# EMISSION TEST ON S.I ENGINE USING ALTERNATIVE FUELS AND ETHANOL

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*Abstract*— The uses of automobiles are increasing day by day and increased Air pollution. Increasing global concern due to air pollution has generated much interest in the environmental friendly alternative fuels. Alternative fuels for IC engines are also becoming important because of diminishing gasoline reserves and increasing air pollution. Also one of method to use tri-fuels (Petrol and Kerosene) with additives of ignition in combustion chamber improves the rate of combustion and reduce the Air pollution. The Air-fuel mixture gets ignited and the flame travel for complete combustion in the chamber. The emission outcomes phenomena are to be analyzed and also efficiency of the engine checked by constructing the load test method. Ethanol is good candidates as alternative fuel. In this study, the effect of ethanol fuel blends and spark plugs ignition are investigated on 2- stroke single cylinder SI engine for analyzing the performance and combustion characteristics. The tests were performed using an electric dynamometer while running the engine and different load conditions. Exhaust gases namely, carbon dioxides (CO2), carbon monoxide (CO2) and unburned hydrocarbons (HC) are measured using multi exhaust gas analyzer. Exhausts emissions of the fuels is founded.

***Key words:*** Air pollution, Alternative fuels, tri-fuels, Air-fuel mixture, Ethanol

## I. INTRODUCTION

Ethanol (which is also called ethyl alcohol or grain alcohol, and abbreviated as EtOH) is an alcohol-based alternative fuel that is blended with gasoline to produce a fuel with a higher octane rating and fewer harmful emissions than unblended gasoline. Ethanol has been used by humans since prehistory as the intoxicating ingredient of alcoholic beverages. Dried residue on 9,000-year-old pottery found in China imply that Neolithic people consumed alcoholic beverages. Although distillation was well known by the early Greeks and Arabs, the first recorded production of alcohol from distilled wine was by the School of Salerno alchemists in the 12th century. The first to mention absolute alcohol, in contrast with alcohol-water mixtures, was Raymond Lull. Ethanol was first prepared synthetically in 1826 through the independent efforts of Henry Hennel in Great Britain and S.G. Sérullas in France. In 1828, Michael Faraday prepared ethanol by acid-catalyzed hydration of ethylene, a process similar to current industrial ethanol synthesis.

## II. SPARK-IGNITION ENGINE

The term spark-ignition engine refers to internal combustion engines, usually petrol engines, where the combustion process of the air-fuel mixture is ignited by a spark from a spark plug. This is in contrast to compression-ignition engines, typically diesel engines, where the heat generated from compression is enough to initiate the combustion process, without needing any external spark. Spark-ignition engines are commonly referred to as "gasoline engines" in America, and "petrol engines" in Britain and the rest of the world. However, these terms are not preferred, since spark-ignition engines can (and increasingly are) run on fuels other than petrol/gasoline, such as auto gas (LPG), methanol, ethanol, bioethanol, compressed natural gas (CNG), hydrogen, and (in drag racing) nitro methane.


Fig. 1: Spark-Ignition Engine

## III. WORKING CYCLE

A four-stroke spark-ignition engine is an Otto cycle engine. It consists of following four strokes: suction or intake stroke, compression stroke, expansion or power stroke, exhaust stroke. Each stroke consists of 180 degree rotation of crankshaft rotation and hence a four-stroke cycle is completed through 720 degree of crank rotation.

