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ORIGINAL RESEARCH

DESIGN OF BIODIESEL APPLICATION ENGINE WITH JIANGFA ENGINE

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Abstract

At present, reliance on conventional fossil-derived fuels remains significant, as reflected in the growth in fuel consumption which requires imports to meet domestic fuel needs. the negative implications of fossil fuel consumption involve the continuous reduction of crude oil reserves and the challenge of exhaust emissions is increasingly concerning. mitigating dependence on fossil fuels necessitates the 2 with alternative energy resources, especially in compression ignition engines. One such alternative is bio-diesel fuel, which can be directly utilized in compression ignition engines without requiring any modification to engine components. Biodiesel is synthesized through the transesterification reaction. Biodiesel can be derived from vegetable oils, animal fats, waste cooking oils, and algal sources therefore, biodiesel fuel is considered a renewable, biodegradable, non-toxic, and environmentally sustainable fuel, as its exhaust emissions are significantly cleaner. In practical applications, compression ignition engines are widely employed to power generators. In use in Indonesia, the government has mandated the blending of bio-diesel fuel with petroleum diesel. Currently, this blending policy has reached the B30 formulation, consisting of 30% bio-diesel fuel and 70% diesel fuel. Diesel motors or compression ignition engines are required to use B30 by the government. Therefore, this study seeks to create a setup machine as a learning medium for bio-diesel fuel applications in compression ignition engines and to facilitate several types of investigation on compression ignition engines with bio-diesel fuel fuel, because the trainer form is simple but still has the same function. The methodology used in this investigation consists of 3 stages, namely design, manufacture, and operational evaluation using halogen lamps as an output. The findings demonstrate that the proposed simplified diesel engine design operates effectively, as evidenced by the illumination of all four halogen lamps during testing

KEYWORDS:

B30, biodiesel, biodiesel engine, design, Jiangfa

1 | INTRODUCTION

Energy plays a pivotal role in achieving sustainable development [1]. Historically, the world's primary energy sources have undergone several transitions. In the early stages, most societies relied heavily on biomass, such as firewood, to fulfill their energy requirements. This reliance gradually shifted toward fossil-based resources—including coal, petroleum, and natural gas—largely driven by the industrial revolution during the early 20th century. The increasing demand for diesel fuel is evident in the growing consumption trends. Data published by the Downstream Oil and Gas Regulatory Agency reported an additional 11.29 million kiloliters of diesel fuel consumption in 2021. This escalation poses a significant concern, as diesel is refined from crude oil, which is non-renewable [2]. If uncontrolled, crude oil reserves are projected to be depleted by 2053 [3]. Moreover, excessive reliance on fossil fuels has contributed to elevated greenhouse gas emissions, destabilizing global climate patterns, increasing global temperatures, and accelerating sea-level rise [4]. Numerous studies further confirm that carbon dioxide emissions were the largest contributor to climate change between 1750 and 2005 [5]. Such conditions intensify climate instability, damage ecosystems, and disproportionately impact vulnerable populations, particularly those living in poverty. To address the declining availability of fossil fuels, particularly petroleum-based products, it is essential to intensify the use of renewable energy alternatives, especially within the transportation sector. Biofuels, such as bioethanol, have been widely recognized as viable substitutes, not only due to their renewable characteristics but also their environmental benefits (Wiratmaja & Elisa, 2020). In recent years, the development and application of alternative fuels in internal combustion engines have become an increasingly important research focus. The transition from fossil fuel dominance toward renewable energy sources has far-reaching implications for environmental sustainability, social welfare, and economic resilience (Yang et al., 2021). Governments worldwide, including Indonesia, have initiated policy frameworks to encourage renewable energy adoption. One such strategy is energy diversification, which involves substituting petroleum-based fuels with biofuels such as biodiesel and bioethanol. These initiatives are intended to optimize energy security while simultaneously reducing dependence on non-renewable resources (Wiratmaja & Elisa, 2020). Biodiesel is a methyl ester which is the result of a triglyceride transesterification reaction or a vegetable oil esterification reaction. Biodiesel is widely acknowledged as an environmentally benign fuel due to its comparatively lower exhaust emissions than conventional fossil-based fuels. In addition, bio-diesel fuel is non-toxic and the sulfur content is also very small., and what is equally crucial is that the raw material comes from vegetable oil which is available in abundant and renewable quantities (Ojolo et al., 2010). Biodiesel is a fuel compression ignition engines made of renewable materials, can be made from oil vegetable like; palm oil, oil coconut, jatropha oil, and kapok seed oil and animal oils such as; lard, chicken fat, beef fat, and also fat comes from fish (Wibisono, 2007). Biodiesel can be applied well quantity 100% (B100) or mixed with diesel oil at level certain concentration (Bxx), such as 10% bio-diesel fuel mixed with 90% diesel known as B10 (Wirawan, et al, 2008), as the most preferred alternative material perfect for replacing fuel diesel engine. Biodiesel reduces pollution of unburned hydrocarbons, carbon monoxide, sulfur and acid rain. The energy produced by diesel engine is more perfect than diesel. This findings engines that use bio-diesel fuel does not emit black smoke in the form of carbon or CO2 (Syahrir & Sungkono, 2021). In use in Indonesia, the government encourages it to be mixed with diesel oil and now it has reached B30 bio-diesel fuel, which is 30% palm oil and 70% diesel oil. Diesel motors or compression ignition engines for land and sea transportation are required to use B30 by the government, on the other hand, the government is concerned about the effect of B30 on diesel engine performance (Tim PPPPTK, 2015).

