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Examining the Jackfruit Seed Oil Methyl Ester (JSME 20) Blend of on a Compression Ignition Engine with Air Pre Heating

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ABSTRACT- The compression ignition engine with air preheating optimal blend JSME20, which yields the best results from the Jack seed oil methyl ester mixes, was the subject of investigations in this study. In order to determine performance and emissions criteria, data from diesel base lines and the ideal blend JSME20 were examined. We anticipate that this extension of the air preheated blend will yield the greatest outcomes in terms of emissions and performance. The study found that brake-specific fuel consumption decreased, brake thermal efficiency increased, and emissions generally decreased.

KEYWORDS: Biodiesel, Jackfruit Seed Methyl Ester (JSME), Compression Ignition Engine, Performance, Emissions, Pre Heating.

I.INTRODUCTION

These days, one of the biggest concerns is the effects of fossil fuel emissions on the global climate. Acid rain, global warming, and health risks are brought on by the buildup of harmful chemicals in the atmosphere, such as NO_x, CO, and particulate matter. The Intergovernmental Panel on Climate Change (IPCC) confirmed in its fourth assessment report that climate change is accelerating and that, if current trends continue, energy-related emissions of greenhouse gases, including carbon dioxide (CO₂), will rise irreversibly, eventually raising the global average temperature by up to 6°C. India was in fifth place globally with 243.3 million tons of carbon released from the use and burning of fossil fuels, behind the United States, China, Russia, and Japan. The creation and application of clean, sustainable bioenergy sources is one strategy to counteract these trends. Numerous noteworthy advantages can be obtained from renewable bioenergy sources, including enhanced employment opportunities in the agriculture sector, less emission of greenhouse gases and pollutants, and improved energy security. The simple alkyl esters of fatty acids that make up biodiesel fuel are one of the most renewable and non-polluting alternative energy sources that is gaining popularity as a replacement for traditional diesel fuels. Animal fats and vegetable oils are used to make biodiesel. The majority of wealthy nations use canola, sunflower, neem, soybean, rapeseed, and canola oil among other ingredients to make biodiesel. In this study, air preheating introduces the ideal mix from the canola oil methyl ester blends. From this, we anticipate that preheating will speed up the combustion process because it generates the most pressure, which could lead to complete combustion. Emissions are reduced and performance is increased as a result. Four cylinders were used in the studies conducted by Vern Hofman and Elton Solseng [1]. Finally, a diesel engine running on sunflower oil and diesel mixes showed that biodiesel had lower energy content. When running on pure biodiesel, the engine's power output dropped by nearly 9%. In other words, more gasoline would be required to do the same task as diesel fuel. The same amount of work could be completed with 1.1 gallons of biodiesel and diesel fuel. Alkersugoza and associates [2], Exhaust emissions and engine performance were examined in diesel engine studies utilizing canola oil methyl ester on single-cylinder engines. The engine's torque and power were found to have decreased as a result of the canola oil methyl ester's lower calorific value. Additionally, because of this rationale, biodiesel's specific fuel consumption was shown to be higher than diesel fuels. Using biodiesel resulted in a decrease in carbon dioxide emissions. When compared to diesel fuel, biodiesel produced greater NO_x emissions. These can be linked to the biodiesel burning more thoroughly when there is more oxygen present in the combustion chamber. In this study, according to Pranil J. Singhet al. [3], hybrid fuels based on coconut oil were utilized. These fuels included coconut oil, aqueous ethanol, and butan-1-ol as a surfactant. Three hybrid fuels—53VCO 23E 24B, 67VCO 17E 16B, and 85VCO 10E 5B—were put to the test in a



