International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 12 Issue 3, March-2023, Impact Factor: 7.957

Studies on the Effect of Pine oil as an Emulsifier on Gasoline-Alcohol Blends in Multipoint Fuel Injection SI Engine: A Review

K. George Melangton[1], K. Siva Satya Mohan[2], B. Satish[1], M. Satya Sai Kumar[1], B. Ashok[1], S. Surya Manikanta[1]

[1]B.Tech, [2]Associate Professor, Aditya College of Engineering & Technology, Surampalem, A.P, India, 533437

ABSTRACT

The future availability of energy resources as well as the need for reducing the emission from the fuels used has increased the utilization of regenerative fuels. Alcohols such as ethanol, isopropanol has good characteristics and can be used in the blends of gasoline. Usage of alcohol as fuel for SI engine has some advantages when compared with gasoline. Ethanol and isopropanol have better anti knocking characteristics than gasoline. Alcohol burns with lower flame temperature decreases the peak temperature inside the cylinder. So that NOx emission and heat loss are lower. This paper presents study of the investigations on the effect of emulsifier on gasoline-alcohol blends in a twin cylinder multi-point fuel injection (MPFI) SI engine. The study reveal that use of gasoline- alcohol blends with pine oil in SI engine, brake thermal efficiency(BTE) and nitrogen oxides (NO_x) emissions increased while carbon monoxide(CO) and hydrocarbons(HC) emissions decreased. It was also found that specific fuel consumption decreased.

INTRODUCTION

The device used by petrol vehicle is known as carburettor to supply air- fuel ratio in correct ratio to the cylinder. The main drawback of this device is the improper mixing of air fuel ratio ,which leads to incomplete combustion which results in the increase of emission from exhaust. To overcome this situation the multi-point fuel injection system is used for proper proportion of air fuel mixture to the engine by electrically injecting fuel in accordance to different driving situations.

Nowadays the world is facing two crisis that is fossil fuel depletion and environmental degradation. The primary energy and raw material reserves in the world are limited. It is estimated that the world the world reserves for 41 years for fuel and 63 years for natural gas and 218 years for coal and this is due to the enormous increase of population , increase in technical development and standard of living in industrial nations. The alternative fuel which is used as substitute of petroleum must be produced from renewable sources. The alcohol gives answer to the problem. Ethanol, methanol, propanol, are the fuels which are suitable for SI engine.

MULTI-POINT FUEL INJECTION ENGINE (MPFI)

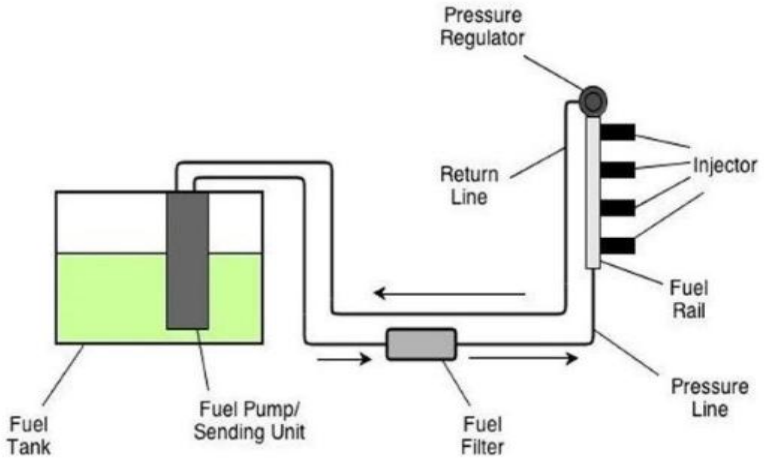

Fig : 1.1 Multi point fuel injection

It is a system which injects the fuel in the cylinder individually based on the command from electronic control unit. It results in not only in higher out put but also quick response in throttling process.

The ECU commands the fuel injector to supply air fuel mixture in optimised ratio in combustion chamber for different driving conditions. The MPFI engine consist of different sensors which are used to detect the engine conditions. The engine ECU controls the engine based on the sensors information. This engine ECU equipped with diagnostic test mode which trouble shoot when it requires.

