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Enhancing Performance and Efficiency in Low Heat Rejection Diesel Engines with Jatropha Fuel

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Abstract: *Increased industrialization, rising energy consumption, diminishing fossil fuel supplies, and worsening pollution all call for the discovery of clean alternatives to petroleum-based gasoline and diesel. Since the beginning, vegetable oils were thought to be a potentially viable alternative diesel fuel. Biodiesel, an alternative fuel made from vegetable oil, has many advantages over regular diesel and is now widely available in industrialized countries. As an alternative to diesel, vegetable oils show a lot of promise. These oils have desirable qualities that are similar to those sought after in C.I.engine fuels. Whether or not vegetable oil can be used in a motor relies on the oil's specific qualities. Jatropha oil's characteristics, especially its cetane rating and heat values, are quite similar to those of diesel. These oils can be easily harvested in rural and forested areas, and it is one of the goals of this study to determine whether or not Jatropha oil is suitable for use in a sealed engine. In this investigation, an Air gap liner and a PSZ coated head and valves were utilized. To determine if Jatropha oil is viable as a C.I., researchers have conducted experiments. Motor gasoline. Both the standard engine and an insulated engine were used for the tests. In this study, we make a serious effort to investigate the effects of using Bio-diesel derived from Jatropha oil in place of diesel fuel on engine efficiency.*

Keywords: Low heat rejection, Jatropha, alternative fuel.

1. INTRODUCTION

Because of its high cetane number, similar to that of diesel, jatropha oil is a superior alternative fuel to edible oils. It's worth noting that Jatropha's non-edible vegetable oil exhibits the desirable physicochemical and performance properties compared to diesel, making it a potentially attractive and commercially feasible alternative to diesel. Diesel made from jatropha oil will be sustainable and use fewer resources to produce. The benefit of its decentralized production across India is that it won't need a huge network of distribution centers to get to consumers. Raw oil has a high flash point, a high pour point, and a low volatility, all of which pose significant challenges when trying to use it as bio diesel. Poor fuel atomization and inefficient mixing with air can cause issues with the engine's performance, including: incomplete combustion; difficulty starting the engine when cold; deposit formation; ring sticking; and lube oil dilution and degradation. Jatropha oil has an initial flash point of 1100C, while diesel's is just 500C. Because of its higher flash point, Jatropha oil is safer to store, handle, and transport than petroleum crude. However, the greater flash point may only cause issues when the system is first turned on. Similarly, Jatropha oil's increased viscosity may cause issues with the oil's ability to flow freely through fuel delivery piping and nozzles.

2. NEED OF THE PRESENT WORK

Diesel fuel is almost essential in the agricultural and transportation industries. There has been no viable replacement for petroleum-based fuel in the transportation sector. Diesel's many potential alternatives have largely been narrowed down to biogas, producer gas, and vegetable oils. Since India continues to import a substantial number of edible oils, this study explored the possibility of using vegetable oils, such as Jatropha oil.

3. OBJECTIVEOFTHE WORK

The purpose of this research is to see if Jatropha oil can be used effectively in a sealed engine. In this study, we make a serious effort to compare the engine performance of a basic engine using vegetable oil instead of Diesel with Jatropha oil and an insulated engine.

4. FABRICATION OF INSULATED COMPONENTS

Before beginning to develop the insulated parts, extensive research was conducted. The combustion chamber of the low heat rejection engine is made up of the Liner, cylinder head, and valves, all of which are insulated. In order to minimize heat loss, three primary ideas have been implemented in modern adiabatic diesel engines.

Cylinder Liner Insulation: The low heat conductivity of air made it an ideal insulator. Over the cast-iron liner, a thin sleeve of mild steel was cinched down to keep a 2mm air cushion between the two. To stop cooling water from leaking through the sleeve's seams and into the air gap, we sealed the joints. Fig. The inner liner of the air gap is shown in detail in 1. Since the liner was insulated, less heat was lost to the cooling water, improving the engine's thermal efficiency.