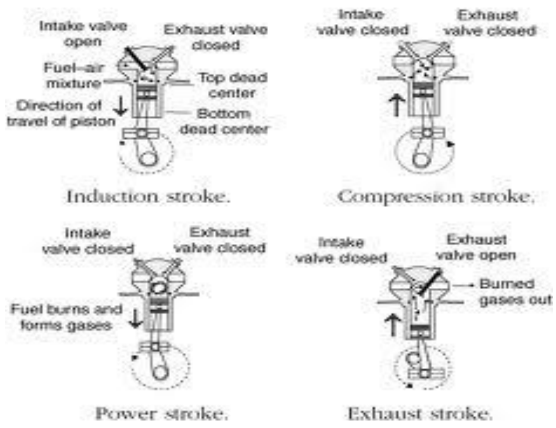



Fig. 2: working cycle

## IV. FUELS PETROL

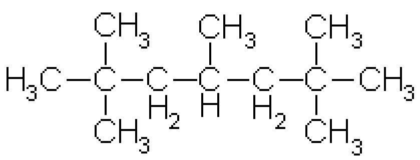
Petrol is a naturally occurring flammable liquid consisting of a complex mixture of hydrocarbons of various molecular weights and other liquid organic compounds, that are found in geologic formations beneath the Earth's surface. The name Petroleum covers both naturally occurring unprocessed crude oils and petroleum products that are made up of refined crude oil. A fossil fuel, it is formed when large quantities of dead organisms, usually zooplankton and algae, are buried underneath sedimentary rock and undergo intense heat and pressure. Petrol is recovered mostly through oil drilling. This comes after the studies of structural geology (at the reservoir scale), sedimentary basin analysis, reservoir characterization (mainly in terms of porosity and permeable structures). It is refined and separated, most easily by boiling point, into a large number of consumer products, from petrol (or gasoline) and kerosene to asphalt and chemical reagents used to make plastics and pharmaceuticals. Petroleum is used in manufacturing a wide variety of materials, and it is estimated that the world consumes about 88 million barrels each day. The use of fossil fuels such as petroleum can have a negative impact on Earth's biosphere, releasing pollutants and greenhouse gases into the air and damaging ecosystems through events such as oil spills. Concern over the depletion of the earth's finite reserves of oil, and the effect this would have on a society dependent on it, is a concept known as peak oil.

$$2C_8H_{18} + 25O_2 \rightarrow 18H_20 + 16CO_2 + \textbf{energy}$$

$$(\text{octane} + \text{oxygen} \rightarrow \text{water} + \text{carbon dioxide} + \text{energy})$$

## V. KEROSENE

Kerosene has more than one chemical structure because it contains carbons from 12 carbons to 15 carbons. The molecular formulas can range from $C_{12}H_{26}$ to $C_{15}H_{32}$



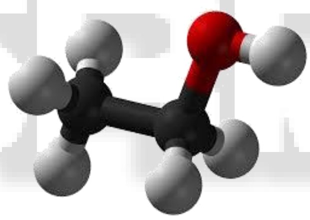
## VI. THE MAKING OF KEROSENE

Kerosene is made by refining petroleum oil. Petroleum oil is also known as crude oil. The first step to refining petroleum oil is washing the oil to get rid of salts and inorganic materials. Next, the crude oil goes through fractional distillation. During fractional distillation, crude oil is placed in a distillation tower. The tower is then heated to a very high temperature. Hydrocarbons separate due to the heat because hydrocarbons boil at a different temperature. Kerosene boils from 200° C to 300° C. Fractional distillation creates 5% to 20% or kerosene. Kerosene can also be obtained from coal, wood and shade oil, but kerosene is mainly obtained through refining petroleum oil.

## VII. KEROSENE AS POISON

Kerosene is poisonous when inhaled or ingested. Some symptoms of being poisoned by kerosene include burning of the skin, irritation of the skin, breathing difficulties, throat swelling, dizziness and drowsiness. Although kerosene is poisonous, kerosene can be used as a type of medicine called folk medicine. It can be used to cure snakebites and kill lice. Some people use kerosene to prevent mosquitoes from breeding. People living in developing countries have difficulties finding medicine and use kerosene to replace alcohol to treats cuts and burns. It can also be used against athlete’s foot and hemorrhoids.

## VIII. ETHANOL



Molecular diagram

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Ethanol has been used by humans since prehistory as the intoxicating ingredient of alcoholic beverages. Dried residue on 9,000-year-old pottery found in China imply that Neolithic people consumed alcoholic beverages

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## IX. PROPERTIES OF ETHANOL

Ethanol burning with its spectrum depicted Ethanol is a volatile, colorless liquid that has a slight odor. It burns with a smokeless blue flame that is not always visible in normal light

The physical properties of ethanol stem primarily from the presence of its hydroxyl group and the shortness of its carbon chain. Ethanol's hydroxyl group is able to participate in hydrogen bonding, rendering it more viscous and less volatile than less polar organic compounds of similar molecular weight.

