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PERFORMANCE AND EMISSION CHARACTERISTICS OF TWO DIFFERENT BIOADDITIVES IN DI DIESEL ENGINE

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ABSTRACT

Diesel engines are widely employed as the power sources for the land and marine transportation; however, pollution emitted from diesel engine like NOx and smoke, produces a very harmful effect on human health and ecological environment. Researches were carried out to enhance the performance and to reduce the emission. In the present work, biobased additives were used. Two different bioadditives, olyl oleate, (Bioadditive I or BA I) and dihexyl nonediate (Bioadditive II or BA II) were used for experimental purpose. Components in the olyl oleate and dihexyl nonediate were analyzed by using GCMS test. Bioadditives were mixed with diesel in the range of 1 mL, 1.5 mL, 2 mL, 2.5 mL and 3 mL per litre. It is noticed that the bioadditives added diesel enhances the cetane number, reduces the viscosity and calorific value. Experimental works were carried out on Kirloskar TV I diesel engine with constant speed and varying loads by using diesel and bioadditives. Eddy current dynamometer was used as loading device, combustion characteristics were measured using AVL-di-gas analyzer and AVL smoke meter. Bioadditive olyl oleate heat release rate, brake thermal efficiency and NOx are reduced and smoke is increased marginally. In bioadditive dihexyl nonediate heat release rate, brake thermal efficiency and NOx are reduced and smoke is increased. Exhaust gas temperature was reduced for both the bioadditives.

Key words: Diesel engine, Bioadditive, Performance, Smoke.

INTRODUCTION

Diesel vehicles remain a major cause of street level air pollution in many cities. For new diesel vehicles, increasingly stringent emissions standards have been imposed to reduce the pollutants, they emitted. For in-use diesel vehicles, improvements are required to reduce air pollution as well. In some cities, after-treatment devices and clean fuels have been applied. After-treatment devices, including the oxidation catalytic converter and the particulate filter, can lead to reduction of CO, HC and/or particulate emissions. However,

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after-treatment devices currently in-use are unable to reduce emission of carbon dioxide (CO_2), and have very limited application for reducing nitrogen oxides (NOx).[1] There is an increasing urgency in finding ways to improve fuel economy of motor vehicles, while controlling tailpipe emissions to meet ever-tighter standards. Diesel engines have the advantages of better fuel economy, lower emissions of HC and CO. However, diesel engines suffered from high emissions of PM and NOx, and it is hard to reduce them simultaneously.[2] Use of oxygenated agent with diesel has been considered as one of the possible approaches without any modification of the engine to improve the performance and emission characteristics of the engine.

In the present work, we have used fuel modification technique to increase the performance and to reduce the emission. Fuel is modified by breaking the carbon chain. Bio additives were added to modify the fuel. Biofuel additives is an enzyme based additive developed by advanced biotechnology (made from a special mixture of organic oils) which, when mixed in proper proportion with diesel fuel, improves the engines combustion efficiency. The components in the bioadditives sample were analyzed by using the GCMS analysis (gas chromatography-mass spectrum) (Figs. 1 and 2). The BA I sample Jojoba seed extract consist of 9-octadeconoic acid & 2-octyl-1-dodeconol, and the BA II sample consist of 9-octatodeconic acid & 2-hydroxly-1-methyl ethyl ester and its properties of bioadditives are shown in Table 2.