Cylinder Head Insulation: Ceramic coating is a less complicated option for insulating a cylinder head. The PSZ insulated the part of the head that was in contact with the combustion chamber. A half millimeter of material was removed from the cylinder head's combustion chamber via machining. Sand blasting was then used to create countless holes in the surface for the ceramic to settle into.

Insulation of Valves: The PSZ coating on the valves' undersides is 0.5 mm thick, and they were machined to a depth of 0.5 mm. Combustion chamber area was approximately 90-92% of the total area with the valves installed on the cylinder head.

5. EXPERIMENTAL INVESTIGATIONS

Fig.2 is a picture depiction of the experimental setup and instruments used for diesel operation. The Kirloskar single-cylinder, four-stroke, water-cooled, vertical, direct-injection diesel engine utilized in the experiments. This engine is widely utilized in the agricultural and industrial sectors and can withstand the greater pressures that are sometimes experienced. This is why this engine is chosen for experimental purposes. This style of engine also makes it simple to make any required adjustments to the liner and cylinder head. That's why we're going with this particular motor for this project. Directly from a mill voltmeter in degrees Celsius calibrated for iron-constantan thermocouple, we were able to determine the exhaust temperature thanks to an iron-constantan thermocouple installed in the exhaust manifold in close proximity to the cylinder head. The engine was outfitted with a quartet of gas analyzers for testing the quality of the exhaust gas. The smoke meter is used to assess the properties of the smoke for the presence of four major pollutants: carbon monoxide (CO), carbon dioxide (CO2), unburnt hydrocarbons (HC), and nitrogen oxides (NOx). Opacity and absorbency are two of the distinguishing features. The opacity of smoke indicates how dark it is. Now we have a way to quantify the obscuring effect of smoke. All of the variable load testing are done at a rated speed of 1500rpm. The cooling water is kept at a constant temperature of 700C at its exit. The temperature of the lubricating oil has been held constant at 600C during all the tests. After the engine has had a chance to stabilize, the dynamometer's load, air and fuel flows, exhaust temperature, manifold pressure, cooling water flow rate, cylinder head and cylinder liner temperatures, HC, CO, and smoke readings are all recorded.

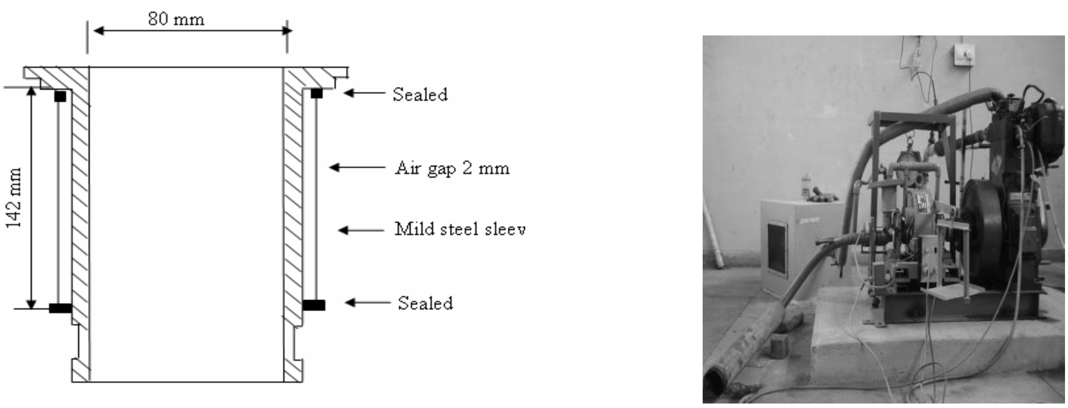

FIGURE .2 air gap insulated liner and photographic view of experimental setup

The experimental setup has been tailored to meet the needs of the current studies. Experiments were run with diesel and jatropha in both the regular engine and an insulated engine. For the first 20 minutes, the engine was run at no load, and it was run at each load until the condition stabilized. All experiments were performed at the maximum allowable speed of 1500 rpm.

