Lao
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Biofuel Series

Processing Biodiesel from Jatropha Curcas seeds

Report

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About us

LIRE is a non-profit organisation dedicated to the sustainable development of a self sufficient renewable energy sector in the Lao PDR. The institute offers agronomical, technological and socio-economic research services, and works to provide a free public resource of information and advice on the use of renewable energy technologies in Laos. LIRE strives to support the development of the country by exploring commercially viable means to establish renewable energy technologies in rural parts of the country, in areas without connection to the national grid and with little access to technical expertise.

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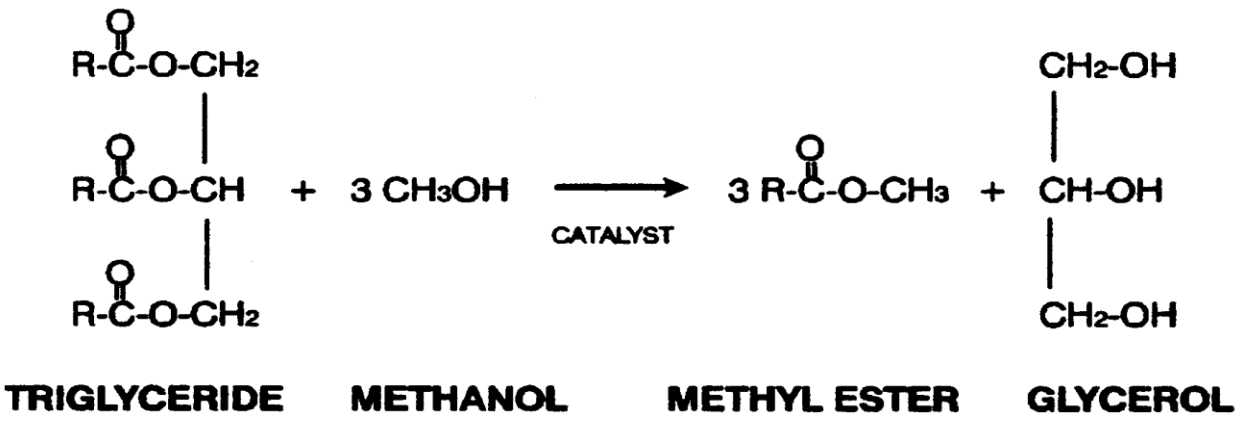
Biodiesel Production Process implemented by LIRE

Biodiesel is produced by the trans-esterification of tri-acyl glycerol (triglyceride) compounds according the reaction of scheme 1. The triglycerides contained in oil react with methanol in presence of basic catalyst like sodium hydroxide or potassium hydroxide for producing fatty methyl ester (biodiesel) and glycerol. The reaction can be implementing at medium temperature (e.g. 60 ^{o}C) without solvent but the obtained yield in biodiesel after processing depends on the amount of free fatty acid and phospholipids contained in the oil.

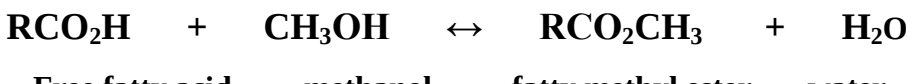
Few amount of free fatty acid naturally occur in oil seed but theirs amount can increase with the water contain of the seed during the storage, relative humidity of storage place, duration and temperature of storage. Free fatty acid can react with the catalyst of trans-esterification and produce soap. The occurrence of soaps during biodiesel processing can affect the yield because they increase the solubility of biodiesel in water during the washing (purification step) thus resulting in biodiesel loss. In order to produce biodiesel with a good yield the amount of free fatty acid contained in the oil should be less than 0.5 percent.



Scheme 1 : *Trans-esterification of triglyceride*

The amount of free fatty acid contained in crude oil is measured by the acid value that is the quantity of potassium hydroxide expressed in milligrams that is need for neutralizing the acidity of one gram of product. In case of an acid value higher than 1 mg of KOH per gram of oil a

treatment should be performed for decreasing acid value. The main process for decreasing acid value of oil is the esterification of free fatty acid with alcohol (methanol) in presence of mineral acid catalyst (hydrochloric acid or sulfuric acid). Free fatty acids react with methanol for producing fatty methyl ester and water according the scheme2.