LITERATURE REVIEW

1. M. al Hassan [1] conducted experiment on the effect of unleaded gasoline ethanol on spark ignition engine and exhaust emissions and performance were tested. The result shows that unleaded gasoline ethanol blend increases the torque, thermal efficiency and brake power and decreases in BSFC and air fuel ratio.
2. NR Silva et.al [2] experimented cold start derivability characteristic of methyl -t- butyl ether blend fuel vehicle. In this investigation different conc of (MTBE) of ethanol were tested. The result shows that satisfactory in derivability characteristic for tested condition, the researcher emphasized that the cold start problem for decreased by utilizing MTBE ethanol blend.
3. Wei-dong et.al [3] conducted experiment on engine performance and pollutant emissions of an spark ignition engine using ethanol blended fuel. Result shows that NO_x emission depend on operating conditions of engine rather than ethanol content.
4. Bang-Quan he.et.al [4] investigated the effect of ethanol blended gasoline fuel on catalyst conversion efficiencies and emissions were investigated. It is found that 30% ethanol by volume can drastically reduced total hydro carbons (THC) at operating conditions tail pipe emissions have close relation between THC, CO, NO_x more over blended fuel can decrease BSFC.
5. Fikret yquskel.et.al [5] investigated the use of ethanol gasoline as fuel and have founded that HC, CO emissions would be reduced approximately by 80% to 50% respectively.
6. Agarwal et al. [6] conducted experiment on methanol gasoline blend on multi cylinder spark ignition engine and he founded that the use of methanol as a substitute in gasoline blend, results in improvement of BTE,NO, CO and slight irregularities in hydrocarbon.
7. Scifter et al. [7] investigated for constant mass fuel rate using ethanol gasoline blend and revealed that decrease in hydrocarbon and carbon monoxide but increase in Nitrous oxide.
8. Keskin et al. [8] after conducting experiment at load condition and concluded that with increase in iso propanol (IPA) blends hydrocarbon , carbon monoxide ,carbon dioxide are decreased and NO emissions are increased. It is founded that alcohol is also suitable for diesel proved by [9-13].when they conducted investigation on isobutonol, n- pentanol, n-hexanol as a substitute diesel blend in C.I engine.

ETHANOL AS AN ALTERNATIVE

Ethanol is one of the family member of alcohol its state is liquid which is produced from Oxygen, Carbon, Hydrogen by fermentation of fructose or by starch which contains in grains , forest trees or biological waste.

Ethanol is presently manufacture from wheat and corn in countries like Canada, America etc. It can be produced from industries, it has good characteristic when it blend with gasoline. It is also known as gasohol. The important thing should be considered while producing the alcohol i.e. It should be free from water because the ethanol with water contain cannot mix completely with gasoline as a result in harmful emission which will be harmful to the living beings as well as the environmental.

In 1981 the ethanol contains in gasoline is about 90% which result in advantage to environment. Countries like Canada, Australia which is providing E10 in some service station presently. In 1827 the ethanol is prepared synthetically by Henry in U.K and sercullas in France. It is also used in lamp fuel in early 1840's in U.S.A.

Production Of Ethanol:

Ethanol is mostly produced biological waste by fermentation process and by usage of glucose which is derived from sugar starch and cellulose. Ethanol production does not effect any agricultural or food production. Now a days research is going on to produce ethanol from algae, cellulose biomass etc.

Chemically ethanol is produce by a process where glucose is where glucose transform by yeast to ethanol by process called fermentation.

Ethanol is considered to be good alternative fuel for gasoline blends because it has good fuel characteristics and can easily mix with gasoline, which results in less emissions from exhaust and its cost is also so low when compare with other alternatives.

