Experimental Investigation of Biodiesel (Caster-RICINUS COMMUNIS) using Variable Compression CI Engine

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Abstract – *In order to meet the energy requirements ,there has been growing interest in alternative fuels like vegetable oils, biodiesels, biogas, LPG, CNG to provide a suitable diesel oil substitute for internal combustion (IC) engine. Vegetable oils, because of their agricultural origin, may be due to less carbon content compared to mineral diesels are producing less CO2 emissions to the atmosphere. It also reduces import of petroleum products. In these experimental study is carried out on an IC engine laboratory single cylinder, four-stroke variable compression ratio (VCR), direct injection diesel engine to analyze the performance and emission characteristics of pure diesel and waste cooking oil (WCO) – diesel blended fuels with various blended rate. Experiments have been carried out to estimate the performance, emission and combustion characteristics of a single cylinder, four-stroke VCR multi fuel engine fuelled with biodiesel land its blends with standard diesel.*

***Key Words*: Biodiesel, Diesel Engine, Emission, HC, CO NOx, Performance**

1. INTRODUCTION

To meet the growing energy needs resulting from spiralling demand and diminishing supply, alternative energy sources "mostly biofuels" are receiving more attention. In addition, the increasing global concern has caused to focus on the oxygenated diesel fuels because of the environmental pollution from internal combustion engines. These issues have triggered various research studies to replace petroleum-based diesel fuel with the biofuel.

1.1 Methodology

In Methodology we are dealing with the actual working of our project there are two main working process in our project these are as follow

1. Biodiesel production
2. Trail on Engine

Why CASTOR?

Caster (RICINUS COMMUNIS) is in very abundant form and it can be easily found in our area . Castor does not require any special atmosphere and irrigation land. India is a largest producer of castor in the world and its production rate is 3 times in ayaer as compare to other resources. In this seed oil contents is about 50% of the total weight . Biodiesel obtained from castor has a very low cloud and pour point which make this biodiesel a good alternative in winter condition Castor oil biodiesel could be used as petroleum diesel additive for improving both environmental and flow behavior of the mineral fuel

1.2 Biodiesel Production

Experimentation

First Process under the methodology section is of biodiesel production consist of following three process

1. Pre Process (Heating of oil and esterification)
2. Main Process (Transesterification)
3. Post Pocess (water wash)
4. Biodiesel Blending

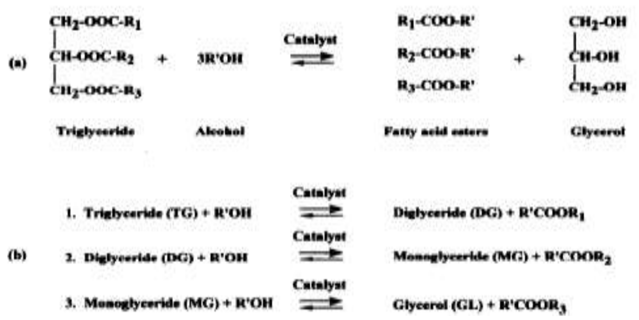
1.3 Extraction of oil

The castor oil was extracted by using a sorbet About 500ml of hexane was poured in a round bottom flask and 100g of ground castor beans was packed in a filter paper placed in the thimble and fixed with a round bottom flask which was connected with a condenser the fitted apparatus then heated in a heating mantle to biol the solvent . When the solvent boiled the vapour rose through the vertical tube into condenser to the top and the vapor condensed dripped into the thimble in the center the extractor seeped through the pore of the thimble and filled siphon tube where it flowed back down into the round bottom flask . The extraction prolonged to eight hours after which the resulting mixture in the round bottom flask was concentrated in rotator evaporator to recover the solvent from the extracted oil . The weight of the extracted oil was recorded .

The crude oil was refined by degumming , neutralization and bleaching process . In degumming process the crude oil was treated with hot water to remove gums , hydrates, FFA and soap . Finally it was bleached with activated clay to remove colour odour impurities and residual soap.

