Experimental Investigation on Ethanol-Petrol Blends Operating With a Petrol Engine

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Abstract The use of bio petrol fuel as alternative fuels in gasoline engine has been around for many years and ethanol-petrol has the potential to be used as alternative fuel that can reduce the total CO2 emission from internal petrol engine. However, the changes of bio-petrol are a very complex and need further understanding for researchers due to the relevance of the increase in the petroleum price and the future environmental regulation. The combination of ethanol and petrol provides a new challenging approach to find the good effect to the engines. This study focuses to certain a new approach from to potential on ethanol-petrol blends operating or in a petrol engine especially the effects of ethanol gas petrol blending ratio and variant types of ethanol on performance and emissions of petrol engine. The recommendations of the ethanol petrol fuel blending ratio that strongly affects the vehicles performance and exhausts emission according to rpm and throttle opening conditions. Its shown that the variant in biodiesel blending ratio and engine operational condition are reduced engine-out emission and increased efficiency. The ethanol petrol blends had been successfully tested as alternative fuel for spark ignition and the result for result for engine power slightly increase without engine modification. The result showed that CO2 emissions decreased at high engine speed, while the CO emission is increases. Thus the process of combustion and stability were increased and engine efficiency was improved with 15% volume ethanol in fuel blend.

***Keywords*— Blend, Combustion, Emission, Ignition, Modification, Performance, Relevance, Stability,**

1 INTRODUCTION

Today the petroleum stockpiles are limited and will ultimately run out. The ascension of population and urbanization makes the demand of energy is increasing daily. As the major typical energy sources like coal, petroleum, and fossil fuel square measure step by step depleted, biomass is rising collectively of the promising environmentally friendly renewable energy choices (A. Demirbas, 2008). Bio-fuel initiative has been backed by government policies within the search energy security through partly replacing the restricted fossil fuels and reducing threat to the surroundings from exhaust emissions and warming. The main fuel found to be associate progressively vital various to crude is bio-fuel. Bio-fuel conjointly produces less greenhouse gases like carbonic acid gas. Once either bio-fuel or crude oil is burned, the carbon content of the fuel returns to the atmosphere as carbonic acid gas (Barber *et al.*, 2008).

Many researchers have according on ethanol-petrol blends engine performance and emissions characteristics. The advantages of biofuels area unit the following: (a) they're simply offered from common biomass sources, (b) carbon oxide cycle happens in combustion, (c) they're terribly environmentally friendly, and (d) they're perishable and contribute to property (Bata *et al.*, 2006). This experiments aims to study the run engine with different percentage of blending of gasoline and ethanol to reduce the exhaust emissions and also to increase efficiency of the engine.

1.1 OBJECTIVES

The objectives of this research are;

i. To investigate the effect of various ethanol petrol fuel blending ratio on performance and emissions of petrol engine.

ii. To make recommendation of the ethanol petrol fuel blending ratio that strongly affects the vehicles performance and exhaust emissions according to rpm and throttle opening conditions.

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1.2 SCOPES

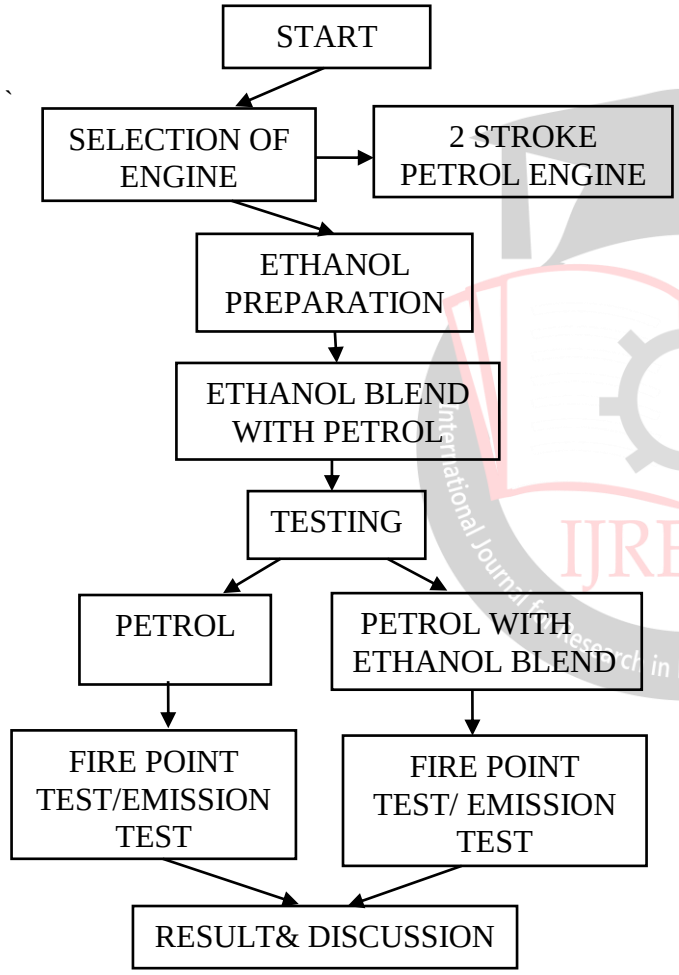
The purpose of this study is to determine the fuel properties of E0, E5, E10 and E15 ethanol petrol blending ratio with under three throttle opening conditions.

