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Experimental investigation on mixing of biodiesel blends On VCR engine with Al2O3 nano particles

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Abstract - *There is an increasing demand for the petroleum based fuels has led to oil crises in the recent times. The research regarding blend of diesel and single biodiesel have been done already. Very few works have been done with the combination of three different biodiesel blends with diesel. The present study brings out an experiment of three biodiesels from custard apple seed oil and mahua oils are blended with diesel at various mixing ratios. The effects of two biodiesel works in engine and exhaust emissions were examined in a single cylinder, variable compression ratio (15 and 17), direct injection, water cooled and high speed diesel engine at various engine loads with constant engine speed. To analyze the performance and emissions of a diesel engine using blend (B20). The results obtained that BTE of C10M10 at CR17 with nano possess higher efficiency than other mixing blends. Compare to other blends BSFC of C10M10 at CR15 has more fuel consumption.*

Key Words: Dual biodiesels, Custard apple seed, Mahua, VCR engine, Nano particles (Al2O3).

NOMENCLATURE:

VCR Engine- Variable compression ratio engine

C10M10D80- Custard apple seed oil 10%+ mahua oil 10%+ diesel 80%

CR15-Compression ratio 15

CR17-Compression ratio 17

Al2O3 -Aluminum oxide

1.INTRODUCTION

Energy is the most fundamental requirement for human existence. Consumption of fossil fuels has highly increased and the use of these energy resources has major environmental impact as well. Diesel fuel is largely used in transport, agriculture, commercial, domestic and industrial sectors for the generation of mechanical energy and electricity. Finding suitable sustainable fuel alternatives has become a high priority for many countries. Also, it will play major role in various industries in the near future. Out of all the alternative fuels available, the bio-diesel obtained from vegetable oils and animal fatty acids are promising to be more eco-friendly when compared to diesel fuel. Biofuels are liquid or gaseous fuels made from agricultural crops, municipal wastes, and forestry by-products.

1.1 Custard apple seed:

Annonasquamosa is also called as Sugar apple or Sweetsop. In some regions of world including India the Sugar apple is also called as Custard apple. Annonasquamosa is a small, semi-(or late) deciduous, much branched shrub or small tree 3 metres (9.8 fit) to 8 metres (26 fit) tall. The pulp of Custard apple is white tinged yellow, edible and sweetly aromatic. Each carpel contains an oblong, shiny and smooth dark brown to black, 1.3 centimetres (0.51 in) to 1.6 centimetres (0.63 in) long seed. There may be a total of 20 to 38, or perhaps more, seeds in the average fruit (Siddalingappaet al2014). Not only the fruit of custard apple but also its seeds have a lot of benefits. People who enjoy custard apple eat the flesh and pelt out the seeds. However sometimes while eating they tent to swallow a seed which could be very harmful; so custard apple are known to be slightly poisonous. These seeds constitute 1/3 of the weight of one custard apple.

In recent years, biodiesel utilization in diesel engines has been popular due to depletion of petroleum-based diesel fuel (Guven Gonca et al, 2016; A.E. Atabani et al, 2012). Biodiesel, which is fatty acid methyl ester (FAME), is environment friendly, releases less NOx and HC and absolutely no Sox and no increase in CO2, when used in different blend ratios with diesel. There has been a lot of research work on biodiesel, but very few studies are conducted on duel biodiesel fuel in diesel engine (K. Sridhar et al, 2014; Mohammed Takes et al, 2015). Duel biodiesel fuel is combination of any two biodiesels with diesel, so that it has advantages of both the biodiesels. Prabhakar et al. studies on pongimia and madhuca oils on diesel engine and reveals that 20% hybrid vegetable oil and 80% diesel can

be used to replace diesel without modifying the diesel engine with less power loss and less HC and CO emissions. K.Srithar conducted experiments on CI engine using pongamia

Corresponding author V Nageswara Rao is working as Associate Professor, S B Prasad Vejendla is working as Jr Technical Superintendent oil and mustard oil with diesel. They have studied performance analysis of diesel engine and exhaust emissions. From the experimental results they concluded that thermal efficiency and mechanical efficiency of blend A-Diesel90%, Pongamia5% and Mustard oil 5% were slightly more that the diesel.