| | |
|---|---|
| Molecular formula | $C_2H_6O$ |
| Molar mass | 46.07 g $mol^{-1}$ |
| Exact mass | 46.041864814 g $mol^{-1}$ |
| Appearance | Colorless liquid |
| Density | 0.789 g/$cm^3$ |
| Melting point | −114 °C, 159 K, -173 °F |
| Boiling point | 78 °C, 351 K, 172 °F |
| log P | -0.18 |
| Vapor pressure | 5.95 kPa (at 20 °C) |
| Acidity ($pK_a$) | 15.9[2] |
| Basicity ($pK_b$) | -1.9 |
| Refractive index ($n_D$) | 1.36 |
| Viscosity | 0.0012 Pa s (at 20 °C) |
| Dipole moment | 1.69 D |

## X. THER BENEFICIALQUALITIES

Kerosene can be a solvent or a fuel. An example of fuel is jet fuel. Kerosene acts a solvent in insecticide spray. Kerosene can also be used for heating homes, this is most popular in Asia. Camping stoves can find use of this hydrocarbon as an alternative fuel.

## XI. INTERESTING FACTS

Kerosene is known to be paraffin oil in the United Kingdom and stove oil in Canada. Kerosene is a clear liquid that is used in oil lamps. An environmental economist from Washington, D.C. has stated hat kerosene can save trees. It saves forests by burning kerosene instead of charcoal. Not only does kerosene save trees but it also creates a healthier environment from those who burn kerosene.

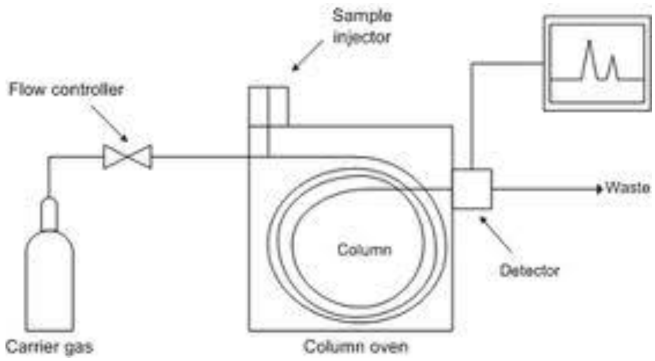
## XII. EMISSION ANALIZER

### A. *Exhaust gas analizer*

Gasboard—5020 emission gas analyzer can be used for measurement of the concentration of automobile emission gas CO, $CO_2$, HC, $O_2$ and NO (optional). It is based on the pulsable infrared source and single source two beams non-dispersion infrared (NDIR) method, this analyzer is designed with portable and smaller physical dimensions.

#### 1) *Opacity meter*

The Gasboard—6010 opacity meter is used to measure the diesel exhaust smoke by the introduction of a proportion of the vehicle exhaust gasses into the smoke check chamber via a sample probe. It is equipped with a gas temperature, pressure valve and distribution control cell in order to ensure accuracy and repeatability. It can measure the complete opacity spectrum from 0-100% in either continuous or free acceleration test mode.




#### 2) *Engine rpm sensor based on vibration and noise:*

Engine RPM Sensor Based on Vibration and Noise Gasboard—8110 adopts advanced design of hardware together with integrated software analysis technology. Petrol engine or diesel engine's RPM is obtained through analysis of vibration and audio spectrum signal. It is easy to operate, accurate and reliable.

## XIII. EXHAUST EMISSIONS CHARACTERISTICS

The experimental results for different load conditions for various percentages of methanol compared with gasoline in the form of graphs are shown below. Emission characteristics are improved for additive methanol compared to petrol except NOx which is slightly higher than gasoline. This indicates that the combustion efficiency is high for additive gasoline. The occurrence of the increasingly severe ambient ozone exceedances, regional environmental managers are examining the possibility of a cleaner fuel for automobiles. At this time the leading candidate appears to be methanol. In anticipation of a shift to methanol, flexible-fueled automobiles capable of operatingon gasoline and/or methanol are being developed. Addition to regulated emissions and fuel economy, emission rates for methanol, aldehydes, and a large number of hydrocarbon compounds were measured. The data indicate that increasing the fuel's methanol content does not affect the exhaust organic emission rate (calculated in accordance with the regulation) from flexible-fueled cars, but formaldehyde and methanol comprise increasingly greater portions of the organic material while hydrocarbons comprise less. Increasing fuel methanol content has no significant effect on exhaust regulated emission rates (organic material, carbon monoxide, and nitrogen oxides) nor on the composition of total hydrocarbons, except for methane, which increases substantially. The effect of ambient temperature on both exhaust and evaporative emissions is similar to its effect on gasoline cars: organic and carbon monoxide exhaust emissions increase substantially at the lower temperatures, and evaporative emissions increase steadily with increases in temperature.

