Bio Diesel: Changing Tomorrow, Today

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Abstract

As a part of the University of Central Oklahoma's core values: Character, Community and Civility the opportunity to take initiative as an individual or a department is highly recommended. The opportunity to foster needed change and be a leader on campus is easier to take advantage in our campus culture. In 2006, the employees of the Physical Plant did just that. They took advantage of the administrative support and the opportunity to use their abilities to promote change in the world of Bio-Diesel.

The employees of the Physical Plant recognized a problem that came with an opportunity. The department explored a move from Petrol-Diesel to Bio-Diesel fuel for their equipment. Bio-Diesel is fuel produced for diesel engines from vegetable oil or animal fat. This change allowed UCO to embrace a more economical fuel source, a more environmentally friendly fuel substitute, and create a template for other interested parties to implement.

UCO is striving to be a "Green University." The development, production, and implementation of Bio-Diesel is an example of UCO's commitment to be environmentally friendly for our community. The benefit's of using Bio-Diesel impacts many stakeholders, including: students, faculty, staff, local geographic community, and other universities. UCO has tested the system that can be implemented at other institutions.

Introduction:

The University of Central Oklahoma is a regional institution with a current enrollment of 15,000+ students. Centrally located in Edmond, Oklahoma, a suburb of Oklahoma City, the University is in the top 7 % of university enrollment across the nation. The student population drawing from 76 (out of 77) Oklahoma counties, 47 states and 76 countries provides the University with a rich cultural diversity.

The University of Central Oklahoma is Oklahoma's oldest institute of higher learning, established 17 years before statehood in 1890. The Oklahoma State Regents for Higher Education was formed by state leaders in 1941 and has governed the University since then.

The University currently has five academic colleges offering both undergraduate and graduate programs. UCO is dedicated to educating responsible, productive and engaged Oklahomans in a dynamic environment where building leaders and welcoming the challenge of change is endorsed. In addition to the three core principles embraced by the University: Civility, Community and Character, the campus culture encourages innovation.

Becoming a "Green University" is one of the Universities strategic goals. UCO has adopted the following environmental friendly practices:

- Use Bio-Diesel fuel
- Electricity powered by wind
- Performance Contracting with Johnson Controls

Statement of Problem/Initiative

Problems are internal situations that are substantially affected by external factors. The problem that UCO faces is the same problem the world is facing, fuel-consumption. Fuel consumption and its effects create problems from the moment fuel moves from inside the earth to outside of the earth. Potential oil spills, war, fuel price inflation, smog, pollution, and many more external forces are visible to anyone who consumes fuel on an individual basis. When considering the amount of fuel consumed at the university level, the external forces are exponential on the impact of the environment.

The Physical Plant was dealing with the following external effects: rising cost of Petrol-Diesel, unknown effects of the new Ultra Low – Sulfur Diesel on heavy equipment (an EPA mandated, effective 2007), and environmental factors that did not correspond with UCO's partnership as a "Green University".

The Physical Plant recognized this problem and began to develop ways to make a change they wanted to see in the world. The Physical Plant invested time, money, and labor into the development of Bio-Diesel. This effort was supported by the students, administration, and community. Through this investment there has been a reduction of hazardous fuel use on campus and fuel budget savings by utilizing university produced Bio-Diesel fuel.

Design

As part of a university-wide effort for continual development as a "Green University" UCO's Assistant Vice President of Facilities, Robert Nall, allowed his employees the flexibility to begin researching the development and use of Bio-Diesel. The Bio-Diesel team consisted of both faculty and staff. Representatives from the Colleges of Business Administration and Math and Sciences teamed up with the Physical Plant to develop the necessary resources for this project to be successful. This was an example of a time where the University came together to help make a difference in both the community of UCO and the world.

The team began by searching various methods of Bio-Diesel production which included internet Bio-Diesel maker websites and 'How To' training videos. Through their investigations they determined the most economical and plausible method for Bio-Diesel production.

The steps are as follows:

1. Oil is pumped into containers from the used cooking oil collection site.
2. The harvested oil is pumped into the heating and filtering system.
3. The oil is heated to 140 degrees to thin it for final filtering.
4. The oil is filtered to remove all water and all but the smallest particulate matter.
5. The still warm oil is collected and held in a secondary tank.
6. The oil is tested with Titration (note: This is the most important step of the process).
    a. Titration determines the amount of Free Fatty Acids (FFA) contained in the oil. FFA's are what make cooking oil "thick", too thick to be safely used in today's diesel engine. Titration consists of three effects.
        i. Isopropyl alcohol.

ii. A diluted solution Lye and distilled water.

iii. A precisely measured amount of filtered oil.

b. Alcohol and oil are mixed together and the Ph is checked.

c. The water Lye solution is added until the Ph spikes.

7. The Lye solution is measured based on the Titration test (accurate to .5 grams)

8. The Methanol is measured (200 ml per liter of used cooking oil)

9. The Methanol and Lye are then added to a floor mounted drill press that is outfitted for mixing Bio-Diesel. The solution is mixed until the lye is completely dissolved.

10. The clean, still warm, filtered oil is added to the Methanol and Lye solution and mixed.

11. The Lye/Methanol/cooking oil mixture is blended for one (1) hour.

12. The oil has now undergone the Transesterification chemical reaction process changing the mixture to Bio-Diesel and glycerin.

