. Allow to settle for 24 hours, then make observations: Is the biodiesel clear or cloudy? How big is the soapy layer in between wash water and biodiesel. *Note: At this point label and keep all test tubes that you see two distinct layers after transesterification. These will be a reference tool which will let you compare different batches and select the best ratio for optional transesterification in the on farm facility.
14. Repeat test batches increasing amount of lye by .25 grams per 500ml batch. Keep going until you get a good separation. The milky layer between wash water and biodiesel should be small and the more clear the wash water the better.

Quality Tests:

3:27

More accurately it could be called 1:9 Test (we used 10:90 so our volumes could be measured easily). One part biodiesel is lightly mixed with nine parts methanol and left to settle. The biodiesel mixes with the methanol leaving a small pearl of un-esterified WVO. This pearl will settle at the bottom of the test tube only a few minutes after mixing. You want to see little to no separation, even after leaving the mixture to settle.

pH

Use the pH strips to loosely determine the pH of your oil or biodiesel. The pH of unwashed biodiesel will be above 8, and you want your finished fuel to be pH 7.^v Make sure you have good quality strips or your test will be inconclusive.

Hydrometer

The Hydrometer test is fairly accurate and fast. Fill a graduated cylinder with biodiesel (enough so the hydrometer floats and doesn't touch the bottom). Place the hydrometer in the cylinder allowing it to stabilize and stay still. Read the hydrometer, not the volume. The specific gravity of biodiesel ranges from 0.86 to 0.90 depending on the type of stock oil used. An average of 0.885 has been reported for soy methyl esters.

BIODIESEL PRODUCTION PROCEDURES

In Biodiesel Facility:

Always wear gloves, protective eyewear and appropriate clothing

If cleaning, wear dust mask

Close all valves

Make sure the work area is tidy

Assuming you have already collected, measured, and tested the WVO, you are now ready to begin production. Read all steps carefully before proceeding.

Transesterification:

1. You must wear protective eyewear, gloves, a chemical mask or hood, and BD suitable clothing.
2. Turn on Exhaust Fan
3. (See: Measuring WVO step and continue)
4. Place the wooden stool below the methanol stand. Remove a methanol can from the storage cabinet and place it on the top of the stool. Close the door of the storage cabinet. *Do not remove the lid of the methanol canister, yet!
5. Connect the ground wire from the side of the carboy stand to, the handle of the methanol canister. Wiggle it slightly to ensure that it make contact directly with metal on the methanol barrel.
6. Make sure that the inside of the catalyst carboy is completely dry of water! Add the calculated amount lye to the catalyst carboy. Replace the lid onto the carboy and close tightly. Once the lye is added, clean or dispose of any utensils that came in contact with the lye. The cleaning should be done at the spigot. Waste may be disposed of in the garbage bin in the processing room. The lye does not need to be stored in the flam cabinet.
7. Connect the Methanol hand pump and seal all connections. Begin pumping slowly, and look for leaks.
8. Observe how full the carboy is after every few pumps. Go slightly over the required amount of gallons of methanol to compensate for the volume of space that the lye took up in the carboy.
9. Once the methanol is added, place the methanol canister in the cabinet. At this point, ideally, we would agitate the lye and methanol inside the sealed carboy. If the lye and methanol isn't mechanically mixed, it may take two or three days to dissolve.

Heating:

1. **Once any spilled methanol is mitigated**, the Heatstrap may be turned on. While the lye is dissolving in the sealed carboy, the WVO needs to be heated. The grease needs to be hot, but no hotter than 60° C. The dial of the Heatstrap should be turned no higher than #9 (it will be lower in summer than in winter). *Note: The inside of the Processor is coated with a highly chemically resistant coating (FX3112) and the outside is painted with strong enamel. High temperatures over time will deteriorate the coatings, especially beneath the Heatstrap!

2. Heating may take a while, (one day +) depending on the ambient temperature of the room. There is a great amount of heat loss from the Processor while heating.
*Note: anytime the lid to the carboy is removed the heat strap must be turned off. We had to open the carboy and stir the lye to get it to dissolve. We also had to remove a blockage in the bottom of the carboy with a long bicycle spoke attached to a short piece of bamboo with a small pipe clamp.
3. Once the biodiesel is between 50-60 ° C, open valve (bottom) and valve #10 (only opening ½ way due to pump efficiency) then turn on pump #1 and listen for circulating WVO. *Note: Odd noises coming from pump #1 usually means that air is entering the black iron piping. This is fixed by partially closing valve #2 until noise is mitigated.
4. Open carboy valve and observe for drainage. If the carboy doesn't drain completely in a couple minutes, there is most likely a blockage. Remove blockage as necessary.
5. Once potassium methoxide has drained close carboy valve.
6. Circulate the oil for 1 hour or more. Document the temperature on the thermometer every 10 minutes in the processing log. **Never exceed temperatures of 60°C.**
7. After 1 hour, turn off pump #1 and close valve #2 simultaneously. Turn Heatstrap, fan and water off. Let process sit for ~24 hours.

