Thermal Performance Analysis for Single Cylinder Diesel Engine using Biodiesel from Waste cooking Cottonseed oil and Diesel

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Abstract

The major source of energy for automobile vehicle is fossil fuel like petrol, diesel or compressed natural gas (CNG). Now a days the alternative fuel is one of emerging research area due to adverse environmental effect of conventional fossil fuels. Moreover there are abundant sources to extract alternative fuels with less complicated process. The aim of present investigation is to study the thermal performance of bio diesel extracts from waste cooking cotton seed oil blended in diesel (10%, 20% and 30% by volume) using single cylinder four stoke diesel engine under different loading conditions with constant speed and compression ratio. The study also focuses on emission parameters and combustion characteristic for bio-diesel obtained from waste cotton seed cooking oil.

Key Words: Waste cooking cotton seed oil, Biodiesel, Diesel engine

1.Introduction

The ever increase in global energy demand, consumption of depletable fossil fuels, exhaust emissions and global warming, all these led to search about alternative fuels. Oil crisis and global warming led to the research has been oriented to find suitable alternative fuels to petroleum oil. Now biodiesel was produced from non edible vegetable oils because the high price of edible vegetable oils, it was becoming environmentally an alternative fuel to diesel oils .

Biodiesel and its blends with diesel fuel are investigated to solve the problem of depletion of fossil fuels and environmental impact. Biodiesel; as an alternative fuel for diesel fuel is methyl or ethyl esters extracted from vegetable oils or animal fats by transesterification process. A diesel engine test using waste cooking-oil biodiesel fuel was run to investigate engine performance. By adding 20% of waste cooking-oil biodiesel by volume, there were increase in specific fuel consumption and decrease in thermal efficiency for biodiesel blends compared to diesel fuel. Vegetable oils caused operational and durability problems when used in diesel engines. These problems are attributed to higher viscosity and lower volatility of vegetable oils. Transesterification was an effective method of reducing vegetable oil viscosity and eliminating operational and durability problems. Waste cooking-oil biodiesel was used in diesel engines at a rated speed of 1500 rpm and different engine loads. Exhaust gas temperatures of biodiesel blends are increased with increasing biodiesel concentration. Performance characteristics of waste cooking-oil biodiesel blends were close to diesel fuel. Tomesh Kumar Sahu et. al [1] focused on effect of compression ratio on waste cooking oil operated engine on parameters like efficiency, BSFC etc. Swarup Kumar Nayak et. al [2] investigated thermal and emission performance of engine using mahua biodiesel with additives. Ahmed I. El-Seesy et.al [3] studied the influence of adding multiwall carbon neon tubes I waste cooking oil on emission and performance of diesel engine, particularly on CO and HC emission also on BSFC. K.A. Abed et. al [4] obtained results of waste cooking oil biodiesel operated engine which indicates that due to blending of biodiesel in diesel reduces HC and increases CO and CO_2 emission and fuel consumption also increases. Selvakumar Raja et. al [5] experimentally investigated emission control strategies for variable compassion engine using waste cooking biodiesel as fuel. Parvaneh Zareh et. al [6] carried out comparative studies of emission and thermal performance using coconut and caster based waste cooking oil biodiesel blending with diesel as a fuel in proportion of 5,10,20 and 30 %.

2.Experimentation

2.1 Experiment Methodology

The setup consists of single cylinder, four stroke, Multi-fuel, research engine connected to eddy current type dynamometer for loading. The operation mode of the engine can be changed from diesel to ECU Petrol or from ECU Petrol to Diesel mode by following some procedural steps. In both modes the compression ratio can be varied without stopping the engine and without altering the combustion chamber geometry by specially designed ***tilting cylinder block*** arrangement. In Diesel mode fuel injection point and pressure can be manipulated for research tests. In Petrol mode fuel injection time, fuel injection angle, ignition angle can be programmed with open ECU at each operating point based on RPM and throttle position. It helps in optimizing engine performance throughout its operating range. Air temp, coolant temp, Throttle position and trigger sensor are connected to Open ECU which control ignition coil, fuel injector, fuel pump and idle air. Set up is provided with necessary instruments for combustion pressure, Diesel line pressure and crank-angle measurements. These signals are interfaced with computer for pressure crank-angle diagrams. Instruments are provided to interface airflow, fuel flow, temperatures and load measurements. The setup has stand-alone panel box consisting of air box, two fuel tanks for duel fuel test, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and hardware interface. Rota meters are provided for cooling water and calorimeter water flow measurement. A battery, starter and battery charger is provided for engine electric start arrangement. The setup enables study of VCR engine performance for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio, heat balance and combustion analysis. Labview based Engine Performance Analysis software package "Enginesoft" is provided for on line engine performance evaluation. PE3 series software package is provided for programming open ECU for petrol mode operation of the engine.