VenkateswaraRao P et.al Conducted the experiments on C I engine with dual biodiesels of pongamia and jatropha along with diesel. The results shows that D90PJBD10 (Diesel 90%, pongamia and jatropha 10%) and D80PJBD20

Diesel 80%, pongamia and jatropha 20%) were very closer to diesel fuel values so that diesel can be replaced with pongamia and jatropha.

Custard apple seeds

Mahua seeds

1.2 Mahua oil: Mahua longifolia is an Indian tropical tree found largely in the central and north Indian plains and forests. It is commonly known as mahua, mahwa or Iluppai. It is a fast-growing tree that grows to approximately 20 meters in height, possesses evergreen or semi-evergreen foliage, and belongs to the family Sapotaceae. It is adaptable to arid environment being a prominent tree in tropical mixed deciduous forests in India in the states of West Bengal, Chhattisgarh, Jharkhand, Uttar Pradesh, Bihar, Maharashtra, Telangana, Madhya Pradesh, Kerala, Gujarat, Orissa and Tamil Nadu.

2. METHODOLGY

There are four ways to use neat vegetable oils in diesel engine

i. Direct use or blending in diesel fuel

ii. ii. Micro emulsions in diesel fuel

iii. Thermal cracking of vegetable oils

iv. Transesterification

Among them transesterification is the best process for vegetable oil.

3. PROPERTIES OF BIODIESEL

PROPERTIES	DIESEL	C10M10D 80	C10M10D 80+ NANO
Density kg/m^3	820	845	851
Calorific Value (kJ/kg)	42575	41278	43167
Kinematic Viscosity 40ºC (cSt)	2.94	3.62	4.1
Flash Point(ºC)	58	66	75
Fire Point(ºC)	72	81	88

4. ENGINE SETUP

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 diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. 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 engine indicator. Rotameters are provided for cooling water and calorimeter water flow measurement.

4.1 Specifications

Engine : 4stroke single cylinder water cooled diesel engine Make : Kirloskar

Rated power : 3.7 KW(5HP)

Bore diameter : 80mm Stroke length : 562cc Connecting rod length : 234mm Swept volume : 562cc Compression ratio : 12:1 to 20:1

Rated speed : 1500rpm

4.2 Features

- CR changing without stopping the engine
- No alteration in Combustion chamber geometry
- Arrangement for duel fuel test
- "-PV plots, performance plots and tabulated results
- Online measurements and performance analysis
- Data logging, editing, printing and export, Configurable graphs,
- Combustion analysis
- IP, IMEP, FP indication

5. RESULTS:

Brake thermal efficiency

It shows the comparison of brake thermal efficiency for biodiesel blends with diesel. From the graph it is clear that brake thermal efficiency of diesel is lower than biodiesel blends. By adding nano particles the brake thermal efficiencies obtained nearly to the diesel at CR15. At compression ratio17 the brake thermal efficiencies of C10M10+NANO possess higher compare to diesel.