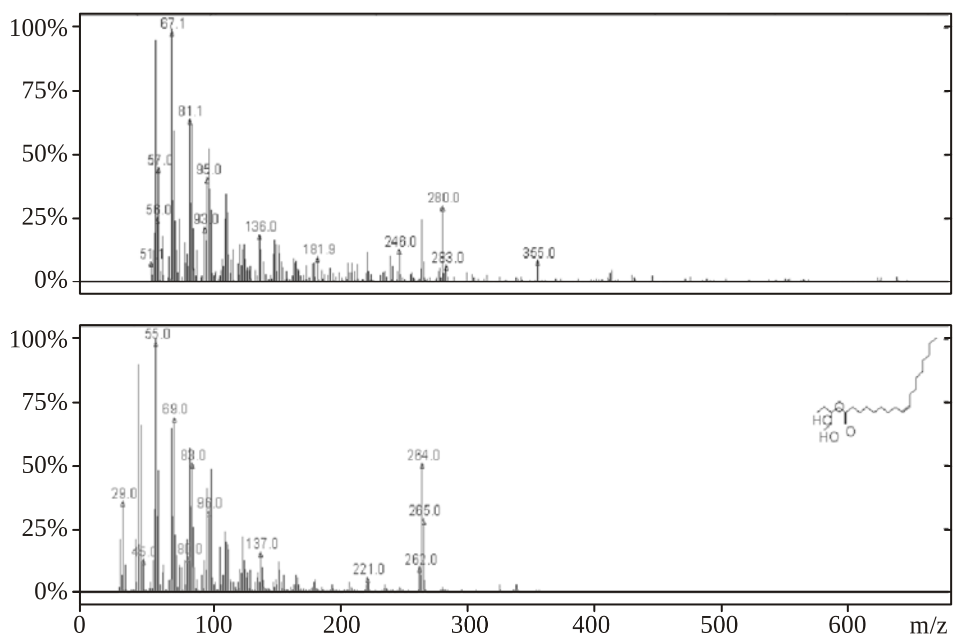

Fig 1: GCMS test for bioadditive I

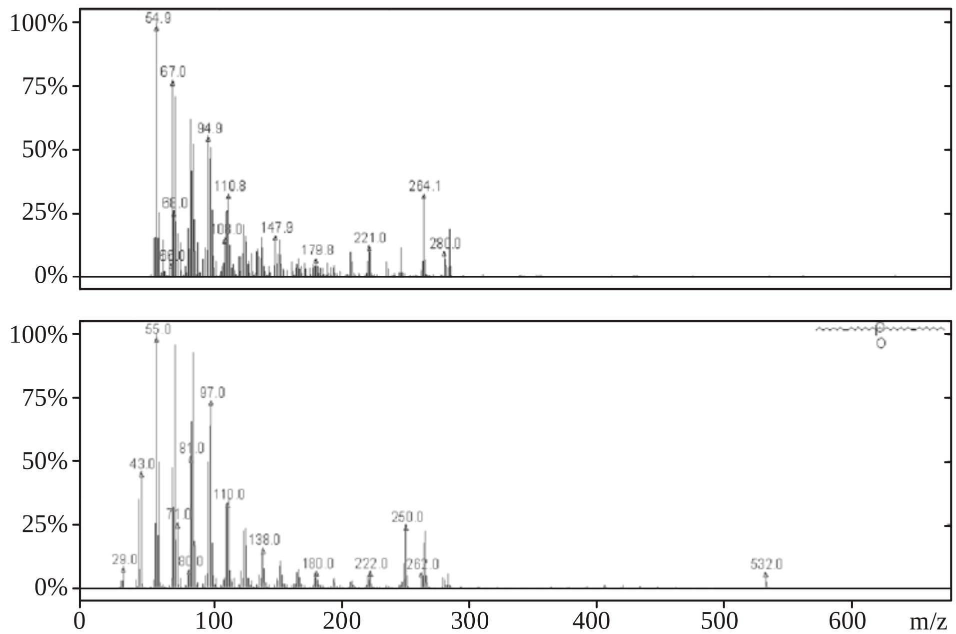

Fig. 2: GCMS test for bioadditive II

EXPERIMENTAL

The performance tests were carried on a single cylinder, four stroke and water cooled, kirloskar TV 1 diesel engine (Fig. 3). The engine was directly coupled to an eddy current dynamometer. The dynamometer was interfaced to a control panel. The engine was run at a constant speed of 1500 rpm. The emissions like HC, CO, NOx and O_2 were measured in the