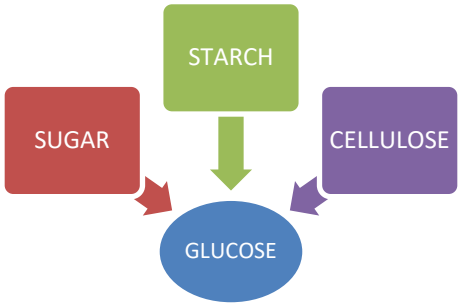

Fig 3.1 Formation of glucose

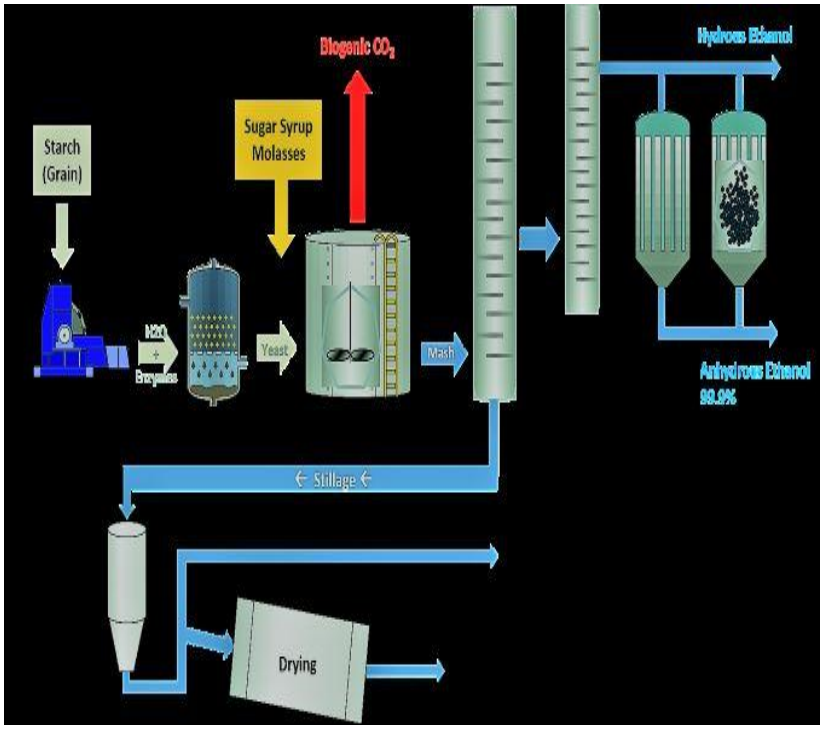

Fig: 3.2 Production of ethanol

In the production of ethanol first feedstock is transformed into glucose($C_6H_{12}O_6$).In case of sugar the process is easy, where sugar is immersed in water to form glucose, where as in starch it require pre processing where it converted into glucose by process called liquification and saccharification, by adding some enzymes the glucose bound with the starch, so, that it can go through the process of fermentation to form ethanol.

