Production of biodiesel using Nano Catalysts, Review study

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Abstract **- Due to the limited conventional fossil fuels, it has become necessary to find alternative clean and renewable energy resources. Biodiesel may become the best solution for conventional fuels. Biodiesel is a liquid fuel consisting of mono alkyl esters (methyl or ethyl) of long chain fatty acids derived from vegetable oils or animal fats or micro and macro algal oil. It is a kind of bio- energy as a substitute for conventional petrol diesel fuel. Recently, the production of biodiesel has been increased due to some crucial reasons such as the rise in crude oil price, limited resources of fossil oil, and pollution reduction. This paper presents a review of the alternative technological methods that could be used to produce this fuel. Biodiesel production using nano catalyst is one of the approaches in the search of alternative fuel. Catalytic processes are used for biodiesel production. This nano catalyst are improved the production quality such as reduce reaction time and increase production yield. This present investigation, the nano particles were used as a nano catalyst for the production of biodiesel. This enhancement leads to reductions in reaction time, catalyst amount, and alcohol-to-oil ratio.**

Keywords **- Biodiesel, Nano-catalyst, Transestrification, Methyl ester**

I INTRODUCTION

The resources of petroleum as fuel are dwindling day by day and increasing demand of fuels, as well as increasingly stringent regulations, pose a challenge to science and technology. With the commercialization of bio energy, it has provided an effective way to fight against the problem of petroleum scarce and the influence on environment. But conventional method of producing biodiesel are transestrification which is take more time and cost whereas ultrasonic method of transestrification has advantage of less reaction time and less in cost. Biodiesel process faces various problems related to immiscible nature of oil and alcohol leads to poor mass transfer rate. This requires long reaction time, higher catalyst consumption, higher methanol-oil molar ratio, high temperature and high stirring rate. This review discusses that the latest advances in ultrasonic assist transesterification reaction with the use of heterogeneous catalysts to produce biodiesel with cost effective. Ultrasonic energy can emulsify the reactants to reduce the catalyst requirement, methanol-oil ratio, reaction time and reaction temperature.

During last twenty years, researcher has been finding alternatives to fossil fuels in to meet world energy demands and reduces pollution. Biodiesel has been widely regarded as a suitable resource because of its availability, renewability, lower gas emissions, non toxicity and its biodegradability. Currently around 90% of biodiesel is produced by the transesterification process of triglycerides with low molecular weight alcohols using homogenous acid or base catalysts. However, the biodiesel industry faces some significant challenges; (i) high cost of biodiesel feedstock (70 to 85% of the overall production cost) and (ii) cost of biodiesel processing, including separation, purification and neutralization of by-products. These issues can be resolved by using low-cost feedstocks, but with catalysts highly tolerant to moisture and Free Fatty Acids (FFA) in oil, because FFA and moisture content in cheap raw materials have an adverse effect on catalyst activity.

The prepared nano-catalyst had a high surface area of 550m2/g compared to SO4 2−/TiO2 nano-catalyst. Nonetheless, the catalyst displayed low catalytic activity for glycerin with acetic acid in toluene at 120^0C. The use of SO4 2−/TiO2-SiO2 as a solid acid catalyst for the simultaneous esterification and transesterification of low cost feedstocks with high FFA. They reported that under 9:1 methanol to oil moral ratio, 6hrs reaction time, 3% Catalyst loading, and reaction temperature of 200C a yield of 92% can be achieved. It was also reported that the SO4 2−/TiO2-SiO2 catalyst can be re-used up to 4 times without reducing the catalytic activity. Recently, an inexpensive precursor was used in the synthesis of SO4 2−/TiO2-SiO2 catalyst by Shao and co-workers. They reported 88% yield for biodiesel production under 20:1 methanol to UCO moral ratio, 10wt% catalyst concentration and 3hrs reaction time at 120oC with constant stirring at 400rpm.