diesel engine with direct injection. The micro-emulsification technology can be used to lower the viscosity of pure coconut oil to a level that is comparable to diesel. Next, assess the performance parameters of a single cylinder, four-stroke, water-cooled, direct-injection diesel engine. These include brake thermal efficiency, brake specific fuel consumption (BSFC), exhaust gas temperature, and the emissions measured, which included carbon monoxide (CO), smoke density, hydrocarbon (HC), and oxides of nitrogen (NO_x). Using some well-known techniques to get around higher viscosity related problems in order to make them compatible with the hydrocarbon-based diesel and biodiesel fuel properties, Mathur Y. B. and et al. [4] worked on efforts to understand and compile the outcome of researches on the economics of biodiesel fuel, issues associated with the use of vegetable oil in diesel engines. Higher viscosity, lower energy content, higher cloud point and pour point, slight increase in nitrogen oxide (NO_x) emissions, decreased engine power and speed, engine oil degradation, injector coking, engine compatibility, high cost of biodiesel, and increased engine wear are some of the main drawbacks of biodiesel. In trials using diesel engines, Baiju et al. [5] discovered that the combustion product was safe to release into the atmosphere. These needs could be met with a variety of gaseous, liquid, and vaporous fuels. Furthermore, the biodiesel derived from non-food sources such as neem, jatropha, mahua, and so forth. satisfy the highest engine performance requirements and, as a result, provide the best practical alternative to diesel fuel in Asian countries. Additionally, tests on the Diesel engine are conducted and it is found that it increases in BSFC by using various blends of biofuel from various assets in addition to Diesel. This finding demonstrates that, when compared to diesel used for a similar power output or yield, there is an increase inside BSFC if biofuel is utilized. The use of biodiesel dramatically reduces pollutants and improves engine performance, according to Agarwal et al. [6]. Green algae growth can fix atmospheric CO₂, according to Demibras et al. [7], and it can develop in elevated temperatures on non-Arable land. According to Agarwal et al. [8], a variety of vegetable plants, including karanja, jatropha, neem, cotton seed, soybean, and raspberry, have been successfully discovered during the production of biodiesel. In their study, Avinash Kumar Agarwal et al. [9] examined the emission, performance, and features of a single-chambered diesel engine running on Karanja biofuel. They found that the engine produced good spray and atomization characteristics once the biodiesel was preheated. In addition to finding that advanced injection timing resulted in better combustion, performance, and emission characteristics than rated timing, Ganapathy et al. [10] investigated the emission, performance, and combustion characteristics of a CI engine using Jatropha biodiesel at various injection timings. A modified DI diesel engine running in dual fuel mode with eucalyptus biodiesel and natural gas produced reduced NO_x emissions than the standard or traditional diesel fuel mode, according to research by Tarabet et al. [11]. The effects of using Indian jujube seed oil as biodiesel on the efficiency and emissions of single-cylinder diesel engines have been studied by Churchill et al. [12]. Tests were conducted using combinations of JB25, JB50, JB75, and JB100. The final results show that JB75's exhaust gas temperature is lower, the emission temperature produced the best results, and the BTE is only slightly lower. Additionally, it reveals that the non-edible oil was a promising resource with the potential to aid in the production of biodiesel. An analysis of the efficacy and emission characteristics of Water Melon biodiesel in a single-cylinder, four-stroke direct injection diesel engine connected to an eddy current dynamometer was conducted by Praveen et al. [13]. Different mixes, such as B0, B20, B40, B60, B80, and B100, were used to fuel the engine throughout the test, and the results were compared to those of pure diesel. The final result showed that B20 performed the closest with the cleanest diesel of all the blends. Oil from *Artocarpus heterophyllus* (Jackfruit) seeds was extracted by Rengasamy et al. [14] and concentrated for use in the production of biodiesel. This study includes both optimization based on the oil yield measure and optimization of oil using practical techniques and corresponding solvents. The extraction method using a microwave oven produced the highest yield, with a yield of almost 19.8% when using methanol as the solvent. By transesterification at 650°C reaction temperature, 1:9 molar ratio of oil to methanol, 400 rpm stirring speed for 120 minutes, and 1 weight percent sodium hydroxide as catalyst, the biodiesel production was approximately 92%. Using vegetable oil methyl ester, Iton Solsenget al. [15] conducted research on diesel engines. This essay examines the growing body of knowledge surrounding the use of biodiesel and assesses how an engine will function on a different fuel. Because biodiesel has less energy than other fuels, using pure biodiesel reduced engine power output by nearly 9%. In other words, more gasoline would be required to do the same task as diesel fuel. The same amount of labor that diesel fuel might accomplish would require about 1.1 gallons of biodiesel. Regarding the public's acceptance of biodiesel, there are two major issues. In cold weather, these are the additional expenses for gasoline and fuel thickening. Fuel heaters are a viable solution to the thickening issue. Customers will either have to absorb the additional expense, require government assistance, or see a comparable increase in the price of diesel fuel.

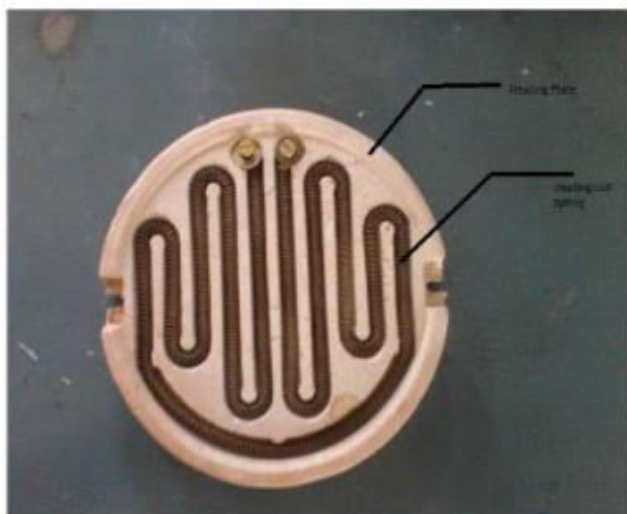
II. MATERIALS AND METHODS

Following the Jackfruit Seed oil biodiesel, an 80% diesel and 20% biodiesel (JSME20) blend was tested; the JSME20 blend was found to be the best. Tests of JSME20 with air preheating were undertaken from that optimal blend. Any device intended to heat air before to another process (such as combustion in a boiler) with the primary goal of