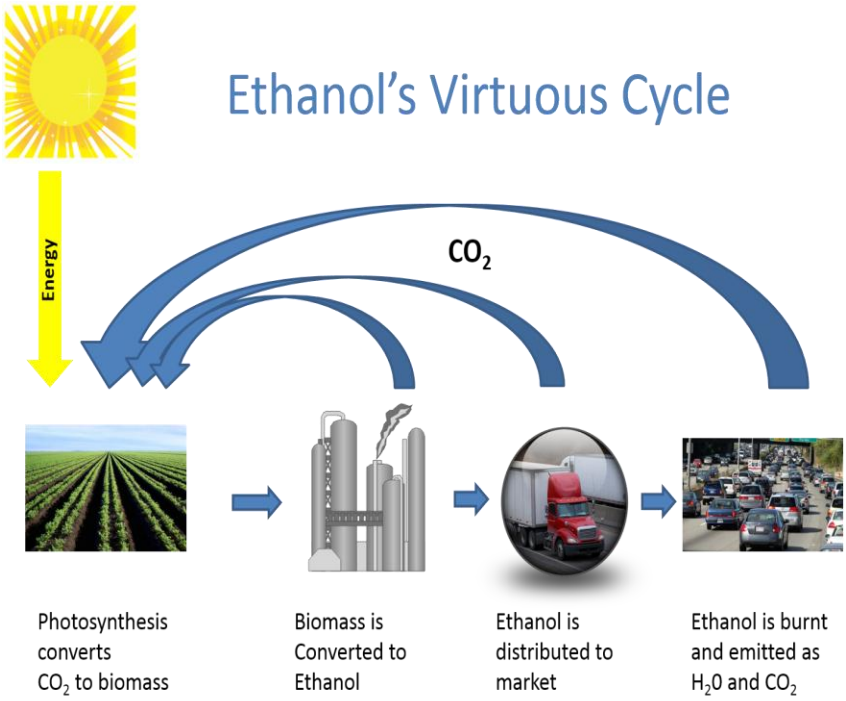

Fig: 3.3 Ethanol's virtuous cycle

As shown in above cycle , the ethanol is purely renewable as first the energy is taken from sun by plants and tress through a process called photosynthesis , where carbon dioxide is converted into biomass than biomass is transformed into ethanol. This is carried out and distributed in market. The burnt ethanol releases water and carbon dioxide which again transform into biomass by process called photosynthesis. In this way cycle repeats.

Isopropanol As An Alternative Fuel:

Isopropanol is also known as isopropyl alcohol. Its chemical formula is C_3H_8O, In 1992 IARC First called as petrochemical. It is one of the family member of alcohol with high volatility flammability and colourless liquid and bitter to taste. It is also used in production of acetone and glycerol. As we know that S.I engine have been widely used as source of power to the engineering machineries such as automobiles transport equipment etc, due to its good thermal efficiency and drivability. The exhaust emissions contains CO, HC, NO_x which are harmful to environment as well as human beings to reduce this emissions one should use the alternative fuel with oxygenates, because more oxygenate present in the fuel then the emissions will be less. The isopropanol contain more oxygen when compare with gasoline, as a result it can be used as an alternative fuel in gasoline alcohol blends. In 1920 first time isopropanol is produced from propylene by standard oil company of new jersey.

Production of Isopropanol:

The isopropanol is manufacture industrially by 3 methods.

1. Hydrogenation of propylene directly
2. Hydrogenation of propylene indirectly
3. Hydrogenation of acetone by catalyst.

Hydrogenation of propylene: In present of catalyst Hydrogenation of propylene is carried on directly to form isopropanol. The reaction takes place during the process is given by equation

$C_3H_6+H_2O$……..$CH_3CH(OH)CH_3$

The reaction took place is exothermic, the heat is measured from thermochemical data is about 11.5 kcal/mol between the

ranges of 400 to 600 degree kelvin in vapour state. The equilibrium constant for this process is noted as

$$\log_{10}k_p = (1949/T)-6.05(\text{vapour state})$$
$$\log_{10}k_e = (2044/T)-5.07(\text{liquid state})$$

the formation of isopropanol during low temperature and high pressure the optimum reaction is attained. By considering the equilibrium limitations and rate limitations the major bi product in this process are di-isopropanol, n-propanol and propylene oligomers. The production of isopropanol various catalyst have been used in recent years. The catalyst used for vapour phase hydrogenation of propylene are phosphoric acid, solid acid of metal oxide. The whole process is carried out by supply of propylene and steam in molar ratio of 0.5=1 by catalyst bed by maintaining the temperature range from 179 to 259 degree centigrade under pressure of 9.5 to 64.5 atm to maintain the reaction in gaseous state.

