

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 6, Special Issue 15, December 2017

Effect of Air Induction on Performance & Exhaust Emission of Diesel Engine Fuelled with Diesel & Biodiesel

Akshath Kumar V¹, Ravi Kumar²

Student, Department of Mechanical Engineering, Sambharam Institute of Technology, Bangalore, India

Assistant Professor, Department of Mechanical Engineering, Sambharam Institute of Technology, Bangalore, India

ABSTRACT: This paper presents a comparative analysis of the diesel engine performance and emission characteristics, when operating on diesel fuel and various diesel-biodiesel (B10, B20, B40, B60) blends, at various loads and engine speeds. The experimental tests were performed on four-stroke, four-cylinder, direct injection, naturally aspirated, 60kW diesel engine D-243. The in-cylinder pressure data was analysed to determine the ignition delay, the heat release rate (HRR), maximum in-cylinder pressure and maximum pressure gradients. The influence of diesel-biodiesel blends on the Break Specific Fuel Consumption (bsfc) and exhaust emissions was also investigated. The bench test results showed that when the engine running on blends B60 at full engine load and rated speed, the autoignition delay was 13.5% longer, in comparison with mineral diesel. Maximum cylinder pressure decreased about 1-2% when the amount of Rapeseed Methyl Ester (RME) expanded in the diesel fuel when operating at full load and 1400 per min speed. At rated mode, the minimum bsfc increased, when operating on biofuel blends compared to mineral diesel. The maximum brake thermal efficiency sustained at the levels from 0.3% to 6.5% lower in comparison with mineral diesel operating at full (100%) load. When the engine was running at maximum torque mode using diesel-RME fuel blends B10, B20, B40, B60 the total emission of nitrogen oxides decreased. At full and moderated load, the emission of carbon monoxide significantly raised as the amount of RME in fuel increased.

KEYWORDS: diesel engine, rapeseed methyl ester, autoignition, opacity of the exhaust

I. INTRODUCTION

The power output of an engine depends upon the amount of air indicated per unit time, the degree of utilization of this air and the thermal efficiency of the engine. The amount of air inducted per unit time can be increased by increasing the engine speed or by increasing the density of air at intake. The increase in engine speed calls for rigid and robust engine as the inertia loads increase. The engine friction and bearing load also increases and the volumetric efficiency decreases when the speed is increased. The method of increasing the inlet air density, called supercharging, is usually employed to increase the power output of engine. This is done by supplying air at a pressure higher than the pressure at which the engine naturally aspirates air from the atmosphere by using a pressure boosting device called a super-charger. The power output can be increased by increasing the thermal efficiency of the engine, say by increasing the compression ratio. The rate of increase of maximum cylinder pressure is less than the rate of increase of break mean effective pressure in case of a supercharged engine. The rate of increase of maximum temperature is also low in case of supercharging. This results in lower thermal loads.

1.1 OBJECTIVES OF SUPERCHARGING

To increase the power output for a given weight and bulk of the engine This is important for aircraft, marine and automotive engines where weight and space are important.

To obtain more power from an existing engine.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 6, Special Issue 15, December 2017

1.2 SUPERCHARGING OF ENGINES

Increase in pressure and temperature of the intake air reduces ignition delay and hence the rate of pressure rise resulting in a better, quicker and smoother combustion. This improvement in the combustion allows a poor quality fuel to be used in a diesel engine and it is also not sensitive to the type of fuel used. The increase in intake air temperature reduces volumetric and thermal efficiency increase in the density due to pressure compensates for this and inter-cooling is not necessary except for highly supercharged engines

Types of superchargers

- Centrifugal supercharger
- Root's blower supercharger
- Vane supercharger

1.3 DIESEL FUEL:

Diesel fuel in general is any liquid fuel used in diesel engines. The most common is a specific fractional distillate of petroleum fuel oil, but alternatives that are not derived from petroleum, such as biodiesel, biomass to liquid (BTL) or gas to liquid (GTL) diesel, are increasingly being developed and adopted. To distinguish these types, petroleum-derived diesel is increasingly called petrodiesel.