1.4 Transesterification Process (Main Process)

Is a reaction of an alcohol with an Easter to form different types of alcohols and ester in the presence or absence of a catalyst . in the production of biodiesel vegetable oil is in the form of triglyceride which reacts with a small chain alcohol (methanol ethanol propanol and so on) in the presence of homogeneous catalyst such as base (KOH Naoh CH3OH (CH3O)2Ca CaO) or acid (HCL H2sO4 H3PO4) or heterogeneous catalyst as zeolites or biocatalyst as enzymes hence the process is also known as alcoholysis for methonal methanolysis and for ethanol ethanolysis . The esters that formed in methonolysis are called as fatty acid methyl estera(FAMEs) and esters that formed in ethnolysis are fatty acid ethyl ester (FAEEs) about 25 ml of oil was kept in three necked round bottom flask and heated to 65C (this is the Pre-Process) then calculated amount of methanol and catalyst (KOH or H2sO4) were added with stirring system. The experiment prolonged for three hours Chemical Reaction which govern this process is given as



1.5 Seperation And Purification Of Biodiesel

After the completion of the reaction , the product was allowed to cool and equilibrate which resulted in separating of two phases . the upper phase consisted of methyl ester with small amount of impurities such as residual alcohol glycerol and partial glyceride while the lower phase contained the glycerol with other material (excess methanol catalyst soap formed during reaction and some entrained esters and partial glycerides)The upper layer was methyl ester (Biodiesel) while the lower layer was glycerol the obtained methyl ester was purified by successive rinse with 2.5% (w/w) sulphuric acid and distilled water . To avoid emulsion during washing process NaCl solution was used . Then the washed methyl ester was treated with anhydrous sodium sulphate to remove excess water . It was then filtered and dried by heating at low temperature (60) for 30min

1.6 Biodiesel Blending

In biodiesel blending the castor biodiesel (B100) is blended with the Diesel (B00) at 40 c and kept it for homogenization for 20min with agitation upto 300 rpm after this kept the solution upto 2 hours and we get the biodiesel blend (B 5 , B10, B 15, B20 etc) B5 means 5% of pure biodiesel with the 95% of Diesel . For solution of 1 litre of B5 we have to Blend 50ml of pure biodiesel with 950 ml of Diesel

2. TRAIL ON ENGINE

The setup consists of single cylinder, four stroke, VCR (Variable Compression Ratio) Diesel engine connected to eddy current type dynamometer for loading. The compression ratio can be changed without stopping the engine and without altering the combustion chamber geometry by specially designed tilting cylinder block arrangement. Setup is provided with necessary instruments for combustion pressure and crank-angle measurements. These signals are interfaced to computer through engine indicator for P□□PV diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. The set up 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 engine indicator. Rotameters are provided for cooling water and calorimeter water flow measurement. 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 and heat balance. Lab view based Engine Performance Analysis software package "Engine soft LV" is provided for on line performance evaluation. A computerized Diesel injection pressure measurement is optionally provided.

