Fuel 222 (2018) 180–184

Contents lists available at ScienceDirect

Fuel

journal homepage: www.elsevier.com/locate/fuel

Full Length Article

Biodiesel with nano additives from coconut shell for decreasing emissions in diesel engines

K. Vinukumar[a], A. Azhagurajan[b], S.C. Vettivel[c,*], N. Vedaraman[d], A. Haiter Lenin[e]

[a] Department of Mechanical Engineering, Dr. Sivanthi Aditanar College of Engineering, Tiruchendur 628215, Tamilnadu, India
[b] Department of Mechanical Engineering, Mepco Schlenk Engineering College, Sivakasi 626005, Tamilnadu, India
[c] Department of Mechanical Engineering, Chandigarh College of Engineering and Technology (Degree Wing), Chandigarh 160019, India
[d] Central Leather Research Institute (CLRI), Chennai 600020, Tamilnadu, India
[e] Department of Mechanical Engineering, Kombolcha Institute of Technology, Wollo University, Kombolcha, Ethiopia

ARTICLE INFO

Keywords:
Biodiesel
Pungamia pinnata
Transesterification
Coconut shell
Diesel engine

ABSTRACT

The aim of this work is to decrease emissions in compression ignition engines fueled with diesel and biodiesel blends and also addition of coconut shell (CS) nano particles were prepared by mechanical ball milling process. The organic nano particle was characterized by Transmission Electron Microscopy (TEM), and energy dispersive analysis of X-rays (EDAX) technique. The biodiesel was prepared by using Pungamia pinnata non-edible oil through transesterification process. The average particle size of coconut shell nano particles was found as 20 nm in diameter. Without changing the engine design the performance and emission test was conducted in single cylinder diesel engine with fuels of 100%DF, 20%BD80%DF and 20%BD80%DF with CS.

1. Introduction

The fossil fuel is a physical deposit of decomposed living organisms and is converted into crude petroleum product which comprises hydrocarbon. In automobiles it requires petroleum products as fuel to change mechanical energy to propel vehicles. Today for increasing automobiles we require enormous amount of fuels to run the vehicles. So researches are searching the alternative fuels to sustain the energy demand. There are various alternative sources to satisfy the energy demand by renewable and nonrenewable sources. This paper focuses on biodiesel as renewable and supplement of fossil fuels and added organic additives are used. Inventor Rudolf Christian Karl Diesel discovered the diesel engine and demonstrated the 100% vegetable oils used in diesel engine [1,2]. In recent days biodiesel is significant because of rise in fuel prices, scarce of fuel and environmental aids researchers are focused in biodiesel [3]. Biodiesel is a renewable [4], ready availability [5], low sulfur [6], biodegradable [7,8], aromatic content [9], production method is simple [10], easy handling, safe to store [11] and a reduced amount of emissions [12]. While burning non-renewable fuels will emits more CO, CO_2, HC, NO_X, and, lead etc [13,14].

The vegetable oils and animal fats are used in transesterification process in order to reduce viscosity. There are four methods to reduce vegetable oils viscosity they are direct use and blending process, micro-emulsion process, pyrolysis process (thermal cracking) and transesterification process [15–18]. Out of four transesterification is apreeminent method for edible and non-edible oil [19]. Non-edible oils are used for biodiesel production this is due to nonedible oil seeds availability, edible oil value and also environmental concerns [20].

Metal based nano particle has such properties: nano particles takes high specific surface area [21], nano particles contains higher thermal conductivity and nano particles exist high reactivity [22]. While adding cerium oxide nano particles with biodiesel which increases cetane number and fuel efficiency of diesel engine [23]. Aluminum oxide nano particles blended in biodiesel which enhances performance and reduction in emissions and also increase heat release rate of combustion [24]. Addition of nano particles will increases combustion efficiency and reduction in emissions, and by varying the nano particle size combustion rate will be increased, high heat release rate [25]. In earlier paper, a metal based nano additive was investigated. In the present paper, organic nano particles as coconut shell were prepared and it is blended with biodiesel and tested in diesel engine.

2. Synthesis of nano particles

The easily available agricultural waste is coconut shell, it has low cost, and also it has higher calorific values therefore coconut shell nano particles is chosen for biodiesel additives [26]. The raw coconut shell was purchased from local market. Dry raw coconut shell was hammered

* Corresponding author.
E-mail address: scvettivel@ccet.ac.in (S.C. Vettivel).

https://doi.org/10.1016/j.fuel.2018.02.129
Received 25 July 2017; Received in revised form 18 February 2018; Accepted 20 February 2018
0016-2361/ © 2018 Elsevier Ltd. All rights reserved.

