BIOSYSTEMS ENGINEERING SERIES
TIMELY INFORMATION
Agriculture, Natural Resources & Forestry

Alabama Cooperative Extension System
Alabama A&M and Auburn Universities

Department of Biosystems Engineering, Auburn University, AL 36849-5626

BSEN-BE-09-01 **May 18, 2009**

Safety for Small-Scale Biodiesel Production

Introduction

Biodiesel is believed to be a viable and sustainable alternative energy source that has the potential to alleviate some of the United State's dependence on foreign oil while improving environmental stewardship. There are several sources from which biodiesel can be produced including vegetable oil, used restaurant cooking oil, and even algae. Because biodiesel is relatively simple to produce, interests have grown over the past few years in producing biodiesel at a "small-scale". Small batches (usually 50 gallons or less) can be produced using the proper equipment. While biodiesel itself is non-toxic, biodegradable, and produces far fewer emissions versus petroleum diesel, producing your own biodiesel does have environmental and personal safety issues that one should understand. These issues occur mainly on the front end of the production process and include safety in handling alcohol and catalysts (i.e. titration solution, methanol, and sodium hydroxide or potassium hydroxide), glycerol handling and disposal, spill response, and storage tank recommendations. Fire safety is also imperative even though biodiesel itself is not as flammable as other petroleum based fuels.

Figure 1. Glycerol (bottom) settling in a sample of Biodiesel.

Precautionary Measures

- Always wear safety gear or Personal Protection Equipment (PPE): safety glasses (A) or a face shield, a respirator (B), an apron (C), and gloves (D; Fig. 3).
- Properly label all containers to avoid improper usage or accidental mixing of chemicals.
- It is recommended to have eye wash fountains or bottles in the work area.
- Always have sorbent on hand to immediately clean-up spilled oil and prevent accidents.
- Have a fire extinguisher on hand.
- Ventilation systems are necessary in confined spaces to keep airborne concentrations of methanol below permissible exposure limits (PEL; 200 ppm or 260 mg/m^3).

Figure 3. Suggested Personal Protective Equipment (PPE) for manufacturing biodiesel.

The Safe Handling of Biodiesel, Methanol, and Lye

Biodiesel and methanol (methyl alcohol) are 100% biodegradable. Biodiesel has a high flashpoint and low volatility, so it does not ignite as easily as petro-diesel. Biodiesel degrades four times faster than

conventional diesel. It is nontoxic and is generally safe to handle, transport, and store. Long-term storage of biodiesel should be in a steel vessel that is labeled appropriately and air-tight. Biodiesel is hygroscopic meaning it will absorb atmospheric moisture and potentially allow microbial growth.

When producing biodiesel, falling or slipping is the largest cause of accidents and personal injury. Floors can be slippery so operate with caution, wear appropriate footwear, and keep floors clean.

Methanol (Fig. 4) is the most dangerous ingredient used in the biodiesel process. Methanol can cause poisoning, systemic acidosis, optic nerve damage, and impact the central nervous system (CNS) if a person is exposed to it. Again, wear proper Personal Protection Equipment (PPE) when handling methanol (Fig. 3). Exposure to methanol can occur via inhalation, ingestion, or absorption. Inhalation of methanol vapors is the most common type of exposure. Because methanol has no scent, keep methanol containers sealed at all times. If exposed to the eyes or skin, irritation may occur but flush eyes or the skin area with water for at least 15 minutes plus remove contaminated clothing and shoes. Methanol ingestion can cause gastrointestinal irritation with nausea, vomiting, diarrhea, and/or headache while posing a serious threat to life. Promptly get medical attention for anyone who has ingested methanol.

While potassium hydroxide is also a very good choice of catalyst for biodiesel production, it poses fewer risks to the environment than sodium hydroxide. For this reason, safety recommendations in this section are geared towards sodium hydroxide. *Lye* (sodium hydroxide; Fig. 4) is a substance that dissolves easily in water and will absorb water when exposed to the atmosphere. Eventually, it will absorb enough water to form a liquid solution. If skin comes in contact with lye, gently wipe it from skin and remove any contaminated clothing. Immediately wash area with water for 15 minutes because lye can cause chemical burns. Always wear a respirator when handling lye to avoid particle ingestion. *If lye is ingested rinse mouth with water and drink one or two glasses of water. Do not induce vomiting!* If lye is ingested in adequate amounts, it can be fatal. Lye can cause blindness so immediately flush eyes with water for at least 20 minutes. Remember to remove any contact lenses. After handling lye, wash hands immediately once your gloves are removed. Immediately get medical attention or call your poison control center at 1-800-222-1222.

