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A BRIEF DESCRIPTION ON BIODIESEL

Rupesh Kumar*

*School of Biotechnology and Bioinformatics,
Faculty of Engineering and Technology,
Shobhit Institute of Engineering and Technology,
(Deemed to be University), Meerut, INDIA
Email id: rupesh@shobhituniversity.ac.kin,

ABSTRACT

Continuous usage of fossil fuels (non-renewable natural resources) is rapidly diminishing, and their combustion is causing an increase in carbon dioxide in the atmosphere. For environmental and economic sustainability, renewable carbon-neutral transportation fuels are needed. Biodiesel made from oil crops has the potential to be a carbon-neutral sustainable alternative to petroleum-based fuels. It is mainly generated via direct usage and mixing, microemulsions, thermal cracking (pyrolysis), and transesterification, and is made up of monoalkyl esters of long-chain fatty acids. Transesterification of vegetable oils and animal fats is the most prevalent technique for producing biodiesel. Batch procedures, supercritical processes, ultrasonic techniques, and microwave methods are all accessible for the transesterification reaction. Water content of oils or fats and free fatty acids, molar ratio of glycerides to alcohol, catalysts, reaction duration, and reaction temperature are all variables that affect the transesterification process. The significance, history, characteristics, suppliers, and methods for producing biodiesel are discussed in this study.

KEYWORDS: *Alternate Fuel, Biodiesel, Renewable, Transesterification, Vegetative Oil.*

1. INTRODUCTION

Petroleum consumption has been steadily rising as a result of industrialisation and modernisation. Energy consumption has increased as a result of economic growth. Fossil fuels such as petroleum, coal, and natural gas provide the energy required to meet demand. According to the International Energy Agency (IEA) and Shahid and Jamal, the world will need 50% more energy in 2030 than it does now, with China and India accounting for half of it. Climate change is now the world's most significant environmental issue. Nearly one million species may go extinct if global temperatures rise by more than 2°C, and hundreds of millions of humans could perish. Between 2007 and 2020, approximately 4.1 billion metric tons of CO2 are expected to be emitted into the atmosphere. From 2020 to 2035, an additional 8.6 billion tons CO2 is projected to be emitted into the atmosphere[1]–[4].

The high viscosity, low volatility, and polyunsaturated nature of triglycerides cause problems when they are substituted for diesel fuels. Pyrolysis, microemulsification, and transesterification are three major methods that have been explored in an effort to overcome these limitations and enable vegetable oils and oil wastes to be used as a viable alternative fuel. Transesterification is the most frequent and generally recognized of these.

The transesterification reaction is the chemical process through which biodiesel is made. Triacylglycerols react with short-chain monohydric alcohols at high temperatures in the presence of a suitable catalyst (alkali, acid, or enzyme) to produce fatty acid alkyl esters (FAAE) and glycerol. Transesterification is the most straightforward and cost-effective method of producing biodiesel[5].

1.1 History of Biodiesel:

The diesel (compression ignition) engine was developed by Rudolf Diesel to operate on a variety of fuels, including coal dust suspended in water, heavy mineral oil, and vegetable oil. Diesel's early engine attempts were a complete disaster. He demonstrated his engine, which ran entirely on peanut oil, at the World Exhibition in Paris in 1900. ‘The diesel engine can be fueled with vegetable oils and would assist greatly in the growth of agriculture in the nations that utilize it,' Diesel claimed in 1911. ‘The use of vegetable oils for engine fuels may seem trivial nowadays,' Diesel wrote in 1912. However, such oils may become as significant in the future as petroleum and coal tar products are now.' Diesel passed away in 1913. Later, his engine was adapted to operate on the toxic petroleum fuel known today as "diesel." Nonetheless, his agricultural ideas and innovation laid the groundwork for a civilization powered by clean, renewable, locally produced fuel. Vegetable oils were utilized to substitute diesel fuel in emergency circumstances. Biofuels are becoming more popular as a result of their renewable nature and ability to reduce pollution[6], [7].

1.2 Source of Biodiesel:

Vegetable oil, waste cooking oil, and animal fats may all be used to make biodiesel. Algae, microalgae, and fungus may all be used to make biodiesel. However, the majority of research has focused on oil-producing plants. The selection of feedstock is the initial stage. More than 350 oil-bearing crops have been identified as possible biodiesel sources throughout the world. The most frequently utilized feedstocks for biodiesel manufacturing. The availability of a diverse variety of feedstocks is the most significant element in biodiesel manufacturing. Low manufacturing costs and large-scale production are two major criteria for the feedstock. Geographical locations, climate circumstances, local soil texture and conditions, and agricultural methods all influence the availability and output of biodiesel feedstock. There are four types of biodiesel feedstocks:

- Vegetable oils that is edible, such as rapeseed, soybean, peanut, sunflower, palm, and coconut.

- Vegetable oils that is not edible, such as jatropha, karanja, sea mango, algae, and halophytes.
- Oil that has been used before or that has been recycled.
- Beef tallow, yellow grease, chicken fat, and by-products from fish oils are examples of animal fats.

