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THE EFFECT OF ADDITIONAL DIETHYL ETHER (DEE) AND JATROPA ON THE POWER AND THE FUEL CONSUMPTION OF DIESEL ENGINE WITH AN EGR SYSTEM

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Abstract. The high demand for diesel engines accelerates the increase in diesel fossil fuels and air pollution. This phenomenon can be reduced by utilizing jatropha. The cetane number and high oxygen content are the main considerations. However, increasing soot emissions and decreasing thermal efficiency are problems that urgently need to be solved. Diethyl ether has an oxygen content, and a high cetane number, and low viscosity. The properties of diethyl ether are predicted to reduce the problem of jatropha. This study aims to observe the power, fuel consumption of a 4JB1 diesel engine with an EGR system with a mixture of jatropha-diethyl ether fuel. Jatropha used is 10% and 20%. Meanwhile, the diethyl ether used was 5%, 10%, and 15%. All fuels are tested at 2500 Rpm engine operation. The test results explain that the hot DJ20DEE15 EGR produces the lowest decrease of 0.116% with 100% loading compared to using pure diesel. In testing the fuel consumption of DJ20 without EGR, the highest decrease is 27.183% at 25% loading compared to using pure Diesel (D100).

1. Introduction

The diminishing oil reserves and the increasingly expensive fossil fuels as well as the increasing consumption of fossil fuels require researchers to develop alternative fuels as a solution [1][2]. Air pollution and global warming are also very important factors faced today. The diesel engine is one of the contributors to exhaust emissions in the industrial and transportation sectors[3]. According to the Central Statistics Agency (BPS) recorded an increase in the number of goods car vehicles from 2015 which was 4,687,789 until 2018 of 7,778,544, an increase of 17% (BPS, 2018). One of the fossil fuels as an alternative material, namely jatropha is a non-food fuel that has environmentally friendly properties, it is cheaper to be developed by researchers as a substitute for fossil fuels [4]. This is also reinforced by previous research conducted by Syarifudin 2019[5] Jatropha contains a cetane number that is almost the same as diesel[6]. However, in general, the use of jatropha still increases exhaust emissions and reduces engine performance compared to using pure diesel[7].

According to Murat Kadir (2020)[8], the addition of additives can improve engine performance and reduce exhaust emissions. Diethyl ether (DEE) is a type of alcohol obtained from ethanol through a dehydration process in the presence of an acid catalyst. Diethyl ether (DEE) has a high cetane number compared to pure diesel and other alcohol content. This is also by research conducted by Imtenan et al, (2015)[9] where the addition of DEE increased diesel engine performance[10].

2. Research methods

The fuel used in this research is pure diesel, jatropha, and diethyl ether (DEE). Pure diesel fuel is obtained from PT. Pertamina, Tbk. Jatropha and Diethyl ether (DEE) was obtained from the chemical shop Indrasari, Semarang. The characteristics of these fuels can be seen in table 2.1. the percentage of mixed fuel used is jatropha 10% and 20%, while the percentage of diethyl ether used is 0%, 5%, 10% and 15% of the volume of pure diesel fuel, respectively called D100, DJ10, DJ10DEE5, DJ10DEE10, DJ10DEE15, DJ20, DJ20DEE10, DJ20DEE15, DJ20, DJ20DEE5, DJ20DEE10, DJ20DEE15.

Tabel 2.1 Fuel Characteristics

No	Propertis	Diesel	Jatropha	DEE
1	Cetane Number	48	41,8	126,49
2	Water Content (%v)	0,05	3,16	1,8
3	Viscocity (at 40^0 C (mPa.s))	2,0-5,0	3,23	0,22
4	Heating Value (MJ/Kg)	45,21	37,97	33,89
5	Fire Point (^{0}C)	60	198	45
6	Oxigen Content (%)	-	10,9	21,6