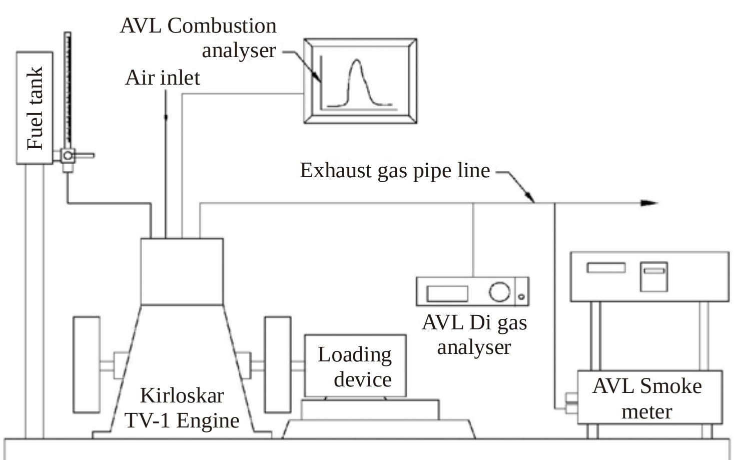

Fig. 3: Experimental setup

exhaust gas analyzer and smoke density was measured by smoke meter. The exhaust gas temperature was measured using a thermocouple. Using AVL combustion analyzer, the combustion parameter such as cylinder pressure, heat release and cycle to cycle variation were analyzed with diesel as a prime component and olyl oleate, (Bioadditive I) and dihexyl nonediate (Bioadditive II) in various ratios such as 1 mL, 1.5 mL, 2 mL, 2.5 mL and 3 mL per liter, respectively. The engine specifications are shown in Table 1.

Table 1: Engine specifications

Type	**:**	**Vertical inline diesel engine, 4 stroke, water cooled,**
No of cylinder		Single cylinder
Bore × Stroke	:	87.5 mm × 110 mm
Compression ratio	:	17.5 : 1
Brake power	:	5.2 kW
Speed	:	1500 rpm
Dynamometer		Eddy current
Ignition system	:	Compression Ignition
Ignition timing	:	23° bTDC (rated)
Injection pressure	:	220 kgf/cm^2

Table 2: Fuel properties

Properties	**Diesel**	**Diesel + BA I 1.5 mL**	**Diesel + BA II 1 mL**
Kinematic viscosity	2.8	2.88	2.86
Flash point	72	54 C	50 C
Pour point	6	-12	-12
Calorific value	45208	44388	44329
Cetane number	43	52	53

RESULTS AND DISCUSSION

Specific fuel consumption

The Fig. 4 shows specific fuel consumption with respect to brake power. It shows the comparison of specific fuel consumption using diesel and two different bioadditives. The specific fuel consumption decreases, when the load increases in all blends. The specific fuel consumption is slightly decreased in maximum load condition, when compared to diesel with bioadditives blends. The 1 mL of BA II gives minimum specific fuel consumption compared to other fuels.

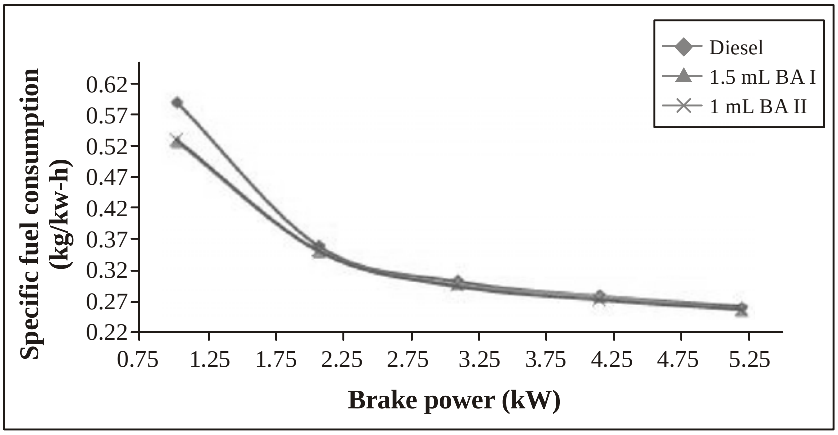

Fig. 4: Specific fuel consumption vs. Brake power

Brake thermal efficiency

The Fig. 5 shows the comparison of brake thermal efficiency using diesel, BA I and BA II. It is clear that the Brake thermal efficiency for diesel is higher, when compared to BA I of 1.5 mL and BA II of 1 mL. This oxygen accelerates the combustion process and more heat is released during the combustion and therefore, it improves the thermal efficiency.

