PRODUCTION OF BIODIESEL FROM REFINED COTTON SEED OIL AS WELL AS ITS EFFECTS AS FUEL IN DIESEL ENGINE

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ABSTRACT

Due to current and attention to future scenario related to fossil fuel utilization of alternative fuel, specifically biodiesel has enhanced. This leads to an imperative to recognize the utilization effect of biodiesel on diesel engine, on the basis of performance and emission parameter. The first phase of this manuscript focused on the production process for biodiesel from cottonseed oil. Prepared variety of biodiesel blends such as B10, B20, and B30 to conduct an experimental investigation. However, the second phase of this manuscript focused on the testing result of various blends compared with diesel fuel result, which leads to giving more clarity to interpretation. From this experimentation, it is observed that B20 has showed 32.71% BTE which is high compared to the B10, B30, and diesel. In this investigation at full load condition, it is noted that Specific fuel consumption for B10 was 0.31 kg/kWh, which are more as compared with rest of the fuels.

KEYWORDS: Cottonseed Oil, Transesterification, Biodiesel, Diesel Engine, Combustion & Emission

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INTRODUCTION

In present-day conventional fuels, petrol and diesel are the main energy resource for almost all areas like automobile, industrial, commercial and domestic [1]. Globally, increment in population had enhanced from last few decades parallel to that requirement of energy going to increase [2]. Worldwide, it is observed that consumption of energy from transport sector has enhanced by 1.1% per year, the cause for this is continuously the number of transport users' increase. According to researchers, forecast in the year of 2010–2040 globally, transport sector alone will consume 63% of liquid fuel. There is a basic rule that defines when demand increases; the price of product also increases. Even though, globally, transport sector is responsible for emitting gases by 22%, which is a very serious issue, according to an environment as well as human health concert [3]. There are several emission gases such as particulate matter (PM), nitrogen oxides (NOX), carbon monoxides (CO), and unburned hydrocarbons (UHC) that are by-products of IC engine from the combustion of conventional fuel. This all emission gases lead to threatening human being [4]. According to Figure 1, prism describes forecast scenario of IC engine emission, then the base will be a global population, which leads to show requirement of vehicles, ultimately these two aspects lead to increase in engine emission. Compared to petrol IC engine diesel, engine is more promising; according to fuel economy as well as performance aspect concerns, due to these reasons, use of diesel engine is more [5].

Figure 1: Forecast of IC Engine Emission According to Growing Global Population and Requirement of Vehicles [3]

According to “peak oil theory”, when a requirement of oil or fuel increases more than supply or source availability causing to increase in cavity between this to an aspect, which leads to enhancing energy crisis [6]. Globally, use of energy from crude oil is determined to enhance 1.75×10^9 tons by 2035 [7]. From this kind of present or future situation, researchers are more focusing on an alternative energy and alternative fuels, to satisfy demand of energy as well as to protect an environment from emission of gases [8]. There are several alternative fuels; on that researchers are continuously as well as effectively doing research [9]. From that long list of alternative fuels, it is recorded that Biodiesel is trust full and capable fuel for diesel engine [10]. In the year 1900, for the first time, Dr. Rudolf tried with peanut oil like fuel to run the engine, which was conducted in Paris [11]. However; engine modification is also not required to utilize biodiesel in a conventional diesel engine. There are so many advantages of using biodiesel as alternative fuels, among that few are listed below:

- Properties of biodiesel are more nearby to diesel fuel
- Sustainable in the creation and raw material for preparation easily available
- More percentage oxygen available that leads to high flammable
- Inbuilt lubrication property helps to reduce wear phenomenon
- No issues related to storage and chemical reactions
- Promisingly capable to reduce CO_2 emission compared to conventional flues

Even though there are some disadvantages related to biodiesel such as lesser spray individuality and less heat substance, such disadvantages can be overcome by selecting an appropriate unprocessed material, as well as proper additives [12].