In this study, set up and conduct the experiment of performance and emissions of Mitsubishi 4G91(1.5L) petrol engine at various rpm (2000 rpm, 3000 rpm, 4000 rpm and 5000 rpm) and gas analyzer IMR 2800-A Series.

The aim of this study is to investigate the comparison of SI engines performance operating by ethanol petrol fuel and normal petrol fuel.

More cars must be made that run with a blend of 85 percent ethanol and 15 percent gasoline, known as E85. That blend is better for the environment and means less oil is needed from the Middle East to fuel our cars.

2 METHODOLOGY



2.1 SELECTION OF ENGNE

The tested engine is normally installed with all the required accessories needed for proper operation like the inlet air cleaner, the starter motor, the cooling water systems, etc

2.2 TWO STRIKE PETROL ENGINE

The four cylinder four stroke petrol engine equipped with automatic experimental technologies is used to measure performance parameters such as engine torque, brake power and BSFC at full throttle position for various engine speeds. The engine was coupled with an eddy current dynamometer and electronic data acquisition measuring meter

2.3 ETHANOL PREPARATION

The boiling point of a liquid is the temperature at which the vapour pressure of the liquid equals the pressure around the liquid, enabling bubbles to form without being crushed. A special case is the normal boiling point, where the vapour pressure of the liquid equals the ambient atmospheric pressure.

Raoult's law states that the vapour pressure of a solution is dependent on the vapour pressure of each chemical component in the solution and the fraction of solution each component makes up a.k.a. the mole fraction.

Dalton's law states that the total pressure is the sum of the partial pressures of each individual component in the mixture.

2.4 ETHANOL BLEND WITH PETROL

Ethanol is similar in nature with gasoline with high octane number. Both are liquid in nature thus storage and transportation are much similar. Both can be mixed easily and burnt. Ethanol has small molecular weight, large oxygen content and high H/C ratio. Octane number for ethanol is 100. Ethanol is oxygenated fuel with small molecules; it can burn fast and fully with oxygen inside. These characters can help to improve thermal efficiency as well as to achieve the cleanliness inside the engine and to reduce exhaust. With low boiling point ethanol is easy to burn and form the mixture gas which is conducive for gasoline to burn completely. Latent heat of vaporization of ethanol is three times bigger than that of petrol. So when ethanol is vaporizing, it absorbs a large amount of heat, meanwhile, the temperature of the mixed gas is lowered down. Although calorific value of ethanol is low, the heat, which the mixed gas of ethanol and gasoline produces under theoretical air fuel ratio, is roughly the same as that of petrol.

2.5 TESTING

At very first all different blends were prepared in laboratory and lubricating oil is added in sufficient ratio with gasoline The engine was started and allowed to warm up for a time period of 10 – 15 min. test were performed at constant speed and varying loads for each individual blends. Before testing with new blend the engine was allowed to run for sufficient time to consume the whole remaining fuel from previous blending. For getting an average value of result from each blending the test were performed four times for each mixture. The fuel consumption is measured via metered measuring jar.

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2.6 ENGINE EMISSION ANALYSIS

For the emission tests, the data for all types of fuels have been recorded include hydrocarbon (HC), oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NOx) and smoke opacity. The average of the data for engine emissions analysis was stated in the following table in appendices.

2.7 RESULT& DISCUSSION

The main focus of this study was to increase the performance and minimize the fuel consumption of two stroke petrol engine by using ethanol and methanol as additive with gasoline. The readings obtained from the conducted test have been evaluated and the result and graphs are compared.

3 EXPERIMENTAL WORK

3.1 BIOETHANOL FUELS

Fuel from ethanol is the most widely used. Ethanol is a type of alcohol came/coming from fermentation of sugars, starch or cellulose (energy from) wood and plant material. Unlimited useful things/valuable supplies and renewable energy is much cleaner when compared with petroleum fuels. Most commercial production of ethanol from sugar cane or sugar red vegetables, such as starch and cellulose (energy from) wood and plant material usually require expensive pre-treatment. Recent findings related to the production of ethanol has increased the money-based ability to be done of ethanol as a transportation fuel.

