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Performance and Emission Analysis of IC Engine using Hemp Seed Oil

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ABSTRACT

Many researchers have done a lot of experimental studies in the field of biodiesel to find an alternative to mineral diesel. It has shown that hemp seed biodiesel can be used as an alternative fuel in diesel engine without modification. An experimental study was carried out to find out the effect of blends (B10, B15, B20) of hemp seed biodiesel with diesel on engine performance. Hemp oil, which is used as a large quantity in various shops, confectionaries, etc. and very little research has been done to utilize this waste oil as a replacement for mineral diesel. In the present work, the trans-esterification process for production of hemp seed oil methyl ester has been investigated. Results showed that biodiesel obtained under the optimum conditions has comparable properties to substitute mineral diesel, hence, hemp seed oil methyl ester could be recommended as a mineral diesel fuel substitute for compression ignition (CI) engines in transportation as well as in the agriculture sector

KEYWORDS: Hemp Seed Oil, Trans-esterification, Load cell

1. INTRODUCTION

Biodiesel is the most diverse fuel on the planet. It's made from abroad range of feed stocks including soybean oil, animal fats and used cooking oil. Biodiesel ability to find new uses for fats and oils makes it an ideal advanced biofuel, reducing emissions by more than 50 percent compared to petroleum. It also drives new feedstock research and development. Next generation feedstock's, like camel in a pennycress, could help meet our nation's energy demands in the future. Biodiesel is a simple solution for users. It fits seamlessly with today's diesel infrastructure. In other words, it fits in existing vehicles and technologies

Typically blended with petroleum diesel, biodiesel blends provide performance characteristics similar to diesel, such as: a) Fuel economy b) Horsepower c) Torque

Additional performance benefits include enhanced lubricity, which can extend engine life. Proven over billions of miles at various blend levels, biodiesel works. About 90 percent of medium and heavy-duty truck Original Equipment Manufacturers (OEMs) approve up to B20 in engines and all OEMs approve up to B5. Biodiesel production is the process of producing the biofuel, biodiesel, through the chemical reactions of trans-esterification and esterification. This involves vegetable or animal fats and oils being reacted with

short-chain alcohols (typically methanol or ethanol). The alcohols used should be of low molecular weight.

2. LITERATURE SURVEY

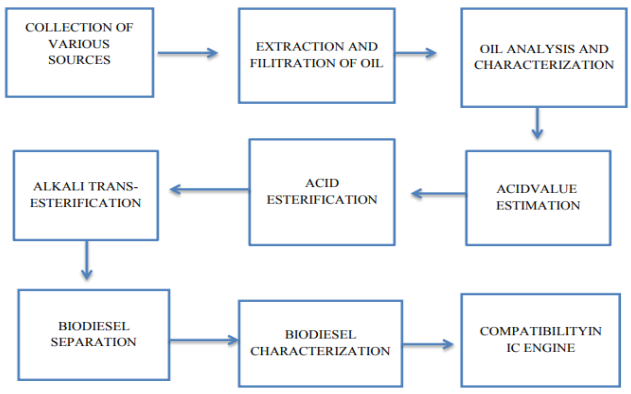
a. Rok Vihar et al. (2015)1. A tire pyrolysis oil (TPO) produced from waste tires was tested in a 6-cylinder compression ignition, turbocharged, 6 9 L heavy-duty engine Experiments were conducted in two operating modes, with and without intercooler at two different engine speeds and at various loads. Impact of thermodynamic and engine performance parameters on combustion process were systematically analyzed in terms of cause and effect phenomena through mechanisms initiated by the fuel properties Results indicate that TPO can be efficiently used in turbocharged non intercooled CI engines at high loads, which opens its use in power generation.