Nomenclature

CS	coconut shell
CO	carbon monoxide
CO_2	carbon dioxide
HC	hydrocarbon
NaCl	sodium chloride
H_2SO_4	sulphuric acid
NOx	nitrogen oxides
100%DF	neat diesel fuel
20%BD80%DF	20%biodiesel and 80% diesel fuel
20%BD80%DF with CS	20%biodiesel and 80% diesel fuel with coconut shell nanoparticles

and sieved and then for fine particle the coconut shell power was grounded by domestic mixer and the lid top most developed particles are collected and for mechanical milling process the planetary mono mill, Fritsch, Gmbh, 'pulverisette 6' is used and it is milled for 5 h with a rotating speed of 300 rpm. Then grounded nanoparticles are dried at atmospheric temperature (shown in Fig. 1) and then it is used as additives for biodiesel. Coconut shell nano particles are blended with biodiesel and filtered. From that process large nano particles are removed.

3. Biodiesel production

The equipment required to produce biodiesel are 500 ml glass round bottom flask is fitted with a condenser, heater with magnetic stirrer arrangement, volumetric flask, measuring jar, separating funnel, and oven. The nonedible oil of Pungamia pinnata oil has higher free fatty acid (FFA) therefore acid-catalyzed esterification and base-catalyzed transesterification of two-step process is carryout to reduce viscosity [27]. In initial step for acid-catalyzed esterification, for 100 ml raw pungaima seed oil which needs 1mlsulphuric acid (H_2SO_4) and 40 ml methanol and it had for 2 h in heater with magnetic stirrer arrangement and maintained at a temperature of 65 °C. Then reacted product is transferred into the separating funnel for 2 h. Here the top most layer is removed and the bottom layer is used for base-catalyzed transesterification process.

Here for base-catalyzed transesterification process, proceeds 100 ml Pungamia pinnata oil is initiated with 50 °C in round bottom flask and the stirring rate of 400 rpm is kept constant for complete process. From measuring jar 30 ml methanol is required for reaction and the inorganic compound of potassium hydroxide (KOH) 0.5 gm is used to soluble in methanol in volumetric flask. After the Pungamia pinnata oil reaches 50 °C the solution in volumetric flask is pour to the reactor and the complete process is maintain for 65 °C and this reaction is kept for 3 h. The boiling point of liquid chemical methanol is 64.7 °C [28] it will evaporate when the temperature reaches 65 °C therefore condenser is attached in the round bottom flask. When reaches 3 h the product is pour into the separating funnel and this is used to separate biodiesel and glycerine by density difference. For complete separation of biodiesel and glycerine the product was kept in the separating funnel for 24 h. To remove impurities from biodiesel hot water and NaCl washing process was performed and the biodiesel flow process is shown in Fig. 2. Final biodiesel product was dried at constant temperature of 105 °C for 1 h. [29]. The complete experiments of 20%BD80%DF with CS fuel blends accumulation of 1000 rpm of coconut shell nano additives is blended and it was done at atmospheric pressure.

4. Experimental

The schematic representation of a diesel engine investigation setup is shown in Fig. 3. The diesel engine coupled with data acquisition system is used to study the performance and combustion of biodiesel with nano particles and for that the four stroke compression ignition engine was selected. From the conducted experiment the technical specification of diesel engine is listed in Table 1. The engine was coupled with an eddy current dynamometer to maintain acceptable constant speed and irrespective engine torque. The pressure transducer is used to measure the cylinder pressure and it is fitted in cylinder head. The crank shaft mounted with encoder to measure crank shaft position. The AVL 444 exhaust gas analyzer is used to measure the emissions of HC, CO, NO, CO_2 and O_2 in the engine exhaust and AVL 437C smoke meter is used to measure the Smoke opacity during accelerating conditions. Initial starting of engine the diesel fuel is used. After few minutes the fuel is changed to biodiesel blends. K-type thermocouple is used to measure all temperatures. All the nodes are connected with data acquisition system and the entire performance and combustion output report was recorded.

5. Results and discussion

5.1. Characterization of coconut shell nano particles

Table 2 provides the coconut shell nano particles of C, O, Al, Si, K and Ca and the elements present in the nano particles were found through energy dispersive analysis of X-rays (EDAX) technique [30]. The coconut shell nano particles had a higher amount of49.08 wt% of carbon and 48.38 wt% of oxygen and the remaining elements are trace on the surface. The carbon, oxygen and all elements are not homogeneous distributed. The energy dispersive analysis of X-ray spectrum (EDAX) of CS sample is shown in Fig. 4. Transmission Electron Microscopy (TEM) analysis is done through Jeol/JEM 2100 Microscope with an accelerating voltage of 200 kV. The average nano particles diameter of coconut shell is 20 nm. The agglomerated coconut shell (CS) nano particles are distributed with higher surface area and almost spherical shaped nano particles are observed in TEM image as shown in Fig. 5.

5.2. Characteristics of engine performance and emissions

Fig. 6 shows the results of specific fuel consumption for fuel blends (100%DF, 20%BD80%DF and 20%BD80%DF with CS). The biodiesel blended with diesel fuel and nano particle added in biodiesel-diesel blends are compared with diesel. The biodiesel blended with diesel and nano particles fuel consumes more fuel when compared to diesel fuel at the minimum load condition and intermediate and maximum load

Fig. 1. Coconut shell Nano additives Photograph.

Download English Version:

https://daneshyari.com/en/article/6631349

Download Persian Version:

https://daneshyari.com/article/6631349

Daneshyari.com