OBJECTIVE OF THIS EXPERIMENTAL INVESTIGATION

According to previous researcher studies, almost all oil blends are given power value near to diesel fuel. The objectives of this experimental investigation are on accomplishment of enhancement in the performance of engine.

- To formulate biodiesel as of refined cottonseed oil, in addition to focusing on detailed parameters related to the production of biodiesel
- To differentiate revision on the basis of performances plus emission for diesel, as well as biodiesel

EXPERIMENTAL METHOD AND SETUPS

Biodiesel Production

Refined cottonseed oil accumulates from a local marketplace in Andhra Pradesh, India. To prepare biodiesel from refined cottonseed oil, transesterification process was adopted. Free Fatty Acid (FFA) test plays a very important role for finding the number of transesterification process required. The FFA value is below three, it requires single stage and for more than three, it requires two-stage transesterification process. The FFA value of cottonseed oil showed 2.8, from that single stage transesterification process was carried out in the present work. At initial conditions, heat was provided to refine cottonseed oil at temperature above 100°C for a time period of 2 hr, purpose of this is to remove moisture from refined cottonseed oil. General steps for biodiesel production is shown in figure 2, and experimental setup for biodiesel production is shown in figure 3.

Figure 2: General Steps Map for Formation of Biodiesel [6]

Figure 3: Experimental Setup of Biodiesel Transesterification Process

For the transesterification process, NaOH is used as the base catalyst. After that, refined cottonseed oil is mixed with methanol at a constant temperature, as well as the speed of stirrer, which is 50°C and 500-600 RPM, respectively. This process continues for 1 hr, later on this, the mixed solution is kept for cooling down at room temperature. Thereafter,

this properly mixed solution is transferred to conical funnel to stand for overnight stability. As result of this overnight stability time period in conical funnel, two different layers are formed at bottom layer glycerol and top layer other methyl ester, as shown in Figure 4. By opening funnel valve, these two-layers are taken out.

**Figure 4: Condition of Crude Biodiesel in Funnel
A) Before Water Wash and B) After Water Wash**

The cotton Methyl ester is containing dust particles. It requires cleaning that is done by a warm water wash. Maintained temperature at 60°C, this cleaning was done for 4-5 times, until Crude biodiesel become clean. When it was confirmed that biodiesel is totally clean, thereafter, it allows to heat at 80°C temperature to remove moisture from it.

Formulated methyl ester is mixed through diesel for making blends of fuel. For this experimental work, Cotton Seed Oil Methyl Ester (COME), with different volume concentration are utilised such as B10 (10% COME + 90% diesel) and B20 (20% COME + 80% diesel), B30 (30% COME + 70% diesel). The properties of prepared biodiesel depends on transesterification process, according to that, there are chances to find different characterization in same base oil biodiesel. Moreover, present research work concentrates on experimental analysis of the basic combustion phenomenon, engine performance and emission characteristics, by utilizing biodiesel made from cottonseed oil and it is mixed with diesel to form blends.

Experimental Setup and Procedure of Experimentation

For this experimental investigation, Kirloskar engine was used, which was a single cylinder, water-cooled, 4-stroke diesel engine. This DI diesel engine was associated through water dynamometer for application in different load conditions. For more details, Figure 5 illustrated a simplistic diagram of diesel test engine; addition to those setup engine specifications given in Table 1. However, to conduct this experiment, standard working temperature and pressure are maintained in working area. To identify the speed of the engine at different load conditions, noncontact tachometer at another hand to record torque dynamometer was used. For measurement of different emissions of gases such as NO_x, CO, digital gas analyzer was utilized.