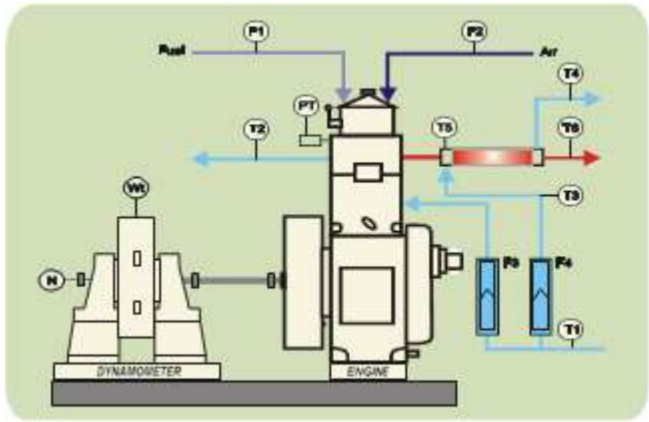


Fig -1: Schematic arrangement

Basic technical specification of the test engine	
Product	VCR Engine test setup 1 cylinder, 4 stroke, Diesel (Computerized)
Engine	Make Kirloskar, Type 1 cylinder, 4 stroke Diesel, water cooled, power 3.5 kW at 1500 rpm, stroke 110 mm, bore 87.5 mm. 661 cc, CR 17.5, Modified to VCR engine CR range 12 to 18bria / 10 pt
Dynamometer	Type eddy current, water cooled, with loading unit
Propeller shaft	With universal joints
Air box	M S fabricated with orifice meter

	and manometer
Fuel tank	Capacity 15 lit with glass fuel metering column
Calorimeter	Type Pipe in pipe
Piezo sensor	Range 5000 PSI, with low noise cable
Crank angle sensor	Resolution 1 Deg, Speed 5500 RPM with TDC pulse.
Data acquisition device	NI USB-6210, 16-bit, 250kS/s.
Piezo powering unit	Make-Cuadra, Model AX-409.
Digital millivolt meter	Range 0-200mV, panel mounted
Temperature sensor	Type RTD, PT100 and Thermocouple, Type K
Temperature transmitter	Type two wire, Input RTD PT100, Range 0–100 Deg C, Output 4–20 mA and Type twowire, Input Thermocouple, Range 0–1200 Deg C, Output 4–20 mA
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
Software	“Engine soft LV” Engine performance analysis software
Rotameter	Engine cooling 40-400 LPH; Calorimeter 25-250 LPH
Pump	Type Monoblock
Overall dimensions	W 2000 x D 2500 x H 1500 mm
Optional	Computerized Diesel injection pressure measurement