3.2 Advantages and disadvantages of bioethanol

Among the advantages of bioethanol to the consumers are (Bayraktar, H., 2005):

(i) Less fossil carbon dioxide (CO_2) emissions compared to conventional fuels.

(ii) High Octane number allowing spark-ignition engines to run more efficiently.

(iii) Lower particulate emissions.

(iv) Lower benzene and 1-3 butadiene unregulated emissions; benzene levels decrease as the ethanol concentration in gasoline increases.

(v) Less ozone forming potential than gasoline and diesel.

(vi) No Sulphur content

(vii) Biodegradable.

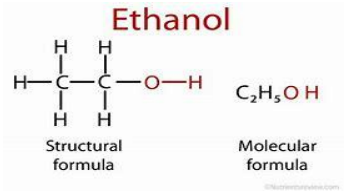

Figure 3.1 Molecular formula and Structural formula for ethanol

3.3 Bioethanol properties

In Malaysia, two major bioethanol standards that are most referred are European Standard for Bioethanol (prEN 15376:2007) and European Standard for E85 petrol as per shown in Table 3.1 respectively.

Property	Unit	Limits		Test Method
		Min	Max	
Ethanol content + higher concentrated alcohol	% (m/m)	98.7	---	EC/2870/ 2000
Higher saturated (C3-C5) mono-alcohols content	% (m/m)		2.0	EC/2870/ 2000
Methanol content water content	% (m/m) % (m/m)		1.0 0.3	EC/2870/ 2000 EN 15489
Inorganic chloride content	Mg/1	-	20.0	EN 15484/ PrEN15492
Copper content	Mg/kg	-	0.1	EN15488
Total acidity	% (m/m)		0.007	EN ISO 5165
Phosphorous content	Mg/1		0.5	EN 15487
Non-Volatile material content	Mg/100ml		10	EC/2870/ 2000
Sulfur content	Mg/kg		10	EN 15485/ EN15486

Table 3.1 Properties of Bioethanol

This section describes the possibilities and difficulties associated with the application of ethanol in gasoline passenger cars. Some important fuel properties, as well as the compatibility and potential of ethanol fuels in spark-ignited (SI) engines, are discussed.

3.4 ENGINE SPECIFICATIONS

The test rig comprises of air cooled petrol engine in which temperature is measured by digital temperature indicator the specification of engine is given as following

S.No.	Description	Data
1	Type of engine	4 stroke petrol engine
2	No. of cylinder	Single cylinder
3	Max B.P.	6.15 KW
4	Max. speed	8000 rpm
5	Direction of rotation	Clockwise
6	Bore diameter	50 mm
7	Stroke length	49.5 mm
8	Cubic capacity	97.2 cc

Table 3.2: Engine specification

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Figure 3.2 Engine setup

Gasoline available in market is blended with ethanol in different blends. These are E-10 (10% ethanol + 90% gasoline) E-20 (20% ethanol + 80% gasoline) E-30(30% ethanol + 70% gasoline). Initially density of gasoline is known from which density of different blends were calculated. Same is done for finding the calorific value of all the blends.

BLEND	DENSITY	CV
E-10	741.30	43.5
E-20	746.71	42
E-30	752.22	40.8

Table 3.3 Density and calorific value of blend

Ethanol is similar in nature with gasoline with high octane number. Both are liquid in nature thus storage and transportation are much similar. Both can be mixed easily and burnt. Ethanol has small molecular weight, large oxygen content and high H/C ratio. Octane number for ethanol is 100. Ethanol is oxygenated fuel with small molecules; it can burn fast and fully with oxygen inside. These characters can help to improve thermal efficiency as well as to achieve the cleanliness inside the engine and to reduce exhaust.

Sl.No.	Character	Ethanol	Gasoline
1	Molecular weight	46.07	100-105
2	Composition	(C) = 52% (H) = 13% (O) = 35%	(C) = 85% (H) = 15%
3	Sp. Gravity	0.794	0.7-0.8
4	Density	790	700-780
5	Boiling Temp (0C)	78	27-255
6	Freezing point (0C)	-114	-57
7	Ignition Temp (0C)	423	390-420
8	Air fuel ratio	9.0	14.7
9	Octane number	100	80-99
10	Cetane number	8	0-10

Table 3.4 The physical and chemical properties of ethanol and blend

3.5 ETHANOL DISTILLATION TEST

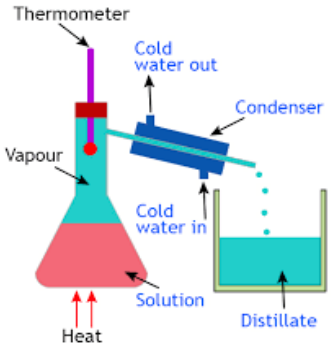

Figure 3.3 Ethanol distillation process

The boiling point of a liquid is the temperature at which the vapour pressure of the liquid equals the pressure around the liquid, enabling bubbles to form without being crushed. A special case is the normal boiling point, where the vapour pressure of the liquid equals the ambient atmospheric pressure.