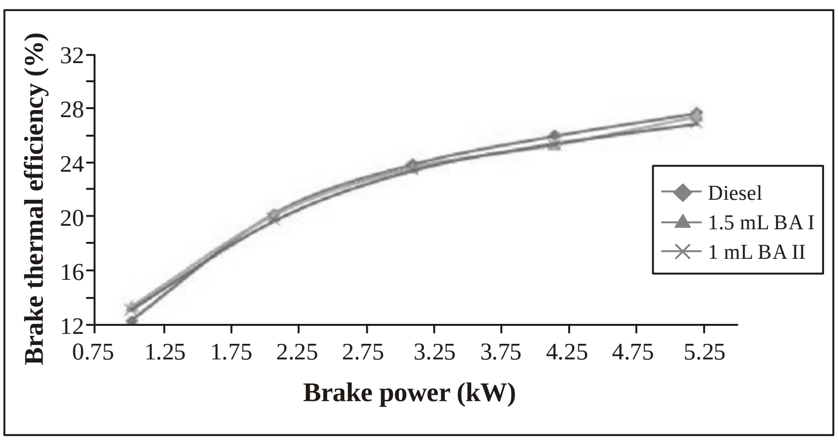

Fig. 5: Brake thermal efficiency vs. Brake power

Emission characteristics

Exhaust gas temperature

The Fig. 6 shows the comparison of engine exhaust gas temperature using diesel and bioadditives. It is clear that for the increasing load, the exhaust gas temperature is lesser on all bioadditives, when compared with diesel. Since the bioadditives have higher latent heat than diesel, it absorbs the heat inside the combustion chamber during phase change and hence exhaust gas temperature gets reduced. The exhaust gas temperature is lesser for the BAII of 1 mL, when compared with BA I of 1.5 mL and diesel.

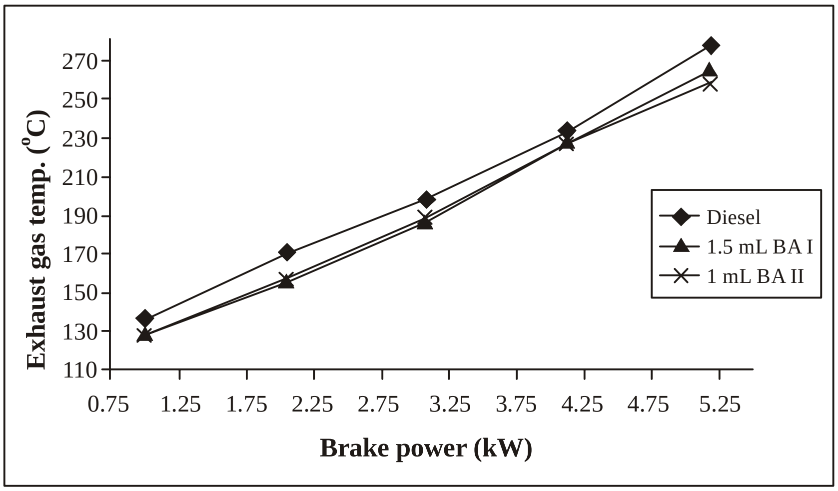

Fig. 6: Exhaust gas temperature vs. Brake power

Smoke density

The Fig. 7 shows the comparison of smoke density with brake power. It is clear that when load increases smoke density also increases. Smoke density is lowers for diesel compared with all bioadditives.

Oxides of nitrogen (NOx)

The comparison of the NOx concentration being emitted from the engine exhaust using neat diesel and bioadditives is shown in Fig. 8. The concentration of NOx is increased, when the load is increased. It is due to conversion of elemental nitrogen to NO under the condition of high gas temperature, which can easily combine with oxygen to create nitrogen dioxide (NO_2). Emission of NOx is significantly in less amount in all bioadditives having high latent heat than diesel. The temperature inside the combustion chamber gets reduced during combustion and hence, NOx is decreased.

