An experimental investigation on the Effects of using/blending ethanol additive with gasoline on the CO and HC emission characteristics of an SI internal combustion engine

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Abstract:

Aim: The main aim of this paper is to present the results of an experimental investigation of using ethanol as an additive in SI engines. In this experiment a single type of fuel additive used that is ethanol, made up of various feed stocks from variety of biomass material popularly known as biofuel additive. This ethanol additive is blended with gasoline by 1:2 volumetrically.

Methodology: Lab investigation using selected samples of ethanol blending with selected gasoline, and measuring the CO and HC concentrations in the range of 1500-2500 RPM at the intervals of 250 RPM.

Results: It is observed that increase in CO emission concentration occured on increasing the engine speed and decrease in HC emission concentration occured on increasing the engine speed.

Conclusion: The data analysis of this experiment concluded that CO emission concentration increases with increase in engine speed and HC emission concentration decreases with increase in engine speed. These results were obtained at the ratio of 1:2 of Ethanol and gasoline .Further experiments may be conducted using different ratios of ethanol and gasoline for optimum values of CO and HC concentrations in emissions.

Keywords: Ethanol, gasoline, blending ethanol and gasoline as fuel, SI engine, emissions.

Abbreviations used (in the alphabetical order)

BTEX	**benzene, toluene, ethyl benzene and xylene**
Co	**carbon monoxide**
HC	**hydrocarbons**
IC	**internal combustion**
MMT	**methyl cyclopentadienyl manganese tri carbonyl**
MTBE	**methyl tertiary butyl ether**
SI	**spark ignition**

I. INTRODUCTION

Fuel additives are the substances or chemical compounds which are used to improve the capability of an engine and to decrease the Co emissions. These additives are the stabilizers which function properly when being stored for a longer time without use. This fuel additives improve the combustion characteristics and reduces the emissions of harmful gases which leads to reduction in burning temperatures and deposits. Lead was the first additive introduced in the year 1921 in United States this additive acts as cleanser. These additives are also known as antiknocking additives as they are used for reduction of knock in vehicles. Later in 1920's tetraethyl lead was introduced into gasoline to reduce engine knock and fuel Octane levels .These additives are later divided into three main grades known as octane grades based on octane level. These grades are 87, 89 and 93 represent regular, midgrade and premium grades. Octane booster is a gasoline additive which includes lead, methyl tertiary butyl Ether (MTBE), benzene, toluene, ethyl benzene and xylene

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(BTEX), and ethanol a biofuel. Due to various reasons only two primary sources of Octane boosters used in gasoline supply they are BTEX complex and ethanol. BTEX complex is a hydrocarbon mixture of benzene, toluene etc. commonly referred to as gasoline aromatic .These compounds are refined from low Octane petroleum products into a high Octane gasoline additive .The total volume of BTEX aromatics in finished gasoline depends on the desired octane value and other desired fuel properties. BTEX volume Rose from 22 % to roughly a third of the gasoline pool by 1990.

MMT is employed as an octane enhancer which infers that the fuel reactivity is decreased. Previous research has shown that MMT has employed into a port injected engine and established that the additive lead to decrease catalyst life which also increases CO and HC emissions which are toxic to human beings.

The main reason of choosing ethanol as an additive is due to its volatile nature, availability, cost and its preventing nature of pre ignition knock. Properties and specifications of both ethanol and gasoline are explained in Annexure-1.

II. METHODOLOGY

Experimental procedure set up is described below.

Experimental single cylinder four stroke SI internal combustion engine test rig as shown in figure 1

Fig 1

The above experimental set up consists of single cylinder four stroke SI internal combustion engine (see Table 1), dynamometer, fuel reservoir, fuel pump, fuel filter, fuel rail, oil reservoir, cooling pump, heat exchanger, oil pump, ECU, computer monitor etc.

The line diagram of the complete experimental set up is shown in figure 2.