Raoult's law states that the vapour pressure of a solution is dependent on the vapour pressure of each chemical component in the solution and the fraction of solution each component makes up a.k.a. the mole fraction. This law applies to ideal solutions, or solutions that have different components but whose molecular interactions are the same as or very similar to pure solutions.

Dalton's law states that the total pressure is the sum of the partial pressures of each individual component in the mixture. When a multi-component liquid is heated, the vapour pressure of each component will rise, thus causing the total vapour pressure to rise. When the total vapour pressure reaches the pressure surrounding the liquid, boiling occurs and liquid turns to gas throughout the bulk of the liquid. Note that a mixture with a given composition has one boiling point at a given pressure, when the components are mutually soluble. A mixture of constant composition does not have multiple boiling points.

3.6 GAS ANALYZER MODEL

Figure 3.4 Gas analyzer model IMR 2800-A.

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Parameter	Resolution	Accuracy	Range
(O2) Oxygen	0.1 vol %	0.2%	0-25 Vol%
(CO2) Carbon Dioxide	0.01%	4%rel	0-10%
(CO) carbon Oxide	0.01%	4%rel	0-10%
(NO) nitric Oxide	1ppm	4%rel	0-5000ppm
(NO2) Nitric Dioxide	1ppm	Z	0-100ppm
(SO2) Sulfur Dioxide	1ppm	Z	0-4000ppm
(HC) Hydro carbons	1ppm	2% of range	0-3000ppm
(TG) Flu Temperature	1K	2%	-4^F/2192^C -20^c/1200^C
(TA) Air Temperature	1K	0.5K	-20^F/120^C 50c/104^C

Table 3.5 Specification of IMR 2800-A type emission gas analyzer device

. A lean mixture contains an excess of oxygen. The surplus oxygen will react with nitrogen to NOx (Oxides of Nitrogen), if the temperature is high enough (around 1600°C) for enough time to permit so.

A rich mixture contains a deficit of oxygen. This makes it impossible for all fuel to combust completely to carbon dioxide and water vapour. Hence, some fuel will remain as a hydrocarbon (HC), or it will react only to carbon monoxide (CO). The carbon monoxide concentration in exhaust gases is closely related, and almost proportional to the air fuel ratio in the rich regions. It is, therefore, of great value when tuning an engine.

4 RESULT AND DISCUSSION

4.1 PARAMETER TEST

The parameters that have been tested are performance tests and emission tests. For the performance tests, the terms that were considered are torque, fuel consumption rate and power. For the emission test, the term that were considered are hydrocarbon (HC), carbon dioxide (CO_2), carbon monoxide (CO), oxygen (O_2) and nitrogen oxides (NOx). The data were recorded and presented by using Origin software to have a clear graphical presentation for further analysis

SI NO	VEHICLE TYPE	CO%	HC (n-Hexane equivalent, PPM)
1	2&3- Wheelers (2/4-stroke) (Vehicles Manufactured on before 21st March 2000)	4.5	9000
2	2&3- Wheelers (2stroke) (Vehicles Manufactured on before 31st March 2000)	3.5	6000
3	2&3- Wheelers (4stroke) (Vehicles Manufactured on before 31st March 2000)	3.5	4500
4	Bharath Stage 2 Complaint 4 Wheelers	0.5	750
5	4-Wheelers other than Bharath Stage 2 Complaint	3.0	1500

Table 4.1 Permissible Limits for Petrol/CNG/LPG Driven Vehicles

4.2 ENGINE EMISSION ANALYSIS

For the emission tests, the data for all types of fuels have been recorded include hydrocarbon (HC), oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NOx) and smoke opacity. The average of the data for engine emissions analysis was stated in the following table in appendices.