b.Juan Daniel Martinez et al. (2014)2. A tire pyrolysis liquid (TPL) fuel produced in a continuous auger reactor on pilot scale was blended at 5 vol % (STPL) with commercial diesel fuel (100D) and tested in a 4 cylinder, 4-stroke turbocharged intercooled, 2.0 L Nissan diesel automotive engine (model MID) with common-rail injection system The engine performance and exhaust emissions were obtained for both the STPL blend and the commercial diesel fuel The fuel did not show significant differences on the combustion pattern, just a slightly longer duration with the TPL blend The low volatile fraction of this blend deteriorated the engine performance in terms of thermal efficiency and fuel economy)***Further Subsequent Headings:*** should me made run on with the text separated by a column.

c. R Ballesteros et al (2014) 3. In this paper two diesel fuels, an animal fat biodiesel and two diesel **blends** with the anımal-fat biodiesel (50 vol %) and with a tire pyrolysis liquid (TPL) fuel (5 vol %) have been tested in a 4 cylinder, 4-stroke, turbocharged intercooled 20 L Nissan diesel automotive engine (model MID) with common rail injection system and diesel oxidation catalyst (DOC) Carbonyl emissions have been analyzed both before and after DOC and specific reactivity of carbonyl profile has been calculated Results showed on the one hand, an increase in carbonyl emissions with the biodiesel fraction in the fuel On the other hand, the addition of TPL to diesel also increased carbonyl emissions 7

D.SI Yang et al (2014)4. This study used the fast pyrolysis method to produce biooil from coffee bean **residue** The oil was mixed with diesel fuel through emulsification to produce emulsified fuel with varying proportions A single cylinder diesel engine connected to a 12 kW power generation system was used as the test system to examine the performance indices of a diesel engine under vanous ads and rotational speeds when using three fuel mixtures with varying proportions of bio-oil (1e, CPO (coffee bean residue pyrolysis oil) o (100% diesel), CPO 5 (5 vol.% bio-oil 95 vol 9diesel), and CPO 10 (10 vol % bio oil 90 vol 4 diesel)). Accordıng to the results, compared to CPO 0, the addition of CPO S and CPO 10 increased the fuel consumed for the same power output

3. METHOLOGY OF WORK



ENGINE TEST

A four stroke, single cylinder variable compression ratio diesel engine is employed for the present study. AVL 437 Smoke meter is employed to measure the smoke opacity of exhaust gas emitted from the diesel engine. The performance tests are carried out on the C.I. engine using various blends of biodiesel and diesel as fuels. The tests are conducted at the constant speed of 1500rpm at various loads. The experimental data generated are documented and presented here using appropriate graphs. These tests are aimed at optimizing the concentration of ester to be used in the biodiesel-diesel mixture for 1hr engine test operation. In each experiment, engine parameters related to thermal performance of engine such as brake power,

brake thermal efficiency, brake specific fuel consumption, exhaust gas temperature and applied load are measured.

Table 1: *Comparative Analysis of Hemp Seed Oil Biodiesel and Diesel.*

Fuel properties	Hemp seed biodiesel	Diesel
Density	890	831
Viscosity	3.6	3.2
Flash point	155	60
Certane number	50.4	46.3
Calorific value	40000	42000

ENGINE SPECIFICATION

Table 2: ***Engine Specification***

Product	Engine test setup 1 cylinder, 4 stroke, Diesel (Computerized)
Engine	Make Kirloskar, Model TV1, Type 1 cylinder, 4 stroke Diesel, water cooled
Propeller	Shaft With universal joints
Fuel tank	Capacity 15 lit with glass fuel metering column
Crank angle sensor	Resolution 1 Deg, Speed 5500 RPM with TDC pulse.
Data acquisition device	NI USB-6210, 16-bit, 250kS/s.
Load indicator	Digital, Range 0-50 Kg, Supply 230VAC
Load sensor	Load cell, type strain gauge, range 0-50 Kg
Fuel flow transmitter	DP transmitter, Range 0-500 mm WC
Air flow transmitter	Pressure transmitter, Range (-) 250 mm WC

