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# Comparison of Performance Combustion and Emission Parameters for Aluminium Oxide Nano Particles Blended with Used Vegetable Oil Biodiesel in an I.C Engine

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**ABSTRACT:** An experimental investigation is carried out to establish the performance and emission characteristics using Aluminium Oxide ( $Al_2O_3$ ) as nano additive in CSO blended with various proportions of nano additives 25ppm, 50ppm and 75ppm respectively. The biodiesel is produced from the CSO by standard transesterification process and subsequently, the nano particles are blended by means of an ultrasonicator to achieve stable suspension. It is observed that the blends are stable which are suitable for the performance test on the compression ignition engine. The whole investigation is carried out in a single cylinder DI diesel engine using different proportions of nano additive blended biodiesel. The result shows a considerable enhancement in brake thermal efficiency and specific fuel consumption due to the influence of Aluminium Oxide nanoparticles addition in biodiesel blend.

**KEY WORDS:** High-Rise Building, Vacuum Suction Force,

## I. INTRODUCTION

Diesel engines are mainly used in industrial, transport and agricultural applications due to their high efficiency and reliability. However, they suffer from high smoke and nitric oxide emissions. The increase in prices of diesel fuel, reduced availability, more stringent governmental regulations on exhaust emissions and the fast depletion of world-wide petroleum reserves provide a strong encouragement to the search for alternative fuels. It is commonly accepted that clean combustion in diesel engines can be achieved only if engine development with fuel reformulation and the use alternative fuels are implemented. In the name of energy security, regional air quality and greenhouse gas emissions reduction, use of oxygenated alternative fuels are advocated to reduce emissions in diesel engines. In this regard, vegetable oil have come across good choice to use as fuel in diesel engines. As a compression ignition engine fuel vegetable oil have cetane number and calorific value very close to diesel.

## II. LITERATURE REVIEW

**V.Nadana Kumar, N. M. Venkatesh, N. Alagumurthi** ‘Influence of Aluminum Oxide  $Al_2O_3$  Nano Particles Blended With Waste Cooking Oil in the Performance, Emission and Combustion Characteristics on a DI Diesel Engine’. The result shows a considerable enhancement in brake thermal efficiency and specific fuel consumption due to the influence of aluminium oxide nanoparticles addition in biodiesel blend.

**Harish Venu, Venkataramanan Madhavan** ‘Effect of  $Al_2O_3$  nanoparticles in biodiesel-diesel-ethanol blends at various injection strategies Performance, combustion and emission characteristics’. Overall, the influence of 25 ppm  $Al_2O_3$  in RET IT of 19 deg bad resulted in better engine performance, combustion and emission characteristics.

**Side Jived, Y.V.V. Satyanarayana Murthy, M.R.S. Satyanarayana, R.Rajeswara Reddy, K. Raja opal** ‘Effect of a zinc oxide nanoparticle fuel additive on the emission reduction of a hydrogen dual-fuelled engine with jatropha methyl ester biodiesel blends’. With an increasing  $H_2$  flow rate, hydrocarbon (HC) emissions decreased for nanoparticles of size 20 nm, but increased for 40 nm. Smoke opacity was increased compared with pure biodiesel owing to the presence of surfactant Triton-X100

**V.Nadana Kumar, N. M. Venkatesh, N. Alagumurthi** Influence of Aluminium Oxide  $Al_2O_3$  Nano Particles Blended With Waste Cooking Oil in the Performance, Emission and Combustion Characteristics on a DI Diesel Engine



**Vivek W. Khond n, V.M. Kriplani** ‘Effect of nanofluid additives on performance and emissions of emulsified diesel and biodiesel fuel in a stationary CI engine: A comprehensive review’. Most of the researchers reported improved particles additives in diesel and biodiesel.

### III. MAIN COMPONENTS

#### SELECTION OF COMPONENTS

- \* Diesel
- \* Waste Cooking Oil
- \* Aluminium

### IV. METHODOLOGY

- Vegetable oil emulsion is prepared from palm oil by emulsification process.
- To prepare a stable emulsion, correct proportion of palm oil, water, surfactant and co-surfactant is found out by trial methods.
- Using correct proportion required amount of emulsion is prepared by mechanical stirring process.
- Diesel engine is run with sole fuel at constant speed for nearly 10 minutes to attain the steady state condition at the lowest possible load and experimental procedure is done.
- The experimental procedure is repeated with prepared vegetable oil emulsion.

