AN EXPERIMENTAL STUDY ON PERFORMANCE OF DIESEL ENGINE OPERATING WITH WASTE TIRE AND WASTE PLASTIC DERIVED FUEL

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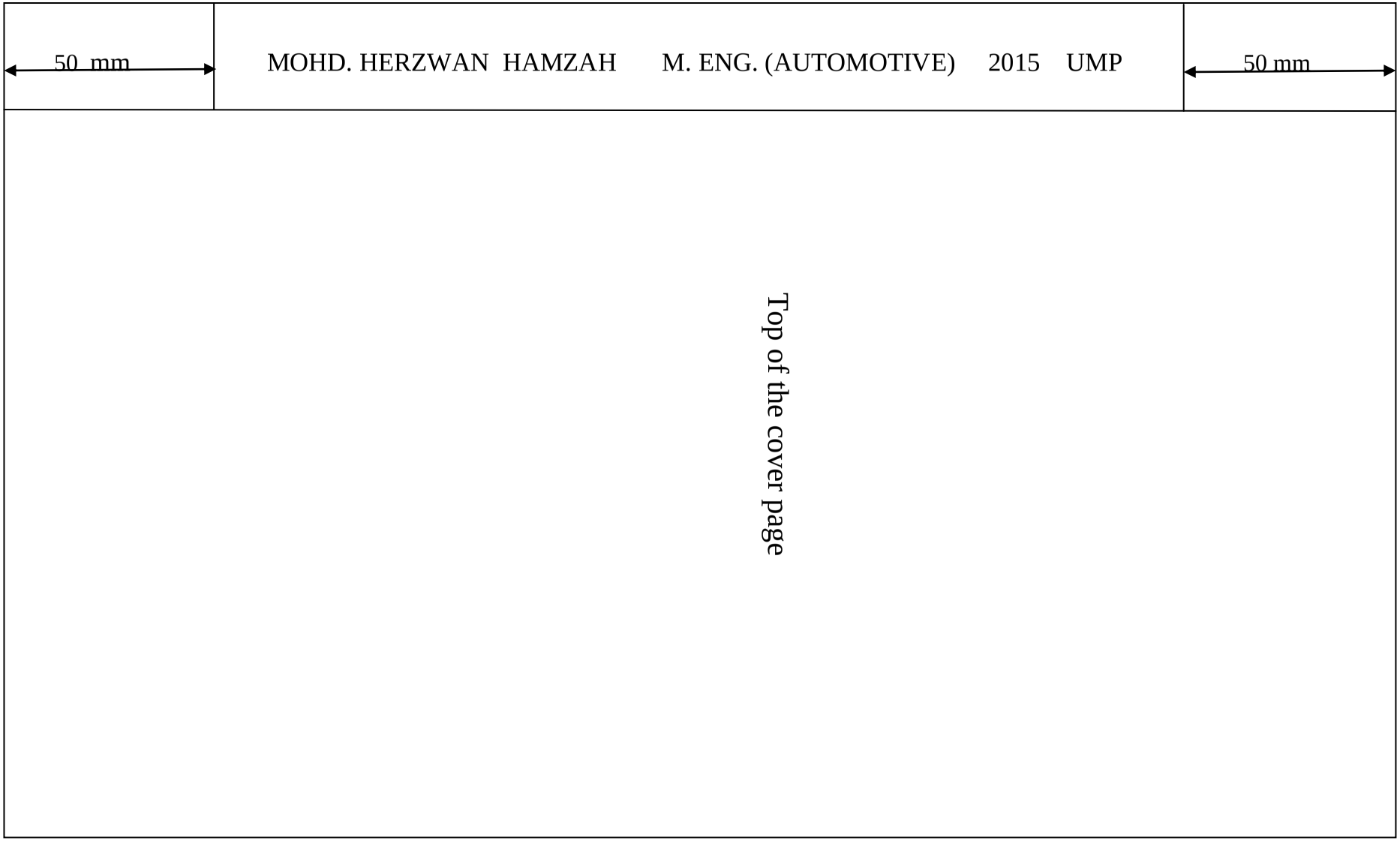
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LIST OF ABBREVIATONS

AAM	Malaysia Automotive Association
ASTM	American Standard of Testing Methods
BTE	Brake thermal efficiency
CI	Compression ignition
CN	Cetane number
CNC	Computer numerical control
CO	Carbon monoxide
CO_2	Carbon dioxide
DAQ	Data acquisition system
EGR	Exhaust gas recirculation
HC	Hydrocarbon
IMEP	Indicated mean effective pressure
NO_x	Nitrogen oxides
PDF	Plastic derived fuel
PM	Particulate matter
SAE	Society of Automotive Engineers
SI	Spark ignition
SO_2	Sulphur dioxide
TDC	Top dead centre
TDF	Tire derived fuel

LIST OF SYMBOLS

C_d	0.6
d_{pump}	Pump displacement
d	orifice diameter
D	Air density in lb/ft^3
h	100 mm H_2O
k	2 (four stroke engine)
n	Maximum engine speed
N_c	Number of cylinder
n_{min}	Minimum engine speed that tested
p	Pressure difference
P_a	1 bar
P_B	Barometric pressure in inches of mercury
$P_{Hydraulic}$	Hydraulic horsepower
P_v	Velocity pressure in inches of water
Q	Flow rate
T_{pump}	Torque absorbed by the pump from the engine flywheel
T_a	293 K (20°C)
V	Air flow rate
V_b	Minimum size of inbox
V_s	Swept volume
η_v	0.8
ω	Engine speed