Scheme 2 : *Esterification of free fatty acid*

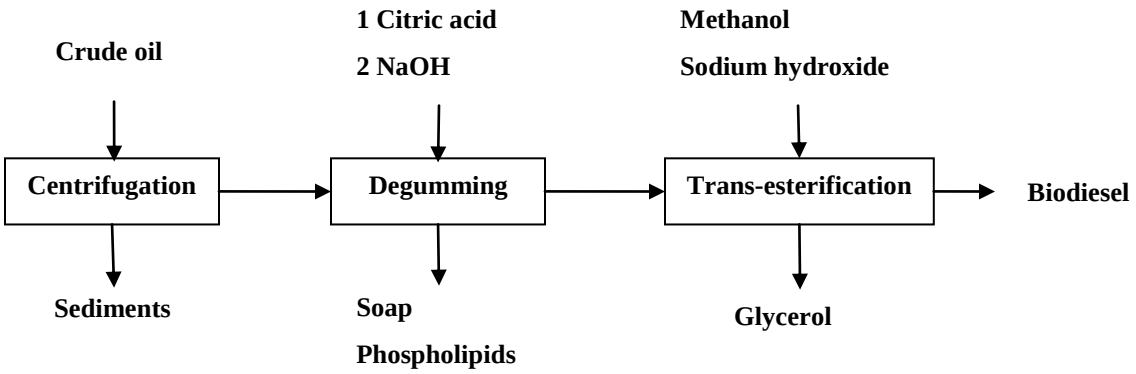
Esterification is an efficient process for decreasing the amount of free fatty acid contained in oil however this process has two main drawbacks that are the need of special equipment and the need to recover methanol after the reaction. For the efficiency of the reaction acid catalyst should be concentrated mineral acid and consequently the equipment for the esterification should be corrosion thought (glass or glass lined reactor) because these kind of catalysts are very corrosive chemicals.

An excess of one of the reactant (acid or alcohol) should also be used for the completion of the reaction. If esterification is implemented with an equal number of moles of acid and alcohol after some time the reaction reach equilibrium and no more ester is produced resulting in low yield conversion. In the case of esterification of free fatty acid an excess of methanol should be used for completely transform free fatty acid in fatty methyl esters.

Consequently after esterification of free fatty acid methanol should be recovered for economic reasons because it use in excess in order to reach the completion of the reaction. Esterification of free fatty acid should also be implementing from oil with high acid value at least10 mg of KOH per gram. If esterification is implemented with an acid value less than 10 mg of KOH per gram of oil the process can be un-economic because the duration for the completion of the reaction is inversely proportional to the concentration of fatty acid in the oil.

Like free fatty acid phospholipids naturally occur in crude oil and should also be removed before trans-esterification because they act as soap during the purification of biodiesel and they can

endanger the engine in their amount in the biodiesel is higher than 5 parts per million (ppm). Considering the problem that can occur during the processing of biodiesel due to the presence of free fatty acid and phospholipids in Jatropha oil we have studied at LIRE a process that can be effective for producing biodiesel from Jatropha oil with an acid value less or around 10 milligrams of KOH per gram of oil without the need of specific equipment. This process can effectively decrease the amount of free fatty acid and phospholipids under the endorsed value and the main step of the process are depicted by the scheme 3.



Scheme 3 : *Biodiesel process studied at LIRE*

The process consist first to make the centrifugation of crude Jatropha oil after pressing in order to remove small solid particles that still remain in the oil after pressing. Then the centrifugated oil is treated first by citric acid at 80 ^{o}C followed by a treatment with sodium of potassium hydroxide at room temperature for removing free fatty acid as soap and phospholipids. The degumming step is followed by trans-esterification with methanol and sodium or potassium hydroxide for producing biodiesel and glycerol.