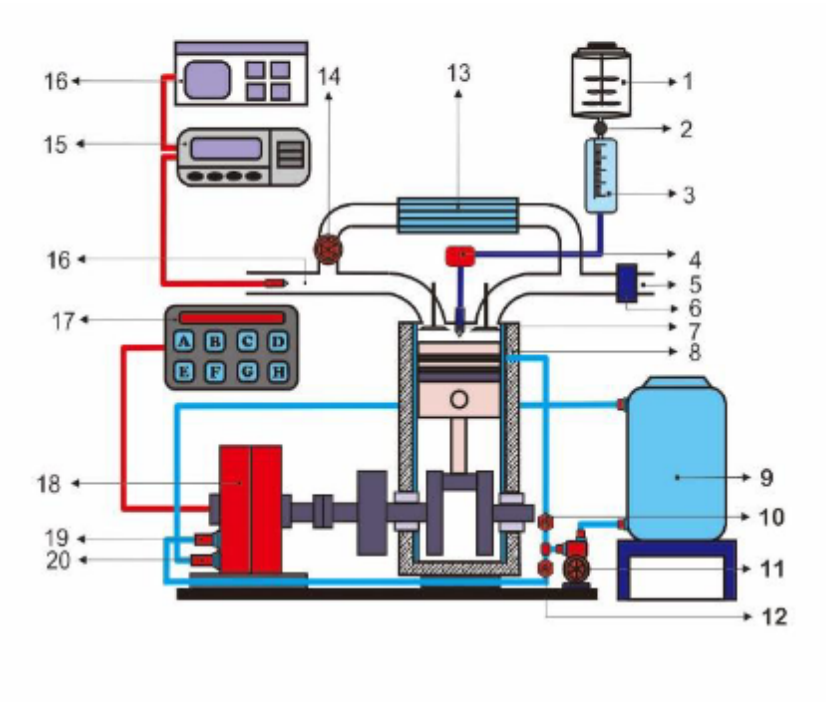

Figure 1. Ekperimental Set-Up

Experiments were carried out with the Isuzu 4JB1 direct-cylinder 4-cylinder diesel engine with a constant speed of 2500 rpm. A mixture of pure diesel fuel, jatropha, and DEE was prepared according to the test percentages before the experiment started. Due to the high polarity of DEE, it is difficult to mix it with pure diesel. Then a mixer (1) is used to obtain the same fuel mixture. The mixer is positioned

higher than the diesel engine so that the fuel mixture will flow into the engine based on the principle of gravity which will be assisted by a pump mounted on the diesel engine. Burette (2) with fuel valve (3) is used to measure fuel consumption, where every 30 ml is timed using a measuring cup which is calculated using a stopwatch which will go to the fuel injection pump (4) and will be sprayed by the injector (7).

The tachometer (17) is used to measure the speed of the diesel engine which will be measured by the proximity sensor. Power was measured using a dynamometer (18) Dynomite Land n Sea brand. The variation of loading used is through the opening of the water flow valve (10) to the dynamometer by 25%, 50%, 75%, and 100%. The water stored in a tank is flowed in a pump (11) to the inlet line (20) on the dynamometer engine and is directly discharged (not circulated) (9). Experiments carried out in this study were using an engine speed of 2500 rpm with variations in the fuel mixture.

