BIODIESEL FROM ALGAE

[1]Gajanan Kumbhar,[2]Ayush Saxena,[3]Bhanupratap Singh,[4]Prachi Vijaywargiya

[1]Assistant Professor,[2]Student,[3]Student,[4]Student,
Department of Chemical Engineering,
Bharati Vidyapeeth College of Engineering, Navi Mumbai, Maharashtra.

Abstract: Increasing demand due to increasing population in transport fuel will eventually lead to complete depletion of fossil fuel and can have severe consequences on human life which has led to discovery of many alternative energy sources. Biofuels are a wide range of fuels which are made from biomass. The term covers sources like solid biomass, liquid fuels and various biogases. Due to factors such as the need for increased energy security and oil price hikes, biofuels are now gaining increased public and scientific attention. Algae Biodiesel is a commonly used alternative to liquid fossil fuels that uses algae as source of energy-rich oils. Also, algae fuels are an alternative to common known biofuel sources, such as sugarcane and corn. From various studies it is found that species of algae can produce 60% or more of their dry weight in the form of oil. Energy scarcity prompted the need for diverse and integrated waste to energy solutions to meet the needs of farmers, the surrounding community, and the environment. In this sense research on making biofuels is being carried out.

1. Introduction

Carbon dioxide (CO2) emissions from the transport sector are contributing a major portion to the environmental pollution and global warming (Balat *et al.*, 2010). The cost of crude oil will continue to rise due to diminishing supply, so production of fuels from comparatively alternate sources will be needed in the future decades (Du *et al.*, 2008). In this scenario, biodiesel is considered as the best alternative fuel (Patil *et al.*, 2011). Bio-fuel obtained from renewable sources can also enhance agricultural farming and fuel production industries (Xue *et al.*, 2006). Oil of agricultural crops like soybean, sunflower, safflower, cotton seeds, coconut, peanut are investigated to be the potential alternative fuels for the diesel engines (Demirbas *et al.*, 2008). Studies showed that tobacco seeds can also be used for biodiesel production (Veljkovic *et al.*, 2006).Biodiesel obtained from oilseeds or the animals has comparatively higher raw material cost .It cannot meet the present needs, and can be used to fulfill only small fraction of existing demand. Therefore microbial oils, produced by various microorganisms like fungi, yeast and algae can be considered as the potential feedstock for biodiesel production. They own high lipid content and are cost effective (Meng*et al.*, 2009). Biodiesel obtained from other vegetable oil has the disadvantage of poor performance in cold weather as their polyunsaturated fatty acids tends to decrease the stability, but algal oil has overcome this problem due to the lower melting point of their polyunsaturated fatty acids. The biodiesel produced from these organisms not only have environmental benefits over the fossil fuel, but also economically competitive with the conventional petro diesel. The accumulated oil in mostly all microalgae is mainly triglyceride (>80%), with the fatty acid profile rich in C16 and C18 (Meng *et al.*, 2009).

2. Experimental-Setup and description:

The setup consists of basically 5 processes where the biodiesel synthesis will be carried out.

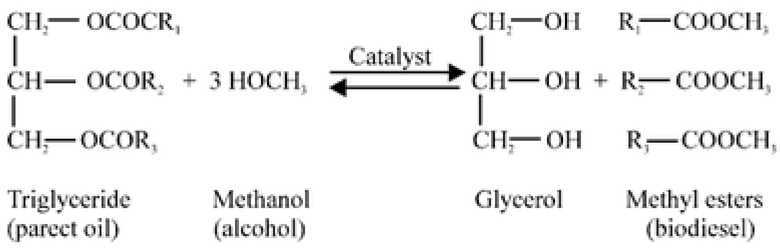
BIODIESEL SYNTHESIS

1**. Sample collection:-**Algae sample was collected near Upvan Lake, thane, (Mumbai) around 30 gm. algae were ground with motor and converted in powder form as much as possible. The ground algae used were dried for 20 min at 80c in an oven for releasing water.20 ml each of hexane and the ether solution were taken in a beaker. It was mixed with the ground algae (dried) to obtain oil and the mixture was kept for 24h for settling

2. **Biomass collection:-**The biomass was collected after filtration and weighted .than the solution was heated to release hexane and ether solution.

3**. Mixing of catalyst and methanol**:-0.25g NaOH was mixed with 24ml methanol and stirred properly for 20min.For biodiesel production the mixture of catalyst and methanol was poured into the algal oil in a conical flask.
4. **Trans esterification:--**The reaction process is called trans esterification. The conical flask containing solution was shaken for an hour.
5**. Settling: -** After shaking the solution was kept for duration of 16 h to settle the biofuel.