2.2 Engine Test Setup

Experiment were performed in a single cylinder four stroke water cooled Diesel engine

And detailed specification in Table

Engine and Dynamometer Specifications:

Compression ratio	17
Fuel	Diesel
No.of cylinder	4
Bore Diameter	87.50 mm
Stroke lengh L	110 mm
Connecting road	234 mm
Swept volume	661.45 cc
Cooling	Water
Speed	1700
Rated Power	3.5 kw
Starting	Electric
Dynamometer type	Eddy current dynamometer

Fig: 1 Experimental Set up

Equipment used for experimental work: Computerized research engine set up, Exhaust Gas Analyzer(AVL444N), Smoke meter(AVL437Standard)

2.3 Experimental procedure

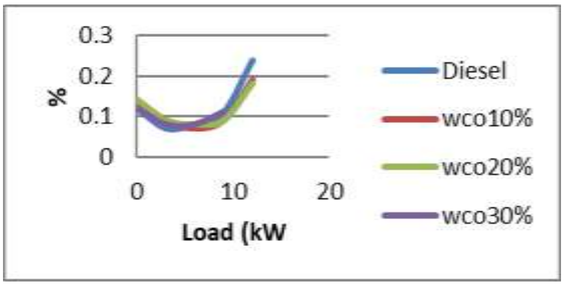
Experimental investigation of combustion and performance characteristics of Waste cooking cotton seed extracted biodiesel blended 10%,20%, and 30%with diesel in CI engine was performed for five loading conditions (no load, 25%, 50%, 75% and 100% loading condition) at constant engine speed of 1700 rpm. Experiments were performed for compression ratios (CR) of 17 for Diesel and waste cotton seed bio diesel at tested conditions, to see the effect of different blending of Waste cotton seed biodiesel(WCOB) in 10%,20%,30% in diesel at 17 CR on combustion and performance characteristics. Injection timing was fixed at 23◦ bTDC (before top dead center) for tested conditions and engine speed was maintained constant at 1700 rpm. Performance and combustion reading was taken after thermal stabilization of engine for each test condition and an average of 50 consecutive thermodynamic cycles were considered for combustion analysis. Waste Cotton seed Cooking oils are extracted from edible oils and vastly used in hotels and restaurants. It has been reported that these edible oils degrade in quality after repeated use. These oils should be discarded once the concentration of polar compounds reach 25% or higher . These discarded oils are useful for biodiesel production as it can solve the problem of waste handling and can act as an alternative fuel as well. The quality of the produced biodiesel may be better compared to the biodiesel produced from non-edible oils.