3. Results and discussion

3.1. Brake Power Diesel-Jatropha-DEE

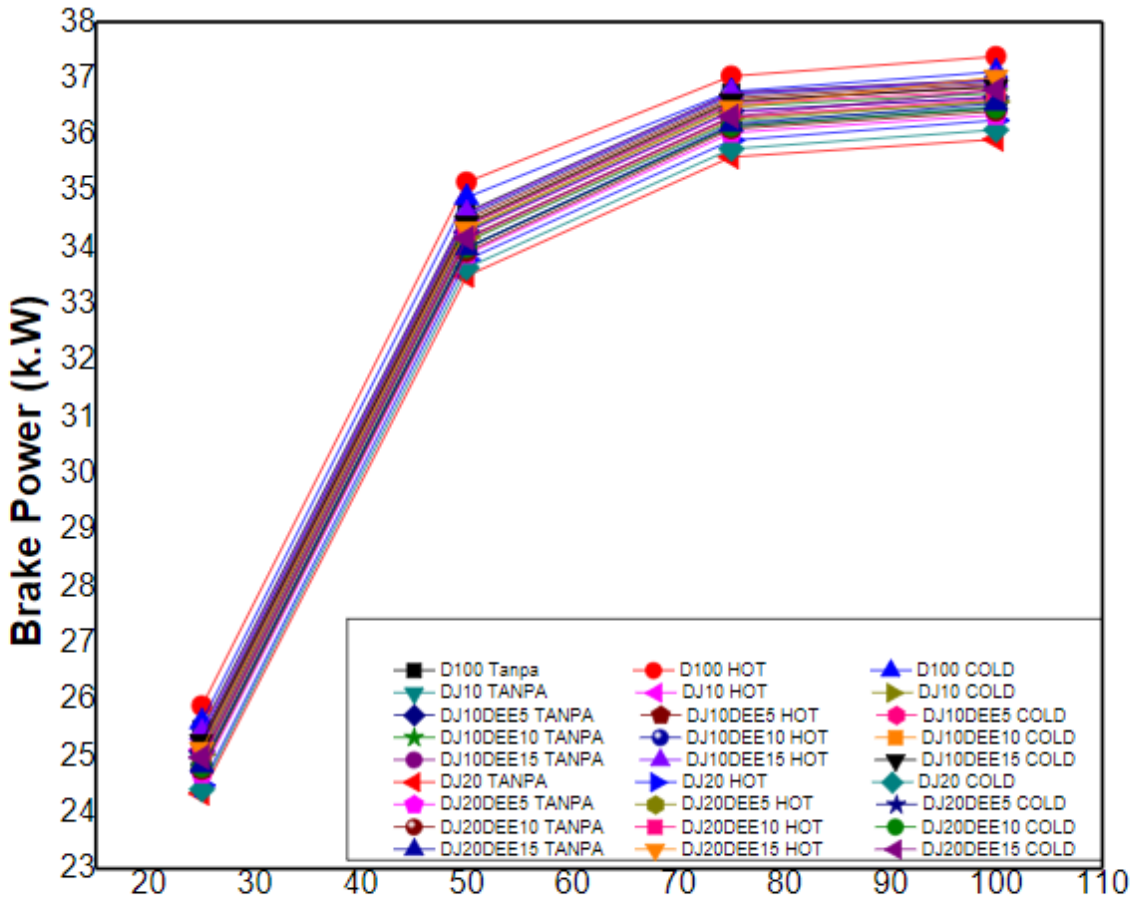

Figure 2. The effect of diesel-Jatropha-DEE fuel variations on engine brake power

Figure 2 is a graph of the results of the power test against Diesel-Jatropha-DEE. Jatropha used in this study was 10% and 20% based on fuel volume. The use of pure diesel and 10% and 20% jatropha resulted in a decrease in the power value compared to using pure diesel[11][12]. This is because the low calorific value and high viscosity of jatropha compared to pure diesel result in poor combustion in diesel engines[13][14]. However, different things were found when the addition of DEE increased the power value of the diesel engine although it was still lower than pure diesel fuel[15].

The highest test decrease was found in DJ20 fuel without EGR of 4.4889% with 25% loading compared to pure D100 diesel. While the lowest decrease in power testing occurred in the DJ20DEE15 Hot EGR fuel of 0.01160% with a loading of 100% than the D100. While the highest power test value in the DJ20DEE15 Hot EGR fuel test is 37.0196 kW with a loading of 100% and the lowest power test

value occurs in the DJ20 fuel test without EGR of 24.3281 kW with a loading of 25% compared to using pure diesel (D100).