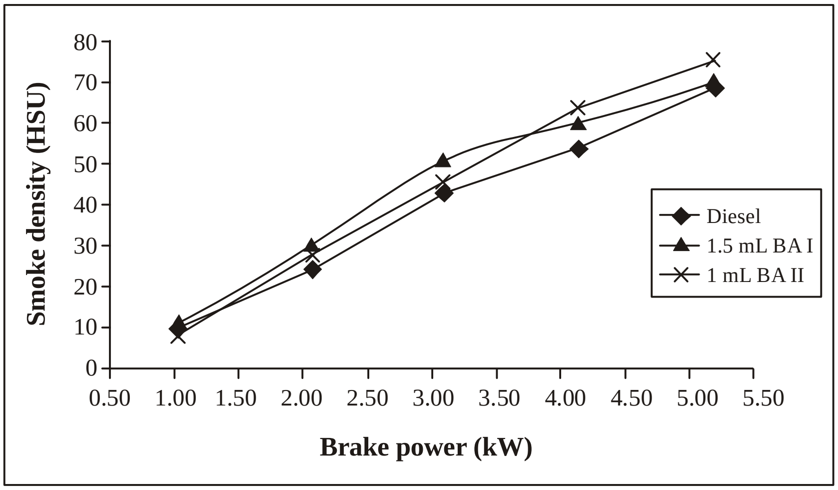

Fig. 7: Smoke density vs. Brake power

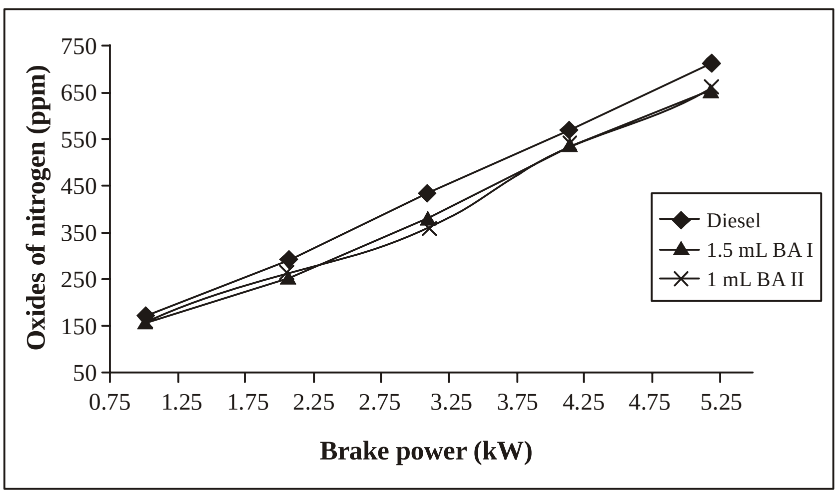

Fig. 8: Oxides of nitrogen vs. Brake power

Hydrocarbons (HC)

The comparison of the HC concentration being emitted from the engine exhausts using neat diesel and bioadditives are shown in the Fig. 9 – BA I for 1.5 mL reduces the HC emissions, when compared to sole diesel and BA II. The bioadditives reduce the surface tension and make the cohesive bonding between the molecules stronger. This leads to better combustion, when compared to sole diesel.

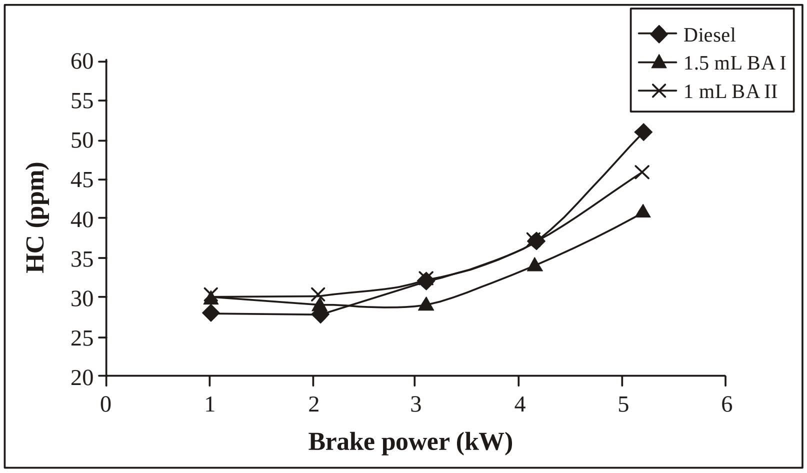

Fig. 9: Hydrocarbons vs. Brake power

Heat release rate

Fig. 10 shows the heat release rate for different concentrations of fuel additive at maximum load. The rate of heat release rate for the additive blended fuel shows short delay period. However, the periods of premixed combustion of the two fuels show no difference. But rate of diffusion combustion additive blended engine is much faster than sole fuel operation.

