Feedstocks, Production, Properties and Blending Effect of Biodiesel: A Review

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Abstract—Demands for energy have been increasing day by day which has led to the depletion of global fossil fuel reserves at an exponentially increasing rate. Alternative fuels like biodiesel seem to be favorable solutions for near future. Renewable diesel fuel, termed as biodiesel, is produced from various edible and non-edible feedstocks. Various methods for production of biodiesel have been used out of which transesterification method, has been reported mostly in many literatures. Despite its many advantages, biodiesel possesses some serious negative features for which blending of biodiesel with petroleum diesel fuels becomes necessary to make it more compatible as conventional fuel. Decrease in the emission of hydrocarbons is remarkable with biodiesel blending that could be observed along with enhanced thermal efficiency of the engine. This paper is an attempt to review various sources for biodiesel production, properties, and use of biodiesel by blending as substitute of the diesel fuel.

Keywords—Biodiesel, renewable, biodiesel blending

I. INTRODUCTION

Due to the depletion of the world’s petroleum reserves and the increasing environmental concerns, there is a great demand for alternative sources of petroleum-based fuel, including diesel and gasoline fuels [1]. Biofuel, a clean renewable fuel is offering many priorities, including sustainability, reduction of greenhouse gas emissions, regional development, social structure, agriculture and security of supply, and so biodiesel is the probable fuel of the future.

Developing countries have a comparative advantage for biofuel production because of greater availability of land, favourable climatic conditions for agriculture and lower labour costs. In developed countries, there is a growing trend towards employing modern technologies and efficient bioenergy conversion using a range of biofuels, which are becoming cost-wise competitive with fossil fuels [2]. In recent years researchers have focused in producing biofuels from various edible and non-edible feedstocks. Several biodiesel production methods have been developed, among which transesterification using alkali catalyst gives high level of conversion of triglycerides to their corresponding methyl ester in short reaction time [3].

II. BIODIESEL FEEDSTOCKS

Biodiesels can be produced from various sources of edible and non-edible vegetable oils, animal fats, used frying oils and waste cooking oils which have similar characteristics to petroleum-derived diesel fuel. The source for biodiesel production is chosen according to the availability in each region or country, physico-chemical properties, production cost and transportation. Commonly accepted biodiesel raw materials are given in the TABLE I.
The stoichiometric oxygen esters (FAME) and glycerol as byproducts (Scheme 2).

Triglyceride MeOH Glycerol FAME

The reactions are reversible, although the equilibrium lies towards the production of fatty acid esters and glycerol. The step wise reactions are reversible and a little excess of alcohol is used to shift the equilibrium towards the formation of esters. In presence of excess alcohol, the forward reaction is pseudo-first order and the reverse reaction is found to be second order. It was also observed that transesterification is faster when catalyzed by alkali [7].
The mechanism of the acid and base-catalyzed transesterification of vegetable oils for a triglyceride is shown in Scheme 4 & 5 respectively [7]. However, diglycerides and monoglycerides are also converted by the same mechanism to a mixture of alkyl esters and glycerol.

Heterogeneous catalysts are receiving more importance for production of biodiesel. They are reusable, environmentally benign, could give high quality of products, and more effective than acid catalysts and enzymes.

Recently, heterogeneous catalysts derived from both waste industrial and biological resources have attracted interest for biodiesel synthesis as these heterogeneous catalysts are biodegradable, environmentally benign and their large scale use pose no disposal problem [8].

Scheme 4: Mechanism of acid-catalyzed transesterification of a triglyceride (vegetable oil) with methanol. Transformation of the three ester functionalities may proceed simultaneously or one after another.
IV. PROPERTIES OF BIODIESEL

The characteristics of biodiesel are found to be close to diesel fuels, so it becomes a strong source to replace the diesel fuels. Biodiesel, formally known as either methyl-ester or ethyl ester, is derived from naturally occurring vegetable oils or animal fats that have been chemically modified to run in a diesel engine. Biodiesel has viscosity close to diesel fuels. These esters contain 10–11% oxygen by weight, which may encourage more combustion than hydrocarbon-based diesel fuels in an engine. The cetane number of biodiesel is around 50 [9]. The unrefined biodiesels showed higher lubricity properties than refined biodiesel. Biodiesel is considered clean fuel. It has no sulphur, no aromatics and has about 10% built in oxygen, which helps it to burn fully. Its higher cetane number improves the ignition quality even when blended in the petroleum diesel. The hydrocarbons present in the diesel fuels include paraffins, naphthenes, olefins and aromatics. Carbon numbers of these hydrocarbons ranges from 12 to 18.

V. BLENDING OF BIODIESEL

To minimize the carbon deposition in combustion chamber [10], premature engine failure [11], piston ring deposits [12] biodiesel is the only alternative fuel so that low concentration biodiesel–diesel blends run on conventional unmodified engines [13]. The biodiesel can be blended in any percentage. Biodiesel blends from 2% to 20% can be used in most diesel equipment with no or minor modifications. The properties of the blend change with the amount of fuel blended with the biodiesel [14]. Liu et al. observed the combination of alcohol-biodiesel blends with intake charge dilution that could reduce the NOx emission and maintains particulate mass concentration at a relatively low level where the intake CO₂ concentration increased from 2% to 5.6% and particulate mass concentration of the alcohol-biodiesel blends remained almost unchanged [15]. A blend of 20% vegetable oil and 80% diesel fuel was also successfully reported [16] which improves the viscosities of the vegetable oils.
VI. USE AND FEASIBILITY OF BIODIESEL

Biodiesel’s advantages compared to petroleum diesel include its renewable nature, superior emission properties like higher combustion efficiency, lower sulfur and aromatic content, higher cetane number and higher biodiesel production: A review‖. J. Braz. Chem. Sustainable, 1525. St. Joseph, MI: ASAE; through the use of biodiesel and gas engine power division of ASME paper II. ADDED DIGESTIBILITY OF BIODIESEL

Biodiesel is a clean-burning diesel fuel. Biodiesel is derived from varied range of edible and non-edible biomass sources. It attributes to lesser emission of CO, hydrocarbons, biodegradable and renewable. Biodiesel is said to be carbon neutral as more of carbon dioxide is absorbed by the biodiesel yielding plants than what is added to the atmosphere when used as fuel. Despite many processes of biodiesel production, transesterification is the method for biodiesel production which is successfully employed to reduce the viscosity of biodiesel and other characteristics. Another advantage of biodiesel is that blending of biodiesel along with diesel fuel gives positive effect. The emission composition of biodiesel is much lesser than petroleum based fuels which have gained attention. Therefore, continuous development and improvement of biodiesel is needed in producing cleaner emissions with less impact on the environment at a lower cost.

REFERENCES