13. The mixture sits sealed in containers for a minimum of eight (8) hours. The glycerin settles to the bottom, leaving pure Bio-Diesel on the top.

14. The Bio-Diesel is pumped off and filtered one last time. This removes any remaining impurities in un-reacted chemicals.

15. The specific gravity is checked to confirm that the reaction sufficiently thinned the oil.

The end result is a cleaner burning, environmentally friendly diesel fuel that has much better lubricating properties than fossil diesel fuel. Another positive reaction of the use of Bio-Diesel fuel is the pleasant smell of French fries when the fuel is burned.

Implementation

With a move toward a "Green University", UCO explores ways to improve the air environment, reduce storage of hazardous waste on campus, and use environmentally friendly energy sources. To address all of these areas the Physical Plant has implemented pilot programs, some ready to be expanded, others still being researched.

One of the programs is the production of Bio-Diesel fuel. The Physical Plant requested waste vegetable oil from the University's Student Union. The Director of Food Services was very supportive, especially since this meant reducing cost of disposing of the waste vegetable oil. The oil was harvested and experiments in Bio-Diesel production began with small test runs. After successful implementation of Bio-Diesel in various heavy equipment applications, the Physical Plan conferred with the Chemistry Department on further testing and for information to improve the Bio-Diesel end production. A bubble washing procedure was implemented to create a higher quality fuel. A Methanol reclaimer was designed and built that enabled the Methanol to be re-used, providing a project savings of approximately 30% in Methanol costs.

The University is currently using Bio-Diesel in their forklift, two trucks, and a John Deere Tractor. The University plans to expand the use of Bio-Diesel to many of their other diesel running engines.

Reducing the hazardous fuel stored on campus is important for staff and student safety and protection from potential spills. A concern of the Physical Plant is the amount of petrol-diesel stored on campus. Currently a 2,000 gallon above ground tank stores the supply for vehicles not currently using Bio-Diesel. This is a potential hazard and the goal is to reduce the storage unit to a 500 gallon tank. The University's plan to expand the Bio-Diesel program will help to meet this goal.

A byproduct of the Bio-Diesel process is glycerin. The motor-pool uses the glycerin as degreaser and soap for the mechanics. The glycerin's use as a degreaser saves the university $2,346.39 per year. Through the implementation of Bio-Diesel, the University of Central Oklahoma is becoming a more environmentally friendly place to study, work, or just enjoy a Sunday afternoon.

Benefits

The benefits of Bio-Diesel have made an impact on the UCO campus. The benefits of Bio-Diesel are as follows:

- Provides a cleaner immediate area around our student population.
- Decreases fuel operation expenditures by a percentage while planning to reduce our hazardous stores of Diesel fuel.
- Saves money
- Reduces oil waste
- Lowers toxic emissions
- Results in budget savings statewide
- Free of hazardous waste mandates for storage, since Bio-Diesel is not classed as "hazardous" due to its characteristics.

- Uses for glycerin byproduct include soap for washing hands and as a degreaser for equipment when mixed with lye soap
- Converts a waste that is readily available and produced in large quantities, cooking oil, to a resource
- Addresses issues of liability for storage, clean-up and responsibility tied to the new federal 2007 Diesel Fuel Mandates
- Results in cleaner engines because Bio-Diesel has detergent and superior lubrication characteristics that helps keep the fuel system components maintained.
- Burning of Bio-Diesel fuel is easier on the engine and machine.
- Provides student research opportunities and participation in the Colleges of Business Administration and Math and Sciences
- Provides a model for teaching other interested parties how to produce their own Bio-Diesel.

Savings

	Cost	Gallons	Cost/Mo	Months	Savings/year
Current diesel usage per gallon	$ 2.40	125	$(300.00)	8	$ (2,400.00)
Reclaimation of Methanol (50% per 125 gal)	1.75	13.75	(24.06)	12	(288.75)
Safety Kleen Aqueous Brake Cleaner	717.63				(717.63)
Non-Chlorinated Brake Cleaner	831.60				(831.60)
J.B. Petroleum Degreaser	615.72				(615.72)
Chemco Hand Cleaner	181.44				(181.44)
Total Savings/year					$ (5,035.14)
Savings/month					$ (419.60)

***Savings based on Bio-Diesel and the byproduct Glycerin.**

Retrospect/Prospect

Considering this project is relatively new there are not many decisions that would be made differently. During the pilot process and into the current production, the correct facets where always informed for authorization of all ideas and decisions being made. The concept of Bio-Diesel was lucrative due to the savings on fuel costs, degreasers, soap, and the cost of waste disposal. The waste is now being disposed of by being a resource for the production of Bio-Diesel.

The university is currently undergoing upgrades and retrofitting of all stages of the Bio-Diesel process. Larger containers, more raw cooking oil, larger batches equal a larger margin for cost savings. Currently the Physical Plant produces in batches of eight (8) gallons. By November 2006 they will be producing in batches of 125 gallons. There is a bright future for the partnership being formed between UCO and Bio-Diesel. Above the importance of cost savings is the concept of the "model". The model can be used by other institutions who wish to turn their waste cooking oil into a useful fuel, Bio-Diesel. The opportunity for other institutions to serve their communities and stakeholders is a choice waiting to be made. This is an idea that other universities around the world can implement. The production of Bio-Diesel and the model that creates a level playing field for all of those people and institutions that want to participate is important to the communities in which we reside.