*A. Carbon Monoxide*

It is observed that CO increases with increasing load for all the percentage of methanol. If percentage of additive increases CO reduces. This is due to the batter combustion of gasoline when methanol used as a additive. The concentration of CO decreases with the increase in percentage of methanol in the fuel. This may be attributed to the presence of O2 in methanol, which provides sufficient oxygen for the conversion of carbon monoxide (CO) to carbon dioxide (CO2).

*B. Nitrogen Oxide*

NOx decreases with increasing load for all the percentage of methanol. If percentage of additives increases, NOx increases. The comparison of NOx emissions for gasoline and additives. It can be seen that NOx emissions increase with increase in percentage of methanol in the petrol The NOx increase for additive of methanol may be associated with the oxygen content of the methanol, since the fuel oxygen may augment in supplying additional oxygen for NOx formation. Moreover, the higher value of peak cylinder pressure and temperature for methanol when compared to petrol may be another reason that might explain the increase in NOX formation. Nitrogen oxides (NOx) is the generic term for a group of highly reactive gases containing nitrogen and oxygen in varying amounts, including nitric oxide (NO), nitrous oxide (N2O),nitrates (NO3–), and nitrogen dioxide (NO2). NOx and volatile organic compounds, in the presence of hot, stagnant air and sunlight, convert to ozone. NOx are classified as hazardous airborne toxins because of their deleterious health and environmental effects. The U.S. Environmental Protection Agency (EPA) has noted that NOxis a major cause of ground- level ozone (a.k.a. smog), acid rain, respiratory disease (emphysema and bronchitis), water quality determination, and global warming.

*C. Hydro Carbon*

It is observed that hydro carbon (HC) decreases with increasing load for all the percentage of methanol. If percentage of additive of methanol increases, HC reduces. The hydrocarbon emissions are inversely proportional to the percentage of methanol added in the fuel. The petrol fuel operation showed the slightly higher concentrations of HC in the exhaust at all loads. Since methanol is an oxygenated fuel, it improves the combustion efficiency and hence reduces the concentration of hydrocarbon emissions (HC) in the engine exhaust. Blending 10% additive with gasoline greatly reduces HC emissions especially at all load condition.

*D. Carbon dioxide*

Carbon dioxide is a naturally occurring gas that is linked to global warming. It is also releasedinto the atmosphere by human activity, such as when solid waste, fossil fuels (oil, natural gas,and coal), and wood and wood products are burned (95). Carbon dioxide by itself is notconsidered to be a toxin. However, any impacts on global climate could cause health problems.

*E. Petrol*

| S. No | Voltage (V) | Ammeter (I) (I) | Power (W) | Time Taken for10 sec (t) | Brake power (KW) | Total fuel consumption (Kg/hr) | Specific fuel consumption (Kg/kw-hr) | Brake thermal efficiency % |
|---|---|---|---|---|---|---|---|---|
| 1. | 220 | 0.5 | 110 | 27 | 0.146 | 1.052 | 7.205 | 15.42 |
| 2. | 205 | 1.2 | 240 | 25 | 0.32 | 1.136 | 3.55 | 33.8 |
| 3. | 190 | 1.9 | 361 | 23 | 0.481 | 1.234 | 2.565 | 50.8 |

*F. Petrol With Ethanol*

| S. No | Voltage (V) | Ammeter (I) | Power (W) | Time Taken for10 sec (t) | Brake power (KW) | Total fuel consumption (Kg/hr) | Specific fuel consumption (Kg/kw-hr) | Brake thermal efficiency % |
|---|---|---|---|---|---|---|---|---|
| 1 | 230 | 0.7 | 161 | 26 | 0.214 | 1.020 | 4.766 | 24.35 |
| 2 | 220 | 1.4 | 308 | 22 | 0.410 | 1.206 | 2.941 | 46.66 |
| 3 | 200 | 2.3 | 460 | 17 | 0.613 | 1.560 | 2.544 | 69.77 |

*G. Kerosene With Ethanol*

| S. No | Voltage (V) | Ammeter (I) (I) | Power (W) | Time Taken for 10sec (t) | Brake power (KW) | Total fuel consumption (Kg/hr) | Specific fuel consumption (Kg/kw-hr) | Brake thermal efficiency % |
|---|---|---|---|---|---|---|---|---|
| 1. | 230 | 0.2 | 46 | 28 | 0.06 | 1.01 | 16.9 | 12 |
| 2. | 200 | 0.6 | 120 | 24 | 0.16 | 1.18 | 7.40 | 35 |
| 3. | 180 | 1.0 | 180 | 20 | 0.24 | 1.42 | 5.92 | 47 |

## XIV. FORMULA TO BE USED

### A. Brake Power

It is defined as the power available at the crank shaft.it is always less than the indicated power.

