iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** VII **Month of publication:** July 2019

DOI: http://doi.org/10.22214/ijraset.2019.7183

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue VII, July 2019- Available at www.ijraset.com

To Examine Exhaust Emissions Control Measures in C.I. Engine through Modification in Fuel: An Experimental Investigation

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Abstract: ***In recent years, the internal combustion engine-powered vehicles have come under massive attack due to the various problems created by them and the most serious of these is air pollution. In the present era, there are many emissions from the automobile such as Carbon-mono-oxide (CO), Unburned Hydrocarbons (UBHC), Oxide of Nitrogen (NOX), Soot and other particulate emissions and to reduce these engines exhaust emissions, fuel composition plays a vital role. For effective combustion, various parameters like cetane number, specific heat capacity, latent heat of evaporation and Stoichiometric air-fuel ratio, etc. are essential.***

The first approach which has used in this investigation is the modification of fuel in the diesel engine to minimise its exhaust gases emission and their impacts on the environment. Exhaust emission is one of a kind emission, contributing to the greenhouse effect in the world.

In this study the blend formulation between Ethanol, Antioxidant and Diesel Fuel were prepared on which experiments continued on a single-cylinder water-cooled, direct injection diesel engine using 0% (neat diesel fuel), 10 % (E10-D), 15% (E15-D), and 22.5% (E22.5-D) and 25% (E25-D) Ethanol and Diesel blended fuels and further adding 2% antioxidant on above-mentioned composition. The performance of diesel engine simulated at 1,350-1,450 rpm with 8-10 kg engine loads. After the completion of the investigation, from the result analysis, we came to know that the NOX level in emissions decreases with ethanol and antioxidants as compared to pure diesel. The result of our work successfully reduces NOX, the most obnoxious emissions.

Keywords: Ethanol, CI engine, Antioxidant, Modified fuel, Emission control, Ethanol -Diesel-antioxidant blends.

I. INTRODUCTION

With the rapid growth in industrialisation, energy demand is rising. Diesel engines: boon or banes, in most of the sector, diesel engines are being used at a vast scale. This scenario is because of its high fuel conversion efficiency, high torque capability, reliability, etc. So, these have broad applications in agriculture, transportation, industrial and automobile sectors worldwide.

In today's world, environmental degradation is a huge problem, which is increasing tremendously. The rising price of diesel fuel, Ozone layer depletion, acid rain, global warming are the results of harmful emissions, emitted by diesel engines. Major pollutants emitted by CI engines, such as carbon dioxide, oxides of nitrogen, hydrocarbon, particulate matter, are responsible for various diseases. So these pollutants have to be controlled.

From the paper prepared by Kirtan Aryal, Bishal Sapkota, Chiran Adhikari various emission control strategies observed by which we can control emissions.

1) Modifications of cylinders parameters.
2) Modification of the combustion process.
3) Post-combustion techniques and Exhaust After-treatment devices.
4) Modification of fuel composition. [1]

In this work, we had used one of these control strategies that is the modification of fuel composition, by blending ethanol-diesel and ethanol-diesel-antioxidant to reduce harmful emissions through CI engines.

Ethanol is in abundance, obtained by fermentation and contains more oxygen as compared to Diesel. It helps reduce pollutants because of better combustion of fuel inside the engine cylinder takes place. According to a paper prepared by Miyamoto, N., Ogawa, H., Nurun, N., Obata, K. et al. it is shown that reduction in the exhaust emissions and the thermal efficiency depends almost entirely on the oxygen content in the fuels. [2]

There are various properties of ethanol which are helpful for better combustion of fuel and thus results in the reduction of pollutants. Ethanol, which has about 35% oxygen, with diesel gives more complete burning. Excess oxygen associated with ethanol contributes in better combustion which drastically reduces the amount of pollutants such as Carbon-di-oxide (CO2), carbon-mono-oxide (CO), hydrocarbon (HC), Oxides of nitrogen (NOx), soot and particulate matter to some extent by using a blend of ethanol-diesel. In the paper presented by Spreen, K. the ethanol-diesel blends with 10% and 15% ethanol can reduce PM emissions by 20–27% and 30–41%, respectively[3]. However, from the paper of Shih, L.K., it is found that ethanol-diesel blends increase unburned hydrocarbons. [4]

The antioxidant helps reduce the reactivity of free radicals which formed during the combustion process. Many experiments have suggested that this blend helps reduce the oxides of nitrogen. The NOx is generated during combustion by three main mechanisms: thermal, prompt, and fuel. While the formation of free radicals produces prompt NOx, and it is a significant contributor in total NOx formation.