Figure 5: Simplistic Diagram of Diesel Engine Testing System along with Arrangement [14]

Where; 1) Engine base 2) Analyzer for exhaust gas 3) House of exhaust gas analyzer 4) Single cylinder arrangement engine 5) Load cell 6) Dynamometer 7) Tachometer 8) Control system 9) Fuel burette 10) Fuel tank

Table 1: Test Engine Specifications

Engine Type	4-Stroke DI Diesel Engine
Number of cylinders	One
Bore $\times$ stroke	80 $\times$ 110 mm
Swept volume	553 cc
Compression ratio	16.5:1
Fuel injection timing	24° BTDC
Number of nozzle hole	Three

RESULTS AND DISCUSSIONS

Brake Thermal Efficiency (BTE)

A comparative study was carried out for this experimental investigation. This section focuses on Brake thermal efficiency, as illustrated in Figure 5 of different biodiesel blends such as B10, B20, and B30 to get more clarity and for that purpose; results were compared with diesel fuel, which tested on same engine setup. Generally, calorific value (CV) of fuel is measured in kJ/kg. Perhaps, as we can see in Figure 6, BTE of fuel increases parallel to load. From this experimental investigation, it is observed that B20 has 32.71 % BTE, which is high compared to rest of fuels. However, there is quite a similarity in % BTE for B10 and diesel, which is around 30%. Whereas, B30 has decreed in BTE compared to B20.

Figure 6: Brake Thermal Efficiency for Different Fuels at Different Load Conditions

Specific Fuel Consumption

For better understanding, SFC result of different blends and diesel are plotted on same graph, as illustrated in Figure 7. In this investigation, at full load condition, it is noted that specific fuel consumption for B10 was 0.31 kg/kWh, which is more as compared to remaining fuels. This happened on account of the minor calorific value, along with high viscosity of biodiesel blends [17]. At other hand, for same load condition, B20 and B30 had less SFC which is 0.28 and 0.29 kg/kWh, respectively. Higher oxygen content in the biodiesel blends leads to enhanced combustion rate [18].

Figure 7: Specific Fuel Consumption of Engine at Different Fuels and Load Conditions

Combustion

Cylinder pressure of IC engine gives overall idea of efficiency of engine, specifically for that fuel. Amount of cylinder pressure mostly depends on fuel burnt factor in the combustion phenomenon of engine. In this experimental investigation, cylinder pressure and crank angle data are carried out by averaging 10 cycles at full load condition [19]. Figure 8 illustrates nature of cylinder pressure at different crank angle conditions for several blends and diesel fuel. The consequence of experimentation represents peak cylinder pressure value for B10 was 65.14 bars at 365° crank angle. At other hand, for the same load condition as well as same crank angle cylinder pressure value for B20 and B30 are having slight lower pressure, but for diesel having the variation drastically i.e. 44.54 bar at a crank angle of 366°. It is because of the higher density and viscosity of biodiesel, leading to increase in the ignition delay [20].

Figure 8: Cylinder Pressure of Engine at Different Fuels and Crank Angle

Smoke

Figure 9 is representation of smoke at various engine load conditions for various fuels. It is observed that, at full load conditions, smoke quantity is high in case of diesel, compared to blended fuels. For more precise, diesel had 39.1 % smokes at full load condition, whereas B30 showed lowest smoke value of 34.8%. This is less compared to rest of the fuels. Cause of this phenomenon is, high oxygen content inside the biodiesel blends provided proper ignition of the fuel [21].

Figure 9: Smoke Vs Load

CONCLUSIONS

In this manuscript, not only biodiesel experimental investigation results were discussed. Addition to that, production process of biodiesel from refined cotton seed oil has been described in broader point of view, which leads to serve the upcoming new researchers. For this research work, several samples of biodiesel blends such as B10, B20, and B30 to conduct an experimental investigation were selected. To get more understanding, results of several samples of biodiesel blends were compared with net diesel sample also. Highlights of this experimentation are described as follows: it is observed that, B20 has around 35 % BTE, which is high when compared to B10, B30, and diesel. In this investigation at full load condition, it is noted that Specific fuel consumption for B10 was 0.31 kg/kWh, which is more as compared with rest of the fuels. The consequence of experimentation represents peak cylinder pressure value for B10 with 65.8 bars at a 365° crank angle. B30 had 55% smoke at full load condition, whereas, diesel fuel had 35% smoke observed.

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