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CHARACTERIZATION OF BIODIESEL AS A FUEL IN A COMPRESSION IGNITION (CI) ENGINE WITH ADDITIVES

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UNIVERSITI MALAYSIA PAHANG

CHARACTERIZATION OF BIODIESEL AS A FUEL IN A COMPRESSION IGNITION (CI) ENGINE WITH ADDITIVES

MOHD HAFIZIL BIN MAT YASIN

A report submitted in partial fulfilment of the requirements
for the award of the degree of
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Thesis submitted in fulfillment of the requirements for the award of the degree of Master of Engineering in Mechanical

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis, and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Engineering in Automotive.

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Dedicated to my beloved parent, Mat Yasin Bin Mohd Nor and Ramlah Binti Muda,

my siblings, Norhafiza, Norhafida, Norhafizan, Norazlina, and Mohd Hafizul.

Especially to my lovely wife, Idura Arniza Binti Mohd Maidin and my adorable children,

Muhammad Haziq Irfan, Damia Humaira and Hasya Dahiyyah.

STUDENT'S DECLARATION

I hereby declare that work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for the award of other degree.

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ABSTRACT

Compression ignition engines have been used widely in the transportation sector and power generation for the decades. These engines are less fuel consumed with higher brake thermal efficiency. However, compression ignition engines produce higher pollution in NOx and PM emission as well as cause several negative drawbacks to the environment. Most countries in the world have regulated several regulations to reduce the emission from the engines. Other than that, the introduction of biodiesel in the engines is beneficial and proven to reduce the emission significantly. However, biodiesel has higher density and viscosity with lower heating value as compared to mineral diesel. Fuel additives are among other methods that proven to modify the properties of biodiesel to be comparable with mineral diesel without doing any engine modification. Although fuel additives' ability to reduce harmful emissions is well known in the literature, the mechanism for these additives is not well understood when operated in the four-stroke, four-cylinder diesel engines. Two alcohol-based additives, methanol and ethanol were diluted with B 20 blend (20% biodiesel + 80% mineral diesel) with the formulation of 5% by volume. The test fuels; mineral diesel, B100 (palm-diesel), B20 blend and B20-alcohol blends (B20 E5 and B20 M5) were investigated on a Mitsubishi 4D68 four stroke, four-cylinder water-cooled diesel engine incorporating sensors for in-cylinder pressure measurement and thermocouples. There were two operating modes dealing with these fuels, which the first mode been conducted on increasing engine speeds at 50% throttle position. While as for the second mode, these fuels were operated at three different engine loads, 0.05 MPa, 0.4 MPa and 0.7 MPa with the engine constant speed of 2500 rpm. The effect of test fuels on brake power, brake specific fuel consumption (BSFC), brake thermal efficiency (BTE), combustion (in-cylinder pressure, rate of heat release, cylinder temperature) and NOx, NO, CO and CO_2 emissions were investigated. Results found that the performance of diesel engine improved with the use of alcohol (ethanol and methanol) in the B20 blends especially in comparison to mineral diesel, B100 and B20. Overall, the results indicated that when compared to mineral diesel, B100, B20, B20 E5 and B20 M5 have higher brake thermal efficiency. The use of alcohol as a fuel additive in the B20 blend has improved the combustion characteristics when the loads were applied to the engine. Besides, the exhaust emission for the B20 E5 and B20 M5 were fairly reduced when compared to mineral diesel.

ABSTRAK

Enjin cucuhan mampatan telah lama digunakan secara meluas dalam sektor pengangkutan dan penghasilan kuasa. Enjin ini menggunakan bahan api yang minimum dengan kecekapan brek termal yang tinggi. Walaubagaimanapun, enjin cucuhan mampatan menghasilkan pencemaran NOx dan zarah terampai (PM) yang tinggi serta kesan yang negatif terhadap alam sekitar. Kebanyakan negara di dunia telah menguatkuasakan beberapa peraturan untuk mengurangkan kadar pencemaran daripada enjin tersebut. Selain itu, penggunaan biodiesel sebagai bahan api alternatif dalam enjin diesel dan terbukti untuk mengurangkan kadar pencemaran. Walaubagaimanapun, biodiesel mempunyai nilai ketumpatan dan kelikatan yang lebih tinggi serta nilai pemanasan yang lebih rendah berbanding diesel mineral. Additif bahan api merupakan antara kaedah yang terbukti bagi mengubahsuai ciri – ciri bahan api biodiesel agar setanding dengan diesel mineral tanpa melakukan pengubahsuaian terhadap enjin diesel. Walaupun keupayaan additif untuk mengurangkan pencemaran banyak dibincangkan namun mekanisme additif tersebut masih belum difahami apabila digunakan dalam enjin diesel empat lejang empat silinder. Dua additif jenis alkohol, etanol dan metanol telah dilarutkan bersama B20 (campuran 20% biodiesel dan 80% diesel mineral) dengan formulasi campuran 5%. Bahan api campuran bersama alkohol dan biodiesel-diesel (B20 E5 dan B20 M5), diesel mineral, B100 (palm-diesel) dan B20 telah diuji menggunakan enjin diesel Mitsubishi 4D68 jenis 4 lejang 4 silinder dengan sistem penyejukan air yang dilengkapi penderia mengukur tekanan dalam silinder serta termogandingan suhu. Terdapat dua jenis pengujian enjin menggunakan bahan api tersebut; iaitu pengujian enjin pertama dijalankan dengan meningkatkan kelajuan enjin bermula 1500 rpm sehingga 3500 rpm pada 50% kedudukan pendikit enjin. Manakala pengujian enjin yang kedua, bahan api tersebut dioperasikan pada tiga bebanan berbeza iaitu 0.05 MPa, 0.4 MPa dan 0.7 MPa menggunakan kelajuan enjin malar, 2500 rpm. Kesan penggunaan bahan api tersebut terhadap kuasa brek, penggunaan bahan api brek khusus (BSFC), kecekapan brek termal (BTE), pembakaran (tekanan dalam silinder, kadar penyingkiran haba, suhu silinder) dan penghasilan gas NOx, NO, CO dan CO_2 telah direkodkan dan di analisa dalam kajian ini. Keputusan eksperimen menunjukkan bahawa prestasi enjin diesel meningkat dengan penggunaan alkohol (etanol dan metanol) dalam bahan api B20 apabila dibandingkan dengan diesel mineral dan bahan api B20. Secara keseluruhan, keputusan menunjukkan B100, B20, B20 E5 dan B20 M5 mempunyai kecekapan brek termal lebih tinggi berbanding dengan diesel mineral. Penggunaan alkohol sebagai additif dalam bahan api B20 telah meningkatkan ciri – ciri pembakaran dalam silinder apabila bebanan dikenakan pada enjin. Selain itu, pengeluaran gas ekzos telah berkurang bagi B20 E5 dan B20 M5 apabila dibandingkan dengan mineral diesel dalam pengujian enjin tersebut.

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