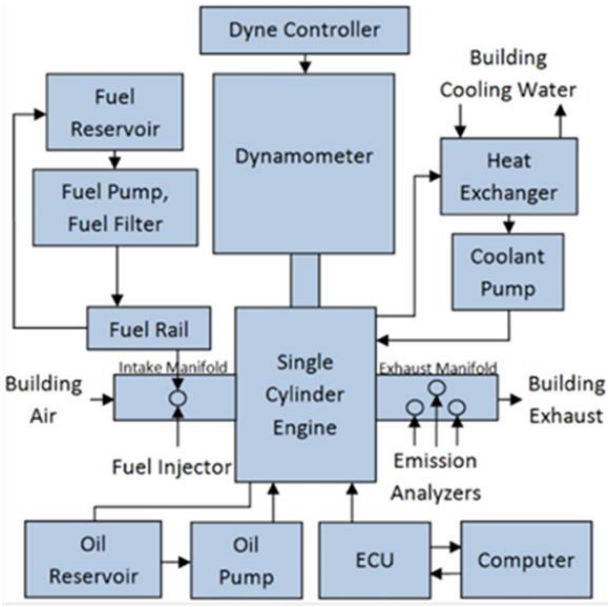

Fig 2

Table 1: specifications of the lab test engine:

Make	Kirloskar
Engine specification	Single cylinder 4 stroke SI engine
Bore	80.5 mm
stroke	88.2 mm
Swept volume	450 cm^3
Compression Ratio	10.5:1
Rated normal speed	2500rpm
Intake temperature	25 ^{O} C

In this experiment and study only one type of additive was employed that is ethanol additive. Ethanol and gasoline are added at a ratio of 1:2 to an SI engine by a rotational speed ranging from 1500 RPM to 2500 RPM at intervals of 250 RPM. The measurement includes CO concentration and HC concentration in emissions at each rotational speed.

Before doing the experiment the engine is switched on and left for 15 to 20 minutes for initial warm up for the smooth working of the engine. After the initial warm up of the engine, the blended fuel in the ratio of 1:2 of ethanol and gasoline blend that is already prepared is introduced in the fuel line. The engine speed is increased from 1500rpm to 2500rpm at regular intervals of 250rpm , and noted down the CO and HC emission concentrations through the CO and HC analysers.

III. RESULTS AND DISCUSSION

The effects and influences of using/blending ethanol additive with gasoline on CO and HC emission characteristics of an SI internal combustion engine are analysed and noted.

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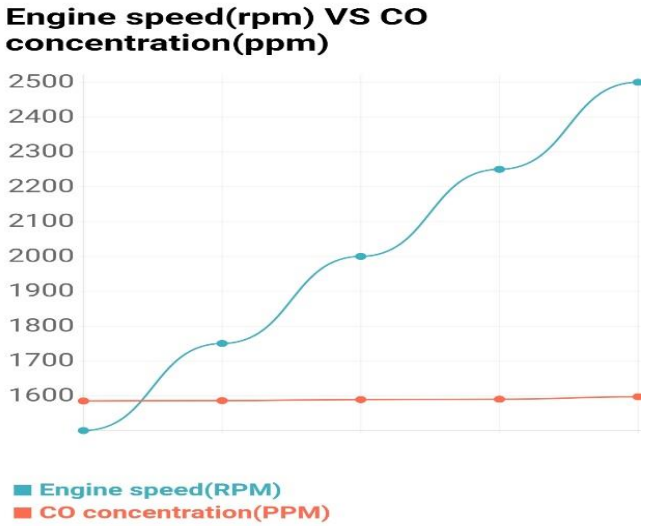

Fig 3

The above graph (fig 3) represents the relation between engine Speed in RPM and CO emission concentration in PPM.It shows that as the engine speed increases at the intervals of 250 RPM then the CO concentration is also increases. It occurs due to larger oxidation rate of fuel carbon to co_2. It is caused because of presence of extra oxygen in ethanol. So it is observed that as the engine speed increases CO emissions increases and if engine speed decreases then CO emissions also decreases. It purely depends on oxidation rate of fuel.

