

CHINQUAPIN BIODIESEL PROJECT



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A BP A+ For Energy Project

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<http://www.chinquapin.org/biodiesel>

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PROJECT SUMMARY

The Chinquapin Biodiesel Project was an ambitious attempt to bring small-scale biodiesel production to The Chinquapin School, a 6th-12th grade private school for low-income students from the Houston area. There were three major components to the project: (1) educating the student population about what biodiesel is and how to make it, (2) building a shed to house the biodiesel processing unit and setting up the processor, and (3) making high-quality biodiesel to fuel various school diesel tractors and vehicles. As a result of this project, the school has a fully functional and sophisticated biodiesel processing plant that has already produced over 60 gallons of fuel. Students have an increased understanding of biodiesel, and a select group of student leaders are well versed in the specifics of how to operate the processor. Thus far we have three school tractors using the fuel and will also start using the fuel in our buses next school year. For further details on the project, please visit the project blog at <http://www.chinquapin.org/biodiesel>.

EDUCATING THE STUDENT POPULATION

Whenever possible, students were involved in the project and were learning from the project. Each component of the project described in this report involved many valuable teaching moments. This section will merely highlight some of the specific activities and results that were targeted to increase student understanding of biodiesel.

Pre-Assessment of Student Understanding

A pre-assessment quiz was given to both the 10th grade Chemistry class and the 12th grade Environmental Science class. The quiz is posted on the biodiesel blog. The quiz was meant to assess whether the students had any idea what biodiesel is, how it is made, and its context within the larger scheme of alternative fuels. As expected, the results of the quiz were rather poor with an average score of 25%. Many students confused biodiesel with ethanol, highlighting the media's attention to the debate over corn-based ethanol. There was also widespread confusion about the ozone layer—most students thought that tailpipe emissions impact the ozone layer, not realizing the difference between ground-level ozone and the ozone layer. A comparison between the pre and post-assessment quizzes is provided in the post-assessment section.

Biodiesel Lecture

A lecture was given to the 10th grade Chemistry class and the 12th grade Environmental Science class with help from a local homebrew biodiesel guru. The lecture provided a background and history of biodiesel, explained the general production process, and compared biodiesel's environmental impact to that of other transportation fuels. Most students were surprised that biodiesel was made from waste-vegetable-oil that can often be obtained at no-cost. Students were also surprised and excited at how simple the production process seemed. Many students appreciated the “coolness-factor” involved in powering school vehicles with school-made fuel from used french-fry oil. They also especially liked the idea that the exhaust would smell like french-fries!

Biodiesel Lab

A three-day chemistry lab was conducted by the 10th grade Chemistry class. The lab instructions and background information are available on the blog. On the first day, the students titrated a batch of waste-vegetable-oil (WVO) in order to determine the amount of potassium hydroxide (KOH) catalyst to add to the methanol. On the second day, the students added heated WVO to 2-liter soda bottles that already contained the correct amount of methoxide (mixture of methanol and potassium hydroxide). The students shook the bottles to start the biodiesel reaction. The third day was spent draining the glycerin byproduct from the bottom of the bottles and then performing multiple water washes.

Safety was emphasized in all three parts of the lab. Students were taught which chemicals were hazardous and why. Additionally, students were instructed on appropriate safety gear and what to do in case of an accident. The teachers involved in the lab tried to strike a balance between educating the students about proper safety gear and lab procedures and not scaring students away from the lab. While methoxide was used in the lab, it was mixed prior to the lab, minimizing the potential for spills or other accidents. Students wore gloves, safety goggles, and lab coats whenever handling the biodiesel (though finished biodiesel is not considered hazardous).

Post-Assessment of Student Understanding

The post-assessment quiz was a combination of repeated pre-assessment questions and new questions related to the organic chemistry of biodiesel. The post-assessment quiz is posted on the blog. The average of the post-assessment quiz was 81% and the average score increase was 56 percentage points. All students increased their score over the pre-assessment quiz, as shown in Figure 1.

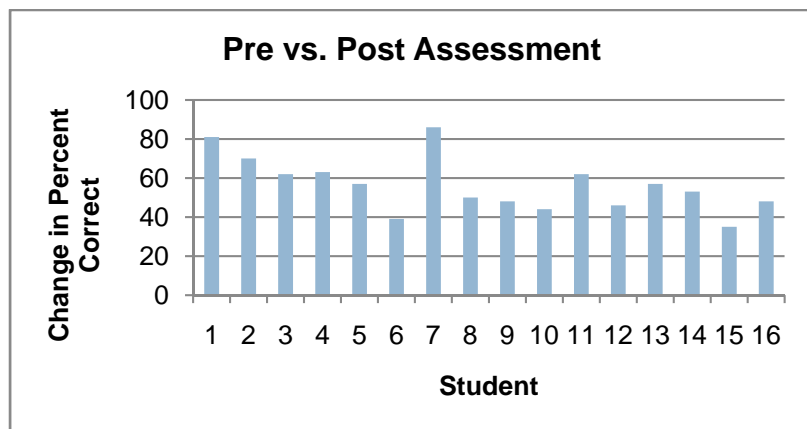


Figure 1: Pre vs. Post Assessment Quiz Comparison

Biodiesel Workshop

Two students from the biodiesel leadership group volunteered to attend a one-day workshop on how to make homebrew biodiesel. The workshop was provided by a local biodiesel homebrewer who also runs his own business selling commercially made biodiesel in the Houston area (<http://www.houstonbiodiesel.com>). The

students helped make a sample batch of biodiesel and learned many of the details of the biodiesel production process.