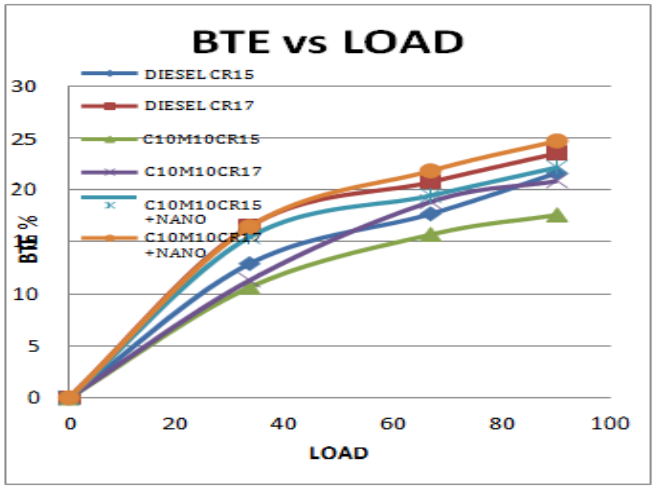

Fig 1 comparison of brake thermal efficiency with load

Specific fuel consumption

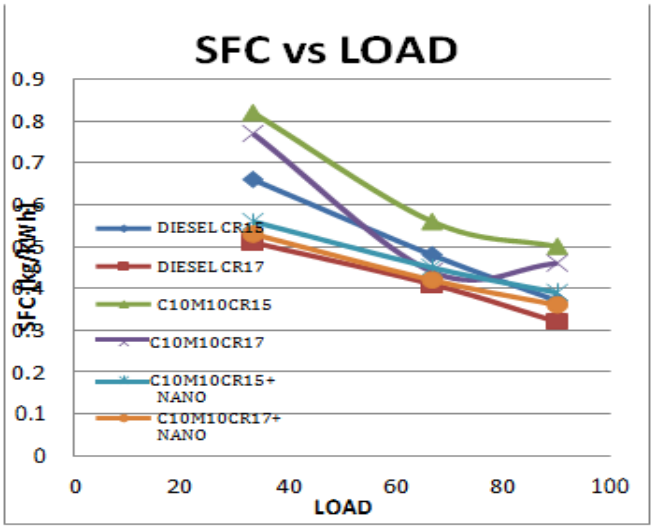

Fig 2 variation of specific fuel consumption with load

Fig 2 shows the brake specific fuel consumption of biodiesel blends as well as diesel as function of brake power. From the

graph it is observed that at CR15 the Specific fuel consumption of bio diesels is more than diesel at all loads. At CR17 by adding nano particles then the fuel consumption is gradually increases when compare to diesel.

Emissions

I. CO

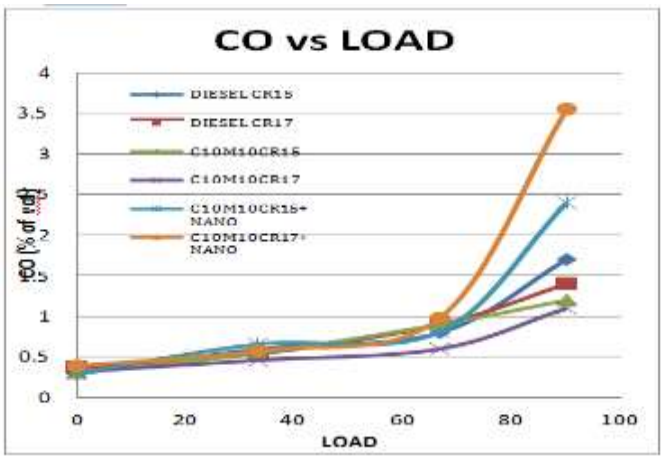

Fig 3 Effect of Carbon monoxide with load

From figure 3 at compression ratio 15 & 17 co emissions are rapidly increasing than diesel due to adding of nano particles at higher loads the richer fuel-air mixture is burned which produces more CO.

II.CO_2

From graph 4 the effect of carbon dioxide with load shows that compression ratio15 tremendously increase in co2 than diesel. Due to the adding of nano particles the emissions of co2 are gradually increases.

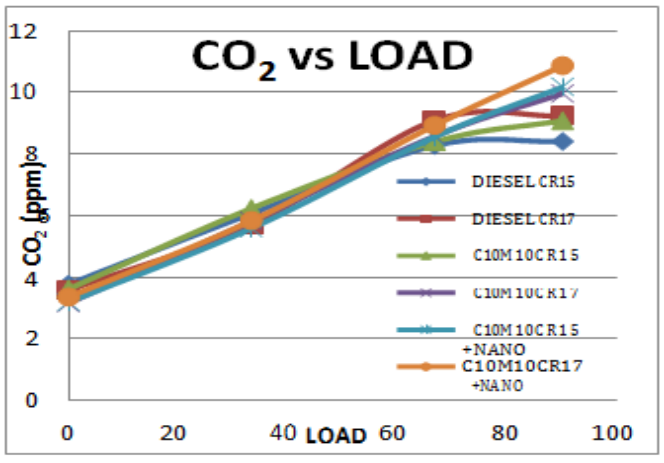

Fig 4 Effect of carbon dioxide with load

III.HC

Fig shows the variation of HC emissions of biodiesel blends and diesel against brake power. At compression ratio 17, C10M10+NANO possess rapid growth in HC emissions when compare to diesel and C10M10CR15 while emits lower HC than other biodiesel blend.