3. Result and Discussion:

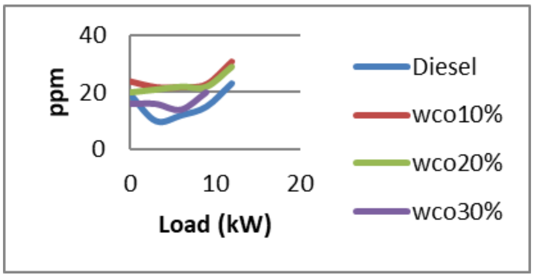
Table: 1

Property of Diesel and Waste Cotton seed Extracted Biodiesel

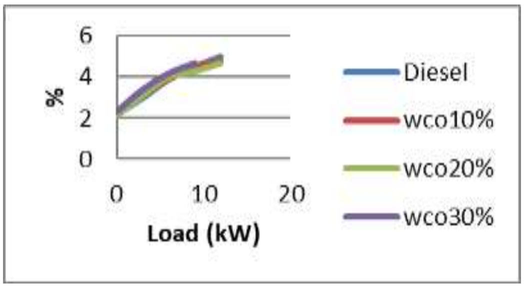
Name of Property	Unit	ASTM Standard	Diesel	Waste Cotton Seed Biodiesel
Density	Kg/m3	D287	816	875
KinematicViscosity@40^{0}c	cSt	D445	2.09	4.07
Calorific Value	Calorie/gm-^{0}C	D4809	10236	9901
Flash Point	^{0}C	D93-58T	53	160
Fire Point	^{0}C	D93-58T	56	171



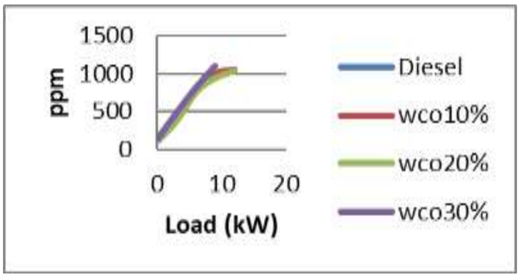
(a): CO % Volume



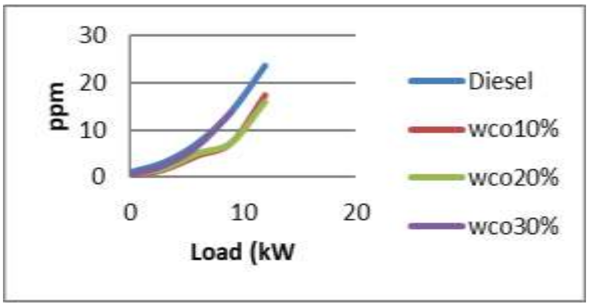
(b): HC ppm



(c) CO_2 % Volume

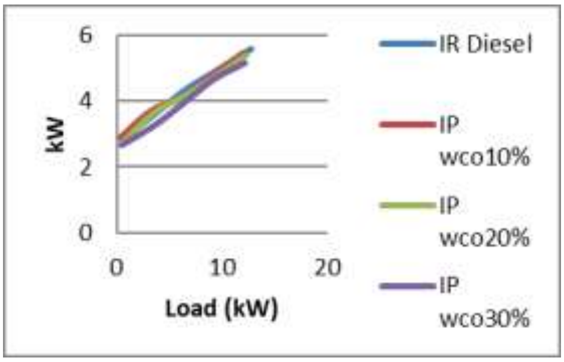


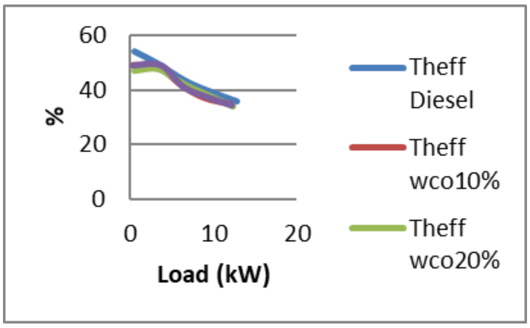
NO_x ppm



(e) Smoke

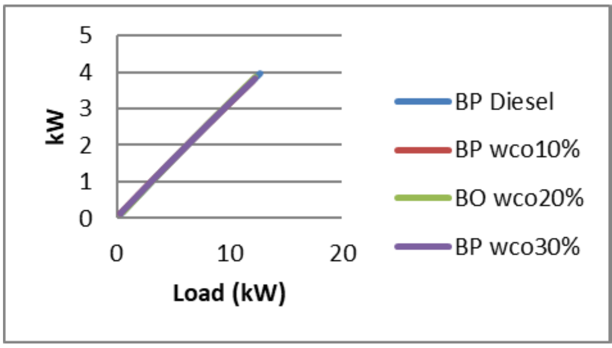
Fig 2 (a,b,c,d,e) Emission Characteristics

