



School District of Westfield Biodiesel Production Program

A Comprehensive Overview

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**School District of Westfield
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Overview

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

1. Create an exciting and challenging curriculum for students
2. Reduce transportation costs for the school district
3. Reduce toxic emissions into the environment
4. Encourage local communities and government to participate in alternative energy initiatives

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:

1. Waste vegetable oil
2. Methanol
3. 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 material that removes any salts and residual methanol from the biodiesel. It takes approximately 2 hours for every 40 gallons to clean.

We are able to currently produce up to 80 gallons of biodiesel per day depending on demand from school vehicles and equipment. This type of production provides a 1:1 ratio in which 1 gallon of waste vegetable oil produces 1 gallon of biodiesel.

Production Quantity

We can currently produce up to 80 gallons of biodiesel per day. Quantity is limited by: the number of processors, process times, glycerol drop times, and purification times. Quantity is also limited by storage space of the finished biodiesel.

Future production capability will be increased to 160 gallons per day with two additional process tanks that were donated to the district.

To date the district has produced over 3,500 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.

Equipment Used for Processing and Distillation

The original processor that was purchased is the Fuel Meister II dual processor system. This system was purchased at a price of \$5,000.

This original system contained:

1. Two (2) process tanks
2. One wash lid
3. One transfer lid
4. One process lid
5. One pump

Several modifications were done to the original system to make it more efficient and easier to use.

The modifications and additions are:

1. Process control center containing:
 - a) Timer control to automatically start circulation pump and heater for raw vegetable oil pre-heater
 - b) Temperature controller for heater on raw vegetable oil pre-heater
 - c) Process timer to adjust mixing time of biodiesel ingredients
 - d) Other controls for various pumps and heaters
2. Additional pump to make processing in second tank simpler
3. Framework with casters for process tanks and control center to make it mobile in order to clean easier
4. Purification tower containing ion exchange material for the dry wash method
5. Various plumbing

The distillation of the methanol is based upon a simple vacuum distillation process. The glycerol is heated and upon reaching a set temperature the heat is removed. The methanol vapor is drawn through 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.

Most of the additional equipment is invented, designed and built by the Transportation Department.

By-Products

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

1. Glycerol containing methanol

The glycerol contains the majority of caustic and methanol. It distilled through a system built by the school transportation department to reclaim the methanol which can be used again in the biodiesel process.

Environmental Impact Pertaining to 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:

1. Using the 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.
2. 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.
3. Soap production. After distilling the methanol out of the glycerol, the glycerol now only contains the caustic and a minute amount of water and so this mixture is now technically a soap. We can now use and market this soap for personal or industrial use.
4. Any glycerol that cannot be used in soap production will be mixed with wood chips or sawdust and then compressed to create an effective and inexpensive fire starter brick.

These four steps are essential in making a truly earth friendly biodiesel.

Fuel Blending

Due to the cloud point of biodiesel being approximately 50°F, it is necessary to blend the biodiesel with petrodiesel 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:

1. 55°F and above: B98 – 2% petrodiesel is added as a mold inhibitor.
2. 32°F to 55°F: B50
3. When temperatures will continuously fall below 32°F: B25

An anti-gel is always added to B25 to ensure that gelling will not occur, though this is not guaranteed when temperatures reach -20°F or lower.

Vehicles and Equipment Used

Since biodiesel can be used as a straight substitute to petrodiesel, 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 vehicles use biodiesel blends:

1. All school buses
2. Dump truck
3. Tractor
4. Lawn Mowers

All district diesel vehicles 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. The Transportation Department will also be installing a 60kW electrical generator to power the bus shop during power outages that will run biodiesel.

Environmental Impact Pertaining to Usage

During the use of the biodiesel in the district vehicles and equipment, we have found the following:

1. Better engine performance. All engines ran smoother and quieter with some buses actually showing improved mileage. With the only 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.
2. Reduced nauseous fumes. The exhaust is actually pleasant smelling and will not produce nausea as quickly as petrodiesel.
3. 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 the included "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions" from the Environmental Protection Agency.

Usable Products

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

1. Biodiesel
2. Glycerol
3. Methanol

Obviously, the biodiesel will be used in all district diesel vehicles and equipment as much as possible.

The glycerol is currently being marketed to the public in the form of hand soap. The process and formulas to make the hand soap 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.

The methanol will be used in the biodiesel production process again to reduce methanol costs.

Education

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

1. Agricultural Business
2. Business Education / Future Business Leaders of America
3. Art

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

1. Teach environmental responsibility of individuals
2. Chemistry and mathematics education
3. Business concepts and marketing
4. Electronic, electrical and structural engineering

5. Basic understanding of diesel engines
6. Art and Design

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

1. Safe Schools Healthy Students (SSHS)
2. Healthy Communities Healthy Youth (HCHY)
3. CBAE
4. Marquette County Health Department

Healthy Communities Healthy Youth provided a \$5,000 grant to purchase the original system.

Additional Phases

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

1. Implementation of second system. The second set of process tanks will allow us to produce up to 160 gallons of biodiesel per day. This will greatly reduce our need of petrodiesel and transportation costs even more.
2. Glycerin purification. This process will separate the Free Fatty Acids (FFA) from the glycerin with the use of sulfuric acid. The glycerin will then be cleaned through a purification tower with ion exchange beads to remove all salts and residual methanol. This will then provide us with cosmetic grade glycerin which can be used in other soap products provided by the district or can be sold to the retail market.

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 wind energy, the school district will continue to prosper even in rough and uncertain times.

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

1. Gasification
2. Ethanol production
3. Methanol production
4. Solar
5. Anaerobic methane production

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