PERFORMANCE OF BIODIESEL BLENDS ON COMPRESSION IGNITION ENGINE

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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Master of Mechanical Engineering.

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I hereby declare that the 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 award of other degree.

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LIST OF SYMBOLS

A_p	Piston Face Area of All Pistons
$\dot{m}_a$	Steady-state Flow of Air into the Engine
η_{bth}	Brake Thermal Efficiency
N	Engine Speed
n	Number of Revolutions per Cycle
ρ_a	Inlet Air Density.
τ	Torque
$\overline{U}_p$	Average Piston Speed
V_{disp}	Displacement Volume
W_b	Brake Work of One Revolution
π	Radian

LIST OF ABBREVIATIONS

ABNT	Brazilian Association of Technical Standards
ANP	National Agency of Petroleum, Natural Gas and Biofuels
AOCS	American Oil Chemists' Society
ASTM	American Society for Testing and Materials
ASTMD6751	American Standard Specifications for Biodiesel Fuel Blend Stock
B100	100% Biodiesel
B15	15% Biodiesel blended with 85% mineral diesel
B20	20% Biodiesel blended with 80% mineral diesel
B5	5% Biodiesel blended with 95% mineral diesel
B50	50% Biodiesel blended with 50% mineral diesel
BDC	Bottom Dead Centre
BMEP	Brake Mean Effective Pressure
BSFC	Brake Specific Fuel Consumption
CAD	Crank Angle Degree
CFD	Computational Fluid Dynamics
CI	Compression Ignition
CN	Cetane number
CP	Cloud Point
CR	Compression Ratio
D2	Mineral Diesel
DF	Diesel Fuel
EBB	European Biodiesel Board
ECE	External Combustion Engines

EN14214	European Standard Specifications for Biodiesel
EN590	European Automotive Diesel Standard
EU	European Union
HHV	Higher heating value
ICE	Internal Combustion Engines
ID	Ignition Delay
IEA	International Energy Agency
ISO	International Standard Organisation
ISO	International Standard Organization
LHV	Lower heating value
MEP	Mean Effective Pressure
MFB	Mass Fraction Burned
MS123:1993	Malaysian Standard for Diesel Fuel
NBB	National Biodiesel Board
PLPO/PD	Process Liquid Palm Oil/Petroleum Diesel
PP	Pour Point
PRC	People’s Republic of China
ROHR	Rate of Heat Release
RPM	Revolution per Minute
SI	Spark Ignition
SOC	Start of Combustion
SOI	Start of Injection
SVO	Straight Vegetable Oil
TDC	Top Dead Centre

ABSTRACT

The developments in alternative energy sources have become gradually more applicable with the increasing exploration for an adequate alternative to oil-based energy. The depletion of the amount of fossil fuels worldwide is steadily creating an incentive to replace them, either partially or completely, with bio-fuels. The purpose of this study is to define and provide a comparison for biofuels, mineral diesel (D2) and straight vegetable oil (SVO). The main properties of fuels have been investigated experimentally in the Chemical Laboratory of the University of Malaysia in Pahang. There are seven fuels, including 5% Biodiesel blended with 95% mineral diesel (B5), 15% Biodiesel blended with 85% mineral diesel (B15), 20% Biodiesel blended with 80% mineral diesel (B20), 50% Biodiesel blended with 50% mineral diesel (B50), 100% Biodiesel (B100), Straight Vegetable Oil (SVO), and Diesel fuel (D2). Tests were conducted to determine the effect of biodiesel blended with diesel fuel on the following properties: the energy content, density, cetane number, viscosity, cloud and pour point, flash point, acid value and moisture content. From the properties testing, the small proportions of biodiesel blended, which included B5, B15, B20 and D2, were analysed for their performance in GT-Power engine simulation. Subsequently, some of properties that have been determined earlier will be used as an input in a GT-Power simulation model. The GT-Power model was built for a single cylinder diesel engine. The input model's engine specifications follow the diesel engine Yanmar TF-120M. Then the engine performance will be compared and discussed between the various blends of fuel. From the graph tendency, B5 is considerably pre-eminent for the good performance of the diesel engine. The higher energy content shows good agreement with the best performance of engine. This is because the lower energy content needs more BSFC to inject more fuel to gain equal brake torque and the same level of power. Nonetheless, the consequence of the lowest value of BSFC is obviously desirable. Attention was also alerted to the properties which influence the injection and engine characteristics extensively, thus affecting the quality of engine performance which also affects injector lubrication and fuel atomisation. Generally, biodiesel fuel blends can improve lubricant; nevertheless, the higher viscosity levels have a tendency to form larger droplets on injection that can cause exhaust smoke and poor combustion reactions.

ABSTRAK

Perkembangan sumber tenaga alternatif secara beransur-ansur telah mendapat perhatian dengan peningkatan kajian penyelidikan untuk tenaga berasaskan minyak. Pengurangan jumlah bahan api fosil di seluruh dunia semakin mewujudkan insentif untuk menggantikan bahan tersebut dengan bahan api semulajadi, sama ada sebahagian atau sepenuhnya. Tujuan kajian ini adalah untuk memberikan perbandingan antara bahan api semulajadi, mineral diesel (D2) dan minyak sayuran (SVO). Sifat-sifat utama bahan api telah disiasat secara uji kaji dalam Makmal Kimia Universiti Malaysia Pahang. Terdapat tujuh bahan api, iaitu Biodiesel 5% dicampur dengan diesel mineral 95% (B5), Biodiesel 15% dicampur dengan 85% mineral diesel (B15), Biodiesel 20% dicampur dengan 80% mineral diesel (B20), Biodiesel 50% dicampur dengan 50 % mineral diesel (B50), 100% Biodiesel (B100), Minyak Sayuran Penuh (SVO), dan bahan api Diesel Mineral (D2). Eksperimen telah dijalankan untuk menentukan kesan biodiesel dicampur dengan bahan api diesel pada sifat-sifat berikut: kandungan tenaga, ketumpatan, nombor cetana, kelikatan, titik beku dan cair, titik nyalaan, nilai asid dan kandungan lembapan. Daripada eksperimen, biodiesel dalam kandungan yang sedikit, termasuk B5, B15, B20 dan D2, dianalisis untuk prestasi dalam simulasi enjin GT-Power. Selepas itu, beberapa ciri-ciri yang telah ditentukan sebelum ini akan digunakan sebagai input dalam model GT-Power simulasi. Model GT-Power telah dibina untuk enjin diesel satu silinder. Spesifikasi enjin model input merujuk enjin diesel Yanmar TF-120M. Kemudian prestasi enjin akan dibandingkan dan dibincangkan antara campuran pelbagai bahan api. Dari kecenderungan graf, B5 menunjukkan prestasi baik yang ketara untuk enjin diesel. Kandungan tenaga yang lebih tinggi menunjukkan pergerakan yang baik dengan prestasi enjin yang terbaik. Ini adalah kerana kandungan tenaga yang lebih rendah memerlukan lebih BSFC untuk menyuntik bahan api yang lebih untuk mendapat tork brek yang sama dan tahap kuasa yang sama. Walau bagaimanapun, nilai BSFC yang rendah adalah jelas diperlukan. Fokus diberikan kepada sifat-sifat yang mempengaruhi suntikan dan ciri-ciri enjin yang boleh menjejaskan kualiti prestasi enjin dan juga memberi kesan pelinciran suntikan dan pengabusan bahan api. Secara amnya, campuran bahan api biodiesel boleh meningkatkan pelinciran, namun, tahap kelikatan yang lebih tinggi mempunyai

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