Draining Glycerin:

1. Measure pH of Biodiesel layer on top. The pH of unwashed Biodiesel should be between 8-10. If the pH is beyond 6 or 12, the oil should be visually "bad" and the entire batch will need to be disposed of.
2. Drain the glycerin into 3 gallon buckets through valve #1, estimate and record the volume of glycerin (the ratio should be similar to your lab results). Empty the glycerin into a container and transport it to leech-aid-tank, later. Notice when the glycerin begins to become cloudy with Biodiesel. When this occurs, close and open valve #1 a few times to get the last of the glycerin. Place bucket underneath to catch any drips that might fall.
3. At this point the Biodiesel should be left, again, to settle any residual glycerin.
4. After 24 hours, drain any more glycerin that has settled, if any, into buckets and pore in "glycerin" barrel. There will always be a little more glycerin that settled.

Washing:

1. Heat the biodiesel slightly. Keep the heat belt between 2 and 4 and don't let the temp get above 20°C. Open valve #1 and drain any last glycerin. Opening and closing a couple times usually gets all of it out.
2. Attach the hose to the mister on the lid and turn it on. Keep acute attention on the water level at all times.
3. Fill the processor until there is a quarter amount of water to Biodiesel in the processing tank. The biodiesel level will rise as water goes in. Turn off water and detach hose.
4. Turn off the heat strap unless the ambient temperature is below 30°C. Allow the mixture to sit for 1-3 days depending on your need (24 hour minimum).
5. When you decide to drain the water, heat the tank to no more than 20°C. The

temperature needs to idle there for at least three hours. This will properly separate the water and biodiesel. Once it is settled, the biodiesel will be on top, and the water on the bottom. There might also be a murky middle layer. Begin to drain the water through valve #1 and add it to the "waste water" barrel. Stop draining when the water becomes murky and the viscosity changes (from thin water to thicker biodiesel). Measure the pH of the wastewater and document it. Try not to open the lid at any time during this procedure because methanol will be evaporating.

6. Let Water settle again and drain.
7. Repeat wash process if needed (this is base on pH and other quality tests).

Filtering:

1. Open valve #1 and turn on Pump #2 and Filter biodiesel into holding tank.
2. Do tests to determine final batch quality.

Quality Tests:

Use the 3:27, pH, and Hydrometer tests, as needed, to determine the final quality of the biodiesel. See *Quality Tests* the end of the section titled *Laboratory Tests* for details.

Example of Catalyst Conversions

WVO in Gallons	KOH in Grams	WVO in Gallons	Methanol in Gallons
20	568	20	4
21	596.4	21	4.2
22	624.8	22	4.4
23	653.2	23	4.6
24	681.6	24	4.8
25	710	25	5
26	738.4	26	5.2
27	766.8	27	5.4
28	795.2	28	5.6
29	823.6	29	5.8
30	852	30	6
31	880.4	31	6.2
32	908.8	32	6.4
33	937.2	33	6.6
34	965.6	34	6.8
35	994	35	7
36	1022.4	36	7.2
37	1050.8	37	7.4
38	1079.2	38	7.6
39	1107.6	39	7.8
40	1136	40	8
41	1164.4	41	8.2

42	1192.8	42	8.4
43	1221.2	43	8.6
44	1249.6	44	8.8
45	1278	45	9
46	1306.4	46	9.2
47	1334.8	47	9.4
48	1363.2	48	9.6
49	1391.6	49	9.8
50	1420	50	10

FUTURE IMPROVEMENTS & GOALS

During winter quarter, 2008, Funding was granted to the Evergreen Biodiesel Project by The Clean Energy Committee (CEC) to accomplish the first phase of the Biodiesel Expansion Project (BEP). The first phase of the BEP consists mainly of installing a dedicated wash tank, thus making the main reactor available for processing while a previous batch of biodiesel is being washed. Other more minor features of the BEP include securing equipment needed to ease the biodiesel making process and to continue daily operations of the facility. This document is intended to guide students who will be installing and operating the new equipment.

The wash tank will be a 55-gallon conical bottom plastic container where the biodiesel will be combined with water. This tank will be installed where the *BDiesel* storage tank is currently located. The storage tank is bolted to the floor (the frame may need to be moved) and the ¾ inch black iron Inlet Piping will have to be disconnected near the second filter.