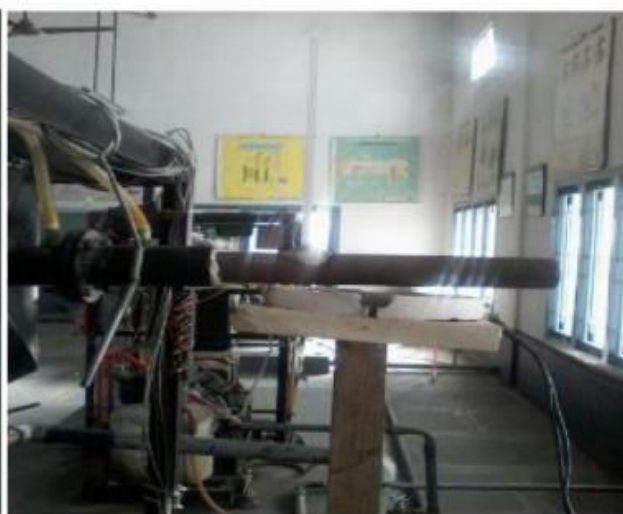
improving the process's thermal efficiency is referred to as an air-preheater (APH) in general. The intake system's goal is to precisely and equitably supply each cylinder with the right amount of fuel and air at the right moment during the engine cycle. The flow into an engine can be modeled as quasi-steady state flow, but it pulses when the intake valves open and reopen. An intake manifold, a throttle, intake valves, and a carburetor or fuel injectors for adding fuel make up the intake system. Fuel injectors can be installed in the cylinder head (CI engines, current two-stroke cycle, and some four-stroke cycle SI automotive engines), at the manifold's input (throttle body injection), or by the intake valves of each cylinder (multipoint port injection). Preheating the intake air that passes through the combustion chamber is the idea behind improving an engine's fuel efficiency. The evaporation in the chamber is influenced by the humidity of the surrounding air. Hence, full combustion can be attained by preheating the incoming air before it enters the combustion chamber for a significant amount of time. This will facilitate vaporization. Additionally, by lowering the amount of water vapor entering the engine, less steam will build within, which will prevent pitting in the exhaust pipe, cylinder, and piston. Put otherwise, it indicates that improving in-cylinder combustion can lower exhaust NO_x. The impact of inlet air preheating on in-cylinder combustion and exhaust NO_x was examined in this study. It is also covered how better fuel qualities affect the amount of NO_x released from the exhaust. Because of the increased air particle excitation and good fuel particle evaporation caused by inlet air preheating, the ignition delay is shortened. There is less fuel clinging to the combustion chamber wall and, as a result, less fuel accumulates in the combustion chamber before ignition is started, which may result in reduced NO_x as well as low noise and vibration. This is because of improved evaporation and a shorter ignition delay.

III. EXPERIMENTAL PROCEDURE AND TEST SET-UP

The air must be heated in this process before entering the combustion chamber. In order to support the heating plate, a heater is set up using a heating coil spring. This is a single-cylinder, vertical diesel engine that runs on water. It is connected to a rope pulley brake system, which absorbs the power generated. To apply force on the brake drum, appropriate cooling water arrangement is supplied, along with the weights and spring balances that are required. Temperature measurement is made possible by separate cooling water lines. A fuel tank placed on a stand, a burette, and a three-way cock make up a fuel measuring system. A mild steel tank with an aperture and a U-tube water manometer to gauge the pressure inside the tank are used to detect air usage. The panel board also has a digital rpm indication for speed measurement and a digital temperature indicator with a selector switch for temperature measurement. To keep the speed consistent, a governor is offered. The gas analyzer is attached to the exhaust flow in order to measure the emissions [16-25]. The experiment was carried out in a single-cylinder diesel engine, and the air was heated using a heating stove coil spring with a 1000-watt capacity. As indicated in the illustration, a 20-cm-long pipe is obtained and put into the engine's air intake pipe. A thermocouple is fastened to the pipe to measure the air's temperature. In this procedure, the coil is first heated using a voltmeter regulator. This heat is then transferred to a rod that is fastened to the engine's air intake pipe, and the thermocouple displays the temperature.