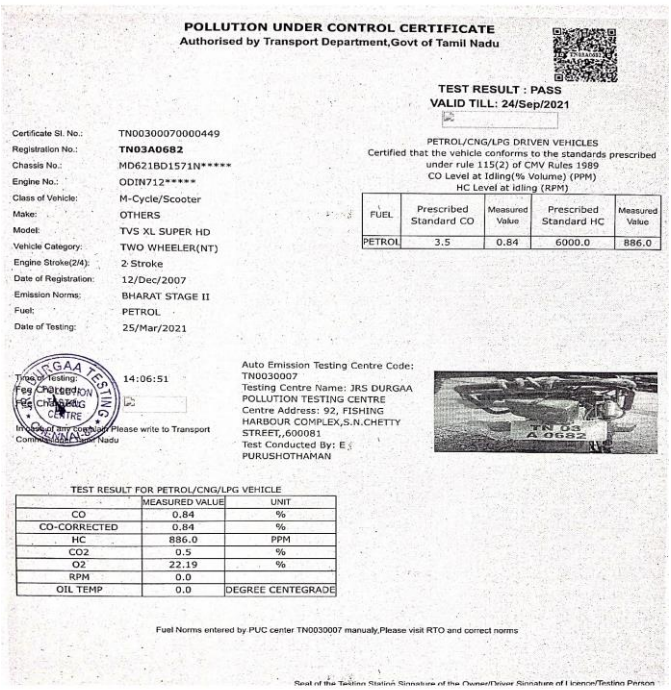
4.3 PUC

PUC (Pollution Under Control) is a Certification Mark issued to certify that motor vehicles in India meet emission and pollution control norms.

4.4 THE PROCEDURE FOR PUC TESTS

- The accelerator should be fully pressed.
- The reading of pollution levels should be noted with the acceleration pedal fully pressed.
- The average of five readings is considered as the Final Reading
- The vehicle is kept idling without the accelerator pressed.
- Only one reading is taken.

4.3 TEST USING IN PETROL


POLLUTION UNDER CONTROL CERTIFICATE
Authorised by Transport Department,Govt of Tamil Nadu

TEST RESULT : PASS
VALID TILL: 24/Sep/2021

Certificate Sl. No.: TN00300070000449
Registration No.: TN03A0682
Chassis No.: MD621BD1571N*****
Engine No.: ODIN712*****
Class of Vehicle: M-Cycle/Scooter
Make: OTHERS
Model: TVS XL SUPER HD
Vehicle Category: TWO WHEELER(NT)
Engine Stroke(2/4): 2-Stroke
Date of Registration: 12/Dec/2007
Emission Norms: BHARAT STAGE II
Fuel: PETROL
Date of Testing: 25/Mar/2021

PETROL/CNG/LPG DRIVEN VEHICLES
Certified that the vehicle conforms to the standards prescribed under rule 115(2) of CMV Rules 1989

FUEL	Prescribed Standard CO (CO Level at Idling(% Volume))	Measured Value	Prescribed Standard HC (HC Level at idling (RPM))	Measured Value
PETROL	3.5	0.84	6000.0	886.0

Time of Testing: 14:06:51
Type of Fuel: Petrol/CNG/LPG

Auto Emission Testing Centre Code: TN0030007
Testing Centre Name: JRS DURGAA POLLUTION TESTING CENTRE
Centre Address: 92, FISHING HARBOUR COMPLEX,S.N.CHETTY STREET,,600081
Test Conducted By: E PURUSHOTHAMAN

TEST RESULT FOR PETROL/CNG/LPG VEHICLE

	MEASURED VALUE	UNIT
CO	0.84	%
CO-CORRECTED	0.84	%
HC	886.0	PPM
CO2	0.5	%
O2	22.19	%
RPM	0.0	
OIL TEMP	0.0	DEGREE CENTEGRADE

Fuel Norms entered by PUC center TN0030007 manualy,Please visit RTO and correct norms

Figure 4.1 Copy of petrol emission report

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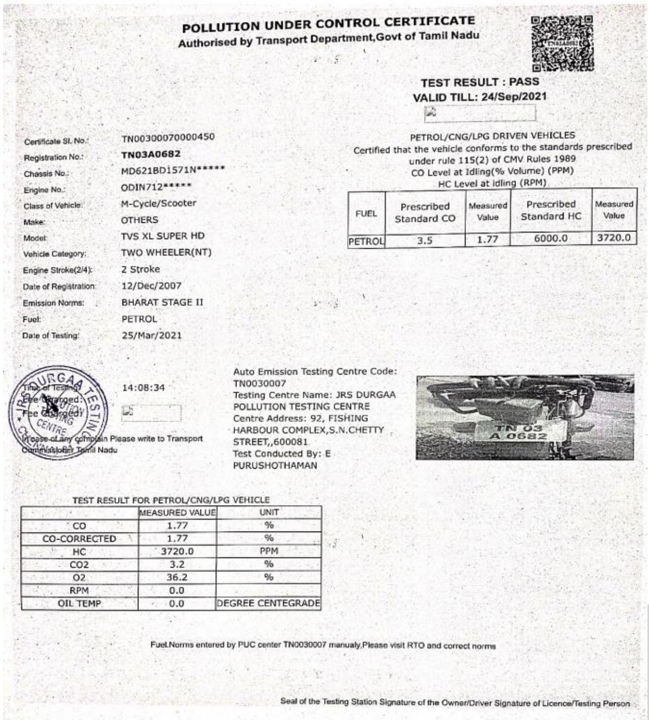
4.4 TEST USING IN BLENDED FUEL