Biodiesel that has been separated from glycerin will be pumped into the wash tank. To do this a small length of vinyl tubing will be attached to the existing black Iron pipe, just after the existing filter, and will feed into the top of the wash tank. A valve at the bottom of the wash tank will lead to a three way black iron fitting that has two ¾ inch valves attached to it. One valve will be for draining off the wash water and the other valve will feed into pump #3 which will transfer biodiesel into the drying and storage tank.

The current storage tank (labeled *BDiesel*) should be opened up, inspected and most likely cleaned at this time. (Large components like the storage tank can be cleaned at the car wash station near Motor Pool). The drying and storage tank will be fabricated from the current storage tank. Pump #3 will feed washed biodiesel into the tank. To do this, a length of vinyl tubing will connect pump #3 to the storage tank. The drying and storage tank should be located close to its current location, near the wash tank but with enough room to allow for easy access to all components.

Future goals also include; further research into biodiesel carbon emissions and how this affects TESC. The biodiesel team also plans to use TESC Lab's Gas chromatography-mass spectrometer (GC/MS) to refine quality testing.

Designs for further improvements and Grant applications for those upgrades are constantly being updated. See the Evergreen Website for more information or contact the current Biodiesel Project Operators.

RESOURCES

HUMAN RESOURCES

Should students require technical advice during any phases of the BEP, a short list of people to contact follows:

Melissa Barker: Organic farm Manager.
360-867-6160

Melissa helped build the facility and is aware of nearly all activities that have occurred during the existence of Evergreen Biodiesel Project. Because the Evergreen Biodiesel Project is part of the Organic Farm, limited funding for things like lye and methanol can be secured through the Farm Budget. (These funds are VERY limited! You must apply for GRANTS)!

Marty Beagle: Evergreen staff.
beaglem@evergreen.edu, 360-867-6466

Marty was involved with the construction of the biodiesel facility. He is very knowledgeable when it comes to construction, electrical and engineering projects. Marty maybe a good person to go to when it is found that you need a specific tool or a task accomplished that you are not prepared for (i.e. bolting equipment to the concrete).

Michelle Bartlett: Fiscal Specialist.
bartletm@evergreen.edu, 360-867-6484

Michelle is The Biodiesel Project's Budget Contact. Any equipment purchases need to be run through her. All receipts are given to Michelle for budgeting purposes. She is very helpful and fairly easy to contact.

EMERGENCY CONTACTS

See *Biodiesel Safety Procedure* (at the beginning of this document) for further contacts and safety precautions.

McLane fire Dept:	9-911
TESC Police Services (also Evening & Weekend contact):	x6140
Lab Stores:	x6489

BIODIESEL RESOURCES

www.attra.org www.biodiesel.org www.biodieselcommunity.org
www.evergreen.edu/cell/biodiesel www.ucsusa.org - union of concerned scientists
www.veggiepower.org www.biodieselwarehouse.com
www.gordosales.com/biodiesel

CREDITS

All information in this manual (unless otherwise noted) was written by the Biodiesel Project Operators Megan P. Ellis-Treasure and John Kemp and edited by Megan P. Ellis-Treasure. Megan and John would like to thank everyone that has been involved in the Evergreen Biodiesel Project throughout its existence.

BIBLIOGRAPHY

ⁱ Anonymous. "The Evergreen Biodiesel Project". The Evergreen State College. Updated May 30, 2007. The Evergreen State College. Accessed February 12, 2008. <www.evergreen.edu/cell/Biodiesel.htm>.

ⁱⁱ Learn about The Evergreen Clean Energy Committee at: www.evergreen.edu/committee/cleanenergy/home.htm

ⁱⁱⁱ Lab Stores. The Chemistry Club. Updated November 6, 2007. The Evergreen State College. February 12, 2008. <<http://chemclub.evergreen.edu/science-support/lab-stores/>> http://scicomp.evergreen.edu/images/lab_safety_manual.pdf.

^{iv} Chemtrec. "Methly Alcohol". Updated August 10, 2004. MSDSONline. Mallinckrodt Chemicals and J.T. Baker. Accessed March 9, 2008. <<http://www.msdsonline.com/>>.

Chemtrec. "Potassium Hydroxide". Updated February 1, 2007. MSDSONline. Mallinckrodt Chemicals and J.T. Baker. Accessed March 9, 2008. <http://www.msdsonline.com/>.

^v Ryan, David, P.E. "Biodiesel – Primer". December 2004. ATTRA/NCAT. Accessed March 2008. <http://attra.ncat.org/attra-pub/PDF/biodiesel.pdf>.

All photocopied materials are excerpts from the original Biodiesel Manual written by David Rack, Sam Stout, and Kolby Bray-Hoagland.