Table -1: Basic technical specification of the test engine

3. PERFORMANCE OF CASTOR BIODIESEL BLENDS IN DIESEL ENGINE:-

3.1 For Compression Ratio 16.5

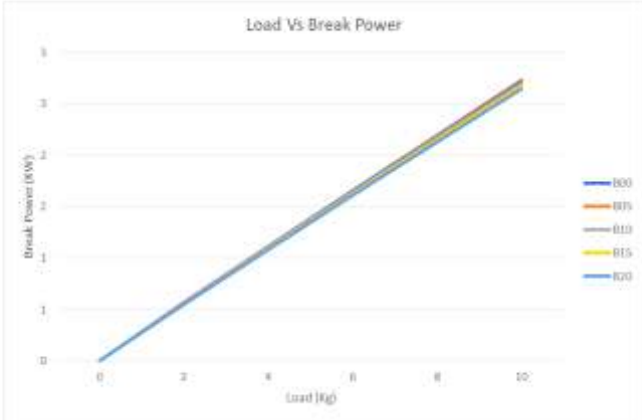


Chart -1 : Load Vs Break Power

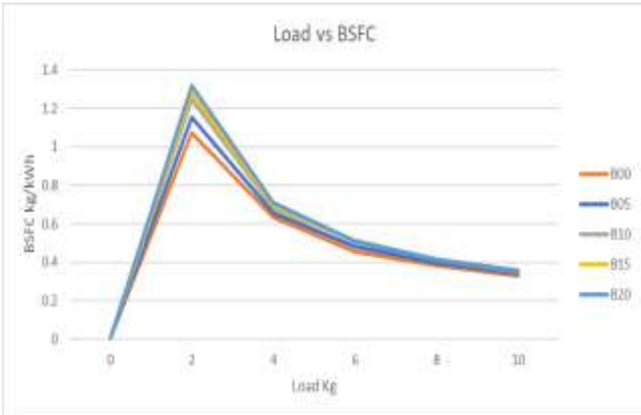


Chart -2: Load vs BSFC

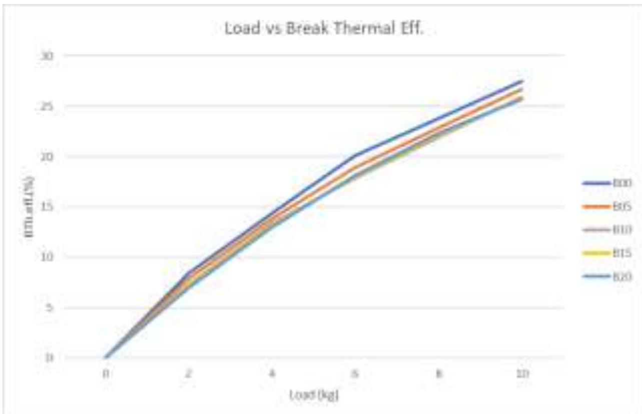


Chart -3: Load vs Break Thermal Eff

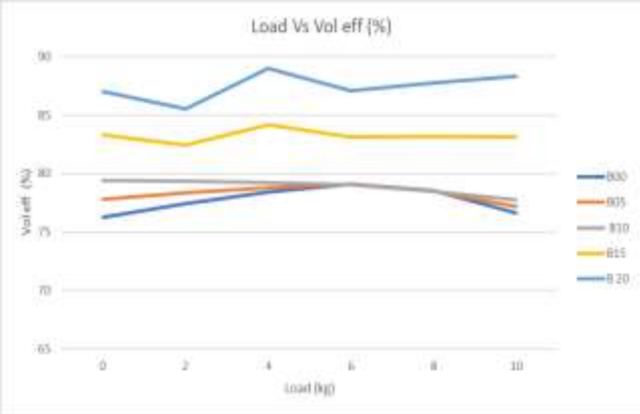


Chart -4 : Load Vs Vol eff (%)