POLLUTION UNDER CONTROL CERTIFICATE
Authorised by Transport Department,Govt of Tamil Nadu

TEST RESULT : PASS
VALID TILL: 24/Sep/2021

Certificate Sl. No.: TN00300070000450
Registration No.: TN03A0682
Chassis No.: MD621BD1571N*****
Engine No.: ODIN712*****
Class of Vehicle: M-Cycle/Scooter
Make: OTHERS
Model: TVS XL SUPER HD
Vehicle Category: TWO WHEELER(NT)
Engine Stroke(2/4): 2 Stroke
Date of Registration: 12/Dec/2007
Emission Norms: BHARAT STAGE II
Fuel: PETROL
Date of Testing: 25/Mar/2021

PETROL/CNG/LPG DRIVEN VEHICLES
Certified that the vehicle conforms to the standards prescribed under rule 115(2) of CMV Rules 1989
CO Level at Idling(% Volume) (PPM)
HC Level at idling (RPM)

FUEL	Prescribed Standard CO	Measured Value	Prescribed Standard HC	Measured Value
PETROL	3.5	1.77	6000.0	3720.0

Time of Testing: 14:08:34
Fee Charged:
In case of any complain Please write to Transport Commissioner Tamil Nadu

Auto Emission Testing Centre Code: TN0030007
Testing Centre Name: JRS DURGAA POLLUTION TESTING CENTRE
Centre Address: 92, FISHING HARBOUR COMPLEX,S.N.CHETTY STREET,,600081
Test Conducted By: E PURUSHOTHAMAN

TEST RESULT FOR PETROL/CNG/LPG VEHICLE

	MEASURED VALUE	UNIT
CO	1.77	%
CO-CORRECTED	1.77	%
HC	3720.0	PPM
CO2	3.2	%
O2	36.2	%
RPM	0.0	
OIL TEMP	0.0	DEGREE CENTEGRADE

Fuel.Norms entered by PUC center TN0030007 manualy,Please visit RTO and correct norms

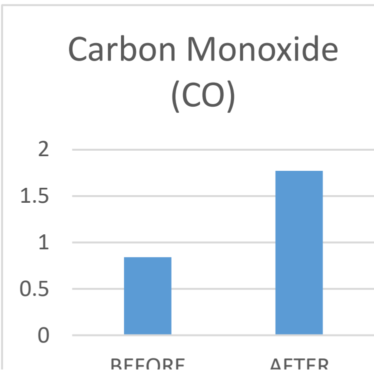
Seal of the Testing Station Signature of the Owner/Driver Signature of Licence/Testing Person

Figure 4.2 Copy of ethanol emission report

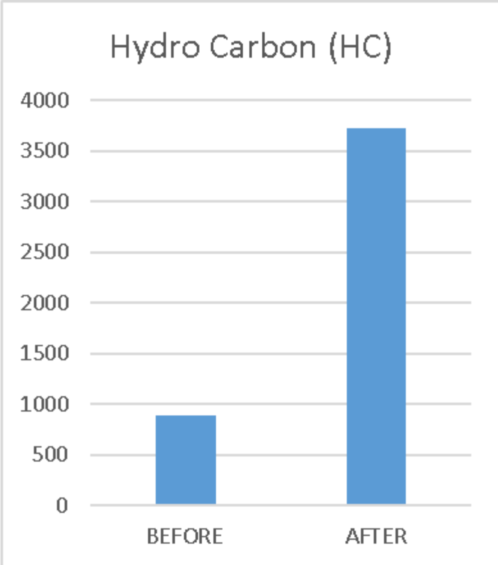
4.5 COMPRESSION BETWEEN PETROL AND BLENDED FUEL

PARAMETERS	BEFORE IMPLEMENTATION	AFTER IMPLEMENTATION
Carbon Monoxide (CO)	0.84%	1.77%
Hydro Carbon (HC)	886.0ppm	3720.0ppm