BP=power/0.75kw

### B. Total Fuel Consumption

TFC is defined as a fuel consumed by the engine in kg for 1 hr of operation

TFC=(10/t)*(s/100)*3600 kg/hr

where

T-time taken for 10ml fuel consumption in sec

S-specific gravity of fuel

### C. Specific Fuel Consumption

Fuel consumed by the engine in kg for producing 1 kw-hr of power

SFC=TFC/B.P kg/kw-hr

### D. Brake Thermal Efficiency

It is defined as the η brake power to the heat supplied to an engine

ηBT= brake power / heat supplied

ηBT=B.P/(mf*cv/3600)

## XV. MODEL CALCULATION

### A. Petrol

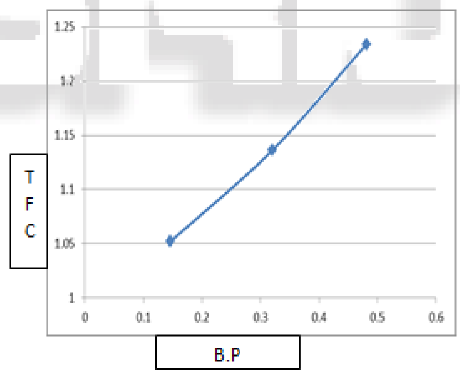
1) BP =P/0.75
   =0.11/0.75
   =0.146KW
2) TFC=10/T * S / 1000 * 3600
   = 10 / 27 * 0.789 / 1000 * 3600
   = 1.052 Kg/ hr
3) SFC=TFC / BP
   = 1.052 / 0.146
   = 7.205 Kg/Kw/hr
4) ȠBT = BP * 3600/MF * CV
   = 0.146* 3600 / 0.71* 48000 * 1000
   = 15.42%

### B. Petrol with ethanol

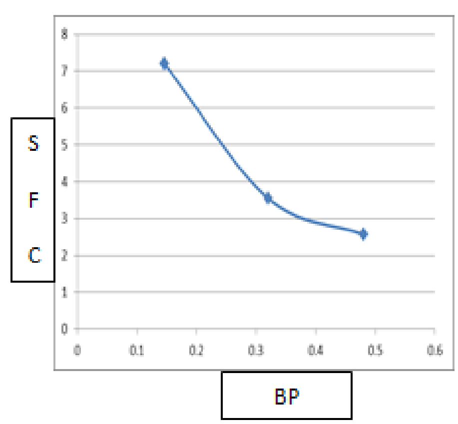
1) BP =P/0.75
   = 0.161/ 0.75
   = 0.214 KW
2) TFC=10/T * S / 1000 * 3600
   = 10 / 26 * 0.737 /1000 * 3600
   = 1.02 Kg / hr
3) SFC= TFC / BP
   = 1.02 / 0.214
   = 4.766 kg / kw / hr
4) ȠBT = BP * 3600/MF * CV
   = 1.02 * 3600 / 68.5 *

