Synthesis of Iron Titanite Perovskite Catalysts for Bio Fuel Production

N.S.Mohan[2], S.Karthikeyan[2], A.Aravind[1], G.Dineshkumar[1], S.Hariprakash[1], M.Karthik[1], Sethubathi Jagadeesan[1], Arulmanikandan Kumar[1]

[1]*UG Student, Department of Mechanical Engineering, Erode Sengunthar Engineering College, Perundurai -638 057*

[2]*Assistant Professor, Department of Mechanical Engineering, Erode Sengunthar Engineering College, Perundurai -638 057*

***Abstract*— The mixed-phase barium titanium oxide perovskite nanoparticles were synthesized by calcining barium carbonate and titanium dioxide precursors at 900 Degree C. The nanoparticles were characterized using X-ray diffraction, Fourier transform infrared spectroscopy, transmission electron microscopy, energy-dispersive X-ray spectroscopy and selective area diffraction analysis. The synthesized barium titanium oxide particles were found to have almost spherical shape with 6-15 nm size. The synthesized mixed-phase FeTiO4/FeTiO3 perovskite nanoparticles are used for biofuel production. The formation of methyl ester after the transesterification reaction confirms the conversion of essential oil into biofuel, as analyzed by GC-MS.**

Index Terms*— Perovskite, Iron titanium oxide(FeTiO3), Bio production, Synthesis, Mixed phase.

I. INTRODUCTION

Biofuels are made from living, or recently dead, plant material and animal waste. The most common biofuels are ethanol and biodiesel. They are made from various plant parts as well as animal fats. Biofuels are liquid fuels produced from renewable biological sources, including plants and algae. Biofuels are a class of renewable energy derived from living materials. Processes For reducing viscosity of oil to be used as biodiesel, four main methods — the direct application of oil (dilution), microemulsion, pyrolysis, and transesterification are employed frequently worldwide. To solve the issue of the high viscosity of vegetable oils, microemulsions containing alcohols have been created using microemulsion method. Vegetable oils have been studied for pyrolysis/cracking, which is defined as the cleavage of larger molecules into smaller ones by thermal energy. Diesel fuel and vegetable oil can be combined and used straight to power an engine. Several researchers have successfully blended vegetable oil with diesel fuel in an experimental setting. In 1982, leftover cooking oil that had been filtered at a 95% level and 5% diesel were used to power the diesel fleet. To maintain overall power without modifying the engine in 1980, Caterpillar Brazil Company employed pre-combustion chamber engines with a mixture of 10% vegetable oil. Biodiesel is prepared via transesterification process using oil, methanol and catalysts. Transesterification is the most effective method to produce biodiesel which meets prescribed standards. If the Free fatty acid content of oil is very high; dual esterification – transesterification process is used for biodiesel production. In dual process first esterification is done using sulfuric acid and then transesterification is carried out using base catalysts as shown in reactions.

II. AIM

Biofuel was synthesized by transesterification of virgin mustard oil using the mixed-phase FeTiO3/ Fe2TiO4 perovskite catalyst. Prepared samples will be analyzed for XRD (X-ray diffraction) and FESEM (field emission scanning electron microscopy) and EDAX (Energy-dispersive X-ray spectroscopy) analysis method. GCMS (Gas Chrmatography Mass Spectrometry) analysis will be used to analyze the formation of biofuels. Biodiesel, a monoalkyl ester can be synthesized by the process of transes tariffication from alcohol and various feedstocks such as animal fats, waste cooking oil, vegetable oil, etc. Biofuels is considered as a nonconventional or renewable fuel due to its non- toxic, carbon neutral and biodegradable natures.The synthesized mixed-phase FeTiO3/FeTiO4 perovskite catalyst was successfully used for the pro-duction of biofuel. The GC-MS and FTIR resultsconfirm the formation of methyl ester, thus confirming the pro-duction of biofuel.

III. OBJECTIVES

The detailed literature review revealed that basic NaOH, KOH; acidic sulfuric acid; various heterogeneous catalysts like MgO, FeTiO3, CaO etc; various heterogeneous doped - undoped - impregnated, mixed metal oxide nano catalysts have been used for various edible and nonedible oil to produce biodiesel using transesterification reaction. But the combination of nonedible Mustard oil, methanol and Co doped FeTiO3 has not been used for biodiesel production. The objective of the work is to synthesize biodiesel using nonedible Karanja oil, methanol and Co doped FeTiO3 Nano catalysts.