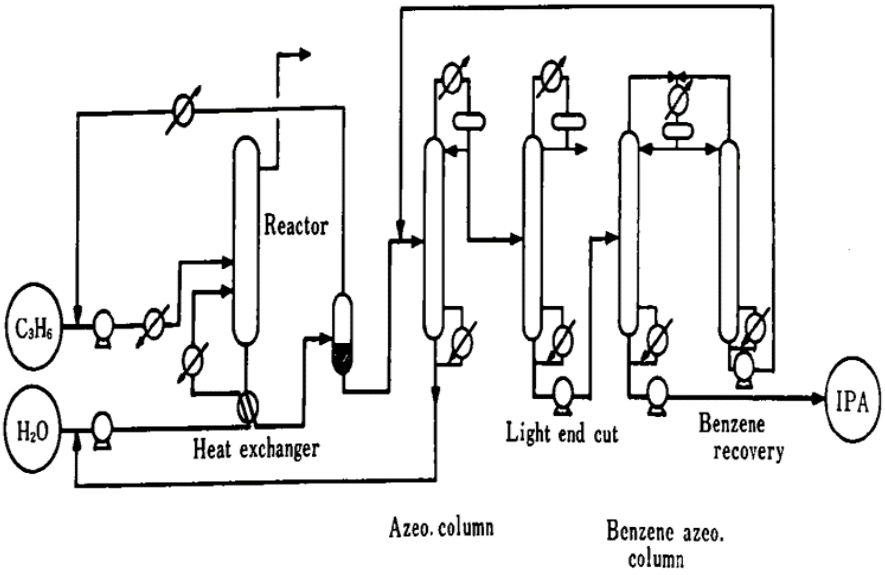

Fig : 3.4 Production of isopropanol

As shown in figure first propylene in liquid state is preheated under pressure and fed into the reactor ,then the solution which is obtained from azeotrope coloumn is preheated in heat exchanger under operating temperature of 239-269 degree centigrate and 149-249 atm. This process takes place in between water and propylene. The aqueous solution which is obtained after the process contains isopropanol and catalyst is withdraw and cooled in heat exchanger. To obtain the isopropanol about (99.9%) another distillation step is required.

Emulsifier-Pineoil:

Pine oil is used as an emulsifier in this investigation. Freshly pine tree Needles are taken from pine tree, the needles must be harvest freshly from pine tree. Now put the pine needles in paper towel to dry, then the needles are clean with extra paper towel to remove all the moisture from needles surface. Put this needles in mortar and pestie and bruise it, take large mouth jar and pour almond oil in it then add needles which are clean from moisture. Close the jar tightly and shake it well and place in dark place away from sunlight under the temperature of 74 degree fahrenhite shake the jar once a day and it should be done till one week. After this process keep the jar in dark place for 10-14 days during this do not shake or touch the jar, after two weeks. Take a cotton cloth and put the material on and squeezed it , place a empty vessel under it and the oil which is collected in vessel is pine oil which is produce by using homemade process.

The pine oil can be produced by other method also,the raw material which is used in production of pine oil is oleoresins which is collected from pine tree by drumming process. First the collected oleresins are washed throughly and placed in reactor, which is surrounded by coils and responsible for supply of steam. The oleoresins are seperated into turpentine and rosin vapours, then this vapours are condensed in condenser and form liquid turpentine . this turpentine is also act as bio fuel with low boiling compounds like α -pinene and β - pinene. Then this low boiling compound are seperated from oleoresins then only rosins are left behind. To synthesized pine oil the turpentine should be react with phosphoric acid at the end of this reaction pine oil is collected , which can be used as bio fuel in gasoline blend.