Ethanol is a biofuel, which is a renewable energy source obtained from sugarcane (Brazil, India), starch (US). Ethanol can be an alternative fuel. [5] Many Countries across the world, they are using a blend of ethanol and diesel-like Brazil, U.S.A they are an epicentre in this field. They consume approximately 80% of the world's total ethanol, and the U.S has the aim to use 164 billion litres per year ethanol in the blend by 2022.

In 2007 Brazilian government mandated the use of 25% ethanol and 75% diesel. After doing modifications in the engine of cars, some cars are also running on pure ethanol in Brazil. [6]

II. EQUIPMENT USED

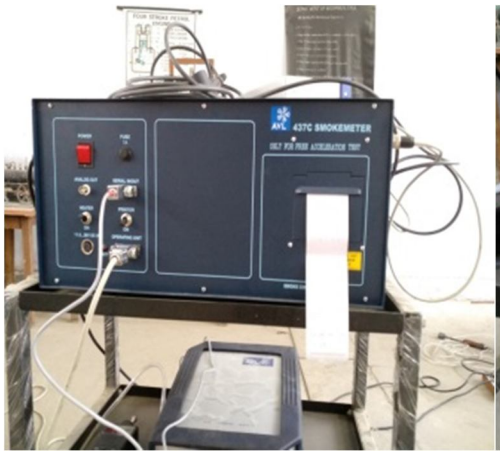


Fig 1 Smokemeter

Fig. 2 Gas analyser

Fig. 3 Diesel engine

Fig. 4 Experimental setup

Table 1 Specification of the Diesel Engine.

Properties	Specification
Make	Rocket Engineering Corporation PVT. LTD.
Model	VRCI
Type	4Stroke, single-cylinder, water-cooled, Diesel engine
Rated Power	3.7 kW
Rated RPM	1500
Bore	80 mm
Stroke	110 mm
Swept volume	5.53 cc
Compression Ratio	17.5:1
Sp. Fuel Composition	25.1 gms/kW
Engine Net Weight	145 kg
Engine Gross Weight	215 kg

All experiments were performed on 4-Stroke, single-cylinder, water-cooled, Diesel engine manufactured by Rocket Engineering Corporation Pvt. Ltd. The basic engine specifications showed in Table 1.

Ethanol about 99.97% pure & Ethylene-di-amine (antioxidant) used for blending with diesel to make modified fuel for our experiment.

A rope brake dynamometer was coupled to the engine and used to measure the engine power. An exhaust gases analyser & smoke meter manufactured by AVL India Pvt. Ltd. was used to measure the emissions of NO_X, NMHC, CO, and CO_2.

III. FUEL PREPARATION

A. The commercial diesel fuel, anhydrous ethanol (99.7% purity) and Ethylene-di-amine (Antioxidant) used in this test.

B. The mixing protocol was first to blend commercial diesel fuel with ethanol using a blending apparatus to prepare 10, 15, 22.5 & 25 % ethanol and diesel blends.

C. The same process of fuel preparation followed while using antioxidants. The existence of ethanol produces various physical and chemical changes in diesel fuel, reductions in the number of cetanes, low heat content, viscosity, boiling point, etc.

D. These modification changes their characteristics, combustion performance, and engine emissions and to be investigated, some of these blended fuels parameters.

IV. PROCESSES CARRIED OUT FOR EXPERIMENT

The experiment conducted in the step by step manner:

A. Only Pure Diesel

To start with, initially, engine tested utilising the base reference diesel fuel, covering all engine loads analysed to decide the engine working characteristics and pollutants emissions comprising the motor benchmark activities. Then, the engine operated on pure diesel sample, and reading of AVL smoke meter video graphed and alongside speed of engine measured with tachometer.

B. Diesel + Ethanol

In the second step, the engine operated with suitable blends of ethanol, i.e., four blends of diesel and ethanol were made using 10, 15, 22.5, and 25 % by volume of ethanol. Now the engine was operated on these four samples, and reading of AVL smoke-meter video graphed and alongside speed of engine measured with tachometer.