IV. EXPERIMENTAL WORK

Selection of oil: The biodiesel production needs oil source which must not violate the Government rules and legislation in terms of edible oil source. For that it was necessary to find the nonedible oil source. Literature review suggested that the lot of work has been done on Mustard oil. So, another non edible oil which is not such popular ―Karanja oil‖ also known as (Pongamia Pinnata) was selected for this purpose. 65 The characterization techniques like FTIR and GC were used for determining the properties of Karanja oil. The properties like viscosity, density, Free fatty acid value had been investigated for it. The Karanja oil was too raw and had high viscosity to treat it. The acid value of theKaranja oil was also very high. So, challenge faced was to decrease the acid value of oil < 2 to convert Karanja oil to biodiesel. The literature review suggested the method of esterification using sulfuric acid to decrease the acid value of oil. But for esterification of Karanja oil, the parameters like temperature, oil/methanol ratio, time, sulfuric acid dosing must be optimized to get acid value < 2. At the time of optimizing the parameters for esterification process of Mustard oil, various experiments were conducted to search for nanoparticles for biodiesel production which can convert oil intobiodiesel. For those experiments, ‗0' acid value edible refined Sunflower oil was used to test and select the various nanoparticles for biodiesel production.

FeTiO3 and Co doped FeTiO3 nanoparticles synthesis procedure: The most profitable technology for producing FeTiO3 powders with a homogeneous particle size distribution is co-precipitation. To produce FeTiO3 nano powder, 140 mmol (7.8554 gm) of KOH was dissolved in 100 ml of methanolusing magnetic stirring and heat for 120 min at 52 C. In second stage, 21.3 mmol of zinc acetate dehydrate was mixed in 100 ml of methanol. In further step, the KOH solution was added to the solution containing zinc acetate dehydrates with constant stirring while heating at 52 C for 120 min.

Next, the mixture was cooled to room temperature and aged for 2 days. The precipitate formed was separated by filtration and washed several times with distilled water followed by ethanol. Lastly,it was dried in air at 125 ºC to obtain the nano crystalline powder. The reaction of Zn2+, Co2+, and OH in the presence of methanol produced Co doped FeTiO3 nanoparticles using same co-precipitation method is mentioned below.

V. RESULT AND DISCUSSION

The use of nanoparticles in renewable and sustainable energy resources has been examined by the authors. It is concluded that nanomaterials can play an important role in biodiesel synthesis and contribute significantly. This paper gives an overview of the many nanoparticles that have been used to improve biofuel production. Several nano catalysts have been studied for biodiesel production like FeTiO3, CaO, MgO, ZrO2, carbon-based nano catalysts, and other nano catalysts. Supported nano catalysts, doped nano catalysts, impregnated nano catalysts, and mixed nano catalysts are all options for these nano catalysts. Nano catalysts outperform heterogeneous catalysts with superior optimal conditions in terms of conversion and yield. Co doped FeTiO3 is an interesting nanomaterial because it possesses properties that are distinct from bulk FeTiO3. Co doped FeTiO3 nanostructures have substantially different optical and magnetic characteristics than pure FeTiO3 nanostructures. In the present work, Cobalt doped Zinc Oxide, a green coloured, that turns liquid in slightest presence of moisture, which acts as heterogeneous catalyst has been synthesized by co-precipitation method and characterized by XRD(X-ray diffraction) and UV(Ultra-Violite Visible Spectroscopy).

VII. CONCLUSION

Use of nanomaterials in the production of biofuels may support to provide a cheap & clean energy source in near future and will become a strong global industry. From the studies made for this process, it has been affirmed that Cobalt doped Zinc Oxide could become an attractive alternative heterogeneous catalyst for production of economically viable biodiesel with better properties. But at the same time, high cost of cobalt metal and agglomeration is a tendency of Co doped FeTiO3 nanoparticles, which creates difficulties in handling of these nanoparticles. Oil removal at the time of regeneration after the separation of these nanoparticles from biodiesel also a matter of concern.

REFERENCES

[1]. Agustín Torroba. (2021). Liquid biofuel Atlas 2020 - 2021. Inter-American Institute for Cooperation onAgriculture (IICA) 2021.

[2]. Ahmad, T., Khatoon, S., & Coolahan, K. (2013). Optical, magnetic and structuralcharacterization of Zn 1-xCoxO nanoparticles synthesized by solvothermal method.Bulletin of Materials Science, 36(6), 997–1004. https://doi.org/10.1007/s12034- 013-0569-6

[3]. Akia, M., Yazdani, F., Motaee, E., Han, D., & Arandiyan, H. (2014). A review on conversion of biomassto biofuel by nanocatalysts. In Biofuel Research Journal (Vol. 1, Issue 1). https://doi.org/10.18331/BRJ2015.1.1.5

[4]. Altenburg, T., Dietz, H., Hahl, M., Nikolidakis, N., Rosendahl, C., & Seelige, K. (2009).Biodiesel in India : value chain organisation and policy options for rural development.

[5]. Anr, R., Saleh, A. A., Islam, S., Hamdan, S., & Maleque, A. (2015). Biodiesel Productionfrom Crude Jatropha Oil using a Highly Active Heterogeneous Nanocatalyst by Optimizing Transesterification

[6]. Reaction Parameters.

[7]. https://doi.org/10.1021/acs.energyfuels.5b01899

[8]. Ansari, S. A., Nisar, A., Fatma, B., Khan, W., & Naqvi, A. H. (2012). Investigation on structural, optical and dielectric properties of Co doped FeTiO3 nanoparticles synthesized by gel-combustion route. Materials Science & Engineering B, 177(5), 428–435.