Fossil diesel is produced from the fractional distillation of crude oil between 200 °C (392 °F) and 350 °C (662 °F) at atmospheric pressure, resulting in a mixture of carbon chains that typically contain between 8 and 21 carbon atoms per molecule.

Chemical composition:

Petroleum-derived diesel is composed of about 75% saturated hydrocarbons (primarily paraffin including n, iso, and cycloparaffins), and 25% aromatic hydrocarbons (including naphthalene and alkyl benzenes).[25] The average chemical formula for common diesel fuel is C₁₂H₂₃, ranging approximately from C₁₀H₂₀ to C₁₅H₂₈.

BIO-DIESEL

Biodiesel is clean burning fuel made from vegetable oil or animal fats. It can be used in modern compression ignition engine without requiring any engine modifications. Biodiesel is the name for a variety of ester-based oxygenated fuels derived from natural, renewable biological sources such as vegetable oils

Vegetable oils can be chemically reacted with an alcohol to produce chemical compounds known as esters and this process is called as Transesterification. Biodiesel is the name given to these esters when they are intended for use as fuel with or without blending it with any other fossil fuel

II. DIFFERENT RAW MATERIALS AVAILABLE FOR PRODUCING BIODIESEL ARE

- Jatropha oil
- Pongamia oil
- Linseed
- Soya bean
- Palm oil
- Cotton Seed
- Olive
- Rice Bran
- Rapeseed
- Karanjia
- Sunflower
- Beef Tallow
- Lard

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 6, Special Issue 15, December 2017

PHYSICAL PROPERTIES

Sl.no	Property	Value
1.	Specific gravity	0.87 to 0.89
2.	Kinematic viscosity @ 40°C	3.7 to 5.8
3.	Cetane number	46 to 70
4.	Higher heating value (btu/lb)	16,928 to 17,996
5.	Sulfur, wt%	0.0 to 0.0024
6.	Cloud point °C	-11 to 16
7.	Pour point °C	-15 to 13
8.	Iodine number	60 to 135
9.	Lower heating value (btu/lb)	15,700 to 16,735

EMISSIONS OF GREENHOUSE GAS

Comparative emissions of greenhouse gases for diesel and biodiesel in various stages of life cycle are depicted in Table-3.2. Life cycle analysis for various fuels including biofuels is diagrammatically represented in Figure-3.2, which shows that biodiesel (JME) has the lowest Greenhouse emissions followed by ethanol from wood. Emissions of greenhouse gases during the production of diesel are about 32 g/km.

MATERIALS COMPATIBILITY

Biodiesel over time will soften and degrade certain types of elastomers and natural rubber compounds. Materials like bronze, brass; copper, lead, tin and zinc may oxidize the diesel or biodiesel fuels and create sediments. Moreover, lead solders and zinc linings should be avoided, as should copper pipes, brass regulators and copper fittings. It is desirable to change all components, which are not biodiesel compatible to aluminum or stainless steel.

ADVANTAGES OF BIODIESEL

- The lifecycle production and use of biodiesel produces approximately 80% less carbon dioxide emissions, and almost 100% less sulphur dioxide. Combustion of biodiesel alone produces over a 90% reduction in total unburned hydrocarbons, and a 75-90% reduction in aromatic hydrocarbons. Biodiesel further provides significant reductions in particulates and carbon monoxide than conventional diesel fuel.
- Biodiesel is the only alternative fuel that runs in any conventional, unmodified diesel engine.
- Needs no change in refueling infrastructures and spare part inventories.
- Maintains the payload capacity and range of conventional diesel engines.
- Diesel skilled mechanics can easily attend to biodiesel engines.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 6, Special Issue 15, December 2017