6. RESULTS

The findings from experiments conducted with both fully insulated and partially insulated engines Both the conventional engine and the semi-adiabatic engine's performance curves (graphs) and heat balance sheets are presented. In this section, we compare and contrast the data from the two engines and explain our findings. Exhibits 1 through 6 display tabulated and graphed data from experiments performed on a 3.68 kW KIRLOSKAR single-cylinder, 4-stroke, water-cooled conventional diesel engine and a semi-adiabatic engine, respectively.

7. ANALYSIS & DISCUSSIONS

The connection between the brake output and the plotted relationship is presented in Figure 1. From the narrative, we can infer that the insulated engine has stronger brakes than the standard engine. Because the semi-adiabatic engine rejects less heat than a traditional engine. According to the results of the research, the thermal efficiency of the engine's brakes improves as a result of the insulation that was installed on the engine. In Exhibit 2, we have a graph depicting the connection between Brake Power and Specific Energy Consumption. Compared to a non-insulated engine, the insulated one has a lower Specific Energy Consumption. This is made possible by the extremely high temperatures inside the cylinder, which boost the effectiveness of the combustion process and cause the pressure inside to spike suddenly. Exhibits 3 and 4 depict the differences in exhaust smoke intensity (opacity and absorptivity) between insulated and non-insulated engine designs, respectively. The Figures show that Diesel produced the most intense smoke in terms of pollutants (opacity and absorptivity), while the insulated configuration produced the least. Higher operating temperatures are primarily responsible for the decrease in smoke, as they more effectively oxidize the soot particles. Furthermore, improved combustion in sealed engines may be a contributing factor. In Exhibit 5, we have a comparison of the HC emissions from various insulated setups. These emissions originate mostly from lean mixing, the combustion of lubricating oil, and wall quenching in a CI engine. There is less HC production in insulated engines because the combustion chamber stays hotter. Exhibit 6 compares the carbon dioxide output of several alternative insulation layouts. Carbon dioxide levels are higher in insulated engines because of the more efficient burning. Carbon dioxide (CO2) levels in the exhaust are maximum when the system is well-insulated. Carbon dioxide (CO2) levels in the exhaust that are higher than normal indicate that the combustion process was successful. Exhibit 6 compares the carbon monoxide (CO) levels in the exhaust of the base engine to those of all the insulated designs, demonstrating that the insulated engines have lower CO levels due to more efficient combustion. Compared to portion loads, insulated designs' lower CO emissions are even more pronounced at greater loads. Exhaust gas temperatures will be greater in insulated engines because of the insulation of the engine cylinder. When the engine is working harder, the exhaust gets hotter. Exhibit 8 displays the relationship between the changing exhaust gas temperature and the braking power output for all possible configurations.

Exhibit 9 depicts the peak pressure variation in relation to the power output. The base engine has a higher peak pressure than the insulated variations. This may be because there is less fuel being accumulated during the delay phase of combustion as a result of the shorter ignition delay.

8. CONCLUSION

The following conclusions can be drawn from the processed results of the experimentation. The analyzed experimental results support the following inferences. Jatropha improved the efficiency of insulated engines compared to those without insulation. There is a 22% increase in brake thermal efficiency at full load operation for the insulated configuration (an Air gap liner and PSZ coated head and valves) compared to the base engine. The smoke emissions were significantly decreased in all insulated arrangements. When compared to the base engine, HC emissions are lower from insulated versions, with the insulated configuration showing the greatest reduction at roughly 250 ppm at full load. Better burning in an insulated jatropha design has resulted in a volumetric reduction of CO emissions to the order of 0.28%. All insulated versions have greater exhaust temperatures compared to the base engine due of the insulation. The results of the experimental research indicate that the insulated Jatropha arrangement functions admirably.

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