Figure 4. Methanol (left) and lye (right).

Biodiesel Waste Product Disposal

Glycerol and wet wash water are the two major waste products from the production of biodiesel; if a wet wash process is used. There are several methods of disposing of glycerol. Glycerol can be added to an existing compost pile, but it is imperative to drive off the excess methanol by adding heat (160 °F) for one hour. In addition to removing the methanol, excess lye and soap have to be combated. Check the pH as it will probably be alkaline because of the unused lye. The pH needs to be reduced by adding some acid such as muriatic acid or even vinegar. When the pH is around 7 (neutral), the glycerol can be composted. Besides composting, glycerol can also be used by water treatment plants or in boilers. The local water treatment plant may have an operating anaerobic digester to which the glycerol may be added. Bacteria in the digester feed off glycerol providing an increase in biogas. Glycerol can also be burned in boilers for heat, but will leave a residue that has to be frequently cleaned.

If a wet wash procedure is performed on the biodiesel, the water must be titrated to determine the pH. When the pH is brought to neutral, the water can be discarded using a brown water drain.

Recommendations for Storage Tanks

Methanol coming in contact with most metals at ambient temperatures has no adverse effect on the metal; exceptions include lead, magnesium and platinum. Select mild steel tanks for storing methanol. Tanks built with copper alloys, zinc (including galvanized steel), aluminum or plastics are not suitable for methanol storage as they are corroded slowly. Many resins, nylons and rubbers, particularly nitrile (Buna-N), ethylene propylene rubber (EPDM), teflon and neoprene are used acceptably as components of equipment in methanol service. While plastics can be used for short-term methanol storage, they are generally not recommended for long-term storage due to deterioration effects and the risk of contamination. When grounding a large storage tank, carbide tipped clamps (to ensure good contact through paint) and dip tube filling are generally used to guard against potential ignition from static electricity.

For storing biodiesel, a general gasoline container may be used, but ensure the container is clean and properly labeled. A hazardous materials cabinet is recommended for product storage. Cabinets should be labeled in eye-catching print, "Flammable - Keep Fire Away." As a general rule of thumb, only acquire enough methanol to use in a two week period and always store all components of biodiesel production in a cool, dry place.

Lye and caustic soda have much stronger hygroscopic properties than activated carbon or silica gel and will readily absorb water. For this reason, lye and/or caustic soda should be stored in an air-tight resealable container, labeled appropriately. A plastic bucket with a sealable lid will suffice. Lye and/or caustic soda may react with magnesium, zinc (galvanized), tin, chromium, brass, and bronze to produce hydrogen gas and this is very dangerous. Do not allow lye or caustic soda to contact these metals.

Fire Fighting Equipment

Methanol flames are almost invisible in daylight, producing no soot or smoke. They may only be detected by the heat generated, a heat haze, or burning of materials in the immediate area. A class B fire extinguisher should be used in all stages of biodiesel operation as it is rated for flammable liquid fires as well as oil/grease fires. In addition to methanol vapors, exposure to formaldehyde and carbon monoxide from ignited methanol can generate oxygen deprivation.

Spill Response

A spill will be inevitable during the production of biodiesel. As a precautionary measure, spill control pallets or basins should be utilized under all containers, in particular those with a capacity of 55-gallons or more. If a spill of methanol or lye occurs, stop or reduce expulsion of material if this can be done without inherent risk. Eliminate all potential sources of ignition. Do not walk through spilled product and stay upwind. Prevent spilled methanol from entering sewers, confined spaces, drains, or waterways. Maximize methanol recovery for recycling or reuse. Vapors can be knocked down using a water spray. Whenever possible, contain land spills by forming mechanical or chemical barriers. Remove spilled product with explosion proof pumps or vacuum equipment. Treat the surface with sorbent materials, such as cat litter or activated carbon, to remove the remaining methanol. Remove the sorbents after use. Soil contaminated with methanol should be removed and remediated. Spills into natural water bodies (i.e. stream or river) cannot be recovered. Whenever possible, contain spills to small surface waters using natural or mechanical barriers. Then remove the contained material with explosion proof pumps or vacuum equipment. Large quantities of waste methanol can either be disposed of at a licensed waste solvent company or reclaimed by filtration and distillation.

Prepared by

Daniel Mullenix, *Research Engineer*, John Fulton, *Assistant Professor and Extension Specialist*, Christian Brodbeck, *Research Engineer*, Biosystems Engineering Department, Auburn University and Mark Hall, *Extension Specialist*, Alabama Cooperative Extension System.

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