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Recent Techniques for Producing Biodiesel

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Abstract

Development of society increases the demand of energy. Particularly in transportation sector the need of diesel fuel is increasing day by day and consequently there is a problem of environmental pollution, so there are severe challenges to human survival and development. Biodiesel provides one kind of sustainable solution to above problems. The supercritical process is one of the innovative methods used in the manufacturing of biodiesel. With this process, oils are exposed to supercritical conditions, which are above their critical temperature and pressure. This allows for faster reaction rates and a higher production of biodiesel. Because supercritical fluids have certain qualities that improve extraction and conversion, this method is quite effective. The use of ultrasonography to help the procedure is another novel strategy. In order to improve mass transfer and mixing in the reaction mixture, cavitation is created using ultrasonic waves. It is possible to produce biodiesel from various animal fats, vegetable oil and algae. There are various techniques of converting oil into biodiesel. This part discusses emerging and new techniques such as super critical process, ultra sound assisted process and micro wave assisted process for producing biodiesel.

Keywords: Biodiesel; Edible Oil; Non-Edible Oil; Fatty Acid; Oil Extraction.

INTRODUCTION

There are several drawbacks of conventional alkyl ester manufacturing process, specifically, the large time of reaction, batch mode operation, and complicated separation. It is needed to address the environmental impacts of residues and by-products generated from biodiesel production. Looking at global demands, competitiveness in the market, Government policies, it is needed to have more efficient processes for production of biodiesel. Conventional techniques' prolonged reaction times limit the scalability and throughput of biodiesel manufacturing facilities in addition to driving up production costs. These difficulties are made worse by batch-mode activities, which necessitate repeated cycles of start-up, shutdown, and cleaning. This results in inefficient use of resources and increased operating expenses.

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Technological and financial obstacles are also presented by the intricate separation procedures used in the traditional biodiesel production process. Energy-intensive and resource demanding processes are frequently used in the separation of glycerol from biodiesel and the purification of biodiesel from unreacted feedstocks and catalysts, which adds to overall process inefficiencies and environmental effects. Considering these obstacles, it is imperative to create more sustainable and effective methods for producing biodiesel. Global needs for cleaner and renewable energy sources, the energy market's competitive environment, and changing governmental regulations that support sustainable development and lower greenhouse gas emissions all highlight this necessity.

In order to fulfill the growing demand for energy and reduce the environmental effects of using traditional fossil fuels, it is imperative that efforts be made to improve the efficiency of the processes involved in the manufacture of biodiesel. Global aspirations for environmental sustainability and energy security can be greatly aided by biodiesel manufacturing's increased process efficiency, decreased waste production, and optimized resource use.

Methods and Discussion

Lipase Catalysed Transesterification

In case of conventional transesterification process, oil containing fatty acids is made to react with an alcohol in existence of alkali catalyst. But there is a problem of soap formation, purification and washing specially in case of oils having more percentage of free fatty acids. In case of lipase catalyst transesterification, enzymes are used as catalyst. The advantages of this process are it can be carried out at low reaction temperature, easy purification, produces high purity yield and allows to recycle restrained enzyme. The limitations are long reaction time and high cost [1]. On the other hand, an alternate method that uses enzymes rather than alkali as catalysts is lipase catalyst transesterification. Lipases are biocatalysts that help convert oils into biodiesel at lower reaction temperatures and other gentler conditions. Compared to traditional methods, this approach produces products of higher purity and makes biodiesel purification easier. Enzymes can also be utilized restrainedly or immobilized, which makes it possible to reuse them in later reactions and adds to the overall sustainability of the process.

Nano Catalysed Transesterification

In this method instead of conventional acid and or alkali catalysts various nano catalysts can be used to enhance the reaction between oil and alcohol. The nano materials like KF/CaO, CaO-Al_2O_3 and MgO can be used. The advantages of this process are fewer quantity of catalyst can be adequate since has more specific surface area, catalyst can be recycled many times, there is wide variety of catalyst choice, easy to isolate final product and efficient. The limitations are it needs comparatively extra alcohol for effective yield and more cost [2].

Ionic Liquid Catalyst for Transesterification

In this method ionic liquids are used as a catalyst. These are nothing but organic salts consisting of cations and anions existing as liquids at room conditions. The cations controls the physical properties like density, viscosity whereas anions are responsible for chemical properties. During transesterification process the ionic liquid such as 1-n-butyl-3-methylimidazolium is commonly used. The advantages of this process are during catalysts preparation, their features can be planned to suit a certain need, catalyst can be simply isolated, can be reused, good catalytic action and admirable stability. The limitations are production cost [3].

