ISSN: 2277-9655
Impact Factor: 1.852

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

The Effect of Additives on Diesel Engine Emissions: An Experimental Investigation

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Abstract

This research work investigates that the emission characteristics of diesel engine by using additive Diisopropyl ether with neat diesel. The additives are mixed with standard diesel in the concentration of 5%, 10% and15% respectively. By using Diisopropyl ether, the emission of exhaust gases carbon monoxide, carbon dioxide and nitrogen oxides were reduced when compared with neat diesel. Slight increase in the hydro carbon emission was observed.

Keywords: Emission, Diisopropyl ether, Diisopropyl ethe

Introduction

Internal combustion engines have propelled society's transportation and power needs for the last century. However, with the regulatory demand to reduce air pollution, internal combustion engines are a major hub to reduce the emissions from these engines. Compression ignition engines are a major contributor to nitrogen oxides (NOx) pollution. These pollutants in diesel exhaust leads to adverse health effects [1, 2]. The emissions produced are dependent on the speed, load, acceleration, and environment [3]. Fuel additives are one method of reducing emissions and enhancing performance in these older diesel engines without the need for technology upgrades and diesel fuel additives ability to reduce harmful emissions. Reduction of the emissions produced by diesel engines may be achieved by different methods. Replacing the current older technology diesel engine with newer engines incorporating emission reduction hardware is one high cost method. Utilization of after treatment devices also can decrease emissions from older technology engines; however, the engines were not designed to operate with after treatment devices and the cost of these devices would be the responsibility of the consumer. Diesel fuel properties have been shown to effect emissions and by altering these properties, emissions reduction can be achieved [4, 5]. Fuel properties can be changed by the addition of fuel additives. Most fuel additives are developed and tested on a limited number of engines, so the overall effect of emissions on the diesel engines is unknown. Fuel additives are essentially any substances added to the fuel. These additives can reduce the total mass of particulate matter, with variable effects on carbon monoxide (CO) and NOx production. Most fuel additives will work with a range of sulfur concentrations as well with other fuels and other fuel additives. Fuel modification techniques like fuel additive, alternative fuel, hybrid fuel etc which reduces the emission .This method is suitable for both stationary and automobile applications. However, the effects of Diisopropyl ether (DIPE) and Triethyl phosphate (TEP) additives on exhaust emissions like carbon monoxide (CO), carbon dioxide (CO2), nitrogen oxides (NOX) and hydrocarbon (HC) of diesel engine were not studied. This research work focuses on the effect of additives on engine emissions and results are compared with neat diesel. The properties of DIPE and TEP are shown in Table 1.

Table 1 Properties of Diisopropyl ether

Molecular formula	$C_6H_{14}O$
Molar mass	102.17 g mol^{-1}
Appearance	Colourless liquid
Density	0.725g/ml
Melting point	-60°C
Boiling point	68.5°C
Solubility in water	2g/L at 20°C
Flash Point	-28°C
Auto ignition temperature	443°C

Materials and Methods

The effects of additives on diesel engine emissions were studied by using additives with various blend ratios. The additives used are Diisopropyl ether and Triethyl phosphate which effects considerable reduction on diesel engine emissions when compared with neat diesel.

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Experimental set-up and apparatus

The engine used for the experimental investigation is a single- cylinder four stroke water cooled diesel engine. The engine technical specification is shown in Table 3. The schematic diagram of the experimental setup is shown in Fig.1.

Table 3 Technical features of the test engine.

Parameter	Specification
Engine type	DI, Naturally aspirated, air cooled
Number of cylinders	1
Bore (mm)	80
Stroke (mm)	110
Displacement (cm)	395
Compression ratio	16.5:1
Maximum power (kW) at rated rpm	5.59
Specific Fuel Consumption	238-860g/Kwhr @full
Rated rpm	1500
Power	3.7KW or 5HP @RTP conditions