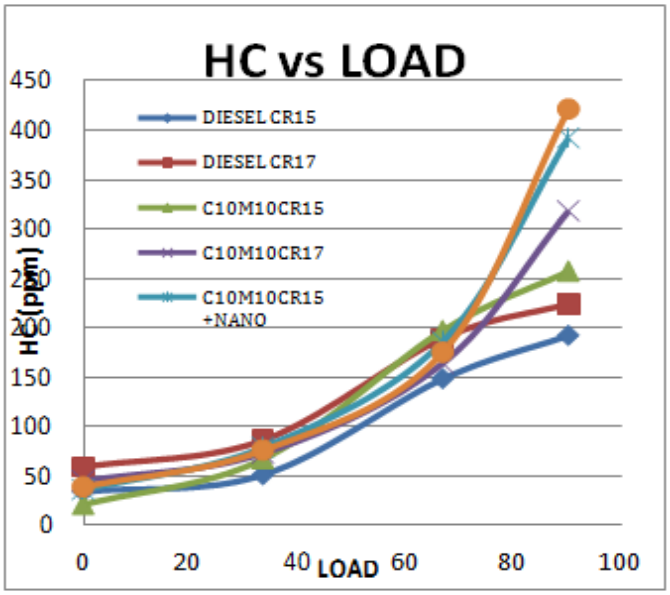

Fig 5 Effect of hydro carbons with load

IV. NOx

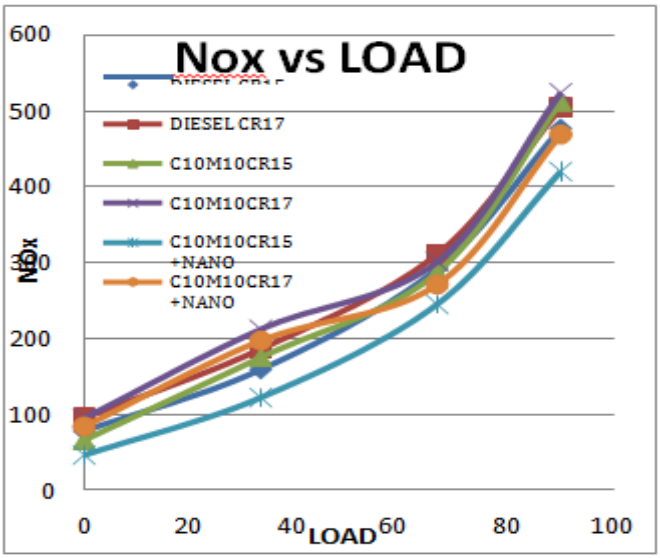

Fig 6 Effect of nitrogen oxide with load

Fig shows the variation of NOx emissions of biodiesel blends and diesel against brake power. Generally nitrogen does not

react with oxygen in the combustion chamber. At Compression ratio15 there is rapid growth in NOx emissions while at CR17 the NOx emissions are slightly decreasing due to by adding of Al2O3 nano particles.

6. CONCLUSION

Single cylinder VCR diesel engine ran successfully during tests on dual biodiesels of custard apple and mahua oil were characterized for their various physical and chemical properties.

From the experimental analysis brake thermal efficiency of C10M10CR17 obtained higher than diesel.

- The fuel consumption by nano particles is also gradually reduced.
- The specific fuel consumption and thermal efficiency of biodiesel blend C10M10CR17 is comparable to that of diesel.
- The dual biodiesel blends gave higher smoke opacity, HC and NOx than diesel.
- As load increases the brake specific fuel consumption reduces for all the biodiesels.

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