## XVI. PETROL

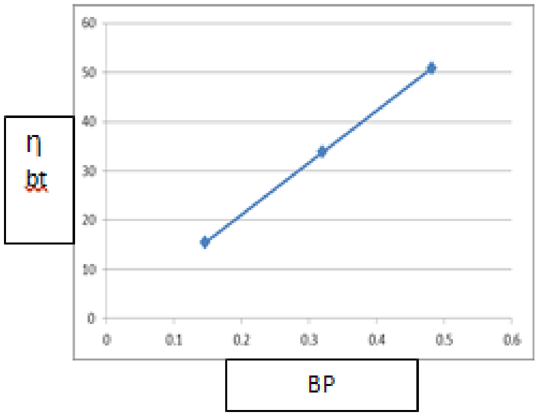
### A. BP VS TFC




### B. BP VS SFC

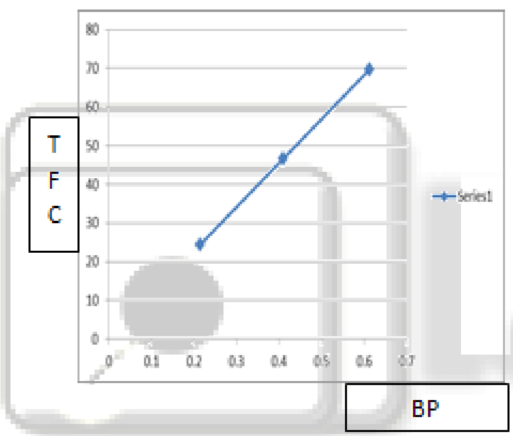


*C. BP VS ηbt*

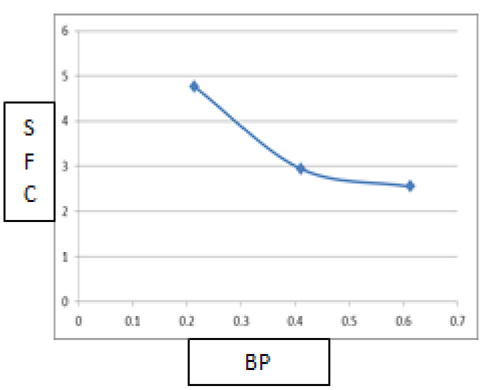



## XVII. PETROL WITH ETHANOL

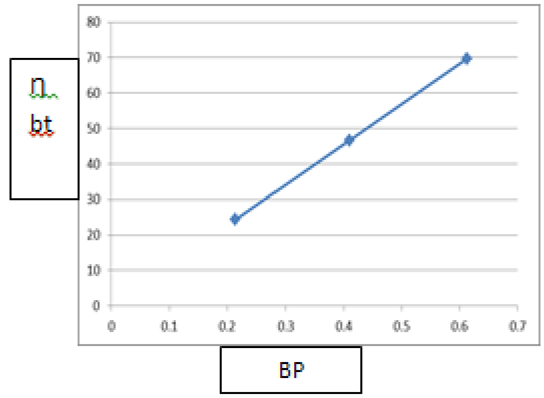
*A. BP VS TFC*




*B. BP VS SFC*

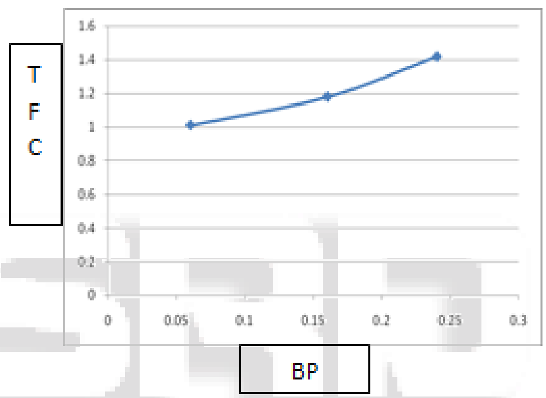



*C. BP VS ηbt*

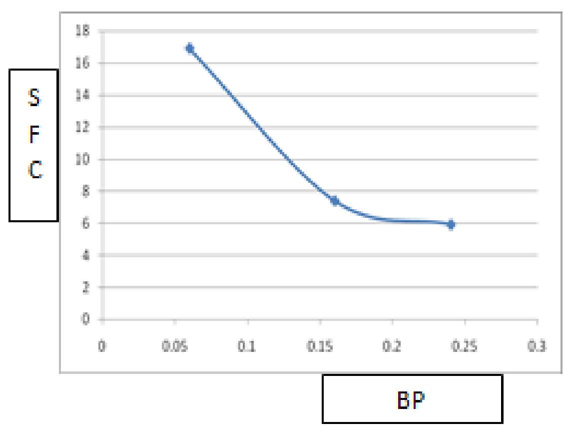



## XVIII. KEROSENE WITH ETHANOL

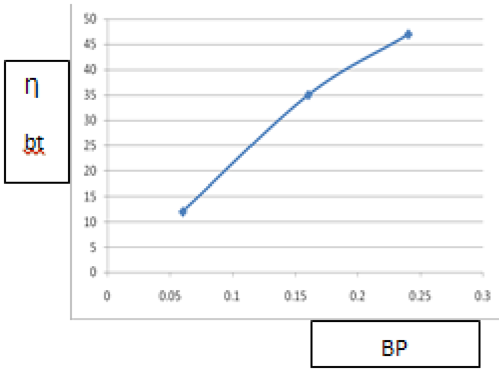
*A. BP VS TFC*




*B. BP VS SFC*



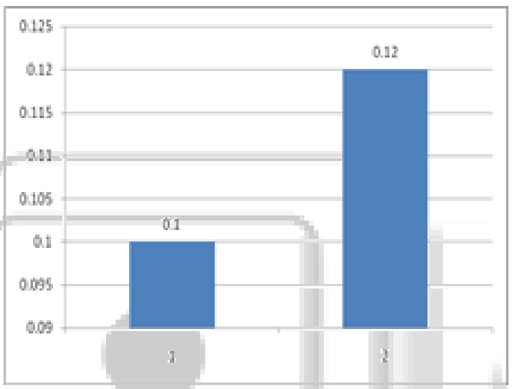
### *C. BP VS ηbt*



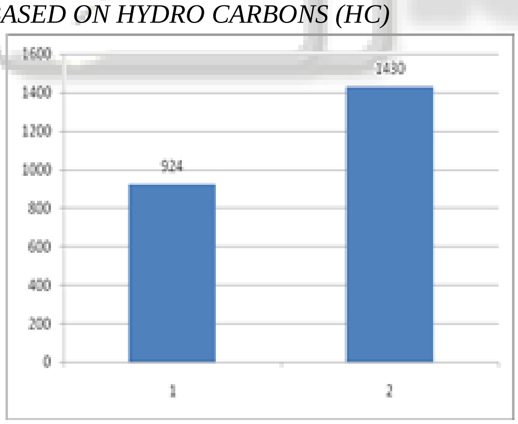

## XIX. EMISSION CHART

### *A. PETROL VS ETHANOL*

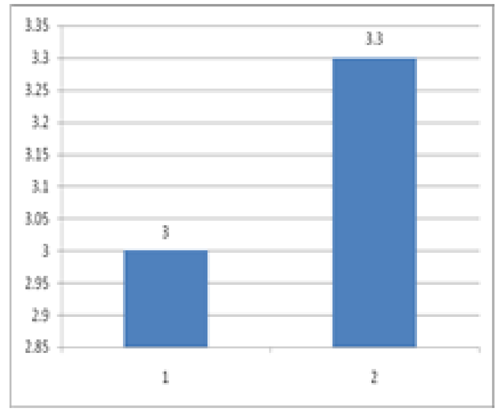
#### *1) BASED ON CARBONS (CO)*



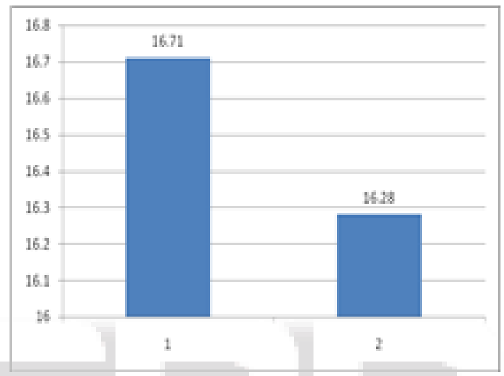

#### *2) BASED ON HYDRO CARBONS (HC)*




#### *3) BASED ON CO2*




#### *4) BASED ON O2*




## XX. CONCLUSION

Experiments have been conducted on generator petrol engine with different percentage of ethanol as additive. It is concluded that, the percentage of additive increases the emission characteristics improved expect NOx and CO2. It is observed that the emission values of The HC and CO are decreased when compared with petrol and kerosene.

But The NOx emissions are increased due to presence of oxygen contention the ethanol and also the combustion temperature is high. The engine performance indicating parameters like brake power, TFC & SFC, brake thermal efficiency, additive at different loads**.** The brake thermal efficiency increases with increase in percentage of additive. Thus ethanol may be used as a additive for gasoline in future.

*From the results of the study, the following conclusions can be deduced:*

*(1)* Using, ethanol as a fuel additive gasoline causes an improvement in engine performance.
*(2)* The addition of 10ml of ethanol is added to petrol and kerosene and achieved in our experiments without any problems during engine operation.

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