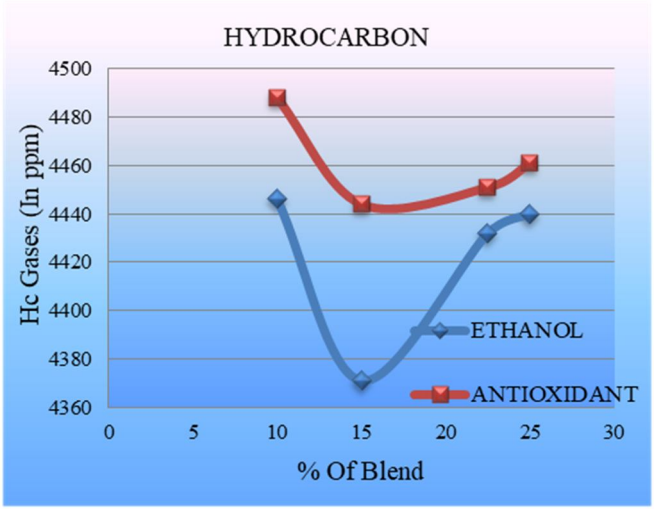
C. Diesel + Ethanol + Antioxidant

In the third step, the above-blended fuel blended with suitable antioxidants, i.e., four blends of diesel, ethanol, and antioxidant were made using 10, 15, 22.5, and 25 % adding by volume of ethanol and also add 2% requisite amount of antioxidant in the four samples. Again the engine was operated on these four samples and readings taken as AVL smoke meter video graphed and alongside speed of engine measured with tachometer. Above data is compared to select the lowest emission composition of the fuel.

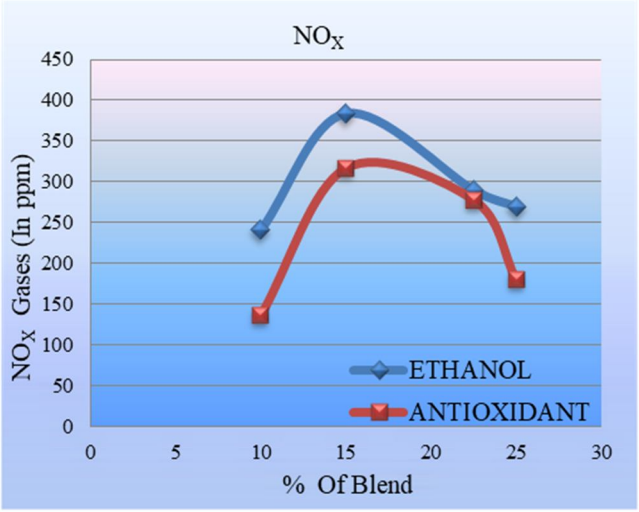
V. RESULTS

Table 2 Reading on Gas Analyser on Different Fuel Blends.

EXHAUST GASES / % OF MIX	RPM	LOAD (Kg)	HC (ppm)	CO_2 (%)	NO_X (ppm)	CO (ppm)
D100	1362	10	14431	1.60	397	0.76
E10D90	1392	10	4446	6.78	241	0.76
E15D85	1408	10	4371	3.67	384	0.76
E22.5D77.5	1404	10	4432	5.82	290	0.76
E25D75	1392	10	4440	6.68	270	0.76
E10D88A2	1380	12	4488	7.16	137	0.76
E15D83A2	1385	12	4444	6.92	317	0.76
E22.5D75.5A2	1404	10	4451	6.80	278	0.76
E25D73A2	1334	11	4461	7.86	180	0.76

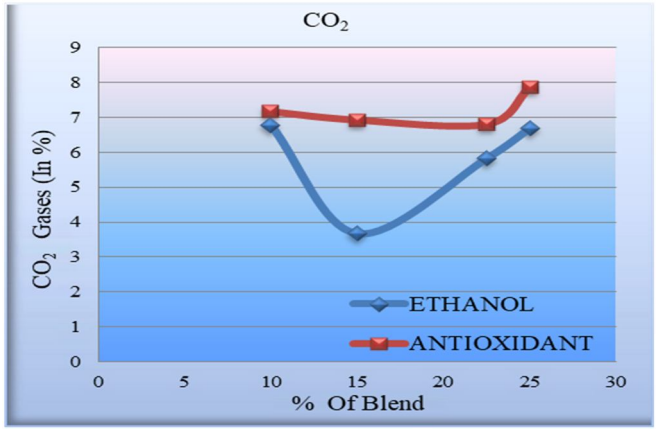


Graph 1. Shows the comparison between the amount of hydrocarbon on burning different fuel blends.



Graph 2. Shows the comparison between the amount of Nitrogen oxide on burning different fuel blends.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue VII, July 2019- Available at www.ijraset.com



Graph 3. Shows the comparison between the amount of Carbon dioxide on burning different fuel blends.