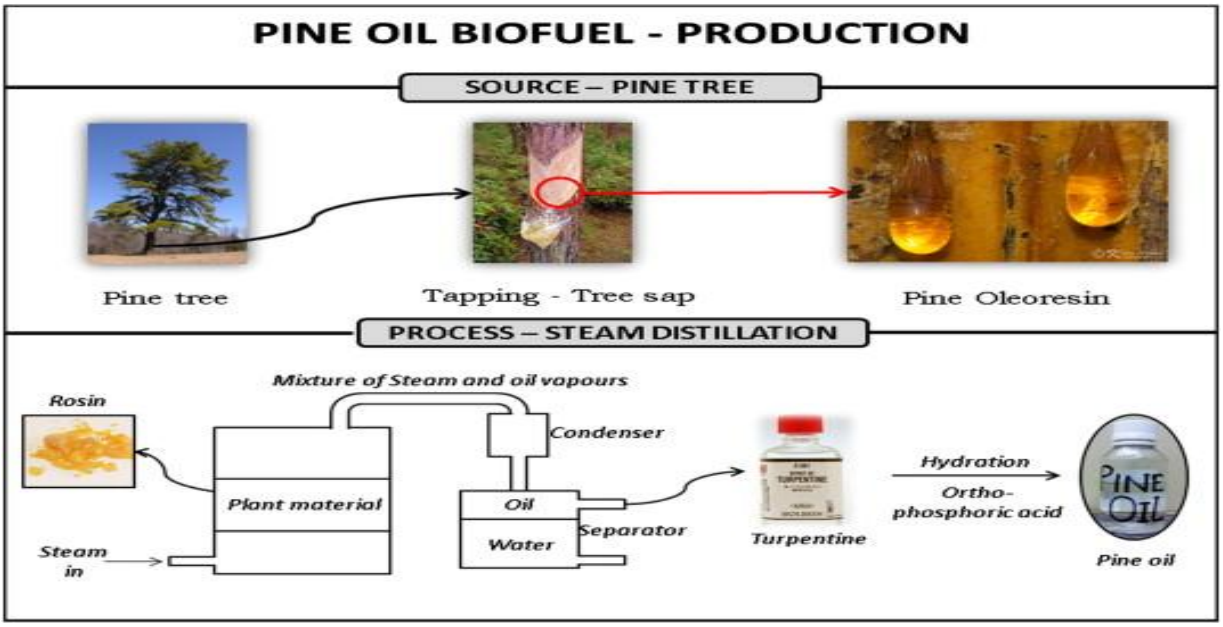

Fig : 3.5 Production of pine oil

FORMATION OF POLLUTANTS IN SI ENGINE

The main pollutants which are released during exhaust stroke from exhaust pipe are :

1) Carbon monooxide (CO)
2) Hydrocarbons (HC)
3) Oxides of nitrogen (NO_X)

The emissions which are released majorly depend on design and operating condition of engine ,the emission may be in the order as follows:

1) NO_X > 490 - 1000 ppm (20gm/ kg fuel)
2) CO > 120% (200gm/kg of fuel)
3) HC > 42000 ppm (24gm/kg of fuel)

Carbon Dioxide Formation:

Step 1 : In this formation the primary fuel is converted in small HC then oxidation is done to aldehyde of ketone and finally CO is formed which again oxidised to form CO_2

$RH \rightarrow R \rightarrow R + O_2 \rightarrow RCHO \rightarrow RCO \rightarrow CO$…….(1)

Where RH → hydrocarbon

R → hydrocarbon radical

Step 2 : In presence of limited oxygen availibility , hydroxyl radical OH oxidised to convert carbon monoxide to carbon dioxide.

$CO + OH \leftrightarrow CO_2 + H$ ……..(2)

Under equilbrium the reaction is faster at high temperature , when the reaches above 1790k the larger part of expansion stroke is taken in equilbirim while

C-O-H system taken in chemical equilbrium .

The equilbrium conc of CO which is emitted is higher than temoerature and perssure condition at end of expansion stroke

For Rich mixtures (f > 1) , The CO conc are almost close to the equilbriun conc during expansion stroke. For stoichiometric mixtures (f ˜ 1) , The CO conc is almost equal to computed equilbrium value.

For lean mixtures CO conc is higher than the computed equilbrium values.