A diesel engine, commonly recognized as a compression ignition engine, is a type of internal combustion engine in which ignition occurs as a result of high compression temperature, ehttps://www.overleaf.com/project/691c1248c8417eb5e56346eenabling the fuel injected into the combustion chamber to ignite spontaneously. Unlike spark-ignition engines, it operates without spark plugs. The concept was first introduced by Rudolf Diesel in 1892, and a patent was granted in 1893. Subsequent enhancements and technical refinements were made by Charles F. Kettering. Among internal and external combustion engines, diesel engines exhibit superior thermal efficiency due to their high compression ratios. In particular, low-speed compression ignition engines—such as those applied in marine propulsion—can achieve thermal efficiencies exceeding 50%. Owing to these characteristics, diesel engines are widely utilized as prime movers for electricity generation, heavy-duty equipment, and various modes of transportation (Syahrir & Sungkono, 2021).

Along with the development of science and technology in an increasingly rapidly industrial world, many technologies and innovations are continuously developed by scientists. The use of bio-diesel fuel as a raw material still has to be investigationed and developed the effect of using bio-diesel fuel on compression ignition engines. To fulfill this investigation, it is necessary to have investigation facilities such as learning media/trainers. In this case the author seeks to create a series of tools as a learning medium for bio-diesel fuel applications in compression ignition engines. Learning media/trainers are made to facilitate several types of investigation on compression ignition engines with bio-diesel fuel fuel, because the trainer form is simpler but still has the same function and working methodology.

2 | MATERIAL AND METHOD

The investigation was carried out at the Mechanical Engineering Manufacturing Laboratory, Department of Mechanical Engineering, Faculty of Engineering, University of Pembangunan Nasional "Veteran" East Java. The investigation consisted of three stages, namely the design, manufacturing, and operational evaluation stages. At the design stage, it includes planning and task explanations, product concept planning, form planning, and detailed planning. The manufacturing stage is the procurement of tools and machines, such as diesel engine with a cylinder volume of 376 cc, electric generator with a capacity of 5 kW, halogen lamps as engine loading with a maximum of 4000 W, Pertamina Meditran SX Bio SAE 15W-40 lubricant, pulleys, belts, exhaust gas analyzers, and burrets, as well as the manufacture of supporting components such as manufacture of engine and generator mounts, assembly of electronic equipment and others. Then, these tools are assembled so that they become a unified machine performance test tool by taking into account the technical specifications of each of these tools. The operational evaluation stage is where the assembled tools are tested to see all components work well.

3 | RESULTS AND DISCUSSION

Additionally, the performance analysis has been expanded by including more technical indicators, such as specific fuel consumption, thermal efficiency, and measured exhaust emissions. This provides a more comprehensive overview of the diesel engine performance when operating with B30 bio-diesel fuel fuel. An overview of the test setup can be seen in Figure 1 .

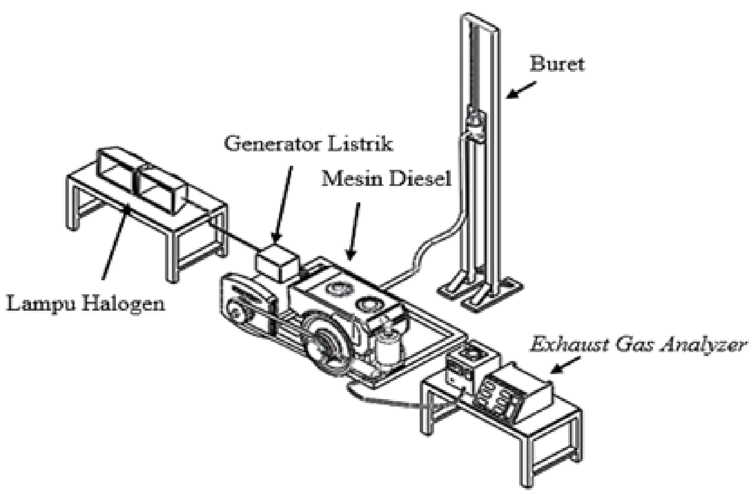

FIGURE 1 Experiment Setup

This study uses a diesel engine with a cylinder volume of 376 cc. The diesel engine is connected to an electric generator with a capacity of 5 kW which is used to turn on the halogen lamp which functions as the engine loading. The selection of a maximum load of 4000 W is carried out with the consideration that the generator has an efficiency of 80%.