(a)



(b)

Fig.1 (a) Heater (b) 4-Stroke diesel engine

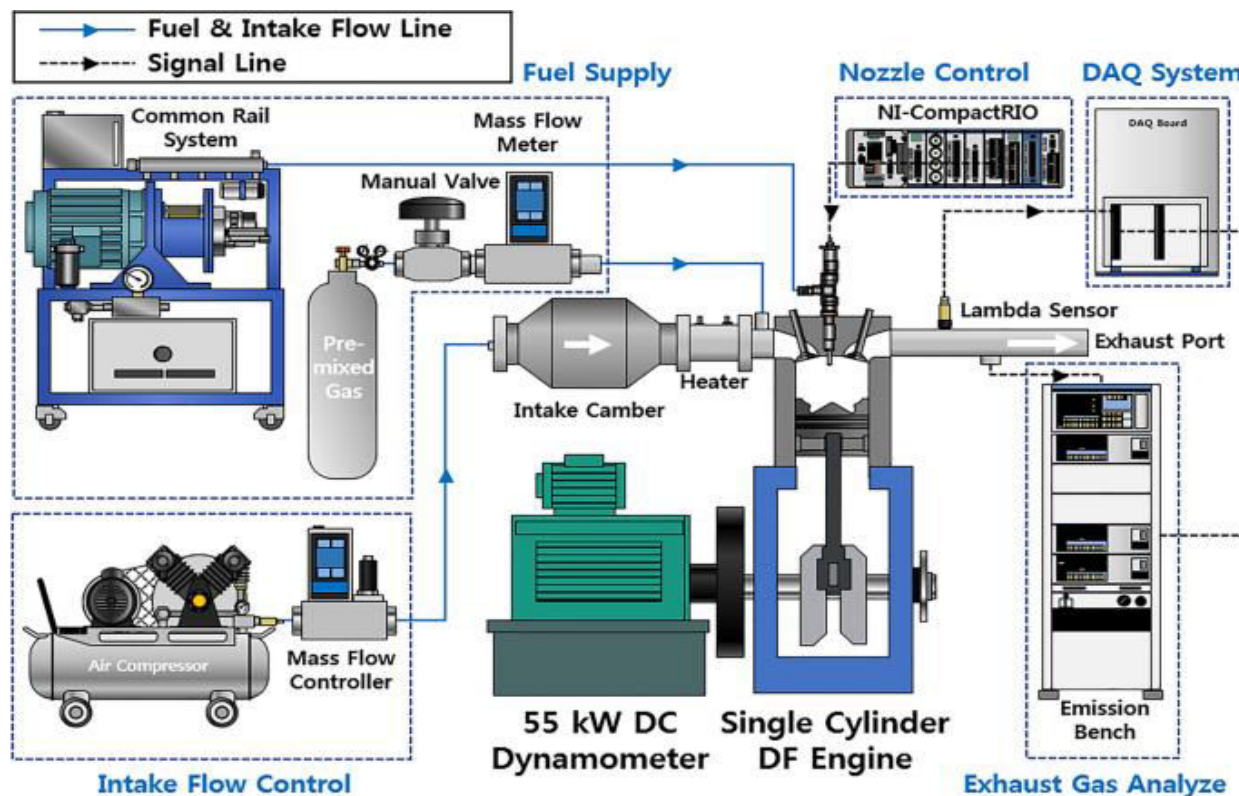


Fig.2 Experimental set-up line diagram

IV.RESULTS AND DISCUSSION

4.1 PERFORMANCE AND EMISSION ANALYSIS FOR JSME20 AIR PRE-HEATING (JSME20APH)

Tests were conducted on a single cylinder water-cooled CI engine operating at 1500 rpm to assess its performance in varying load conditions using diesel fuel and varying JSME20 blending ratios with air preheating. Graphs are used to plot the emissions and performance data. By preheating the intake suction air, air preheating serves the primary functions of increasing brake thermal efficiency, decreasing pollutants, and improving combustion rate.

4.2 Performance Analysis for B20 with Air Preheating

The four-stroke, single-cylinder, water-cooled diesel engine is used in the trials, running at a constant speed of 1500 rpm while carrying different loads [16]. The next section discusses a number of performance metrics, including air-fuel ratio, brake-specific fuel consumption, indicated-specific fuel consumption, volumetric efficiency, mechanical efficiency, and brake-specific fuel consumption [17-25].

4.2.1 Brake Thermal Efficiency

Fig. 3 shows how brake thermal efficiency varies with brake power for various fuels. It rose in every instance as brake power increased. Diesel's BTE at full load is 32.16%, whereas the blends of JSME20 and JSME20APH are 34.02% and 37.68%, respectively, and JSME20 with APH has the highest brake-thermal efficiency of the three. When comparing biodiesel to the ideal blend under full load conditions, the BTE of the fuel increases by up to 4.98%. The improvement in brake thermal efficiency brought about by better combustion as a result of preheating the intake air will result in reduced time consumption and increased efficiency.