3. Reaction :



4. Experimental analysis:

1. Characterization of fuel
The properties of fuel such as viscosity, specific gravity, moisture content, saponification value, pour point, cloud point etc were measured and presented in table given below.

2. Preparation of FFA from fuel
FFA was prepared from fuel by saponification followed by acidification. With different stoichiometric amount of NaOH, using the method described above saponification was done using the method described above. After applying saponification and acidification free fatty acid was produced.

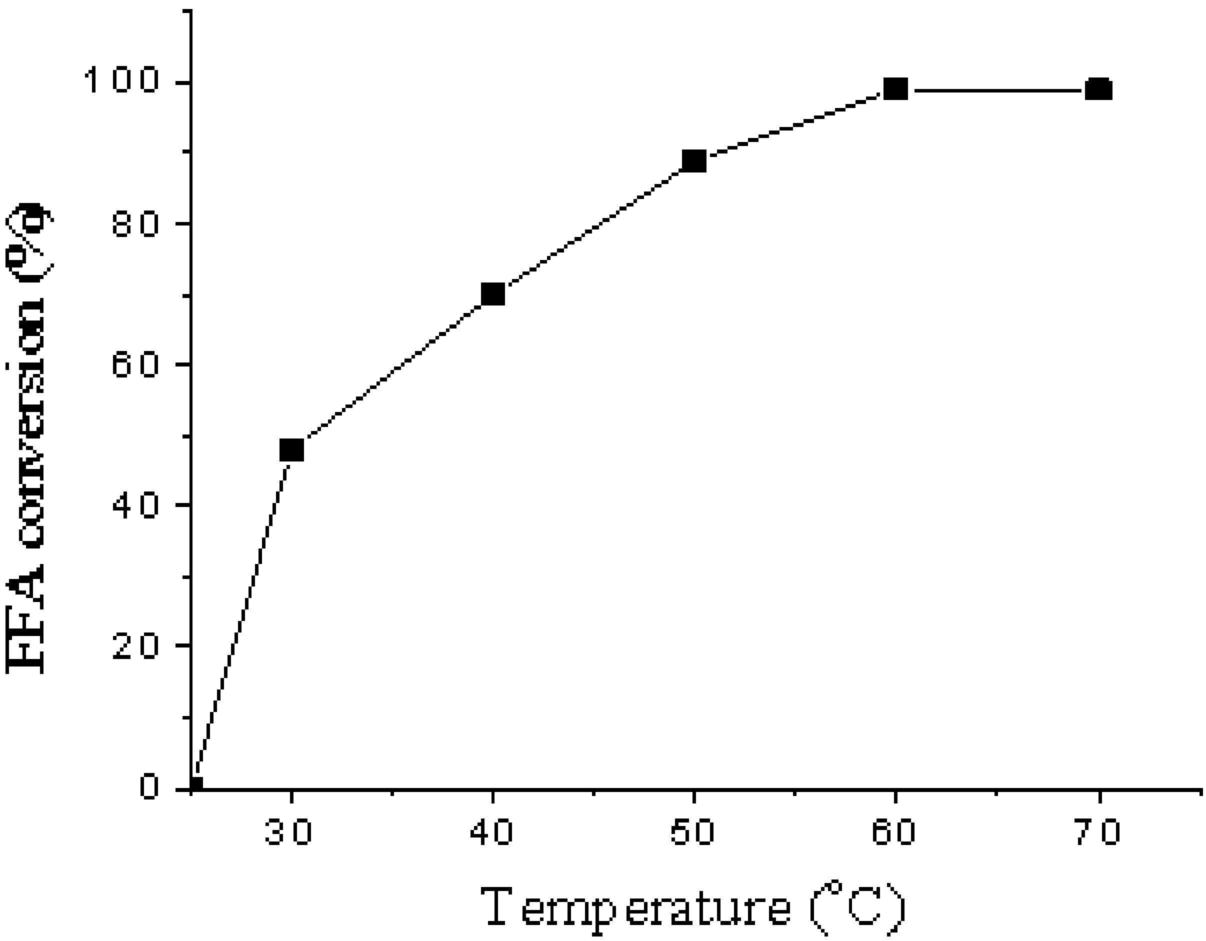
3. Property of fuel

Property	Experimental value
Physical state	Liquid
Color	Deep oily
Specific gravity	0.902
Kinematic viscosity	54.3
Cloud point (^{0}c)	12
Pour point (^{0}c)	6

PROPERTY OF FUEL

4. Preparation of biofuel from FFA
1. Effect of the Methanol to FFA Molar Ratio
The methanol to FFA molar ratio is one of the most important parameters that affect the FFA conversion to biodiesel. The effect of methanol to FFA molar ratio on conversion of FFA was determined at fixed temperature and catalyst concentration.

