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Heterogeneous Catalysts for Biodiesel Synthesis By Transesterification

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Abstract– This review focuses on the heterogeneous base-catalyzed Trans esterification in terms of catalyst development, based on the published research, especially over the last decade. Heterogeneous base catalysis is the most viable process for the Trans esterification of triglyceride into biodiesel. The research and development on heterogeneous base catalysis for biodiesel synthesis have focused mainly on improving its slow reaction rate up to the level of its homogeneous counterpart. The heterogeneous catalysis features lower corrosiveness, environmental friendliness, easy catalyst recovery and high process integrity, all at levels superior to those of homogeneous catalysis.

Keywords: Renewable energy-Biodiesel synthesis, TransesterificationHeterogeneous, catalyst

I.INTRODUCTION

Diesel fuels are used in many areas and have importance for the Economy of countries. Interest in the use of alternative fuels for diesel engines has risen with the decrease of petroleum reserves and the rise in environmental consciousness. Because of the energy and global warming crisis, developmentof renewable energies, for example, H2 energy, solar energy and biodiesel have been focused worldwide.Biodiesel has gained international attention as a source of alternative fuel. due to the properties like high degradability, no toxicity, low emission of carbon monoxide, particulate matter and unburned hydrocarbons. Biodieselcan be used in conventional compression ignition engines, which need almost no modification. It can be used asheating oil and as fuel.

II.BIODIESEL

The fuel which willbe alternated to diesel fuel must be suitable and acceptable technically, Biodiesel which can be produced from vegetable oils and animal fats is an alternative fuel for diesel engines. It is long-chain fatty acid alkyl ester and is one of the interesting alternativefuels which can be produced from renewable sources and provides complete combustion with less gaseous pollutant emission. Biodiesel is an ecofriendly and alternativeenergy source for diesel engines that can be synthesized by transesterification of vegetable oil or animal fat with alcohols.

III.HETEROGENEOUS CATALYST-

Inconventional industrial biodiesel processes, the methanoltransesterification of vegetable oils is achieved using a homogeneouscatalyst system operated in either batch or continuous mode. The transesterification reaction can be carried out usingboth homogeneous (acid or basic) and heterogeneous (acid, basic or enzymatic) catalysts .Homogeneous basic catalysts provide much faster reaction rates than heterogeneous catalysts, but it is considerably costly to separatehomogeneous catalysts from the reaction mixture. To avoid catalyst removaloperations and soap formation andmost important to save lots of waste stream , much effort has been expended on thesearch for solid acidor basic catalysts that could be used in aheterogeneous catalyzed process.In this paper a new continuous process is described, where thetransesterfication reaction is promoted by a completelyheterogeneous catalyst. The reaction is performed at a highertemperature than homogeneous catalysis processes, with an excess ofmethanol. This excess is removed by

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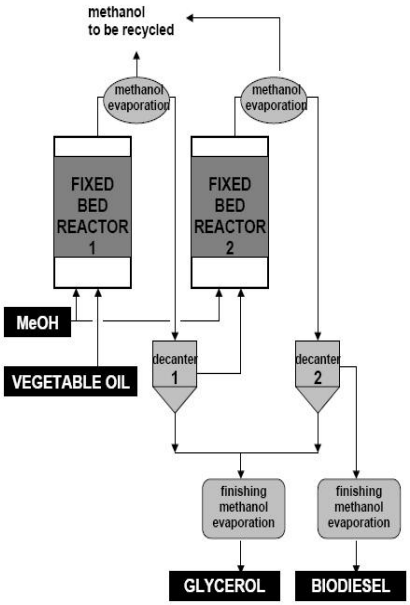
vaporization and recycled to theprocess with fresh methanol. In this heterogeneous process, the catalyst is very stable with nometal leaching. There is no formation of either glycerate salts ormetal soaps which affords the advantages: noneutralization step is required, there is no introduction of water and there is no salt formation; these accounts for exceptional glycerol purity. In addition, there is no waste production of low-value fattyacids. The process feeds are limited to vegetable oils and methanol andthe only products are biodiesel and a high-purity glycerol that is freeof water and salt. With all its features, the process can be consideredas a green process.[6]

IV.TRANSESTERIFICATION REACTION

Nowadays, there are four known methods to reduce the high viscosity of vegetable oils to enable their use in conventional compression ignitions engines: blending with diesel, pyrolysis, emulsification and transesterification. The most common way to produce biodiesel is by transesterification of triglycerides of refined/edible types of oils using alcohol, in presence of an acid or a basic catalyst. The alcohol used for transesterification is usually methanol. Producing biodiesel is a bulk process.In principle, transesterification is a reversible reaction, although in the production of biodiesel, the back reaction does not occur or is negligible because the glycerol formed is not miscible with the product, leading to a two-phase system.[6]