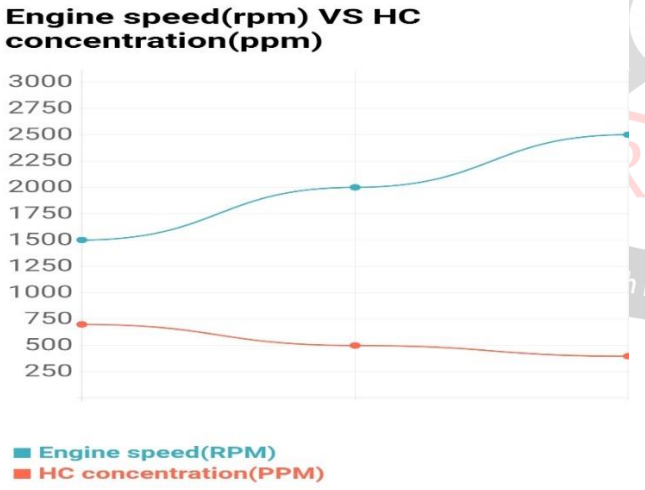

Fig 4

The above graph (fig 4) represents the relation between engine speed in RPM and HC emission characteristics in PPM. It shows that as the engine speed increases the HC emission decreases.it occurs due to longer ignition delay at low engine speed. Due to this reason as the engine speed increases HC emission concentration decreases and as the engine speed decreases HC emission concentration increases.

IV. CONCLUSION

In this paper test is done experimentally and analysis is taken out for the emissions from single cylinder four stroke SI internal combustion engine by using gasoline with ethanol additive. In this experiment the engine runs at various speeds, and it is found that blending ethanol with gasoline decreases CO and HC concentration in the exhaust gas emissions. It can be concluded that increase in engine speed increases CO emissions and decreases HC emissions. It is recommended that further research using different ratios of ethanol and gasoline may be conducted to know the optimum ratio. It is also expected that the performance of the engine improves by using ethanol additive which was not in the scope of this study.

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ANNEXURE 1

Specifications of IOC Gasoline:

IOC gasoline is a compound with complex mixtures of HC.Hydrocarbon in gasoline ranges from C4-C11 gasoline is an oxygenate which is an ash -less, organic compound.

According to Indian standard gasoline oxygenate blend is IS2000.

IOC plans to introduce XP 100 that is hundred octane premium petrol into the market because it has higher antiknocking property and increases engine life and performance.

Gasoline properties:

Formula: C8H18

Molecular weight: 114.23g/mole

Boiling point: 25-215 ^{O} C at 1 ATM

Enthalpy of vaporisation: 33.97KJ/mole

Latent heat of evaporation: 370-500KJ/Kg

Octane number: 95-98

Stoichiometric ratio: 14.7:1

Other ignition temperature: 257 ^{O} C

Density at 1 atmospheric pressure and 20 ^{O} C temperature: (720 - 780) kg/m^3

Auto ignition temperature: 257-300 ^{O} C

Gasoline is volatile in nature, acts as knock resistance.

Gasoline consist of 0.4 to 2.6 % of benzene content by volume. Alkanes by 4 - 8%, Alkenes by 2-5%,

Iso alkanes 25-40%, cyclo alkanes3-7%, cyclo alkenes 1-7%, total aromatics20-50%.

Gasoline is a mixture of hydrocarbons and is extracted from crude petroleum oil. These hydrocarbons includes methane, ethane, propane etc.

Gasoline is mostly used as a fuel in internal combustion Spark ignition engines. It is a flammable liquid.

History of gasoline:

Gasoline was first introduced in 19th century in Germany and is used in Otto engines.

By the time it was introduced the boiling point is near 85 to 90 ^{O} C.

Later in 1910's as production of automobiles increasing the gasoline amount is also increasing.

ETHANOL PROPERTIES

Ethanol is a flammable, colourless liquid, with volatile nature and specific smell.

Ethanol is made up of various feed stocks which are variety of biomass materials..

C_2H OH is the molecular formulae. When there are two carbons present in alcohol consisting of hydrogen, carbon and oxygen Atoms is known as ethanol. Ethanol is often used as booster additive because of its easily availability and cheaper compared to additives like BTEX, MTBE etc.

Ethanol also helps to improve octane number of fuel and also helps in preventing pre ignition knock. Using ethanol as an additive increases the running capacity of the engine and also its efficiency.

Properties of ethanol:

Boiling temperature: 78 – 79 ^{0}C

It consist of 96-97% of alcohol

It has low melting point

Density: 789g/litre

It is also known as bio fuel additive.

Ethanol is mixed with gasoline in order to improve the fuel burning capacity completely and also increases octane rating and to decrease CO emission concentration.

The main advantage of using ethanol is to oxygenate the gasoline. Due to this oxygenation of gasoline with ethanol helps in burning the fuel completely and also produces clean emissions by decreasing CO concentrated emissions. And also does not cause any damage to the environment. Air quality is also improved by reducing CO emissions. By mixing both ethanol and gasoline it is noticed that thermal efficiency improved up to 31.12%.

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