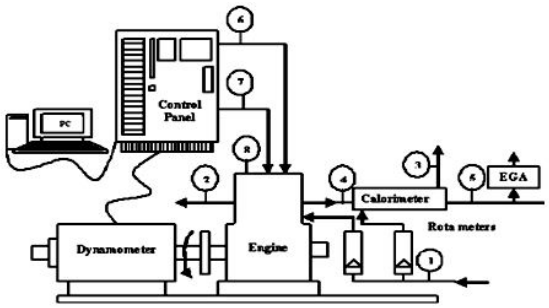

Fig.1 Diesel engine setup with exhaust gas analyzer

Results and Conclusions

Emission characteristics of Diisopropyl Ether

The CO, CO_2, NO_X and HC emission characteristics of DIPE additive with diesel for various blends are shown in the Fig 1, 2, 3 and 4 respectively. From the figure, it is evident that CO emitted by the additives is lesser than neat diesel. This is due to the complete combustion is achieved in the cyl;inder. Among the various blend proportions the minmum CO emission is obtained at 10% of fuel additive blends. It is observed that CO_2 emitted by the additives is lesser than neat diesel. Among the various blend proportions (5%,10%,15%) the minmum CO_2 emission is obtained at 10% of fuel additive blends. The reason for this could be incomplete combustion. It is inferred form the experiment that NOx emitted by the additives is lesser than neat diesel. Among the various blending proportions (5%,10%,15%) the minmum NOx emission is obtained at 15% of fuel additive.This is due to the reduction in temerature of cylinder [6,7]. The variation of UHC emitted from the engine at different load conditions are given below. From the figures, it is observed that HC emission is increased with increasing blending proportions. This is due to the flame quenching in walls of the cylinder which leads to incomplete combustion [8]. Also HC emission from fuel additive blends is higher than the neat diesel.

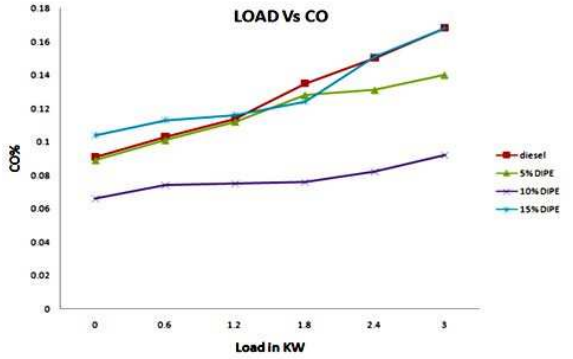

Fig.1 The variation of CO emissionfor different blend ratios of DIPE

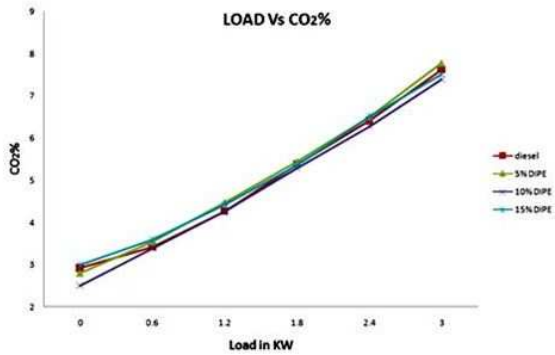

Fig.2 The variation of CO_2 emissionfor different blend ratios of DIPE

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Impact Factor: 1.852

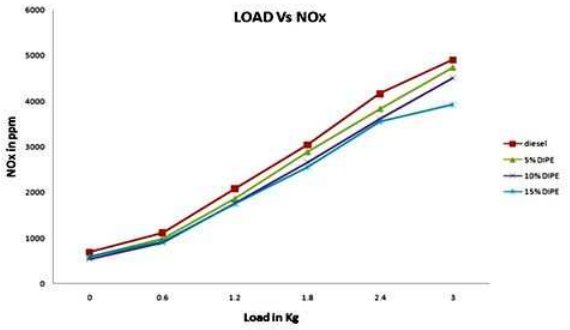

Fig.3 The variation of NO_X emissionfor different blend ratios of DIPE

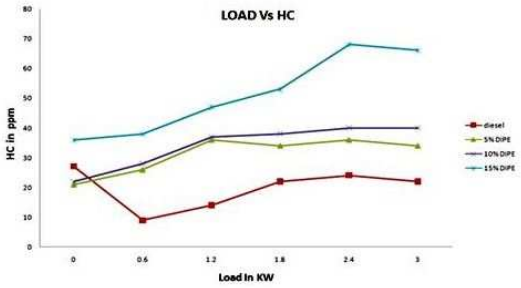

Fig.4 The variation of HC emissionfor different blend ratios of DIPE

Conclusions

- The emission of CO, CO_2 and NO_X emitted by the engine when fueled by DIPE is lower than the diesel mode.
- Among the various proportions (5%, 10%, 15%) the most optimum is 10% for DIPE.
- HC emissions of the engine are slightly higher with DIPE than diesel mode.
- The better results are obtained by using the additive DIPE when added with neat diesel.

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