BIODIESEL SHED CONSTRUCTION AND PROCESSOR ASSEMBLY

Shed Construction

It was determined at an early stage that the production plant would need to be housed in its own shelter away from potential hazards. We looked into purchasing a pre-built shed but decided that the learning experience that would come from building our own was worth the extra time and effort. The shed is essentially a (8' x 16' x 8') room constructed inside of a shop garage that is open to the outside on one side. The shed is insulated, sheet-rocked, plumbed, and includes three electrical breakers for biodiesel equipment. While the plumbing and electrical work was done by the lead teacher, the students helped frame, insulate, sheathe, and sheetrock the shed. Next year, students will help design and paint a mural on the outside of the shed. Various construction skills were taught through the course of building the shed, and the group of four student helpers shares a sense of pride in helping create a permanent fixture on campus.

Processor Design and Assembly

A severely reduced cost processor was obtained and substantially modified for this project. Most biodiesel kits sold online have a similar setup of plastic conical tanks connected with various piping and an included water pump. There are certain disadvantages to using these kits as is and we decided to supplement our processing kit with two water heaters, a heat exchanger, and a water transfer pump. These additions helped support a production process (described in the next section) that eliminated environmental waste products and ensured the safest and highest quality fuel we could make. The blog contains general pictures of the completed processor facility and will have detailed pictures of the assembly in the future.

BIODIESEL PRODUCTION, USE, AND ADVERTISING

Production

Once the processor was designed and assembled, we started making fuel. The details of our production design will be posted on the blog next year, however, a summary will be provided here.

The general design was built upon ideas from William Kemp's *Biodiesel: Basics and Beyond*. The main processor is an electric water heater that is converted for biodiesel use. Once the biodiesel reaction takes place, methanol is recovered using a heat-exchanger. The biodiesel is washed in a plastic conical tank using both mist-washing and bubble-washing techniques. The biodiesel is then dried by recirculation through a shower-head in another plastic conical tank. The dried biodiesel is transferred to a 55-gallon drum that is equipped with an electric fuel pump and meter.

The glycerin waste product is diverted to another smaller water heater where further excess methanol is recovered. The decontaminated glycerin is then mixed with water and used in a sprayer to kill poison-ivy around campus.

Special attention was paid to making sure that our biodiesel plant did not have an adverse impact on the surrounding environment. Many biodiesel homebrewers take hazardous shortcuts that lead to the disposal of hazardous wash water and the unnecessary addition of hazardous methanol fumes to the workspace. Students were taught proper biodiesel production methods and how to minimize or eliminate any environmental hazards associated with biodiesel production.

Any student that enters the biodiesel production facility is educated about the relevant safety concerns and the proper safety attire that must be worn for each stage of the production process. All hazardous chemicals are clearly labeled and locked up when not in use.

Use

At the time of this report, 65 gallons of biodiesel (2 batches) have been produced. Roughly 30 gallons have been used in the school's three diesel tractors without any problems.

A 3-phase diesel generator was obtained to provide an easy visual aid of the application of biodiesel on campus. Unfortunately, the generator did not arrive in time for the chemistry students to test out the small batches of biodiesel that they made in their lab. However, future classes will be able to test their biodiesel fuel (and that of the production facility) in this generator. Last fall the school suffered a two-week power outage as a result of hurricane Ike. Because an electric pump-driven well supplies the school's water, the school was without potable water for those two-weeks. This generator, in addition to providing an easy way to test and display the results of future biodiesel labs, will also provide a much needed backup power source in case of emergencies.

The school will continue to run the biodiesel in the tractors all summer and then begin to introduce it into the two large school buses at the start of the year. The buses will consume more fuel throughout the year than our small production facility can keep up with, thus they will have to be supplemented with regular diesel or locally available commercial biodiesel.

Advertising

As part of the grant, magnetic signs were purchased to advertise that our vehicles are running on biodiesel. Some of these signs can be viewed on the blog.

The blog will continue to be updated and will serve as a conduit for public outreach and information sharing. We will also begin to advertise in local news outlets for waste-vegetable-oil. We plan to work with local public schools in an effort to share information as well as tap into a potential source of waste-vegetable-oil.

BUDGET

A summary of major expense categories and the grant funds dedicated to each category is provided in Table 1. Most categories were on budget and the small amount of leftover funds will be used to purchase future chemical supplies. A more detailed listing of expenses is attached to the Grant Utilization Form along with all relevant project receipts.

Table 1: Budget Summary

Expense Categories	Est. Cost	Actual Cost
Biodiesel Processor	\$4,000.00	\$3,505.66
Processing Chemicals	\$400.00	\$394.40
Oil Collection Container & Pump	\$200.00	\$569.15
Training	\$250.00	\$250.00
Safety Equipment	\$100.00	\$58.98
Shelter for Processor	\$1,000.00	\$839.81
Magnetic Signs	\$100.00	\$141.90
Miscellaneous	\$300.00	\$407.22
Diesel Generator	\$3,650.00	\$3,623.00
Funds for Future Supplies	\$0.00	\$209.88
Total	\$10,000.00	\$10,000.00

FUTURE WORK

Despite not applying for a project continuation grant, the Chinquapin Biodiesel Project will continue for years to come. Leftover funds from the project will be used to purchase chemicals to support the continued production of biodiesel. The blog will also continue to be updated, including video posts with detailed instructions on the production process. Next year's Environmental Science class will work to produce process placards that will be placed within the production facility. For years to come, biodiesel lectures and labs will be included in our chemistry and environmental science curricula.

CONCLUSION

A lot of learning was involved in this project, from both the perspective of the student and the teacher. Concepts of sustainability, organic chemistry, environmental science, construction, and foreign policy were spread throughout the project and the potential for teachable moments was astounding. Despite the relatively simple biodiesel production process, the students soon began to appreciate the details behind each step in the process and the amount of work needed to ensure a smooth running and safe procedure.