

BIODIESEL PRODUCTION



Biodiesel Production Methods

Summary of the advantages and disadvantages of the different techniques for transesterification of oil and/or fat for biodiesel production.[7]

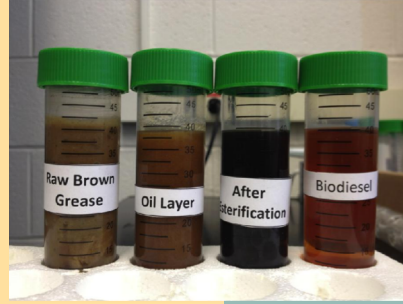


Corn seed.

Transesterification method	Suitable feedstock character	Advantages	Disadvantages
Homogeneous Acid catalyzed	Any type of oil/fat feedstock including those with high free fatty acid.	<ul style="list-style-type: none">✓ Gives relatively high yield✓ Insensitive to FFA content in feedstock, thus preferred-method if low-grade feedstock is used✓ Esterification and transesterification occur simultaneously✓ Less energy intensive	<ul style="list-style-type: none">× Corrosiveness of acids damage equipment× More amount of free glycerol in the biodiesel× Requires higher temperature operation but less than supercritical× Relatively difficult to separation of catalyst from product.× Has slower rate of production (relatively takes longer time)
Homogeneous Base catalyzed	Oil/fat feedstock with FFA content less than 0.5% by weight of the oil	<ul style="list-style-type: none">✓ Faster reaction rate than acid catalyzed transesterification✓ Reaction can occur at mild reaction condition and less energy intensive✓ Common catalysts such as NaOH and KOH are relatively cheap and widely available✓ less corrosive	<ul style="list-style-type: none">× Sensitive to FFA content in the oil× Saponification of oil is the main problem due to quality of feedstock× Recovery of glycerol is difficult,× Alkaline wastewater generated requires treatment



Biodiesel Production Methods



Biodiesel production step samples.[9]

Heterogeneous Base Catalysis

Oil/fat feedstock with FFA content less than 0.5% by weight of the oil

- ✓ Improved selectivity
- ✓ Easy to separate catalyst from reaction mixture
- ✓ Reduced process stages and wastes
- ✓ Enable to regenerate and reuse the catalyst
- ✓ Reaction can occur at mild reaction condition and less energy intensive

- × Catalyst might be poisoned when exposed to ambient air
- × Sensitive to FFA content in the oil so selective to feedstock type
- × Soap will be formed if there is high FFA content
- × Soap formation associated with reduced biodiesel yield and problem in product purification
- × Leaching of catalyst active sites may result to product contamination

Heterogeneous Acid Catalysis

Any type of oil/fat feedstock including those with high free fatty acid.

- ✓ Catalyst separation from reaction mixture is easy
- ✓ Has reduced process stages and wastes
- ✓ Insensitive to feedstocks' FFA content.
- ✓ Preferred-method if low-grade oil is used
- ✓ Esterification and transesterification occur simultaneously
- ✓ Solid acid catalyst can be easily removed recycled

- × Complicated catalyst synthesis procedures lead to higher cost
- × Requires high reaction temperature, high alcohol to oil molar ratio and long reaction time.
- × Relatively energy intensive



PRODUCE

Biodiesel Production Methods



Flax seed.

Lipase catalyzed transesterification

Any type of oil/fat feedstock including those with high free fatty acid and water content.

- ✓ Insensitive to FFA and water content in the oil, thus preferred when low grade feedstock is used
 - ✓ It is carried out at low reaction temperature
 - ✓ Purification requires simple step, by enabling easy separation from the by-product, glycerol
 - ✓ Gives high purity product (esters)
 - ✓ Enables to reuse immobilized enzyme
- ✗ The cost of enzyme is usually very high
 - ✗ Gives relatively low yield
 - ✗ It takes high reaction time
 - ✗ The problem of lipases inactivation caused by methanol and glycerol

Nano catalyzed transesterification

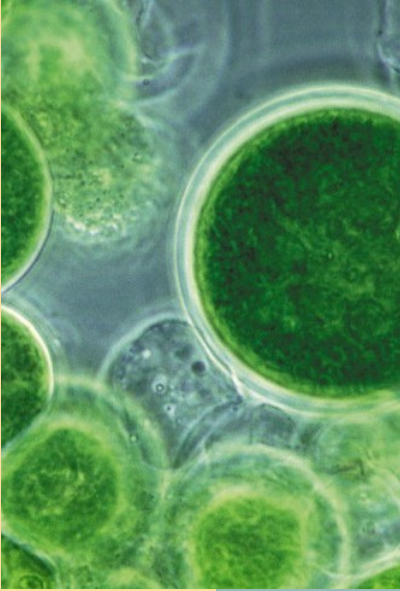
Any type of oil/fat feedstock including those with high free fatty acid and water content

- ✓ Relatively with shorter reaction time
 - ✓ Less amount of catalyst can be enough since has high specific surface area
 - ✓ Catalyst can be reused many times
 - ✓ Wide range of catalyst choice
- ✗ Requires relatively more alcohol for effective yield
 - ✗ In some cases preparation of appropriate catalysts costs more



PRODUCE

Biodiesel Production Methods



Microalgae have great potential for biodiesel production.

Ionic liquid catalyzed transesterification

Any type of oil/fat feedstock including those with high free fatty acid and water content but dependent on which type of ionic liquid is used (Acidic/basic)

- ✓ Easy to separate final products due to formation of biphasic.
- ✓ Efficient and time saving
- ✓ While preparing catalysts their properties can be designed to suit a particular need
- ✓ Catalyst can be easily separated and reused many times
- ✓ High catalytic activity, excellent stability

- × High cost of ionic liquid production
- × Requires relatively more alcohol for effective yield

Supercritical transesterification

Any oil and fat with greater range and water content and high FFA content (in particular, used cooking oil)

- ✓ It takes very less time to complete
- ✓ Insensitive to greater water content of the feedstocks
- ✓ Produces more than a kilo of fuel per kilo of feedstock
- ✓ No need of washing the product as there is no catalyst used
- ✓ It is more easier to design as a continuous process

- × Requires higher temperature and pressure
- × It is not an economic alternative due to its high operating cost, due to high pressures and high temperatures
- × Relatively there is high methanol consumption (e.g., high methanol/crude-oil molar ratio of 40/1)



REFERENCES

- 1 <https://articles.extension.org/pages/27135/history-of-biodiesel>
- 2 https://www.eia.gov/energyexplained/index.php?page=biofuel_biodiesel_home
- 3- Ge, J.C.; Yoon, S.K.; Choi, N.J. Using Canola Oil Biodiesel as an Alternative Fuel in Diesel Engines: A Review. Appl. Sci. 2017, 7, 881.
- 4- Romano, S. D. and Sorichetti, P. A. Dielectric Spectroscopy in Biodiesel Production and Characterization, Green Energy and Technology, 2011, Springer.
- 5- UFOP Report on Global Market Supply 2017/2018
- 6 Marchetti J.M.; Miguel V.U.; Errazu A.F. Possible methods for biodiesel production. Renewable and Sustainable Energy Reviews. 2005.
- 7 Gebremariam, S.N.; Marchetti, J.M. Biodiesel production technologies: review. AIMS Energy. 2017.
- 8 <https://www.sebiodiesel.com/2017/11/06/biodiesel-synthesis-simplified/>
- 9 Motta, Justin & S Parnas, Richard. (2015). Creating Renewable Energy from the Effective Management of Fats, Oils, and Grease (FOG).