II. PRODUCTION OF BIODIESEL BY CONVENTION METHOD

In the biodiesel production method, transesterification is the chemical reaction between triglycerides and alcohol within the presence of a catalyst for producing monoesters. The triglyceride molecules are transformed to monoesters and glycerol. The transesterification method incorporates a sequence of three reversible reactions. The conversions of triglycerides to diglycerides, diglycerides to monoglycerides and glycerides into glycerol yield one ester molecule in each stage. The general transesterification reaction can be represented by Figure 1 (Gerpen, 2005).

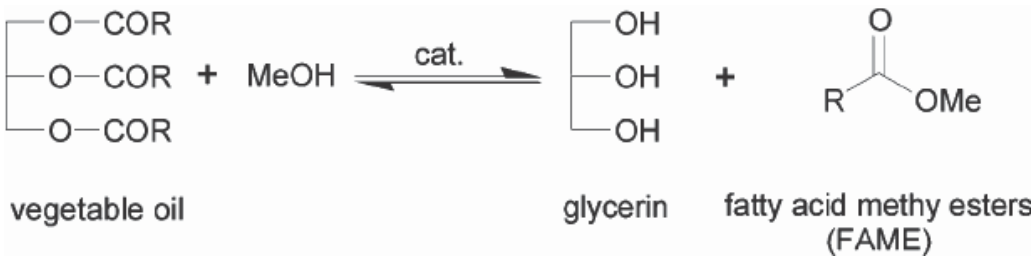

Figure 1 Transesterification of vegetable oil with methanol

The transesterification reaction of oil and alcohol with a homogeneous catalyst is the general method for the preparation of biodiesel. However, the homogeneous catalysts have many shortcomings, such as requiring large amounts of water, difficulties in product isolation, and environmental pollution caused by the liquid wastes.

III PRODUCTIN OF BIODIESEL WITH NANO CATALYST

The use of ‘‘a green” method based on heterogeneous catalysts is a new trend in the preparation of biodiesel. Biodiesel synthesis using solid catalysts instead of homogeneous ones could potentially lead to cheaper production costs by enabling reuse of the catalyst and opportunities to operate in a fixed bed continuous process. Heterogeneous catalytic methods are usually mass transfer resistant, time consuming and inefficient. Despite the solid phase, catalytic methods are intensively studied, the industrial applications are limited. This fact suggests that further research is necessary to solve current problems. Nano catalysts that have high specific surface and high catalysis activities may solve the above problems. A number of researchers have studied the preparation of nano sized heterogeneous catalysts to increase the catalytic activity. It is evident that the large surface area, which is characteristic of nano sized material, resulted in a rise within the amount of the catalytically basic and acidic sites.

IV.REVIEWS OF VARIOUS LITERATURES

The literature reviews in with this topic is in below table with chronological order.

Table 4.1 Review of Various Literatures

Author	Year of paper published	Parameter	Objective of the research paper	Outcomes
Sidra Hashmi et al	March 2016	Use of nano catalyst CaO-Al2O3	Biodiesel Production by using CaO-Al2O3 Nano Catalyst.	CaO-Al2O3 nano catalyst was investigated as a substitute for the homogenous and heterogonous catalysts used in conventional transesterification process. Furthermore, the amount of catalyst used and soap formation reaction was carefully observed.
B Vijaya Kumar et al	March 2016	Nano Catalyst KF/CaO-Fe3O4	Magnetized-Nano Catalyst KF/CaO-Fe3O4for Biodiesel Production from Beef Tallow	This work shows that KF/CaO-Fe3O4based catalyst is suitable for biodiesel production from beef tallow
Noriaki Sano et al,	August 2016	new catalyst using carbon nano horn supporting calcium ferrite was synthesized	A novel solid base catalyst for transesterification of triglycerides toward biodiesel production: Carbon nano horn dispersed with calcium ferrite.	It was considered that the hybridization of the ferrite possessing the basic sites with the hydrophobic CNH in the catalyst structure should be the key property to exhibit the high catalytic performance. .
Shalini Chaturvedi et al	January 2011	Nano catalyst	Applications of nano-catalyst in new era	The field of nano catalysis has undergone an explosive growth during the past decade, both in homogeneous and heterogeneous catalysis. Nano particles have a large surface-to-volume ratio compared to bulk materials, they are attractive to use as catalysts. Catalysts daily accelerate and boost thousands of different chemical reactions.
Jabbar Gardy et al.	2016	Ti(SO4)O nano-catalyst	Synthesis of Ti(SO4)O solid acid nano-catalyst and	The amount of yield and optimized process conditions (e.g. catalyst loading, methanol to