TABLE 4.2 COMPRESSION BETWEEN PETROL AND BLENDED FUEL



Graph 4.1 Hydrocarbon (HC) Emission from the engine



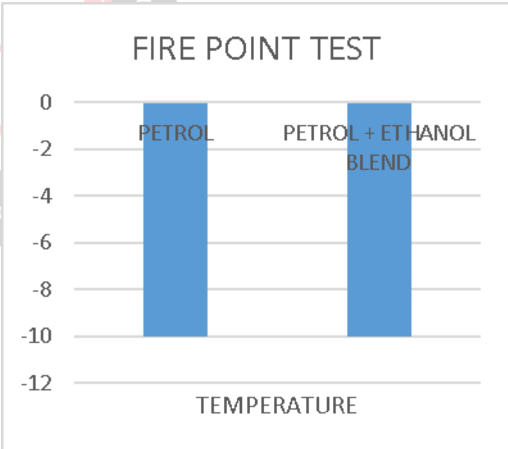
Graph 4.2 Hydrocarbon (HC) Emission from the engine

In the above shown the result of the hydrocarbon (ppm)before implementation of ethanol and after implementation of ethanol in the SI engine while comparing this results in ethanol blend HC emission is comparatively low.

4.6 FIRE POINT TEST

TEST DESCRIPTION	PETROL	PETROL + ETHANOL BLEND
FIRE POINT	BELOW-10^{O}C	BELOW-10^{O}C

Table 4.3 fire point test



Graph 4.3 Fire Point Test Comparison

5 CONCLUSION

The objective of this study is to investigate the effect of ethanol petrol mixing on performance and emissions of a petrol engine.

The performance of all mixtures was successfully investigated based on engine emission test, the parameter that was investigated are Carbon Dioxide (CO_2), Carbon Monoxide (CO), Hydrocarbon (HC),

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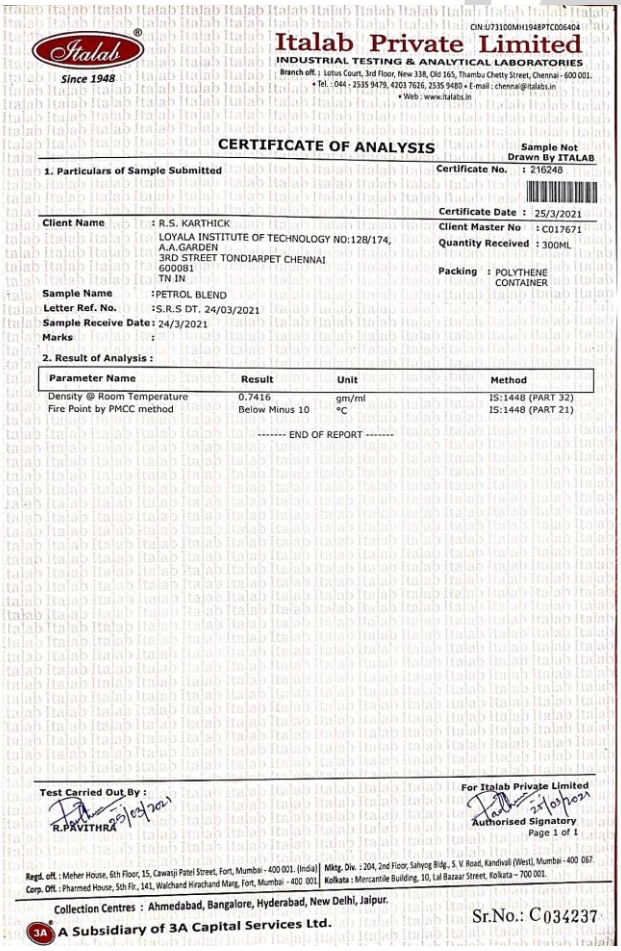
i. Ethanol improves engine torque are that ethanol has higher anti-knock quality due to high octane number. The decrease results from a difference of mole numbers of combustion products compared to petrol.

ii. The tested blends developed higher power and fuel consumption rate, and less emission.

iii. The ethanol petrol blends had been successfully tested as alternative fuel for spark ignition and the result for engine power slightly increase without engine modification.

iv. The result of this study showed, CO decreased at high engine speed and HC decreased at the high blending ratio (E10) at WOT position. This is due to the oxygen content in ethanol petrol perform the complete combustion in the combustion chamber. The engine performance and emission of a SI engine have been investigated by using ethanol petrol blended fuel and pure petrol. Experimental results indicated that when ethanol petrol lend is used, the engine power and fuel consumption of the engine slightly increase, CO emission decrease as a result of the leaning effect conditions and CO_2 emission increase because of the improved combustion.