VI. ANALYSIS OF DATA

A. NO_X emissions

In the current investigation, the amount of NO_X emission had shown a considerable variation on changing the percentages of the blend. All fuel blends decreased the amount of NO_X emission comparative to diesel fuel. Usually, for reducing the NO_X emission level from engine exhaust, the cylinder temperature is to be lowered. In our experiment, we found that on adding 10% by vol. Ethanol, the NO_X emission level decreased enormously. This decrease in emission level is so because ethanol (2100 j/kgC) has higher specific heat capacity as compared to diesel (1800 j/kgC) which results in higher heat absorption from the cylinder wall and which further reduces harmful NO_X emissions from the exhaust. However, on increasing the ethanol percentage in blends, i.e., 15%, 22.5%, 25% the NO_X emissions level gets lowered as compared to diesel but not as in 10% blend this is so because ethanol is having the lower cetane number (5-8) than diesel (50). On increasing the percentage of ethanol in diesel fuel an increase in the ignition delay and more accumulation fuel takes place due to which sudden explosion takes place which causes a steep heat release at the beginning of the combustion, resulting in high temperatures and high NO_X formation.

B. CO Emission

The variation in CO emissions is not visible. The CO emissions of all the eight fuels blends showed similar trends.

C. HC Emission

HC emissions had a minimum level when the diesel engine fuelled with E15. On the other hand, the NMHC emissions with E10, E22.5, and E25 increased insignificantly relative to that with E15 fuel. This trend indicates that the presence of ethanol might be an essential factor for the increase of non-methane hydrocarbon emissions. NMHC emission means that due to the broader ethanol dispersion region in the combustion chamber, some unburned ethanol emitted in the exhaust.

D. CO_2 Emission

CO_2 emissions had shown a considerable variation on changing the percentages of the blend. All fuel blends increased the amount of CO_2 emission comparative to diesel fuel because ethanol is having the lower cetane number (5-8) than diesel (50). Due to which for generating same power output more fuel required as compared to pure diesel and due to the burning of more fuel & more complete combustion, there is an increase in the formation of CO_2 gas in a gradual trend on blends (15, 22.5, 25%) respectively.