			its application for biodiesel production from used cooking oil	CO molar ratio, reaction time, temperature, tolerance to FFA and catalyst reusability) have been significantly improved using the catalyst synthesized in this work as compared to the reported sulphated metal oxides.
Mookan Rengasamy et al,	2014	Nano sized iron catalyst	Transestrification of castor oil using Nano –sized Iron Catalyst for the production of Bio Diesel.	The use of iron nano particles as catalyst showed more advantageous than the conventional acid/base catalyst for the production of biodiesel. Hence, the produced biodiesel can be considered as an alternative to the conventional diesel.
Mookan Rengasamy et al	2014	Pongamia pinnata Oil using synthesized Iron Nano catalyst	Biodiesel Production from Pongamia pinnata Oil using Synthesized Iron Nano catalyst	The use of iron nano particles as catalyst showed more advantageous than the conventional acid/base catalyst for the production of biodiesel, because of its large specific surface area, high catalytic activity and high resistance to the saponification.
P. Sivakumar et al	August 2013	Nano MgO as catalyst	Studies on Sono-Chemical Biodiesel Production Using Smoke Deposited Nano MgO Catalyst	An excellent result of conversion was obtained at 1.5 wt% catalyst; 5:1 methanol oil molar ratio at 55 °C, a conversion of 98.7% was achieved after 45 min.
Rintu Varghese et al	2016	CuO:Mg Heterogeneous Nano catalyst	Ultrasonication Assisted Production of Biodiesel from Sunflower Oil by Using CuO:Mg Heterogeneous Nano catalyst	The biodiesel yield of 71.78% was achieved under reaction condition. The presence of methyl ester groups at the produced biodiesel was confirmed using the Gas Chromatography -Mass Spectrometry (GC-MS). The FAME conversion yield up to 82.83 % could be obtained under the operating conditions.
Tanguy F. Dossin et al,	2006	Heterogeneously MgO-catalyst	Simulation of heterogeneously MgO-catalyzed transesterification for fine-chemical and biodiesel industrial production	Magnesium oxide offers a viable heterogeneous solid base catalyst for the standard transesterification of ethyl acetate or triolein with methanol at industrial conditions for the industrial Production of fine-chemicals or biodiesel.
Kambiz Tahvildari et al	2015	CaO and Mgo nano catalyst	The study of CaO and MgO heterogenic nano-catalyst coupling on transesterification reaction efficacy in the production of biodiesel from recycled cooking oil	Nano MgO is not capable of catalyzing the transesterification by itself, because it has a much weaker basic affinity but when used with Nano CaO due to its surface structure, the basic properties increase and it becomes a proper base for the catalyst so that CaO contact surface increases and transesterification reaction yield significantly increases as well. This study investigates the repeatability of transesterification reaction in the presence of these Nano catalysts as well.

V. CONCLUSION

From above literature reviews following conclusions are derived

- Production of biodiesel with conventional transeseterification takes almost 24 hours, whereas using heterogeneous nano catalyst for transesterification in only one hour so it is time saving process. Heterogeneous nano catalyst is reusable for process and separation are easy and the amount of yield is increase compare to conventional method.
- Biodiesel properties are same as conventional method hence, the produced biodiesel can be considered as an alternative to the conventional diesel.
- The field of nano catalysis has undergone an explosive growth during the past decade, both in homogeneous and heterogeneous catalysis. Nano particles have a large surface-to-volume ratio compared to bulk materials, they are attractive to use as catalysts. Catalysts daily accelerate and boost thousands of different chemical reactions.

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