



School District of Westfield Biodiesel Production Program

A Comprehensive Overview

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**School District of Westfield
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Overview

It is personal belief that alternative energy knowledge should be free and available to everyone since it pertains to the overall health of the whole world. It is the School District's responsibility to provide this knowledge and educate all who want to obtain it.

The School District of Westfield started producing biodiesel on June 1, 2008. To date the District has produced over 12,000 gallons of biodiesel with a current production capacity of 160 gallons per day.

There are five primary reasons for having the Biodiesel Production Program:

- Create an exciting and challenging curriculum for students
- Share our knowledge at no cost to anyone that is interested in having their own production
- Reduce transportation costs for the school district
- Reduce toxic emissions into the environment
- Encourage local communities and government to participate in alternative energy initiatives

Education

There are currently three different educational classes involved in the biodiesel program:

- Agricultural Business
- Business Education / Future Business Leaders of America
- Art

There are several different aspects of education that can be obtained from the biodiesel program:

- Teach environmental responsibility of individuals
- Chemistry and mathematics education
- Business concepts and marketing
- Electronic, electrical and structural engineering
- Basic understanding of diesel engines
- Art and Design

We also work very closely with the following grant and county programs:

- PAI
- Healthy Communities Healthy Youth (HCHY)
- CBAE
- Marquette County Health Department

Environmental Impact

- **Production**
 - It is very important that our biodiesel production process does more good than harm to the environment. With several advancements since the beginning of this program, we will be able to achieve almost a 0% waste process.
 - There are several steps that we use to achieve a near 0% waste biodiesel process:
 - Using a purification tower to clean the biodiesel
 - The purification beads can be returned to the manufacturer where they will be cleaned and resold. The beads can be recycled several times and this also eliminates the need to water wash the biodiesel.
 - Methanol distillation
 - The distillation process removes nearly 100% of the methanol from the glycerol. The methanol can then be used again in the biodiesel process. This eliminates the need to find a location that will accept glycerol containing methanol as a waste. It also reduces the need to purchase more methanol, thus reducing the cost to produce the biodiesel further.
 - Soap production
 - After distilling the methanol out of the glycerol, the glycerol now only contains the caustic, glycerin, FFA's and a minute amount of water so this mixture is now technically a soap. We can now use and market this soap for personal or industrial use.
 - Any glycerol that cannot be used in soap production is used as a feed stock in dairy farm slurry pits.
 - Testing is currently underway to use the glycerin as a heat source using the Babington burner application.

- **Usage**
 - During the use of the biodiesel in the district vehicles and equipment, we have found the following:
 - Better engine performance
 - All engines ran smoother and quieter. With the only petro-diesel fuel available being ultra-low sulfur, the biodiesel now acts as a very important injector and upper cylinder lubricant, thus reducing engine wear significantly. This will reduce repair and replacement costs.
 - Reduced nauseous fumes
 - The exhaust is actually pleasant smelling and will not produce nausea as quickly as petro-diesel.
 - Reduced toxic emissions
 - A significant reduction in carbon monoxide (CO) and hydrocarbons (HC) is found in exhaust with only a slight increase in Mono-Nitrogen Oxides (NOx). Please see “A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions” from the Environmental Protection Agency.

Production Process

Waste vegetable oil is obtained from local businesses where the district has placed a collection drum for their convenience. This oil is collected on a regular basis to ensure that overfilling of the drum does not occur and also that the drum and area are cleaned and maintained.

There are only three ingredients required for biodiesel production and are listed in order of quantity:

- Waste vegetable oil
- Methanol
- Sodium Hydroxide or Potassium Hydroxide

We have chosen potassium hydroxide over sodium hydroxide as it is known that sodium content of soil is of concern.

Once the mixing process is complete, glycerol is emptied and a purification process is started. The biodiesel is pumped into a tower containing an ion exchange resin that removes any salts and residual methanol from the biodiesel. It takes approximately 8 hours for every 160 gallons to clean.

This type of production provides a 1:1 ratio in which one gallon of waste vegetable oil produces one gallon of biodiesel.