### V. CONSTRUCTION



#### 5.1 ENGINE SETUP

**Product**

Research Engine test setup 1 cylinder, 4 stroke, Multi-fuel VCR with open ECU for petrol mode (Computerized)

**Product code**

240PE



<b>Engine</b>	Type 1 cylinder, 4 stroke, water cooled, stroke 110 mm, bore 87.5 mm. Capacity 661 cc. Diesel mode: Power 3.5 KW, Speed 1500 rpm, CR range 12:1-18:1. Injection variation: 0- 25 Deg BTDC ECU Petrol mode: Power 4.5 KW @ 1800 rpm, Speed range 1200-1800rpm, CR range 6:1-10:1
<b>Dynamometer</b>	Type eddy current, water cooled, with loading unit
<b>Propeller shaft</b>	With universal joints
<b>Air box</b>	M S fabricated with orifice meter and manometer
<b>Fuel tank</b>	Capacity 15 lit, Type: Dual compartment, with fuel metering pipe of glass
<b>Calorimeter</b>	Type Pipe in pipe
<b>Piezo sensor</b>	Combustion: Range 5000 PSI, with low noise cable Diesel line: Range 5000 PSI, with low noise cable
<b>Crank angle sensor</b>	Resolution 1 Deg, Speed 5500 RPM with TDC pulse.
<b>Data acquisition device</b>	NI USB-6210, 16-bit, 250kS/s.
<b>Piezo powering unit</b>	Make-Apex, Model AX-409.
<b>Engine control unit</b>	PE3 series ECU, full build potted enclosure.
<b>Sensors for ECU</b>	Air temp, coolant temp, Throttle position and trigger.
<b>Engine Control hardware</b>	Fuel injector, Fuel pump, ignition coil, idle air
<b>Digital voltmeter</b>	Range 0-20V, panel mounted
<b>Temperature sensor</b>	Type RTD, PT100 and Thermocouple, Type K

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 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 hardware interface. Rotameters 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. The setup has stand-alone panel box consisting of air box,manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and hardware interface. Lab view based Engine Performance Analysis software package “Engine soft” is provided for on line performance evaluation of the engine. A standard burette and a digital stop watch are also provided to measure fuel flow manually.

**5.2. SPCIFICATION**

<b>Temperature transmitter</b>	Type two wire, Input RTD PT100, Range 0–100 Deg C, Output 4–20 am and Type two wire, Input Thermocouple, Range 0–1200 Deg C, Output 4–20 mA
<b>Load indicator</b>	Digital, Range 0-50 Kg, Supply 230VAC
<b>Load sensor</b>	Load cell, type strain gauge, range 0-50 Kg
<b>Fuel flow transmitter</b>	DP transmitter, Range 0-500 mm WC
<b>Air flow transmitter</b>	Pressure transmitter, Range (-) 250 mm WC
<b>Software</b>	“Enginesoft” Engine performance analysis software
<b>ECU software</b>	peMonitor & peViewer software.

**5.2.1 ELECTRIC SUPPLY**

Provide 230 +/- 10 VAC, 50 Hz, single phase electric supply with properearthing. (Neutral – Earth voltage less than 5 VAC)

Provide 5A, three pin socket with switch (2 Nos.) for engine set up Provide additional 5A, three pin sockets for computer and peripherals

**5.2.2 WATER SUPPLY**

Continuous, clean and soft water supply @ 2000 LPH, at 10 m. head. Provide valve with 1” BSP hose terminal connection.

**5.2.3 COMPUTER**

With standard configuration. Typical configuration as follows: CPU: Pentium 300 GHz, RAM: Min. 2GB or higher, DVD ROM drive, USB Port. OS: Windows XP

+ SP3, Microsoft office2007. Monitor: Screen resolution 1280x1024.

## VI. RESULT AND DISCUSSION

It has been observed that the operation of the engine was very smooth throughout the rated load, without operational problem. The performance and emission characteristics of the engine fuelled with Aluminium oxide nano particles blended fuel blends were discussed and compared with the neat diesel fuel.