6 LAB REPORT



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CERTIFICATE OF ANALYSIS

Sample Not Drawn By ITALAB

1. Particulars of Sample Submitted

Certificate No. : 216248

Certificate Date : 25/3/2021

Client Name : R.S. KARTHICK
LOYALA INSTITUTE OF TECHNOLOGY NO:128/174, A.A.GARDEN
3RD STREET TONDIARPET CHENNAI
600081
TN IN

Client Master No : C017671

Quantity Received : 300ML

Packing : POLYTHENE CONTAINER

Sample Name : PETROL BLEND

Letter Ref. No. : S.R.S DT. 24/03/2021

Sample Receive Date : 24/3/2021

Marks :

2. Result of Analysis :

Parameter Name	Result	Unit	Method
Density @ Room Temperature	0.7416	gm/ml	IS:1448 (PART 32)
Fire Point by PMCC method	Below Minus 10	°C	IS:1448 (PART 21)

------- END OF REPORT -------

Test Carried Out By : R.PAVITHRA 25/03/2021

For Italab Private Limited

Authorised Signatory

Page 1 of 1

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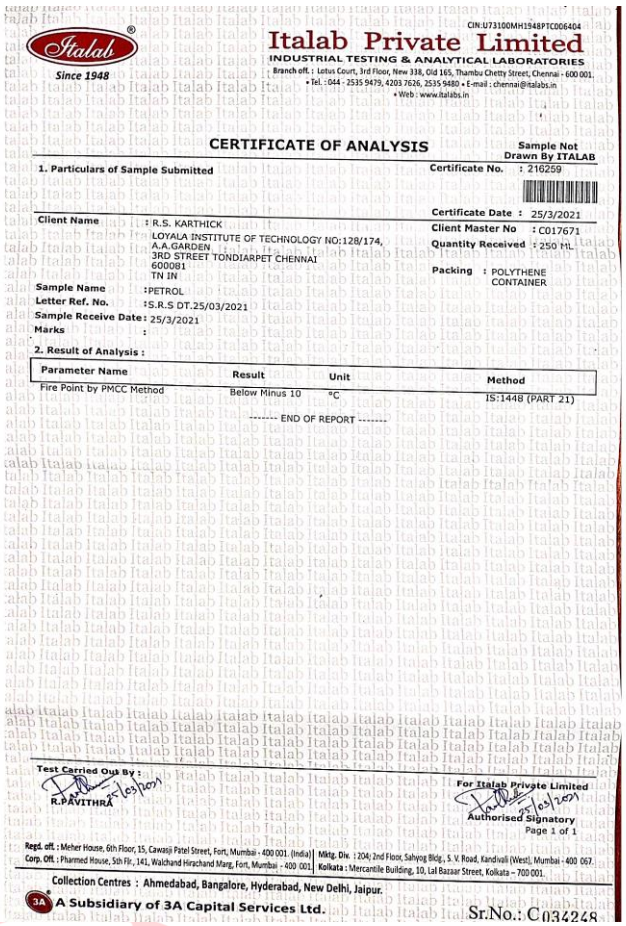
Figure 6.1Density and Room Temperature fire point by PMCC report



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CERTIFICATE OF ANALYSIS

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1. Particulars of Sample Submitted

Certificate No. : 216259

Certificate Date : 25/3/2021

Client Name : R.S. KARTHICK
LOYALA INSTITUTE OF TECHNOLOGY NO:128/174, A.A.GARDEN
3RD STREET TONDIARPET CHENNAI
600081
TN IN

Client Master No : C017671

Quantity Received : 250 ML

Packing : POLYTHENE CONTAINER

Sample Name : PETROL

Letter Ref. No. : S.R.S DT.25/03/2021

Sample Receive Date : 25/3/2021

Marks :

2. Result of Analysis :

Parameter Name	Result	Unit	Method
Fire Point by PMCC Method	Below Minus 10	°C	IS:1448 (PART 21)

------- END OF REPORT -------

Test Carried Out By : R.PAVITHRA 25/03/2021

For Italab Private Limited

Authorised Signatory

Page 1 of 1

Regd. off. : Meher House, 6th Floor, 15, Cawasji Patel Street, Fort, Mumbai - 400 001. (India) | Mktg. Div. : 204, 2nd Floor, Sahyog Bldg., S. V. Road, Kandivali (West), Mumbai - 400 067.
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3A A Subsidiary of 3A Capital Services Ltd.

Sr.No.: C034248

Figure 6.2 Fire point by PMCC Method

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