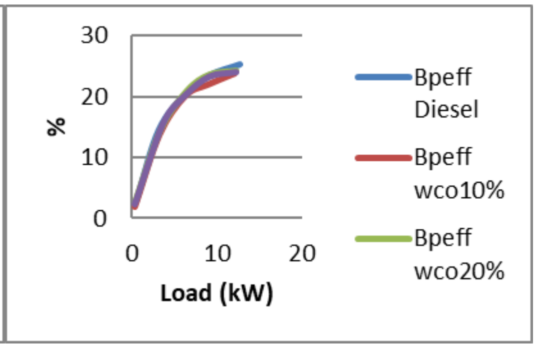




(a) Indicated Power

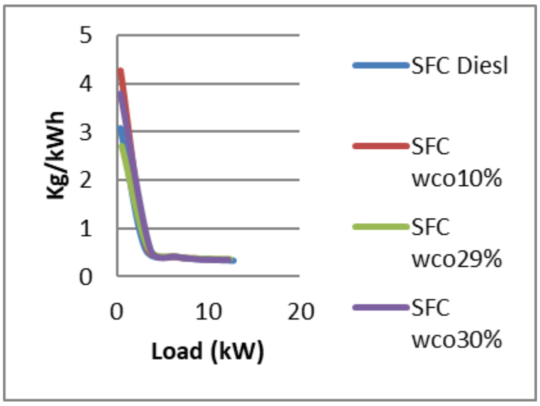
(b) Indicated Thermal efficiency

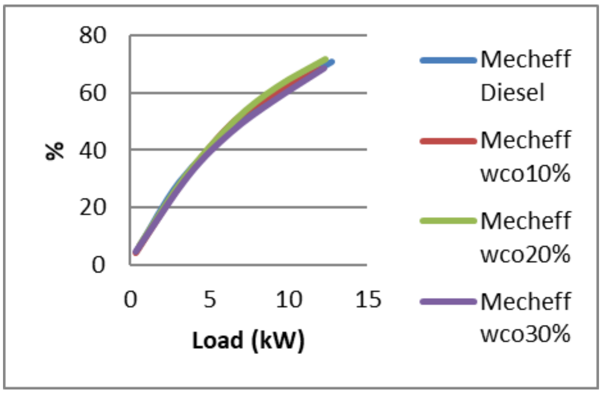




(c) Break Power

(d) Break Thermal efficiency





(e) Specific Fuel Consumption

(f) Mechanical efficiency

Fig 3 (a, b, c, d, e, f) Thermal Performance Characteristics

Fig 2 and Fig 3 indicate emission and performance characteristics of diesel and blended of standard diesel biodiesel extracted from cotton seed waste cooking oil with in 10, 20 and 30 % by volume, respectively. In emission characteristics with increase in load emission increases but increment in CO, HC and smoke is gradual while for CO_2 and NO_x is Sharpe. The emission generation rate in case of CO and smoke is less compare to diesel while it is appreciable in case of CO_2, HC and NO_x with rises in load and blending of biodiesel too. Fig 2 shows performance characteristics of diesel and cotton seed blended oil of single cylinder diesel engine. Figure 3 (a) shows indicated power increases with increases in load and compare to diesel in case of 10 % blending cotton seed biodiesel but as percentage blending increases of biodiesel indicated power reduces. As per Fig 3 (b) thermal efficiency decreases with blending may be because of incomplete combustion fuel. Fig 3 (c) and (d) focuses on break power and break thermal efficiency respectively which shows no significant change in break power and efficiency due to blending. Fig 3 (e) SFC with rises at low load with increment in blending and at higher loads it is almost overlapping the diesel SFC values. . Fig 3 (f) shows with % rise in biodiesel blending appreciable reduction in mechanical efficiency.

4. Conclusion

1. The emission rate is comparatively in controlled manner with rise in % blending of biodiesel in diesel.
2. Indicated power is highly influence by rise in % blending its value diminishes at larger scale.
3. As blending increases all emission parameters reduce expect HC.
4. Break thermal efficiency and break power point of view % increment in blending not much affect the output but SFC increases with rise in load.
5. Mechanical efficiency is better for low percentage blending.

5. References

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