1.3 Biodiesel production technologies:

The extraction of oil is the second stage in the biodiesel manufacturing process. The oil contained in the seeds is removed during the oil extraction process. The primary result of this process is crude oil, with seeds or kernel cakes as significant by-products. The oil may be extracted using one of three methods:

- Enzymatic extraction.
- Solvent extraction.
- Mechanical extraction.

The most common technique (using mechanical expellers or presses) is the mechanical method. Whole seeds, kernels, or a combination of both are utilized in this technique, although whole seeds are the most frequent choice. Oil extraction yields are 68–80 percent using the mechanical technique. The chemical extraction technique uses just kernels as a feedstock. A liquid solvent is used to extract the oil from the seed in the solvent extraction technique. The pace of oil extraction is influenced by a number of variables (such as particle size, type of liquid chosen, temperature and agitation of the solvent). The solvent approach is used in three methods for oil extraction:

- Ultrasonication technique
- Soxhlet extraction.
- Hot water extraction.

1.4 Direct use and Blending:

It was proposed in 1980 that vegetal oil might be utilized as a fuel. The idea of utilizing edible oil as a fuel implies that petroleum will be used in lieu of vegetable oil and alcohol as alternatives, and that renewable energy must be used to replace non-renewable resources. Sunflower oil was investigated by academics in South Africa (during an oil embargo). In Caterpillar, Brazil, in 1980, pre-combustion chamber engines were run using a 10% vegetable oil mixture to sustain complete power without any changes or adjustments to the engine. At the time, replacing 100% vegetable oil for diesel fuel was not feasible, but a mix of 20% vegetable oil and 80% diesel fuel was feasible and effective. In certain short-term tests, a 50/50 mix of vegetal oil and diesel was utilized[5], [8].

1.5 Pyrolysis:

Thermal cracking is another name for pyrolysis. Pyrolysis is a chemical transformation caused by the application of heat energy in the absence of air or nitrogen in the presence of a catalyst. Vegetable oils, animal fats, natural fatty acids, and methyl esters of fatty acids may all be used as substrates for the pyrolysis process of producing biodiesel. The pyrolysis of triglycerides to produce biodiesel has been shown to be acceptable for diesel engines. The liquid portions of temperature-based vegetable oil conversion are expected to resemble diesel fuels. Alkanes, alkenes, alkadienes, aromatics, and carboxylic acids are produced during this kind of triglyceride breakdown. The pyrolyzate was shown to have lower viscosity, flash point, and pour point than petroleum diesel fuel while having similar calorific values.

1.6 Catalytictransesterification:

Alkali, acid, enzyme, and heterogeneous catalysts are used in the transesterification of triglycerides. Sodium hydroxide, sodium methoxide, potassium hydroxide, and potassium meth oxide are more effective alkali catalysts. Sulfuric, hydrochloric, and sulfuric acids are the most often used acid catalysts. Heterogeneous catalysts may also be used to produce biodiesel. Enzymes, titanium-silicates, alkaline-earth metal complexes, anion exchange resins, and guanidinesheterogenized on organic polymers are examples of heterogenous catalysts. The catalytic transesterification of vegetable oils/animal fats with methanol is a crucial industrial process in the production of biodiesel. This process, also known as methanolysis, has been extensively researched and established utilizing acids or alkalis as catalysts, such as sulfuric acid or sodium hydroxide. For long-chain alcohols, however, these catalytic systems are less active or totally inert. Sodium or potassium hydroxide, or sodium or potassium meth oxide, are often used as catalysts since they are comparatively less costly and very active for this process.

1.7 Enzyme-catalysedtransesterification:

Enzymes may also catalyze transesterification. Lipase is the most often utilized enzyme for transesterification. Lipase from Candida antarctica, Candida rugas, Pseudomonas cepacia, immobilized lipase (Lipozyme RMIM), Pseudomonas sp., and Rhizomucormiehei has been described. Using a commercially available immobilized lipase, the enzymatic transesterification of soy bean oil with methanol and ethanol was studied (Lipozyme RMIM). The greatest results were obtained in a solvent-free system with a 3.0 ethanol/oil molar ratio, a temperature of 50°C, and a 7.0 percent (w/w) enzyme concentration. They got a 60% yield and it took 1 hour to complete the reaction. Using P. cepacia lipase immobilized enzyme on celite material at 50°C in the presence of 4–5 percent (w/w) water for 8 hours, Shah and Gupta achieved a 98 percent yield. The transesterification process in the enzyme-catalyzed system takes longer than the other two catalytic ways of transesterification. Extracellular and intracellular lipases may efficiently catalyze the transesterification of triglycerides in both aqueous and non-aqueous environments. Using alkali or acid-catalyzed transesterification, enzyme-catalyzed transesterification may solve the issues described above.