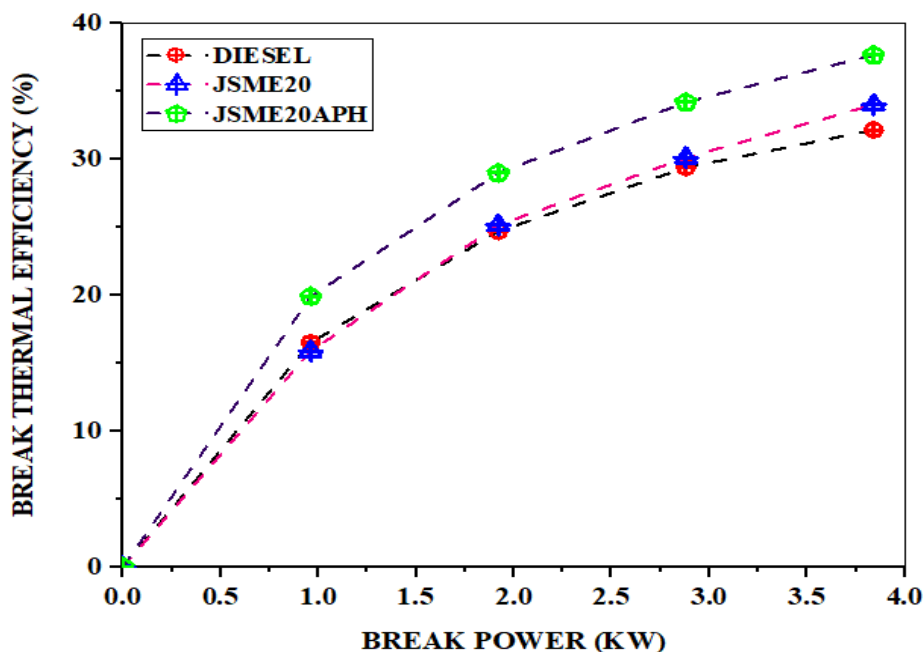


Fig.3 Variation of BTH with BP Using Diesel, JSME20 and JSME20APH

4.2.2 Mechanical Efficiency

Figure 4 illustrates how mechanical efficiency changes with brake power. Diesel has a content of 63.17% at full load and 67.32% for JSME20APH, up to 69%. These data show that the ideal blend rises above diesel fuel under full load conditions. However, due to its lower frictional powers than diesel, the blend JSME20 with air preheating shown a notable gain in mechanical efficiency.

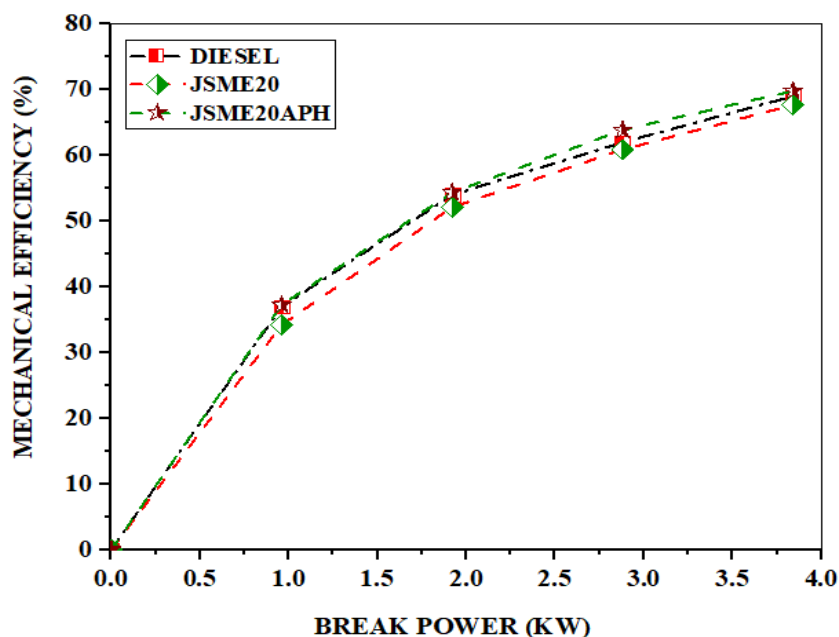


Fig.4 Variation of Mechanical Efficiency with BP Using Diesel, JSME20 and JSME20APH

4.2.3 Brake Specific Fuel Consumption

Fig. 5 illustrates how brake power affects the variation in brake-specific fuel consumption. For both fuels, there was a significant drop in BSFC as brake power increased. The primary explanation for this could be that, because a comparatively less amount of heat is lost at greater loads, the percentage increase in fuel needed to run the engine is less than the percentage increase in brake power. As can be seen, the diesel had a BSFC of 0.263 kg/kW-hr, the JSME20 had a BSFC of 0.25 kg/kW-hr, and the JSME20APH was 0.24 kg/kW-hr. Among these, JSME20APH exhibits lower BSFC.