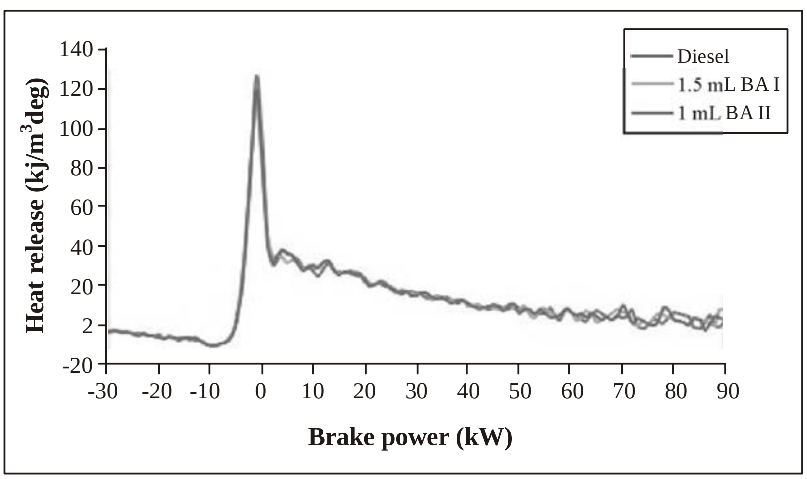

Fig. 10: Heat release rate vs. crank angle

Maximum cylinder pressure

The Fig. 11 shows the variation of maximum cylinder pressure with number of cycle. The maximum cylinder pressure is higher for 1 mL BA II which measures 72.5 bar pressures compared to other fuel. The peak pressure can be increased by shorting diffusion combustion phase.

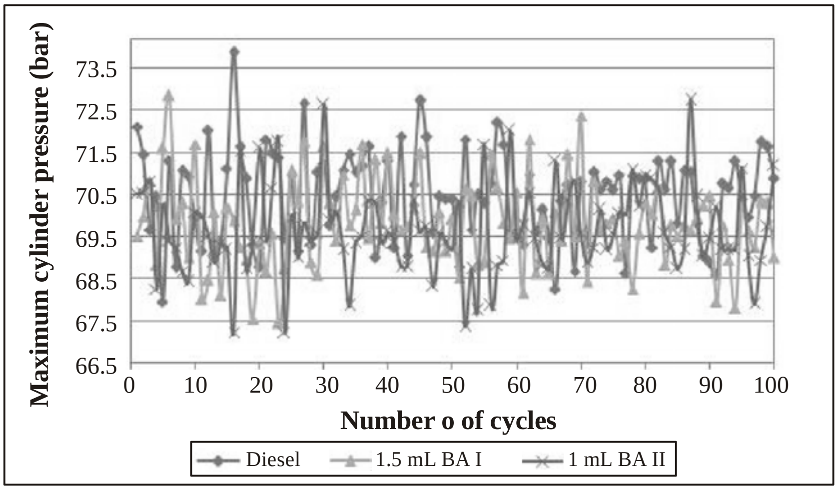

Fig. 11: Maximum cylinder pressure vs. Number of cycles

CONCLUSION

(i) The fuel consumption increases with increase in percentage of bioadditives due to lower calorific value.

(ii) NOx is reduced in BA II compared to others.

(iii) The HC emission of fuel additive engine shows reduction of 30 ppm for 2 mL concentration.

(iv) Almost same power output is noticed with bioadditives with slightly reduced thermal efficiency.

(v) Exhaust gas temperature is less for bioadditives.

(vi) The engine develops maximum cylinder pressure and maximum heat releases rate for bioadditives compared to diesel.

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