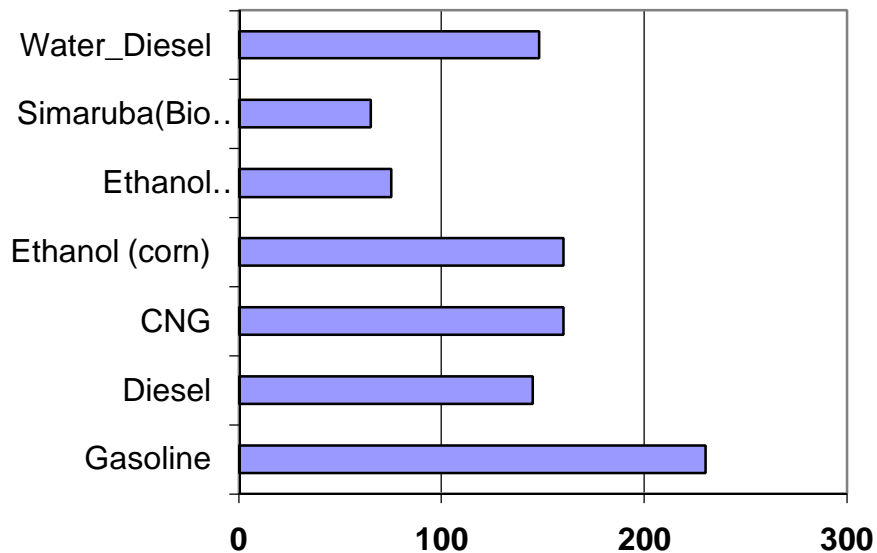


Fig : graph showing the increase in consumption of fuel in India over the years

DISADVANTAGES OF BIODIESEL

- Quality of biodiesel depends on the blend thus quality can be tampered.
- Biodiesel has excellent solvent properties. Any deposits in the filters and in the delivery systems may be dissolved by biodiesel and result in need for replacement of the filters.
- There may be problems of winter compatibility.
- Spills of biodiesel can decolorize any painted surface if left for long.
- Neat biodiesel demands compatible elastomers (hoses, gaskets, etc.).

LUBRICITY OF BIODIESEL

Biodiesel blends offer superior lubricating properties, which may reduce engine wear and extend the life of fuel injection systems. Tests with two leading lubricity measuring systems-the BOCLE machine and the HFRR machine-show biodiesel blends offer better lubricating properties than conventional petroleum diesel. Lubricity is especially important for rotary/distributor type fuel injection pumps in which parts are lubricated by the fuel itself and not the engine oil.

OPERATION & PERFORMANCE

- Horsepower, fuel economy and torque are similar to those of conventional diesel fuel engines.
- Cetane number is higher than that of conventional diesel fuel.
- Improved lubricity.
- No engine modification required when used in compression ignition engines.
- Range of vehicle akin to that of conventional diesel vehicles.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 6, Special Issue 15, December 2017

MATERIALS AND METHODS

Simarouba fruit was procured for the study from Orissa, eastern part of India. The sample was cleaned manually to remove all foreign materials such as dust, dirt, immature fruits etc., and pooled together to obtain approximately 100kg of fruit materials. The fruits were sun-dried and kept in jute bags and allowed to dry under ambient room conditions (27-32°C, 75-80% RH) to the equilibrium moisture.

III. EXPERIMENTATION PROCEDURE

ENGINE SPECIFICATIONS

This engine is a variable compression ignition, water cooled, electrical loading, four stroke diesel engine.

Sl.no	Engine Parameters	Specifications
01.	Engine type	TV 1 (Kirloskar)
02.	Number of cylinders	Single cylinder
03.	Number of strokes	Four stroke
04.	Rated power	5.2KW(7HP)@1500 rpm
05.	Bore	87.5mm
06.	Stroke	110mm
07.	Cubic capacity	661cc
08.	Compression ratio	17.5:1
09.	Rated speed	1500rpm
10.	Dynamometer	Electrical
11.	Type of cooling	Water cooling
12.	Fuel injection pressure	200 bar
13.	Fuel	Diesel

EXPERIMENTAL SETUP

Schematic diagram

Tabulation of results
Inlet manifold pressure (Naturally aspirated) case -1 DIESEL
TABLE NO.1