In designing the display stand in various forms, models and frame constructions are selected based on the ability to support the load on each component. The shape and size of the material must also be taken into account in the process, in order to support all the components on the trainer. Dimensions size 2D engine trainer mounting frame is shown in Figure 2 .

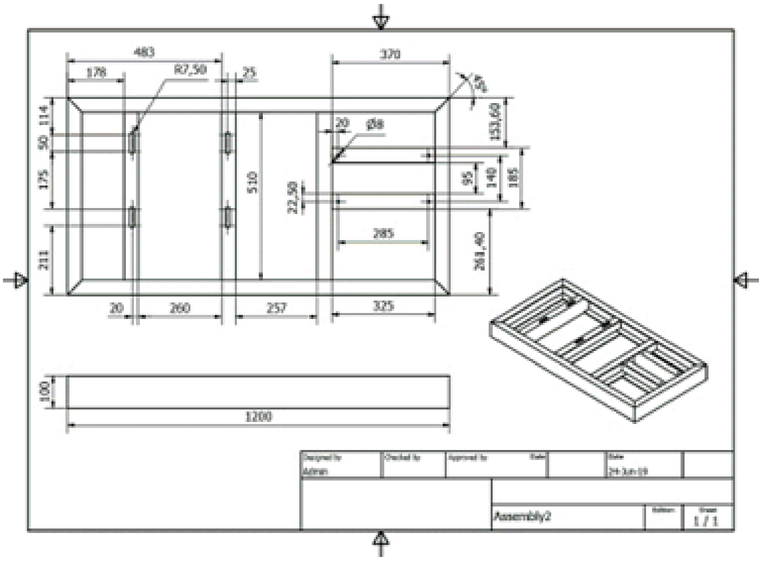

FIGURE 2 2D Dimension Size For Engine Mounting Frame

After designing the size of the engine mount frame, preparing components and getting each component purchased, the overall assembly process can be carried out as shown in Figure 3 c. designing the size of the engine mount frame, preparing components and getting each component purchased, the overall assembly process can be carried out as shown in Figure 3 c.

In the performance testing stage, the machine is operated with an allogen lamp as a load. The fuel used is Dexlite which is B30 fuel, which is 30% biodiesel and 70% diesel. The characteristics of the Dexlite used are in table 1 .

TABLE 1 Characteristics of Dexlite

Test Parameters	Unit	B30 Test Result
Density at 40 °C	kg m^{-3}	–
Density at 15 °C	kg m^{-3}	845.7
Kinematic viscosity at 40 °C	mm^2/s	2.92
Cetane numbers (Min: 51)	–	56.7
Flash point	°C	65
Distillation temperature 90%	°C	344
Color	ASTM Colour	1.1
Methyl ester levels	% (mm^{-1})	–
FAME content	% v/v	20
Water content	ppm	159.63

Performance testing begins with a diesel engine coupled to a Denyo FA-5 electric generator with a peak capacity of 5 kW and an efficiency of 80%. Then the electric generator is used to turn on the halogen lamps. The machine is operated at a constant speed. The test results show that all components function properly, all four halogen lamps can be lit with the same intensity as shown in Figure 4 . other supporting equipment is also functioning properly such as a burette to measure fuel consumption per unit time, rpm sensor, equipment to measure current and voltage, and an exhaust gas analyzer brand Tecnotest Model Stargas 898 tomeasure gas emissions. Performance testing with halogen lamps is shown in Figure 4 .

(a) (b) (c)

FIGURE 3 (a) Welding process for engine mount frame, (b) Engine mount frame, (c) Engine and generator are assembled to the mount frame

3.1 | Conclusion

From the findings of the investigation that has been done, it can be ascertained that the shape and design of the engine trainer engine trainer for bio-diesel fuel applications is made in such a way as to facilitate investigation related to the effect of using bio-diesel fuel on compression ignition engines. The trainer apparatus is designed with simplicity yet demonstrates reliable functionality. This is indicated by the test findings using halogen lamps which are all lit during the testing process. All components, both main components and supporting components, are functioning properly, starting from the diesel engine, generator, burette to measure fuel consumption per unit time, rpm sensor, equipment to measure current and voltage, and exhaust gas analyzer to measure gas emissions.

4 | RESULTS AND DISCUSSION

The specimen for this test is a cylinder with 10 cm diameter and 20 cm height. There are three samples for each kind of concrete. Table 5 and Figure 4. represent the result of this test.

FIGURE 4 Performance Testing With Halogen Lamps

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