## VII. CALCULATIONS

### B20 AS FUEL

1. Indicated thermal efficiency ( $\eta_t$ ):

$$(\eta_t) = \frac{(\text{Indicated Power} \times 3600)}{(\text{Fuel Flow} \times \text{Calorific Value})} \times 100$$

$$= \frac{3.91 \times 3600}{0.28 \times 43987} \times 100$$

$$(\eta_t) = \mathbf{116.24\%}$$

3. Indicated thermal efficiency ( $\eta_t$ ):

$$(\eta_t) = \frac{(\text{Indicated Power} \times 3600)}{(\text{Fuel Flow} \times \text{Calorific Value})} \times 100$$

$$= \frac{3.91 \times 3600}{0.28 \times 43987} \times 100$$

$$(\eta_t) = \mathbf{116.24\%}$$

3. Mechanical efficiency ( $\eta_m$ ):

$$\eta_m = \frac{BP}{IP}$$

$$\eta_m = \frac{0.08}{3.91}$$

$$\eta_m = \mathbf{1.96\%}$$

### B20- Al<sub>2</sub>O<sub>3</sub> 25PPM AS FUEL

4. Indicated thermal efficiency ( $\eta_t$ ):

$$(\eta_t) = \frac{(\text{Indicated Power} \times 3600)}{(\text{Fuel Flow} \times \text{Calorific Value})} \times 100$$

$$= \frac{2.95 \times 3600}{0.26 \times 40642} \times 100$$

$$(\eta_t) = \mathbf{98.86\%}$$

5. Brake thermal efficiency ( $\eta_{bth}$ ):

$$\eta_{bth} = \frac{(\text{Break Power} \times 3600)}{(\text{Fuel Flow} \times \text{Calorific Value})} \times 100$$

$$= \frac{0.02 \times 3600}{0.26 \times 40642} \times 100$$

$$\eta_{bth} = \mathbf{0.74\%}$$

6. Mechanical efficiency ( $\eta_m$ ):

$$\eta_m = \frac{BP}{IP}$$

$$\eta_m = \frac{0.02}{2.93}$$

$$\eta_m = \mathbf{0.7\%}$$

**B20- Al<sub>2</sub>O<sub>3</sub> 50PPM AS FUEL**

7. Indicated thermal efficiency ( $\eta_t$ ):

$$(\eta_t) = [( \text{Indicated Power} \times 3600) / (\text{Fuel Flow} \times \text{Calorific Value})] \times 100$$

$$(\eta_t) = 2.35 \times 3600 / 0.30 \times 40668 \times 100$$

$$(\eta_t) = \mathbf{69.95\%}$$

8. Brake thermal efficiency ( $\eta_{bth}$ ):

$$\eta_{bth} = [( \text{Break Power} \times 3600) / (\text{Fuel Flow} \times \text{Calorific Value})] \times 100$$

$$\eta_{bth} = 0.01 \times 3600 / 0.30 \times 40668 \times 100$$

$$\eta_{bth} = \mathbf{0.40\%}$$

9. Mechanical efficiency ( $\eta_m$ ):  $\eta_m = [BP/IP]$

$$\eta_m = 0.01 / 2.35$$

$$\eta_m = \mathbf{0.5\%}$$

**B20-Al<sub>2</sub>O<sub>3</sub> 75PPM AS FUEL**

10. Indicated thermal efficiency ( $\eta_t$ ):

$$(\eta_t) = [( \text{Indicated Power} \times 3600) / (\text{Fuel Flow} \times \text{Calorific Value})] \times 100$$

$$= 2.40 \times 3600 / 0.28 \times 40696 \times 100$$

$$(\eta_t) = \mathbf{77.21\%}$$

11. Brake thermal efficiency ( $\eta_{bth}$ ):

$$\eta_{bth} = [( \text{Break Power} \times 3600) / (\text{Fuel Flow} \times \text{Calorific Value})] \times 100$$

$$\eta_{bth} = 0.02 \times 3600 / 0.28 \times 40696 \times 100$$

$$\eta_{bth} = \mathbf{0.55\%}$$

12. Mechanical efficiency ( $\eta_m$ ):  $\eta_m = [BP/IP]$

$$\eta_m = 0.02 / 2.40$$

$$\eta_m = \mathbf{0.71\%}$$

**VIII. CONCLUSION**

The performance and emission characteristics of DI diesel engine with diesel- blended biodiesel with the addition of Aluminium oxide nanoparticles were investigated. The following conclusion were drawn the experimental result. The brake thermal efficiency was increased in B20AL2O375ppm at all load than neat diesel.

The specific fuel consumption is higher for the B20AL2O375ppm than neat diesel at the entire load comparing with the different dosing level of blends.

The CO emission decreases by addition of B20AL2O375ppm.

The HC emission level was decreased at B20AL2O3 75ppm.

The NO<sub>x</sub> emission is lower for the diesel than the addition of B20AL2O3. By addition of AL2O3 slightly increased compared with diesel.

The overall performance and emission characteristics were clearly obtained that the addition of Aluminium oxide nanoparticles (AL2O3) is efficient in improving the properties of biodiesel blend.

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