Supercritical Process

It is novel method for biodiesel production. It does not make use of any catalyst. A fluid is said to be supercritical when its temperature and pressure is above critical point. Under supercritical condition the fluid can diffuse like a gas through solids and dissolves the materials as if liquid. More commonly alcohol, CO_2 and water can be used. The advantages of this process are faster reaction rate, large production, no need of washing and easy to design the equipment. The limitations are it requires high temperature and pressure along with more operating cost [4].

Comparing the supercritical fluid approach to traditional biodiesel manufacturing procedures reveals numerous clear advantages:

Faster Reaction Rate: Triglycerides convert into biodiesel much more quickly thanks to the supercritical fluid environment, which improves mass transfer and reaction kinetics. Residency times are shortened and manufacturing efficiency is raised by this faster reaction rate. Absence of Washing

Steps: Supercritical fluid technology eliminates the need for significant washing, which is necessary in typical processes to remove catalyst residues and byproducts. This lowers trash output and water usage while streamlining the entire production process [610].

Ease of Equipment Design: Compared to complicated reactor systems used in conventional procedures, designing equipment for supercritical fluid processes is very simple. Scaling up production facilities is made easier by this simplicity. But there are a few other restrictions with the supercritical fluid approach that need to be taken into account:

High Temperature and Pressure Requirements: In order to achieve supercritical conditions, high temperatures and pressures are usually needed, which calls for durable and specialized equipment. Both the initial capital expenditure and operating expenses rise as a result.

Operating expenses: Compared to conventional techniques, operating expenses are greater because maintaining supercritical conditions during the biodiesel synthesis process requires a large amount of energy.

Safety considerations: Strict safety procedures and specialized knowledge are needed when handling high-pressure and high-temperature supercritical fluids in order to guarantee operational safety.

In spite of these obstacles, research and development activities are still concentrated on refining supercritical fluid technology in order to produce biodiesel. Improvements in reactor design, fluid choice, and process management are intended to lessen constraints and raise the viability and sustainability of this novel strategy from an economic standpoint.

Ultrasound Assisted Process

Ultrasound waves are nothing but sound waves having frequency more than limit of human hearing that is above 20 KHz. These can be used in biodiesel production to accelerate the rate of reaction. During transesterification since oil and methanol cannot be mixed easily, ultrasonic waves plays a vital role for proper mixing and promoting liquid to liquid mass transfer [11]. Due to dynamic mixing it rises reaction area between alcohol - oil and produces small droplets compare to conventional stirring. Ultrasonic waves can be produced using transducer made of piezoelectric material. The advantages of this process are better mixing between oil and alcohol, increases reaction rate, yield and saving in energy consumption. The limitations are particle size is a critical factor and it is usually less robust [5].

Microwave assisted transesterification

In this method microwaves are used for heating during biodiesel production. Microwaves are nothing but electromagnetic radiations having frequency between 300 MHz to 30 GHz, the heat is transferred due to molecular friction that causes rapid increase in temperature of reagents. The advantages of this process are it is very efficient and rapid heating, short reaction time, yields highly pure product and low cost of production. The limitations are it may not be easily scalable from small scale to industrial production, its safety, special equipment need, less selectivity, and obvious reaction at high temperature [6,12,13].

Future Prospective

Biodiesel production from non-edible feedstocks is increasingly attractive alternative to both fossil diesels and renewable fuels derived from food crops. Thus, one of the current research focus in biodiesel production is optimization of oil extraction methods from non-edible oils sources, characterization of the oils and suitability test for biodiesel, and searching for proper methods of biodiesel production from these oils [14].

CONCLUSION

The efficiency of biodiesel production depends on the method adopted and the material source. Solvent processes reduce the bio diesel production time and mechanical wave based systems are capable of increasing the efficiency as well as yield. The other side, each method has its own drawbacks. The process of bio diesel production has experienced a tremendous change and in particular advancements with the development of unconventional extraction techniques such as microwave,ulatra-sonication and supercritical fluid extraction techniques. However, the limitations associated with these techniques still demands further research in the field to satiate the alternate fuel energy needs.

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