PERFORMANCE CHARACTERISTICS

Brake Thermal Efficiency

Brake thermal efficiency is the ratio of energy in the brake power to the fuel energy. • The oxygenated molecule of the biodiesel and because of that excess oxygen molecule there occurs complete combustion of fuel and which in turn results in maximum efficiency than the diesel fuel. 44 • At 50% of load Brake thermal efficiency of B100 4LPM is 79.03%.while the Brake thermal efficiency of diesel is 35 to 40%

Indicated Thermal Efficiency

It defined as the ratio of the work produced per cycle to the amount of fuel energy supplied per cycle that can be released in the combustion process. • Indicated efficiency is derived from measurements taken at the flywheel. The thermal efficiency is sometimes called the fuel conversion efficiency. • At 50% of load, indicated thermal efficiency of B100 4LPM is 139.45.whilethe indicated thermal efficiency of diesel is51.7%.

BIODIESEL EMISSION CHARACTERISTICS

Carbon Monoxide Emission:

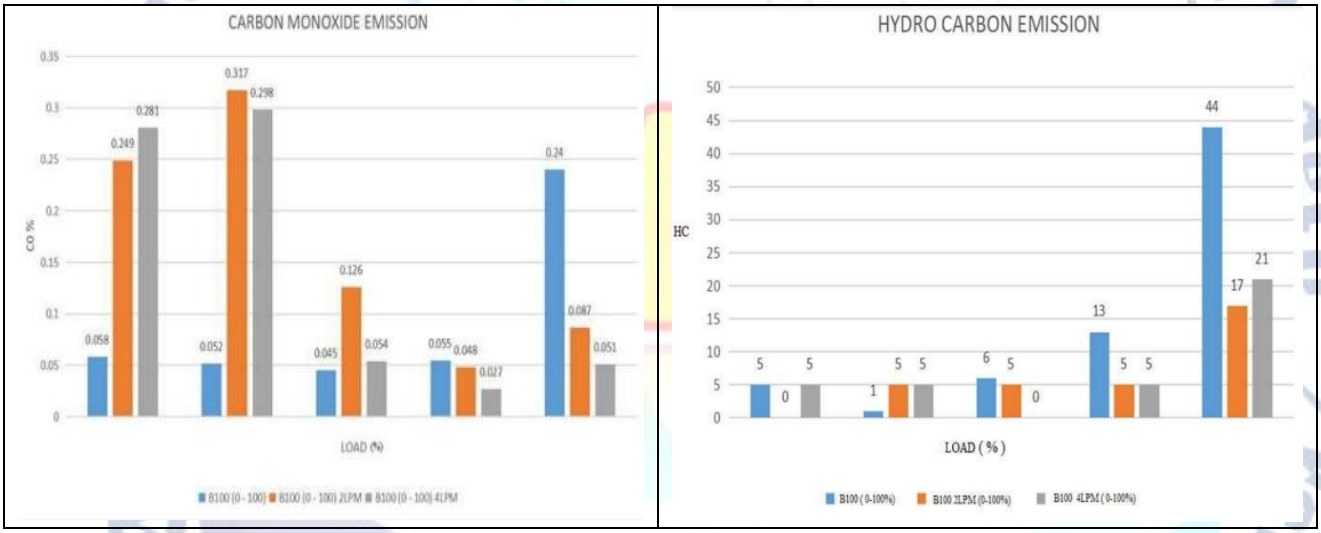
Carbon monoxide is a highly poisonous, odorless, colorless, and tasteless gas. It's very flammable in air over a wide range of concentrations and burns in air with a bright blue flame • it is spatially variable and short-lived, having a role in the formation of ground level ozone. • CO emissions generally remained low at high loads due to high in cylinder temperatures that prevail during such loads. • At 25% of load, carbon monoxide emission of B100 2LPM is 0.317%.whilethe carbon monoxide emission of diesel is0.149%.

