Biodiesel from an environmentally sustainable resource –Microalgae

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Introduction

Technology for producing biodiesel has been started more than 50 years ago. Microalgae are prokaryotic as well as eukaryotic photosynthetic microorganisms that grow rapidly due to their simple structure. Biodiesel is considered as a renewable fuel because it can be obtained from the transformation of vegetable oils, cooking greases or animal fats. Microalgae are a sunlight-driven cell factory that converts carbon dioxide to potential biofuels, foods and nourishes high-value bioactive compounds. Biofuel is a clean burning alternative fuel, created from domestically increased, renewable resources. It comprises of nil petroleum products, but it an alternative energy source instead of petroleum-based diesel fuel. Production of bio fuel from algae is a promising mechanism.

Biodiesel

Biodiesel is a mixture of fatty acid and alkyl esters obtained by transesterification of oils taken from microalgae. These lipids or oils contains 90 – 98 % of triglycerides, also small measures of mono as well as Diglycerides, free fatty acids (1 – 5 %), residues of Phospholipids, Phosphatides, Carotenes, Tocopherols, Sulphur compounds and traces of water.

Production of biodiesel

Selection of strain

Choose a high –oil producing microalgae strain. Various species like *Chlorella, Spirulina* and *Nannochloropsis* can be selected fro biofuel production.

Cultivation

It can be cultivated in both outdoor and indoor (Controlled conditions). For cultivation microalgae has to be provided with water, nutrients (nitrogen and phosphorus), carbon dioxide and sufficient light (usually from sunlight or artificial sources)

Harvesting

Harvesting can be done by centrifugation or filtration, to separate them from the growth medium.

Lipid extraction

It can be extracted through Solvent extraction, Mechanical pressing and Supercritical fluid extraction. By using anyone of the above methods lipid can be extracted (oils) from the harvested microalgae.

Trans Esterification process

Transesterification is a multiple step reaction, it composes of three reversible categories in series, where it converts the extracted lipids or oils into triglycerides, diglycerides, monoglycerides and then it is

converted into esters (biodiesel) and glycerol (by-product)

Extracted lipids or oils (Contain triglyceride)

↓

Diglycerides

↓

Monoglycerides

↓

Esters (biodiesel) and glycerol (by-product)

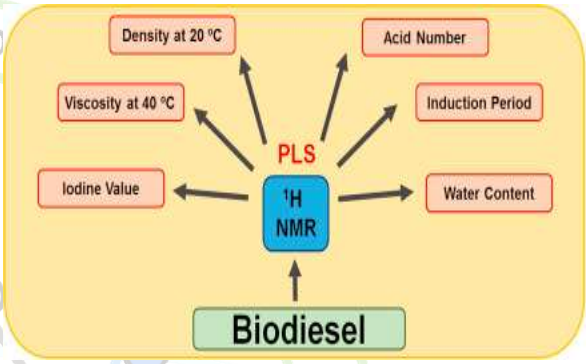
Among the alcohols, methanol, ethanol, propanol, butanol and amyl alcohol are used for transesterification process. Methanol and ethanol are frequently used. Methanol is chosen for the commercial production process as it is low in price and also because of its physical and chemical benefits (polar and shortest chain alcohol). Alcohol (usually methanol or ethanol) can be catalysed by using both homogenous and heterogeneous catalysts such as sodium hydroxide or potassium hydroxide to produce biodiesel (fatty acid methyl or ethyl esters) and glycerol.

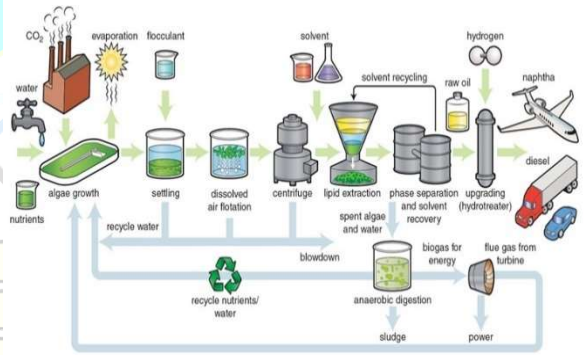
on and Purification

Biodiesel has to be separated from the glycerol and other remaining impurities. This is often done through gravity settling and washing