1.8 Catalyst effect:

Alkali, acid, or enzyme catalysts are employed in the transesterification of triglycerides. The most common commercially utilized transesterification is alkali-catalyzed transesterification, which is considerably quicker than acid-catalyzed transesterification. The most efficient catalysts were determined to be Na, NaOH, and KOH in that research. The authors used ultrasonic energy to examine the impact of various catalyst concentrations on base catalyzed transesterification during biodiesel synthesis from vegetable oil. When the catalyst was employed at a low concentration, such as 0.5 percent wt/wt of oil, the highest yields of ester were achieved. At greater reaction temperatures, hydrochloric acid outperforms sodium hydroxide, according to the findings of several researches[9].

1.9 The effect of temperature and time:

Depending on the kind of vegetable oil or fat used, transesterification may occur at various temperatures. At room temperature, there are few reports on the transesterification process. The reaction of palm oil transesterification with methanol (6:1) and 1% KOH was studied at various temperatures. Ester yields at 50 and 65 degrees Celsius were 73 and 82 percent after 4 minutes, respectively. At 40–70°C, the impact of reaction temperature on propyl oleate synthesis was investigated using free immobilized P. fluorescens lipase. At 60°C, the conversion ratio to propyl oleate was greatest, but at 70°C, the activity reduced.

1.10 Properties and qualities of biodiesel:

Physicochemical characteristics are used to characterize the qualities or quality of biodiesel. CN, caloric value (MJ/kg), density (kg/m3), viscosity (mm2 / s), cloud and pour points (°C), flash point (°C), acid value (mg KOH/g-oil), ash content (%), water content and sediment, copper corrosion, distillation range, carbon residue, sulphur content, glycerine presence (percent m/m), phosphorus (mg/kg), and oxidation The chemical and physical characteristics of biodiesel are determined by the kind of raw material used and the fatty acid content.

1.11 Viscosity:

The ability of a fuel to flow is described by its viscosity. This property is essential in the functioning of fuel injection equipment and spray atomization, especially at low temperatures when the fuel's fluidity is affected by the rise in viscosity[10].

1.12 Fuel density and relative density:

The density of a fuel is defined by its weight per unit volume. Oils have a higher energy density and are thus denser. Biodiesel density may be determined using the EN ISO 3675/12 185 and ASTM D1298 standards. Density should be evaluated using this reference standard at a temperature of 15 or 20°C. The density of the fuel in comparison to the density of water is known as relative density. Biodiesel's relative density is used to convert mass to volume, compute flow and viscosity characteristics, and evaluate the homogeneity of biodiesel tanks.

1.13Flash point:

When exposed to a flame, the flash point of a fuel is the temperature at which it will ignite. Fuel volatility is inversely proportional to its flash point. Biodiesel has a higher flash point than petroleum diesel, making it safe to carry, handle, and store.

1.14 Titre:

Titre is the temperature at which solidified oil transforms into liquid oil. Because the transesterification process for biodiesel production is essentially a liquid process, oils with high titre may need heating, increasing energy requirements and production costs for a biodiesel plant.

1.15 Free Glycerin:

The quantity of glycerol left in the final biodiesel is referred to as free glycerol. The quantity of free glycerol in biodiesel is determined by the manufacturing method.

1.16 Ash of Sulphate:

The quantity of inorganic impurities in the fuel, such as abrasive particulates, catalyst residue, and soluble metal soaps, is referred to as ash content. To measure the proportion of sulphated ash present, the bio diesel is ignited and burnt, then treated with sulphuric acid. The ASTM D874 standard specifies that the samples may include no more than 0.02 percent sulphated ash.

2. DISCUSSION

Biodiesel is a biodegradable, renewable fuel made in the United States from vegetable oils, animal fats, or restaurant grease. Biodiesel is a liquid fuel that is often referred to as B100 or "neat" biodiesel. Biodiesel, like petroleum diesel, is used to power compression-ignition engines. Biodiesel is a resource that has a lot of potential. Esterification and transesterification are the two most important processes in biodiesel synthesis. The kind of feedstock oil, reaction circumstances, catalyst employed, and alcohol to oil molar ratio all have an impact on these reactions. Biodiesel produced from rapeseed oil and ethanols made from maize were formerly thought to be the pinnacle of future low-carbon transportation. Biofuels may account for 27% of worldwide transportation fuels by 2050, according to the International Energy Agency. By 2030, transportation fuels must achieve a 14 percent reduction. Biodiesel has a bright future since it is the perfect fuel for future generations.

3. CONCLUSION

Energy is a key need for sustaining economic development and maintaining human growth index norms. After the industrial sector, transportation is the second most energy-intensive sector, accounting for 30% of total supplied energy. Oil accounts for almost all fossil fuel energy use in the transportation industry (97.6 %). However, the anticipated depletion of fossil fuels, as well as the environmental issues connected with their use, has prompted many academics to look into alternate fuels. Biodiesel is a resource that has a lot of potential. Esterification and transesterification are the two most important processes in biodiesel synthesis. The kind of feedstock oil, reaction circumstances, catalyst employed, and alcohol to oil molar ratio all have an impact on these reactions.

Another method to save manufacturing costs is to recover glycerol. The biodiesel glycerol is more concentrated since water is present in the system. Physicochemical characteristics such as CN, density, viscosity, cloud and pour points, flash point, acid value, copper corrosion, glycerine, and oxidation stability define biodiesel.

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