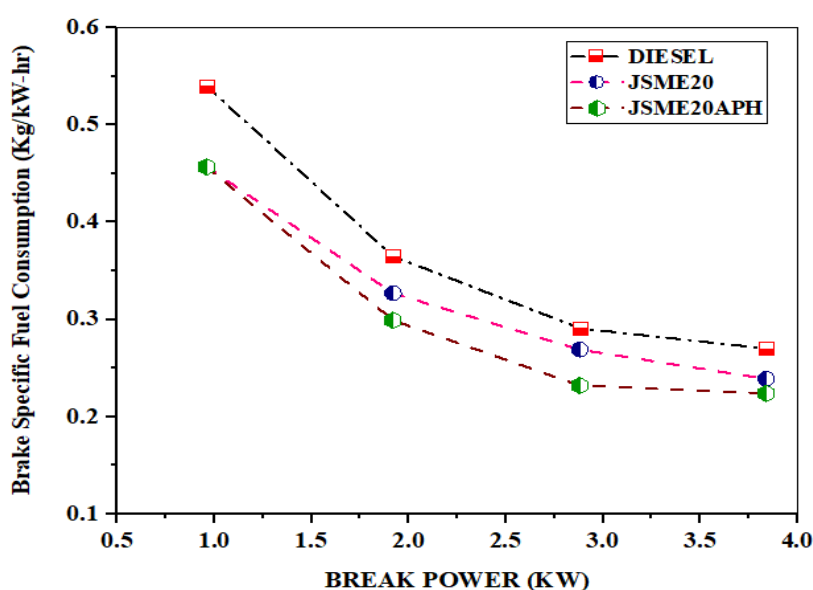


Fig.5 Variation of BSFC with BP Using Diesel, JSME20 and JSME20APH

4.3 emission analysis using optimum blend with Air Preheating

4.3.1 Carbon Monoxide Emissions (CO)

Figure 6 illustrates the change in CO with engine braking power for diesel and blends JSME20 and JSME20APH. When compared to diesel, the JSME 20 blend has less CO at full load. Compared to diesel and JSME20, JSME20APH has a lower CO content of 0.05% at full load. The reduction in CO emissions by 50% and 16.66% in comparison to JSME20 and diesel.

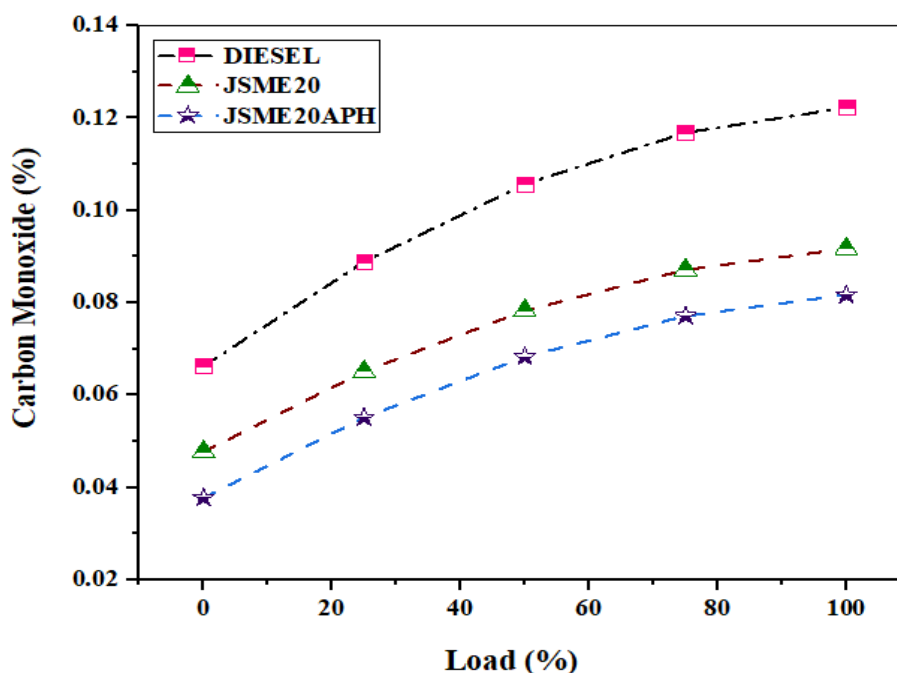


Fig.6 Variation of CO with Load Using Diesel, B20 and B20APH

4.3.2 Carbon Dioxide Emissions (CO₂)

Figure 7 illustrates how CO₂ emissions change in relation to braking power. The plot shows that, for all blends, the CO₂ output rose as the load increased. Blends JSME20 and JSME20APHlow emit 6.40 percent and 9.60 percent less emissions, respectively, at full load than diesel fuel (6.0%). When blending APH and JSME20 to the ideal ratio, CO₂ emissions rise by 60% and 50%, respectively, when compared to diesel and JSME 20.