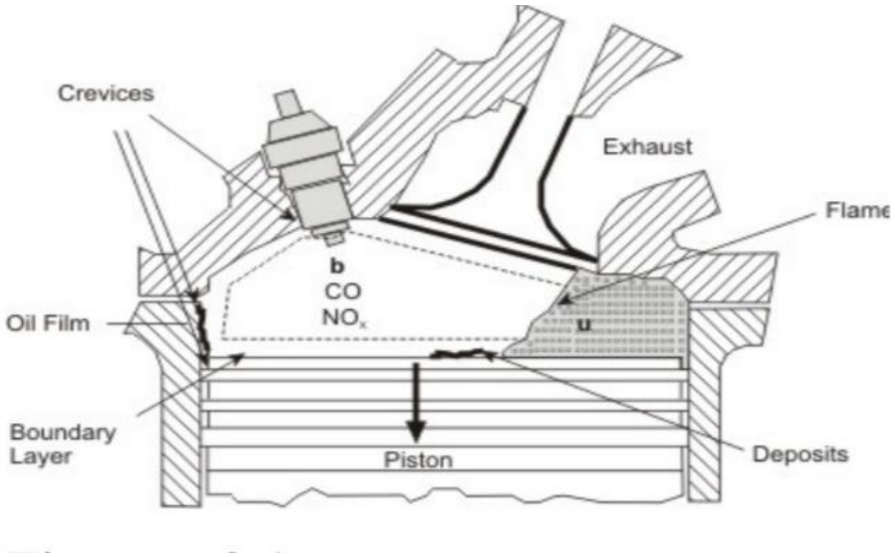

Fig 4.1 Formation of CO

Hydro Carbons Formation (HC): The combustion process leading hydrocarbons emissions which are known as HC source, which results in air fuel mixture with cold surface. This is due to the prevention of oxidation of fuel during flame passage , After the flame passage the un burned hydrocarons from source are oxidised in burnt gas mixtures. The left out hydrocarbons is retained in the cylinder , while remaining leaves out as exhaust emissions. The figure shows the main source of HC in spark ignition engine. During steady state operation the main source of emissions are from the Crevices which is having small passages around combustion chamber where flame cannot propagate.

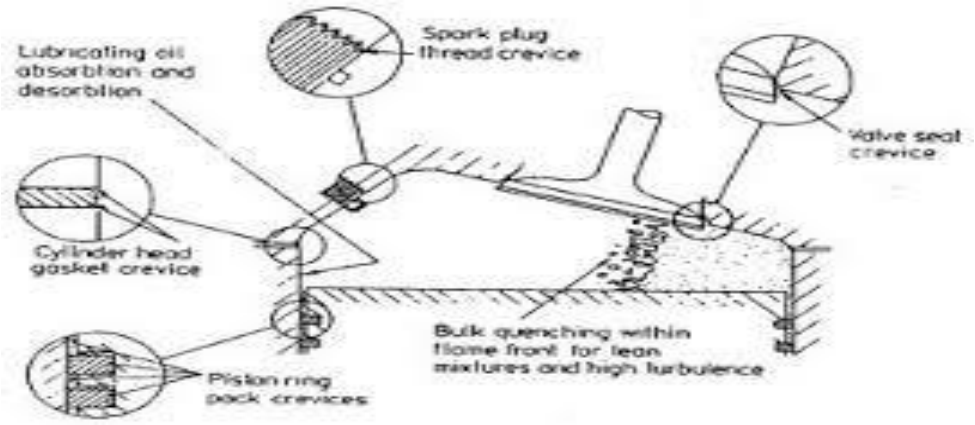

Fig : 4.2 Formation of HC

The contribution of hydrocarbons sources are very little different during cold start and warmed conditions . the HC emissions during cold start are due to improper mixture of aur fuel ratio , where as during warmed conditions Crevices is the main reason. The research scholar Cheng has examine that only 90% charge is burnt in combustion chamber , the remainig 10% is due to the Crevices where flame cannot propagate.

Formation Of Oxides Of Nitrogen (NO_X) : The nitrogen is considered as one of irritant gas. During combustion when nitrogen combines with oxygen to form nitric oxide (NO). It again further combines with oxygen to form nitrogen dioxide (NO_2). The nitric oxide is not considered as hazardous to health only till ambient concentreation. Nitric oxide and nitrogen dioxide together referred as oxides of nitrogen (NO_X).