2. Effect of Temperature
Temperature has a relatively significant effect on conversion of FFA to methyl ester. By increasing temperature %FFA conversion was increased. At a certain temperature the conversion was relatively higher. The effect temperature on conversion of FFA was determined and the results are represented in Figure. From the Figure, it can be seen that the conversion was 98% at 60°C temperature. Further on increasing temperature, the percentage of FFA conversion does not increase. The optimum temperature was 60°C.



PLOT OF FFA CONVERSION (%) AND TEMPERATURE (CELCIUS)

5. Properties of biofuel

Physical Properties: Properties are one of the commonly used methods to determine the standard of biodiesel. Biodiesel can check using properties like density, viscosity, flash point, acid value and water content.

1. Density

Figure show how to find density by specific gravity bottle. The density of biodiesel was found to be 0.88 (g/c.c) that density is a function of temperature and decreased linearly for canola methyl esters.

SPECIFIC GRAVITY BOTTLE

2. Acid number

Figure is testing for acid value using method ASTM D 664 – Acid number, Acid number is a measure and defined as the quantity of base, expressed as milligrams of potassium hydroxide per gram of sample, required to titrate a sample to a specified end point. The acid number is a simple and direct measure of the free fatty acids in B100. The free fatty acids can lead to severe issues like corrosion and may be a symptom of water in the fuel. The acid value after production will be low usually for the base catalyzed reactions since the base catalyst will result in stripping of the available free fatty acids. However, it may increase with time as the fuel has the tendency to degrade due to contact with air or water.

5. Results and discussion:

The different properties of the produced algae fuel, standard biofuel and standard diesel were compared as shown in table.

PROPERTIES	PRODUCED ALGAE FUEL	STANDARD BIO-FUEL	STANDARD - DIESEL
Specific gravity (g/c.c)	0.88	0.88	0.85
Kinematic viscosity (mm2/s)	5	1.9-6.0	1.3-1.5
FFAcontent (%)	0.94	0.965	-
Calorific Value	37.27 MJ/Kg	43.4 MJ/kg	45MJ/Kg
Flash Point (°c)	>136	100-140	70-80
Physical state	Liquid	Liquid	Liquid

- The FFA content and calorific value of produced algae fuel is comparable with the standard biofuel and diesel which are available in the market.
- However, the viscosity of algae fuel is much higher making it difficult to use and store.

6. Conclusion:

Algae are considered as a very efficient means of producing biodiesel. The oil production from algae farms is scalable and feasible. Further research is necessary in this area to unlock full potential of algae. **Biofuels** can be used for lighting, power, heating and transport. Wood and grasses are considered as good **biofuels** as they grow relatively faster. **Biodiesel** is produced from oil crops, biogas is the result of breakdown of organic matter and bioethanol is produced from crops with very high sugar content.

Acknowledgement:

The authors highly acknowledge PROF. GAJANAN KUMBHAR (Project Guide), PROF. DR.MANISHA BAGAL (Project Co-Coordinator) for the conduction of this study.

References:

1. Balat, M., Balat, H. Progress in biodiesel processing. *Appl. Energ*., 2010; **87**: 1815–1835.
2. Du, W., Li, W., Chen, X., Liu, Perspectives for biotechnological production of biodiesel and impacts. *Appl. Micro boils Biot*. 2008; **79**: 331–337.
3. Lapinskiene, A., Martinkus, P., Eco-toxicological studies of diesel and biodiesel fuels in aerated soil. *Environ. Pollut.* 2006.
4. Lee, D.H., Algal biodiesel economy and competition among biodiesels. *BioresourceTechnol.* 2011; **102**: 43–49.
5. Christi, Y. Biodiesel from microalgae. *Biotechnology Adv.*, 2007; **25**: 249–306.
6. Rawat, I., Kumar, R. R., Mutanda,T, T. Bux, F, biodiesel from microalgae: A critical evaluation from laboratory to large scale production. *Appl.Energ.* 2013; **103**:444–467.
7. Lapuerta, M, Fernandez, and J.R., Effect of biodiesel fuels on diesel engine emissions.*Prog Energ. Combust*. 2008; **34**: 198–223.
8. Patil, P.D., Deng, S.; Munson-McGee., Rhodes, I., Lammers, P., Nirmalakhandan,N, N., Optimization of direct conversion of wet algae to biodiesel under supercritical methanol Conditions .*Bio resource Technol.*, 2011; **102**:118–122.