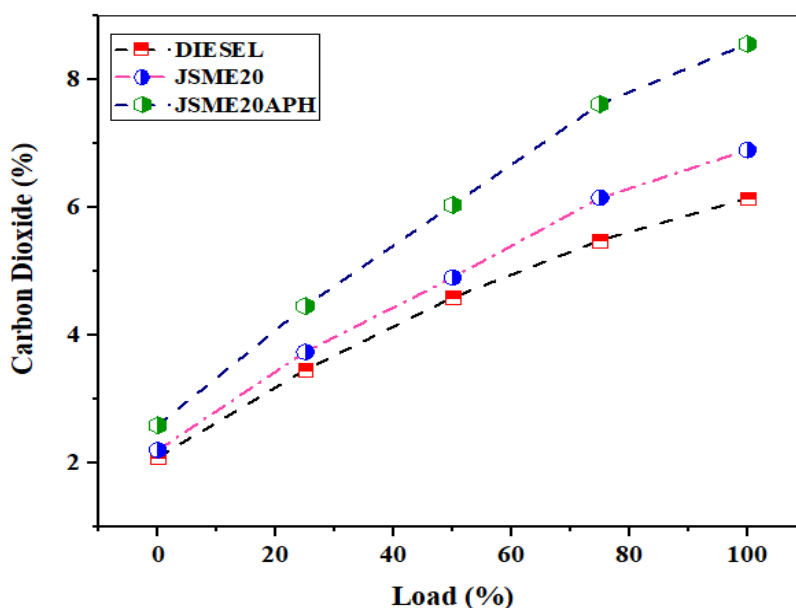


Fig.7 Variation of CO₂ with Load Using Diesel, JSME20 and JSME20APH

4.3.3 Oxides of Nitrogen Emissions (NO_x)

Figure 8 displays the change in NO_x emission with brake power. Diesel has 872 ppm at full load, JSME20 has 975 ppm, and JSME20APH has 939 ppm, according to the plot. In JSME20APH, the reduction in nitrogen oxides occurs in 5.9% and 3.6%. For every fuel examined, the NO_x emission showed an increasing trend with load.

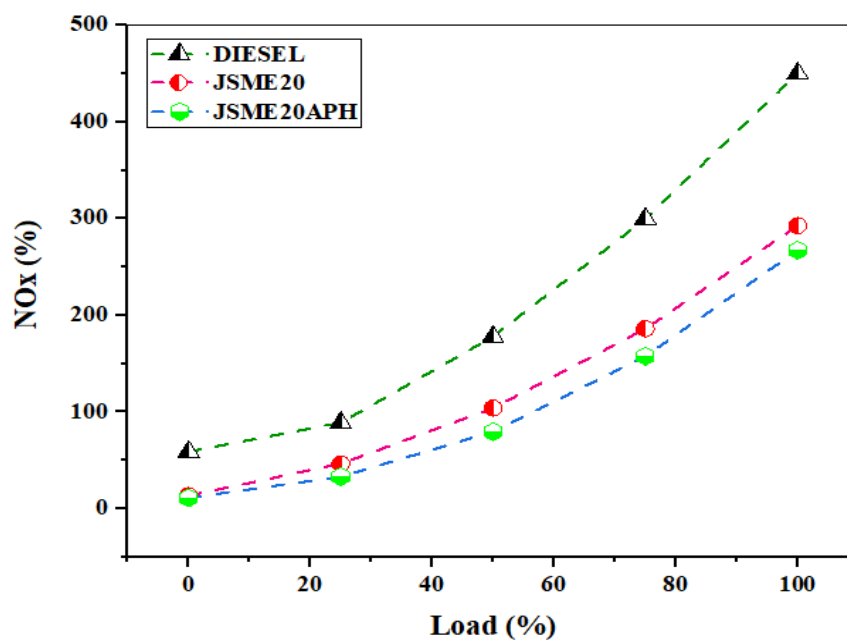


Fig.8 Variation of NO_x with Load Using Diesel, JSME20 and JSME20APH

4.3.4 Hydrocarbon Emissions (HC)

Figure 9 illustrates how HC emission changes with brake power. It is evident from the graphs that the differences in HC emissions at various blends are noted. As the load increases, HC decreases. Diesel has 58 ppm at full load, JSME20 has 53 ppm, and JSME20APH has 47 ppm.