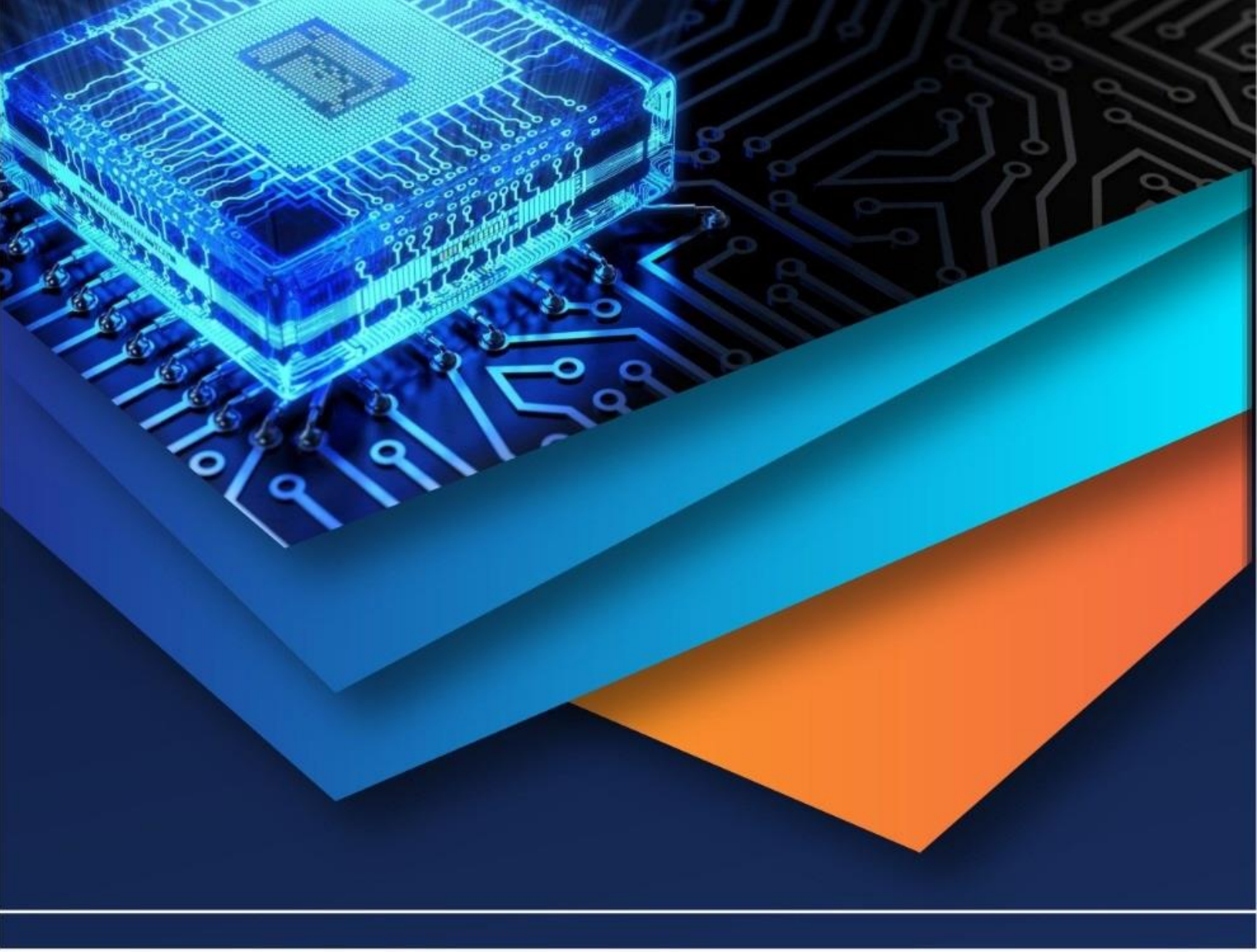
VII. CONCLUSION

As the world is facing many environmental issues, controlling pollution has become very important we had performed this test to control pollutants & based on the data, which we have obtained by result analysis, we can say that reduction in the amount of pollutant from exhaust emission of CI engines is possible. By use of ethanol and antioxidants in different proportions, we saw that pollutants get reduced. The blends of ethanol, diesel, and antioxidants had a significant effect on engine performance and emissions, by adding the different percentage of ethanol we got a reduction in non-methane hydrocarbon, and most importantly it reduced the amount of nitrogen oxide. There was not much significant reduction in pollutants when ethanol was less than 10%. When we increased the percentage of ethanol hydrocarbon, oxides of nitrogen got reduced, but there was no reduction in carbon-mono-oxide.

Thus we added antioxidant, an additive along with ethanol, which helped in lowering the amount of nitrogen oxide furthermore as compared in ethanol blend & amount of CO_2 in exhaust gets increased as compared to ethanol blend which shows more complete combustion taking place in the combustion chamber. Many countries are using this blend. Ethanol is a renewable energy source, obtain from sugarcane. Brazil, USA, EU they are using this. These countries consume 80% of ethanol, but for running with a very high amount of ethanol as a fuel, there will be a need for some modifications in the engine. India is also one of the largest producers of sugarcane, so if we start using this blended mixture, pollution as well as the price of fuel, both may decrease. For the future, if we want to save the environment, and to save diesel, we have to find an alternative to the traditional method. So by using this method, we can protect engines, we can control the rising price of diesel, and most importantly, we can reduce pollutants from exhaust emissions to protect the environment.

REFERENCES

[1] Kirtan Aryal, Bishal Sapkota, Chiran Adhikari 2016. Vehicular Emission Control Techniques. International Journal of Advances in Science Engineering and Technology Vol-4, Iss-4, Spl. Issue-2 Dec.-2016: 141-145
[2] Miyamoto, N., Ogawa, H., Nurun, N., Obata, K., & Arima, T. (1998). Smokeless, Low NOx, High Thermal Efficiency, and Low Noise Diesel Combustion with Oxygenated Agents as Main Fuel. SAE Transactions, 107, 171-177. Retrieved from http://www.jstor.org/stable/44746439
[3] Wrage KE, Goering CE (1977). Technical feasibility of diesehol. Trans ASAE23: 1338-1343.
[4] Turner, J., Pearson, R., Holland, B., & Peck, R. (2007). Alcohol-Based Fuels in High Performance Engines. SAE Transactions, 116, 55-69. Retrieved from http://www.jstor.org/stable/44650843
[5] Spreen, K. (1999). Evaluation of oxygenated diesel fuels. Final Report to Pure Energy Corporation, SWRI, 08-2990.
[6] Shih, L. K. L. (1998). Comparison of the effects of various fuel additives on the diesel engine emissions (No. 982573). SAE Technical Paper.



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