3.2 For Compression Ratio 17.5

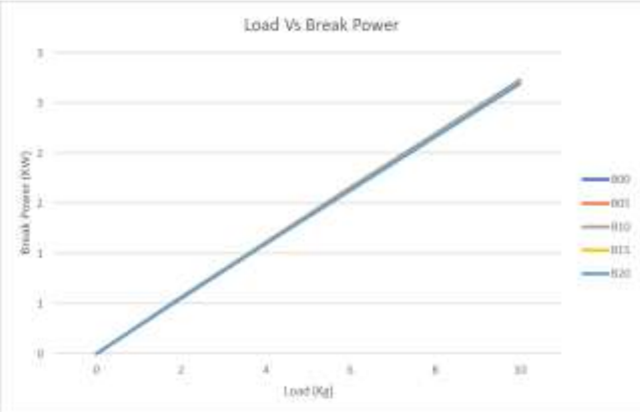


Chart -1 : Load Vs Break Power

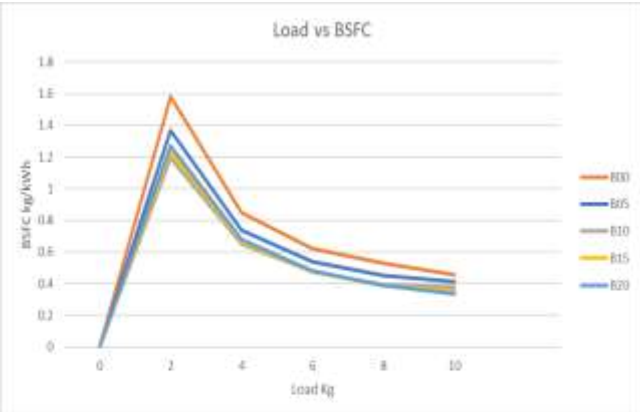


Chart -2: Load vs BSFC

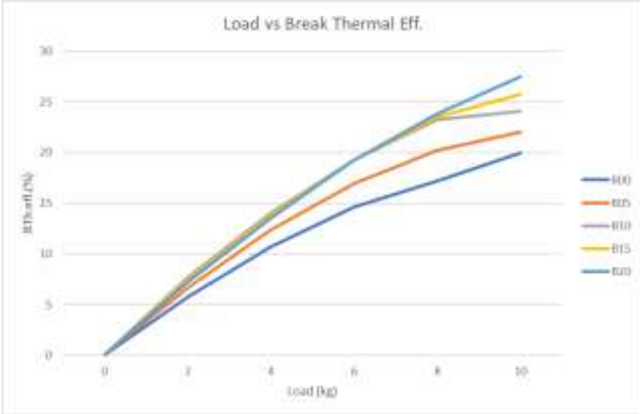


Chart -3: Load vs Break Thermal Eff

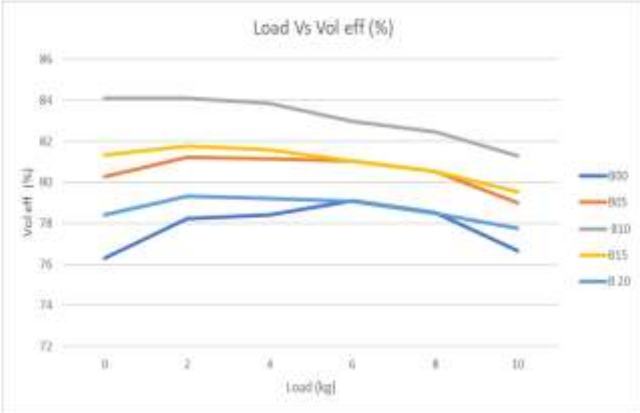


Chart -4 : Load Vs Vol eff (%)

4. EMISSION CHARACTERISTICS:-

4.1 For Compression Ratio 16.5

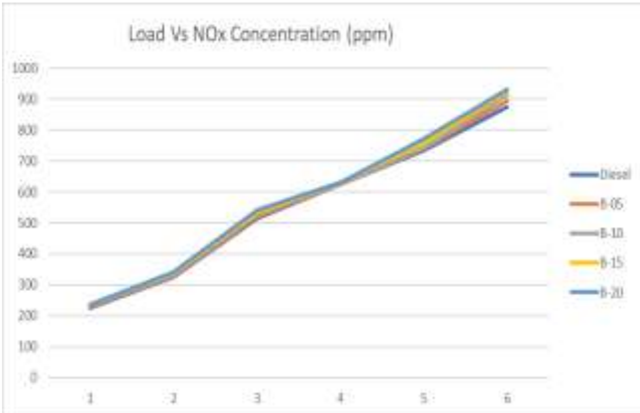


Chart -1 : Load Vs NOx Concentration (ppm)

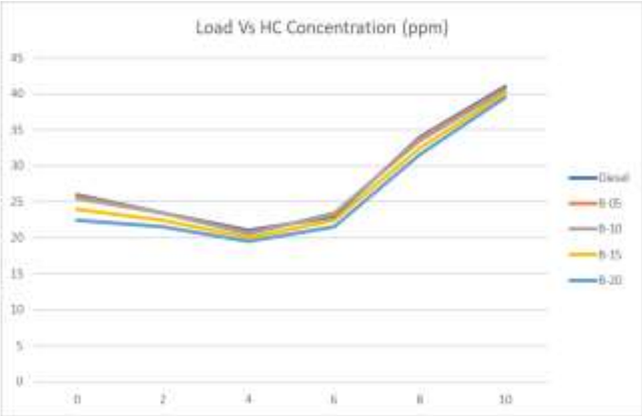


Chart -2 : Load Vs HC Concentration (ppm)

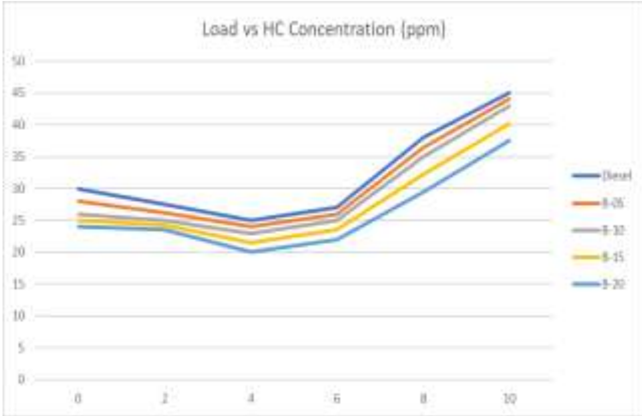


Chart -2 : Load Vs HC Concentration (ppm)