FengGuo, Ning-Ning Wei, Zhi-Long Xiu , Zhen Fang have been carried out transesterification mechanism of soybean oil to biodiesel catalyzed by calcined sodium silicate. They found that Solid calcined sodium silicate (CSS) was successfully used to produce biodiesel from vegetable oil, but itstransesterification mechanism is still not well-understood. CSS was demonstrated to be an excellent catalyst for the transesterification of oil with methanol, and it was a water-resistantcatalyst. At the beginning of the transesterification, ion-exchange proceeded after methanol absorbed on the surface of catalyst where the catalytic active species (CH3O) were produced, and the mechanistic route of the transesterification was elucidated.[1]



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N. Viriya-empikul, P. Krasae, W. Nualpaeng , B. Yoosuk , K. Faungnawaki used Ca-based solid catalysts derived from industrial wastes for production of biodiesel.In this research, three raw materials were used to synthesize the solid catalysts and their physical and catalytic properties were then investigated. The biodiesel production in heterogeneous transesterificationcould be achieved by all CaO catalysts derived from eggshell, golden apple snail shell, and meretrixvenus shell. The optimum calcinations temperature and time were 800 ^{o}C and 2–4 hr, respectively. The shorter time and lower temperature caused the incomplete formation of active Ca-based catalysts, while the longer time and higher temperature caused the severe sintering of catalyst particles, resulting in suppressedbiodiesel yields.[2]

HamedMootabadi, BabakSalamatinia, Subhash Bhatia, Ahmad Zuhairi Abdullah were worked for Ultrasonic-assisted biodiesel production process from palm oil using alkalineearth metal oxides as the heterogeneous catalysts. The ultrasonic-assisted transesterification of palm oil in the presence of alkaline earth metal oxide catalysts(CaO, SrO and BaO) was investigated. The transesterification reaction was carried out in a 500 mlthree-neck glass batch reactor equipped with an ultrasonic transducer and probe, a condenser, a stirrer and thermocouple thermometer. After the desired reaction times varying between 10 min to60 min, excess methanol was distilled off and the mixture was then centrifuged in an Eppendorf centrifuge for 20 min at 2500 rpm. The biodiesel layer was then collected. The chemical stability of the heterogeneous catalysts was investigated by analyzing the presence of free Ca, Sr or Ba in the biodiesel product. The activity of the heterogeneous catalysts correlated well with their basic strengths. Despite high activity, BaO catalyst underwent relatively more severe activity drop in the catalyst reusability test, especially under ultrasonic condition.[3]

Hong-yanZeng , Zhen Feng, Xin Deng, Yu-qin Li have done activation of Mg–Al hydrotalcite catalysts for transesterification of rape oil. In the present work, calcined Mg–Al hydrotalcites were adoptedfor methanolysis of rape oil to methanol. The catalytic efficiency was studied regarding the methyl ester conversion. Attention was focusedon to develop heterogeneous catalysts. The use ofheterogeneous catalysts makes separation of the product easierand produces neither corrosion nor emulsion. Knifton and Duranleauused free organic phosphines supported on partially cross-linked polystyrene for the reaction.The catalyst brings advantages such as high catalyticactivity, easy separation of the catalyst by simple filtration, possiblerecycling of the catalyst and use of non-toxic and inexpensive catalysts. It is probable that the solid base catalyst becomes a practicalalternative to soluble bases.[4]

ErtanAlptekin, Mustafa Canakci carried out optimization of transesterification for methyl ester production from chicken fat. In this study, low cost feedstock chicken fat was used to produce methyl ester. After reducing the free fatty acid level of the chicken fat less than 1%, the transesterification reaction was completed with alkaline catalyst. The effects of catalysttype, reaction temperature and reaction time on the fuel properties of methyl esters were investigated. The measured fuel properties of the CFME met both the ASTM D6751 and EN 14214 biodiesel standards when using KOH and NaOH at 60 ^{o}C for a 4 h reaction.[5]

V.CONCLUSIONS

Increasing biodiesel consumption requires optimized production processes that are compatible with high production capacities andthat feature simplified operations, high yields, and the absence ofspecial chemical requirements and waste streams. In the heterogeneous process, the catalyst is very stable with nometal leaching. There is no formation of either glycerate salts ormetal soaps which affords the following advantages: noneutralization step is required, there is no introduction of water andthere is no salt formation; this accounts for exceptional glycerolpurity. In addition, there is no waste production of low-value fattyAcids. A heterogeneous catalyzed continuous process gives these objectives to be attained. A simple method wasfound to recover the basic sites to regenerate the catalyst that performedgood activity and reproducibility.

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