Load	Speed Rpm	BP Kw	Exhaust temp °C	Time for 20 CC	CO %	HC Ppm	NO _x ppm
¼	1425	0.95	210	113	54	7	392
½	1390	1.972	276	86	42	12	410
¾	1350	2.6	398	67	56	14	430
full	1330	3.8	416	51	72	16	446

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 6, Special Issue 15, December 2017

Results & discussions

Tabular column

Graphical representation of emissions at varying conditions

air induction

	naturally aspirated			1 Kg/cm ²				1.05 Kg/cm ²				1.1 kg/cm ²				1.15 kg/cm ²				1.2 kg/cm ²			
	BP	CO	HC	Nox	BP	CO	HC	Nox	BP	CO	HC	Nox	BP	CO	HC	Nox	BP	CO	HC	Nox	BP	CO	HC
Diesel	3.8	72	16	446	3.9	67	12	462	3.9	64	12	475	4	54	9	490	4	46	8	488	4	42	8
B10	3.7	69	15	459	3.9	62	11	475	3.7	58	10	495	4	52	10	520	4	49	9	536	3	38	6
B20	3.8	63	14	472	3.8	58	10	497	3.8	52	9	510	4	48	8	532	4	45	7	547	4	36	6
B30	3.7	58	13	482	3.8	52	9	538	3.8	46	8	532	4	41	7	548	4	39	6	558	4	33	6

ADVANTAGES OF THE STUDY:

There exist many advantages by considering simarouba oil as an alternate form of fuel or as a blend with diesel for running the existing diesel engine

By using the above mentioned blends to run the CI engine, less amount of fossil fuel is being used which reduces usage to a certain level, thus helps the nation financially by reducing imports of fossil fuel.

At microeconomics level cultivation of simarouba helps the farmer financially as from each acre of land he can get a profit of Rs 65000 or more

The cultivation does not require excessive usage of chemical fertilizers, pesticide & harmful agrochemicals to required yield . Employment generation.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 6, Special Issue 15, December 2017

IV. CONCLUSION

The aim of the project was to justify the use of Simaruba –diesel blend as an Alternative fuel for Compression Ignition Engine. The following conclusions were drawn from the experimental results

- Diesel (@ 1.05Kg/cm^2) develops more power when the results are compared with B30 conditions (@ 1.05Kg/cm^2), the increase in power developed percentage in BP is 2.55%.
- Simarouba blend (B30 @ 1.15 Kg/cm^2 & 1.2 Kg/cm^2) gives less HC emissions when the results are compared with naturally aspirated conditions, the reduction percentage in HC is 37.5%
- The blend can be used in the engine without any changes of fuel supply system or any other engine design.

BIOGRAPHY

- 1)Constantine D. Rakopoulos, Athanasios M. Dimaratos, Evangelos G. Giakoumis, Dimitrios C. Rakopoulos, Investigating the emissions during acceleration of a turbocharged diesel engine operating with bio-diesel or n-butanol diesel fuel blends, Energy 35 (2010) 5173to5184
- 2) Y. Lei, D.S. Zhou, H.G. Zhang , Investigation on performance of a compression-ignition engine with pressure-wave supercharger, Energy 35 (2010) 85–93
- 3) C. Liew a, H. Li a, S. Liu a, M.C. Besch a, B. Ralston a, N. Clark a, Y. Huang ,Exhaust emissions of a H2-enriched heavy-duty diesel engine equipped with cooled EGR and variable geometry turbocharger, Fuel 91 (2012) 15
- 4) Murat Karabektas, The effects of turbocharger on the performance and exhaust emissions of a diesel engine fuelled with biodiesel , Renewable Energy 34 (2009) 989–993
- 5) Mustafa Canakci , Combustion characteristics of a turbocharged DI compression ignition engine fueled with petroleum diesel fuels and biodiesel, Bio resource Technology 98 (2007) 1167–1175
- 6) Li Xinling, Huang Zhen , Emission reduction potential of using gas-to-liquid and dimethyl ether fuels on a turbocharged diesel engine, science of the total environment 407 (2009) 2234 – 2244