3.2. Fuel Consumption (BSFC) Diesel-Jatropha-DEE

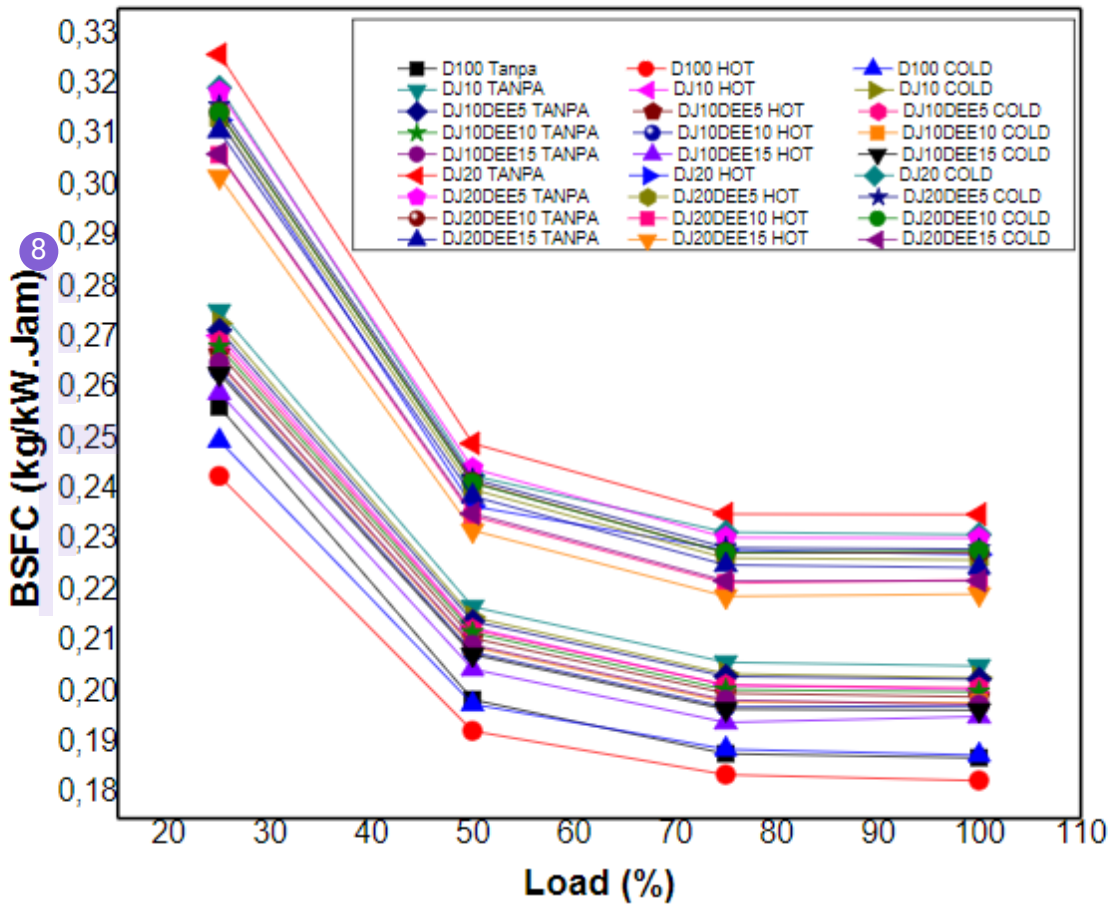

Figure 3. Effect of variation of pure diesel fuel-jatropha-DEE on BSFC

Figure 3. Presenting test results with 10% and 20% jatropha fuel variations. In general, the use of a pure-jatropha-DEE diesel fuel mixture resulted in a higher BSFC value increase with increasing loading. The jatropha fuel content of 10% and 20% resulted in a higher BSFC value increase compared to pure diesel fuel (D100)[16][17]. This is because the calorific value of jatropha is lower, resulting in more fuel required to produce the same engine power output as pure diesel fuel (D100)[18][19]. The addition of DEE alcohol in the mixture of 10% and 20% jatropha fuel and pure diesel causes a decrease in the BSFC value due to the high oxygen content and low viscosity of DEE but the value is still higher than pure diesel (D100)[20].

The EGR system found in diesel engines causes a decrease in BSFC, this is because the cetane number and high oxygen content contained in DEE can result in a partial reduction in BSFC when operating in EGR mode [21],even though the value is still above pure diesel (D100)[22].

The test results represent variations in jatropha fuel 10% and 20%. The highest increase in BSFC value occurred in DJ20 fuel without EGR of 27.1830% at 25% engine load and the lowest increase

in BSFC value occurred in DJ10DEE15 cold EGR fuel of 1.0831% when loading 25% compared to pure diesel (D100). While the highest BSFC value occurs in DJ20 fuel without EGR of 0.3259 when loading 25% and the lowest BSFC value occurs in DJ10DEE15 cold EGR fuel of 0.1940 when loading 75%.

4. Conclusion

Based on the results of the research conducted, it can be concluded as follows:

a. the use of DJ20DEE15 hot EGR mixed diesel fuel produces lower power compared to using pure diesel (D100). The highest decrease in power values occurred in the use of DJ20DEE15 hot EGR fuel, which reached 0.01160%, however, the addition of DEE additives to the 10% and 20% jatropha fuel mixture improved the power of the diesel engine. The increase in the highest DEE content occurred in DJ20DEE15 hot EGR fuel, which was 37.0196 kW at 100% loading.

b. The use of pure diesel-Jatropha-DEE fuel mixture resulted in an increase in the BSFC value with increasing loading. Pure diesel-jatropha-DEE blend fuel resulted in a higher BSFC value increase than pure D100 diesel. The addition of DEE additives in the fuel mixture of jatropha and pure matter caused a decrease even though the value was still above D100. The highest increase in BSFC value occurred in DJ20 fuel without EGR of 27.183% when loading 25% and the lowest increase in BSFC value occurred in DJ20 fuel without EGR of 0.3259 Kg/kW when loading 25% compared to pure diesel (D100).

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