Quality Control

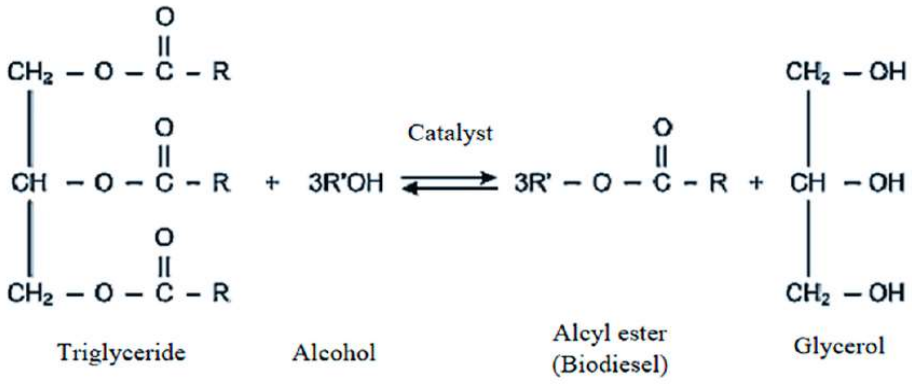
The biodiesel has to be analysed for the following quality parameters such as viscosity, acid value and cetane number to meets its fuel standards





By Product Utilization

Glycerol, a by-product of transesterification, can be further refined for making crude glycerol which is also used as a biodiesel for transportation and other industrial uses.



Microalgae for biodiesel production

Microalgae have the potential to produce around 5000 – 15000 gallons of biodiesel per acre per year. In addition, it also produces biodiesel, bio-oil, bio syngas and bio hydrogen. The extraction will be high only by the selection of high yielding algae biomass with high lipid content and an effective technique to harvest the green algae.

Sl.No.	Microalgae	Oil content (% dry weight)
1	*Botryococcus braunii*	25 - 80
2	*Chlorella protothecoides*	23 - 30
3	*Chlorella vulgaris*	14 - 40
4	*Nitzschiasp*	45 - 47
5	*Schizochytrium sp*	50 – 57
6	*Spirulina*	4 - 9
7	*Neochloris oleoabundans*	35 - 65

Advantages of microalgae

- They use solar energy with efficiencies 10 times higher than terrestrial plants
- It fixes higher quantities of CO_2 as well as atmospheric nitrogen.
- They can be grown in a fresh, salty and even in wastewater.
- They can be used as metal absorbers in wastewaters treatment.
- Algae can be harvested within a few days of culture, which does not happen with other crops.
- Flue gases from power plants can be directly used in algae culture to recover carbon dioxide and nitrogen dioxides.
- Algal production system can be installed in surfaces next to industries and in non-cultivable surfaces, in order to avoid competition with the lands.
- Several researches suggested that high quantity of oil can be obtained from microalgae than other types of oilseeds.
- Algae can be grown in an aquatic environment by the use of light and CO_2.
- The major techniques presently applied to the harvesting of microalgae include centrifugation, flocculation, filtration, screening, gravity sedimentation immobilization floatation and electrophoresis.

Conclusion

Algal biofuel is an ideal biofuel candidate which eventually could replace petroleum-based fuel due to several advantages such as high oil content, high production and less land etc. but main disadvantage is that the cost of biofuel production is high.

References

- Zhang, S., Zhang, L., Xu, G., Li, F. and Li, X., 2022. A review on biodiesel production from microalgae: Influencing parameters and recent advanced technologies. *Frontiers in Microbiology*, *13*, p.970028.
- Hoang, A.T., Sirohi, R., Pandey, A., Nižetić, S., Lam, S.S., Chen, W.H., Luque, R., Thomas, S., Arıcı, M. and Pham, V.V., 2022. Biofuel production from microalgae: challenges and chances. *Phytochemistry Reviews*, pp.1-38.