By-Products

Only one by-product is created from the production of our biodiesel:

- Lye-glycerol containing methanol and FFA's

The lye-glycerol contains the majority of caustic, methanol and FFA's. It distilled through a system built by the School Transportation Department to reclaim the methanol which can be used again in the biodiesel process.

Glycerol Distillation

The distillation of the methanol from the glycerin is based upon a simple vacuum distillation process. The glycerol is heated to 210 F and maintained at that temperature for a couple of hours. During the heating process, a vacuum of 2-8 in/Hg is maintained in the whole system. The methanol vapor is drawn through a copper line inside of a drum filled with cool water where it then enters a second vessel. A complex safety system has been designed to monitor vacuum, pressure and temperature. This system will shut completely down when any variable is out of range.

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Usable Products

After all processes are completed, there are three separate usable products remaining:

- Biodiesel
- Lye-glycerin containing FFA's
- Methanol

The biodiesel will be used in all district diesel vehicles and equipment as much as possible and the methanol will be used in the biodiesel production process again to reduce methanol costs.

The lye-glycerin is currently being marketed to the public in the form of hand soap. The process and formulas to make the soaps were created by the Transportation Department. All packaging and bottling will be done by students in the district in which all proceeds will be used to help offset general district operating costs, fund additional alternative energy programs and produce an overall better learning environment.

Production Quantity

We are able to currently produce up to 160 gallons of biodiesel per day depending upon demand from school vehicles and equipment. Quantity is also limited by storage space of the finished biodiesel.

To date the district has produced over 12,000 gallons of usable biodiesel.

Location of Production Facility

All production of biodiesel, distillation and soap manufacturing is done at the School District of Westfield Transportation Department.

Fuel Blending

Due to the cloud point of our biodiesel being approximately 34°F, it is necessary to blend the biodiesel with petro-diesel when temperatures start to drop below the cloud point. Also, the warranty on most new engines only allows a maximum of B20 to be used.

We currently follow these guidelines for fuel blending:

- 45°F and above: B99 or B100 – 1% petro-diesel is added as a mold inhibitor if needed
- 32°F to 45°F: B50
- When temperatures will continuously fall below 32°F: B33

An anti-gel is always added to B33 to ensure that gelling will not occur, though this is not guaranteed when temperatures reach -20°F or lower.

As of the date of this revision, we have successfully run all school buses on a minimum blend of B33 through the entire winter season with no problems of fuel gelling or separation.

Vehicles and Equipment Used

Since biodiesel can be used as a straight substitute to petro-diesel, there are no mandatory modifications that need to be done to an engine. Modifications would need to be done if a high biodiesel percentage would want to be used during cold temperatures and this would entail the installation of a fuel tank heater and in line fuel heater.

The following district equipment uses biodiesel blends and/or B100:

- All school buses
- Dump truck
- Tractor
- 60 kW generator – Bus garage
- 5 kW portable generator
- 10 kW portabe generator

All district diesel vehicles and equipment use biodiesel whenever they can depending upon availability from the Transportation Department.

In addition to vehicles, the Transportation Department will be installing an oil burning furnace that will use biodiesel to help heat the bus shop during the winter season.

Additional Phases

The system will receive additional phases of equipment in order to make processes more efficient:

- Implementation of second system - The second set of process tanks will allow us to produce up to 320 gallons of biodiesel per day. This will greatly reduce our transportation costs and need of petrodiesel even more.

Summary

With the advancement of technology and the unwanted dependence on fossil fuels, the School District of Westfield is a pioneer in alternative energies. With the successful implementation of the biodiesel program along with the study of gasification, methane, hydrogen and wind energy, the school district will continue to prosper educationally even in rough and uncertain times.

We will continue to research other fuel possibilities, including, but not limited to:

- Gasification
- Methane from composting
- Glycerin as a heating fuel
- Ethanol production
- Methanol production
- Solar

The future of all mankind is dependent upon the use of alternative energies and the responsible & limited use of fossil fuels.