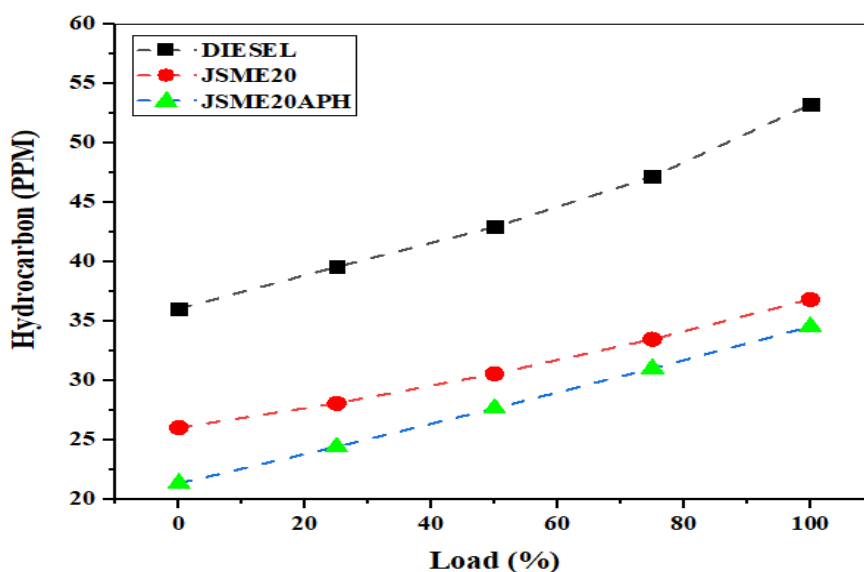


Fig.9 Variation of HC with Load Using Diesel, JSME20 and JSME20APH

4.3.5 Smoke Density

Figure 10 illustrates how smoke density changes as braking power increases. All that smoke is made of is solid soot particles floating in exhaust fumes. The fluctuation of smoke level with brake power at different loads for different blends, such as diesel, JSME20, and JSME20APH fuels, is depicted in the figure. When compared to the ideal blend, diesel fuel is shown to produce more smoke.

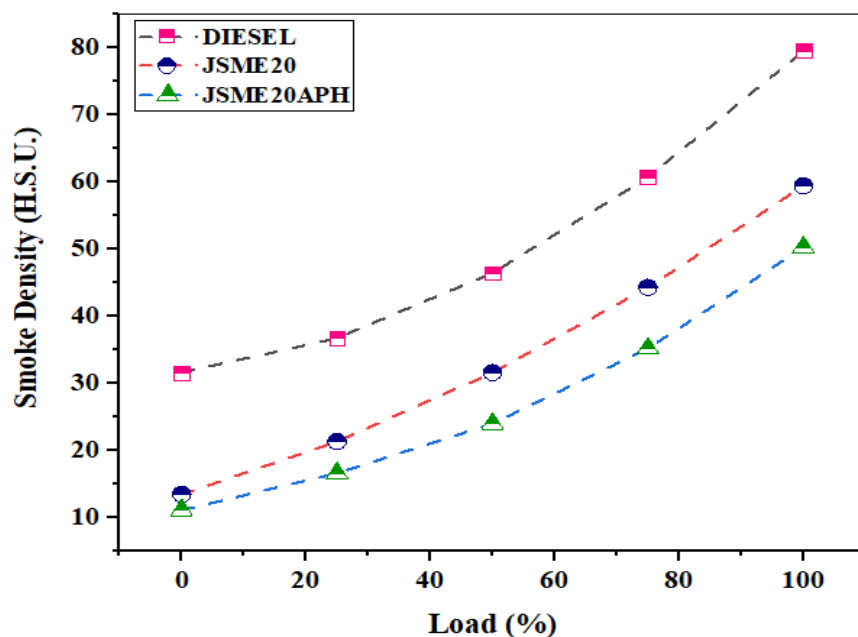


Fig.10 Variation of HSU with Load Using Diesel, JSME20 and JSME20APH

V.CONCLUSIONS

- JSME20 with air preheating had a better maximum brake thermal efficiency (38.81%) than JSME20 and diesel. Comparing the brake thermal efficiency with JSME20 and diesel, there was a 3.02% gain.
- When blended fuels are coupled with ignition improver, the amount of fuel used specifically for brakes is reduced. The JSME20 and diesel have a higher BSFC than the JSME20 with air preheating.
- When compared to JSME20 and diesel at the engine's maximum load, blend JSME20 with air preheating resulted in significantly lower emissions of unburned hydrocarbons.
- The intriguing items were acquired. When comparing In JSME20 with air preheating to the ideal blend JSME20, NOx emissions were reduced.
- When comparing JSME20 with diesel, a notable rise in CO₂ emissions was seen when air preheating was used.
- The slight rises in smoke density in comparison to JSME20.
- In comparison to JSME20 and diesel, the maximum reduction in CO emissions was achieved with air preheating in JSME20.

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