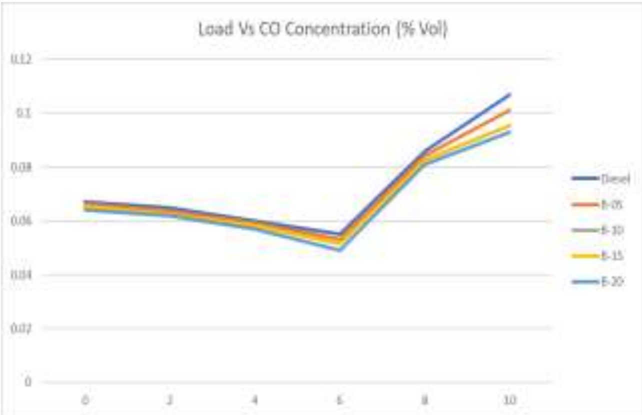


Chart -3 : Load Vs CO Concentration (ppm)

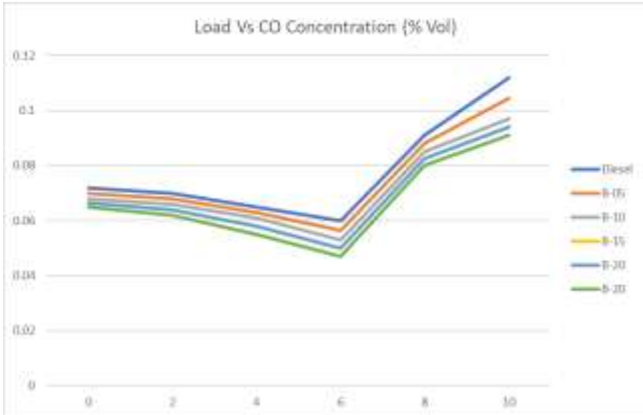


Chart -3 : Load Vs CO Concentration (ppm)

4.2 For Compression Ratio 17.5

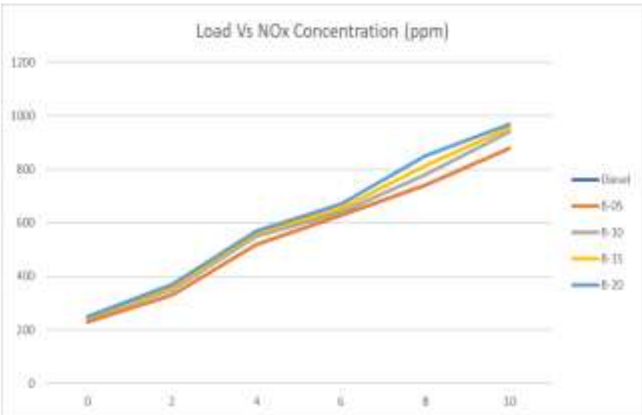


Chart -1 : Load Vs NOx Concentration (ppm)

5. CONCLUSIONS

Biodiesel obtained by Castor oil has good inherent properties and most of its properties resembles to that of diesel. The performance of biodiesel can be further improved by blending

1. When B20 castor biodiesel Blend used in engine at CR 16.5 has Lower BSFC than the B10 castor Biodiesel Blends but has higher Break thermal eff. And lower CO, HC emission and comparatively higher NOX emission but it can be controlled by several methods

2. When B10 castor biodiesel Blend used in engine at CR 17.5 has Lower BSFC than the B20 castor Biodiesel Blends but has higher Break thermal eff. And lower NOX, and comparatively higher CO , HC emission but it can be controlled by several methods

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