ABSTRACT

This thesis presents the experimental study on the performance of single cylinder diesel engine operating with tire derived fuel (TDF), TDF-diesel fuel blends and also plastic derived fuel (PDF). The objectives of this project is to determine the fuel properties of TDF, TDF-diesel fuel blends and PDF, evaluating the performance of TDF and PDF when used in diesel engine and also to investigate the effect when several blend ratios between TDF and diesel fuel are used. The performance testing is conducted using a single cylinder engine test rig operating with variable engine speed and constant load exerted to the engine. The diesel engine is equipped with hydraulic dynamometer and necessary sensors to collect and measure the desired data. The parameters that were measured during testing include engine torque, power, combustion pressure and exhaust emissions. The obtained data for all tested fuels are compared to diesel fuel performance data. Then, the properties of all tested fuels are also determined. Six samples of tested fuels are prepared where TDF is blended with diesel fuel at three different ratios which is 10%, 30% and 50% together with 100% unblended TDF, PDF and diesel fuel. The PDF that used is 100% not blended with any other fuel. The comparison between TDF, TDF-diesel fuel blends and diesel fuel shows that TDF-diesel fuel blends produce higher power and torque compared to TDF and diesel fuel. Among tested blend ratio, TDF10% yield highest power and torque compared to other tested fuel. When the TDF blend ratio increases, the power and torque decreases. For cylinder pressure, TDF50% produce highest peak pressure compared to other tested fuels. When the TDF blend ratio decrease, the peak pressure will decrease. For emission, diesel fuel produce lowest CO_x and NO_x emission level compared to other tested fuels while TDF10% produce closest emission level to diesel fuel. PDF produce lowest power, torque and peak pressure compared to TDF and diesel fuel. PDF also produce lowest NO_x and CO emission level compared to TDF and diesel fuel. From the results that were obtained in the experiment, it is concluded that TDF and PDF can be used in diesel engine. However, TDF is not suitable for high speed application since it will cause backfires. Blending process between TDF and diesel fuel enhance the properties of TDF thus producing better performance. From the results obtained, TDF10% produced most optimum performance output compared to the other test fuels.

ABSTRAK

Tesis ini membentangkan hasil kajian berkenaan prestasi enjin diesel silinder tunggal yang beroperasi dengan bahan bakar berasaskan tayar (TDF), campuran antara TDF dan diesel dan bahan bakar berasaskan plastik (PDF). Objektif projek ini adalah untuk menentukan ciri-ciri kimia TDF, campuran antara TDF dan bahan api diesel dan juga PDF, menilai prestasi TDF dan PDF apabila digunakan dalam enjin diesel dan juga untuk mengkaji kesan apabila beberapa nisbah campuran antara TDF dan minyak diesel digunakan terhadap enjin diesel. Ujian prestasi dijalankan menggunakan enjin diesel silinder tunggal yang beroperasi dengan kelajuan enjin yang dimanipulasikan dan beban malar yang dikenakan kepada enjin. Enjin diesel dilengkapi dengan dinamometer hidraulik dan sensor yang diperlukan bagi mengumpul dan mengukur data yang diinginkan. Parameter yang diukur semasa ujian termasuk daya kilas enjin, kuasa enjin, tekanan pembakaran dan kandungan gas ekzos. Data yang diperolehi bagi semua bahan bakar ujian dibandingkan dengan data prestasi bahan api diesel. Kemudian, ciri-ciri kimia semua bahan bakar ujian juga ditentukan. Enam sampel bahan api ujian telah disediakan yang mana TDF dicampur dengan bahan api diesel pada tiga nisbah campuran yang berbeza iaitu 10%, 30% dan 50% bersama-sama dengan 100% TDF yang tidak dicampur, PDF dan bahan api diesel. PDF yang digunakan adalah 100% tidak dicampur dengan apa-apa bahan api lain. Perbandingan antara bahan bakar TDF, campuran bahan bakar TDF-diesel dan bahan api diesel menunjukkan bahawa campuran bahan bakar TDF-diesel menghasilkan kuasa dan daya kilas yang lebih tinggi berbanding TDF dan bahan api diesel. TDF10% menghasilkan kuasa dan daya kilas tertinggi berbanding bahan api ujian yang lain. Apabila nisbah campuran TDF dalam minyak diesel meningkat, kuasa dan daya kilas semakin menurun. Untuk tekanan silinder, TDF50% menghasilkan tekanan puncak paling tinggi berbanding dengan bahan api ujian yang lain. Apabila nisbah campuran TDF menurun, tekanan puncak juga akan menurun. Bagi kadar pelepasan asap ekzos, bahan api diesel menghasilkan COx dan NOx paling rendah berbanding bahan api ujian yang lain. TDF10% menghasilkan tahap pelepasan asap ekzos yang terhampir dengan bahan api diesel. PDF pula menghasilkan kuasa, daya kilas dan tekanan puncak yang paling rendah berbanding TDF dan bahan api diesel. PDF juga menghasilkan kadar NOx dan CO yang paling rendah berbanding TDF dan bahan api diesel. Daripada keputusan yang diperolehi dalam eksperimen, dapat disimpulkan bahawa TDF dan PDF boleh digunakan dalam enjin diesel. Walau bagaimanapun, TDF tidak sesuai untuk kelajuan enjin yang tinggi kerana ia akan menyebabkan '*backfires'*. Proses campuran antara TDF dan bahan bakar diesel menambah baik ciri-ciri kimia TDF bagi menghasilkan prestasi enjin yang lebih baik. Nisbah campuran yang memberikan prestasi optimum dalam kajian ini adalah TDF10%.

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