Hydro carbon Emission:

Hydrocarbon emissions are simply unburned fuel being pumped raw in to the exhaust system. • It can come from an ignition problem, or an internal engine failure that reduces compression. • Hydrocarbon is commonly used as fuels. Generally hydrocarbons are generated from the waste of old vegetation. • At full load, Hydrocarbon emission of B100 is 44.while the Hydrocarbon emission of diesel is58.

FIGURE 1: ***PERFORMANCE CHARACTERISTICS (BRAKE THERMAL EFFICIENCY & INDICATED THERMAL EFFICIENCY)***

*FIGURE 2****: BIODIESEL EMISSION CHARACTERISTICS (CARBON MONOXIDE EMISSION & HYDRO CARBON EMISSION)***



4. CONCLUSIONS

1) Biodiesel is an alternative fuel that is cleaner than petro diesel. Biodiesel can be used directly as fuel for a diesel engine without having to modify the engine system. It has the major advantages of having high biodegradability, excellent lubricity and no sulfur content
2) Waste vegetable oil was found to be safe and efficient alternative fuel and has a low impact on the environment
3) As the B20 produced significant reductions in the CO, HC, and smoke emissions compared with standard diesel andB5.
4) The biodiesel increased volumetric fuel consumption due to its chemically bound oxygen content. In contrast the petroleum derived fuels showed about the same consumption results. Overall, vegetable oil is an attractive alternative for diesel fuel in the frame of Single Fuel Policy.
5) Different blends with diesel fuel were used as fuel in a compression ignition engine and its performance and emission characteristics were analyzed. Lower percent of blends (B5, B20) give a good improvement in the engine power. Lower percent of blends also reduced BSEC. Furthermore they were found to improve exhaust emissions.
6) Biodiesel can be used safely in the diesel engine, at least in small blending ratios with normal diesel fuel.
7) The fuel consumption increases as the biodiesel

content in the fuel rises due to its lower heating power. Nevertheless, it should be noted that the biodiesel maintains approximately the same engine efficiency at that obtained with diesel fuel.

8) Increasing the biodiesel content reduces the particulates in the engine exhaust prior to the after treatment. The engine after-treatment reduces particulate emissions drastically, hiding the potential benefits of biodiesel.
9) Regarding NOx emissions the results obtained in this study1 show that thehigherthebiodieselcontent,thehighertheNOxemissions.Inaddition,it 53 should be underlined that the effect of the fuel composition is less important than the effect of the EGR reduction due to the lower heating power of biodiesel.
10) The increase in engine speed caused an increase in fuel consumption rate, brake thermal efficiency, equivalence ratio, and exhaust gas temperature, while at the same time decreasing the bsfc, emission indices of CO2, CO and the NOx for the four fuels. emission of B100 4LPM is 10.9%.while co2 emission of diesel is 10.4%. Testing of Dates seed bio-diesel is done with the help of Kirloskar 4- stroke single cylinder diesel engine. Performance and emission analysis have been conducted and the results are summarized as follow.
11) At 50% of load Brake thermal efficiency of B100 4LPM is 79.03%.while the Brake thermal efficiency of diesel is 35 to40%.
12) At 50% of load, indicated thermal efficiency of B100 4LPM is 139.45.while the indicated thermal efficiency of diesel is51.7%.
13) At 25% of load, carbon monoxide emission of B100 2LPM is 0.317%.while the carbon monoxide emission of diesel is0.149%.
14) At full load, Hydrocarbon emission of B100 is 44.while the Hydrocarbon emission of diesel is58.
15) At full load, oxides of nitrogen emission of B100 4LPM is 3167ppm.while the oxide of Nitrogen emission of diesel is1826ppm..
16) At full load, co2
17) At full load, smoke emission of B100 is 99.6%.while the smoke emission of diesel is65.9%.

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Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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