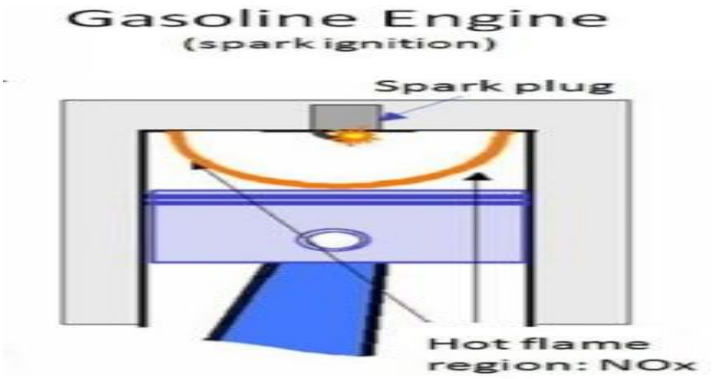

Fig :4.3 Formation of NOx

The formation of NOx

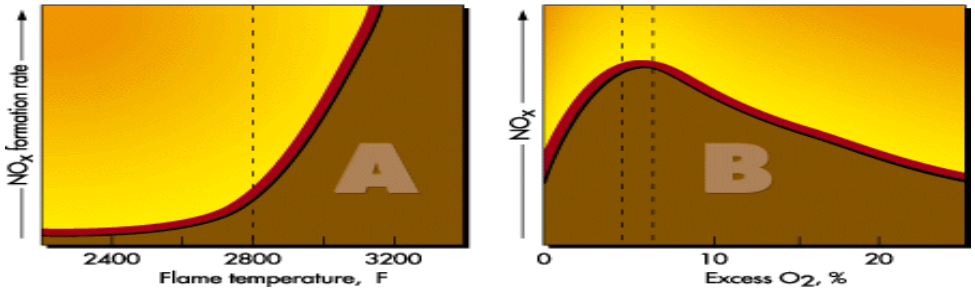

Fig: 4.4 Graphical representation for the formation of NOx

NOx outflows don't shape in huge sums until fire temperatures arrive at 2800 F When that limit is passed, in any case, any further ascent in temperature causes a quick increment in the pace of NOx development (A). NOx generation is most elevated (B) at fuel-to-air ignition proportions of 5–7% O2 (25–45% abundance air). Lower overabundance air levels starve the response for oxygen, and higher abundance air levels drive down the fire temperature, easing back the pace of response. NOx decrease is the zone of most concern today. Thermally delivered NOx is the biggest supporter of these sorts of outflows. Warm NOx is created during the ignition procedure when nitrogen and oxygen are available at raised temperatures. The two components join to frame NO or NO2. NOx is created by numerous ignition forms other than heater activity. It joins with different toxins in the climate and makes O3, a substance known as ground level ozone.

NOx in heater burners can be decreased with either pre-ignition or post-burning innovation. Post-ignition innovation enables NOx to frame, at that point separates it in the fumes gases (a procedure called reactant decrease). This strategy is ordinarily limited to bigger, utility-size gear.

Pre-burning strategy keeps NOx from framing in any case. Pre-ignition NOx decrease is practiced by either arranging the burning procedure or recycling vent gases into the ignition procedure (FGR).

FGR is practiced by compelling the pipe gases with a different fan once again into the burning zone (constrained FGR), or by drawing the vent gases through the ignition air fan (prompted FGR). The two techniques diminish the mass fire temperature in the heater to hinder the compound response between the nitrogen and oxygen. FGR frameworks lessen NOx emanations without decreasing effectiveness. NOx esteems can drop to under 20 ppm revised to 3% O2 when consuming flammable gas. Uncontrolled NOx readings are by and large in the region of 80-120 ppm.

CONCLUSIONS

The performance and emission characteristics of ethanol and isopropanol with pine oil as an emulsifier have been studied. The conclusions from this investigation are follows:

1. The addition of an emulsifier in quantity of 20% with alcohol-gasoline blends increase the brake thermal efficiency of the engine and reduce the specific fuel consumption due to the presence of oxygenates.

2. It can be concluded that better combustion of emulsified fuel with alcohol- gasoline blends lower the carbon monoxide (CO) emissions.
3. Due to higher cetane value of alcohols and emulsified fuel, the unburned hydrocarbon(HC) decreases when compared with gasoline.
4.The oxides of nitrogen (NO_x) emissions increased with the usage of alcohol gasoline blends.

REFERENCES

[1]. M.Al-Hasan "Effect of ethanol-unleaded gasoline blends on engine performance and exhaust emission" Energy Conversion and Management, 44, 2003.
[2]. N.R. silva and J.R. sodre "Cold start and drivability characteristics of an ethanol-methyl-t-butyl Ether blend fuelled vehicle" proceeding of intuition of mechanical engineering, 215, 2001.
[3]. Wei-Dong Hsieh, Rong hong "Engine performance and pollutant emissionof an SI engine using ethanol gasoline blends". Journal of atmospheric environment, 2003.
[4]. Bang-Quane He,Jian-xin wang "A study on emission characteristics of an EFI engine with ethanol blended gasoline fuels" Journal of atmosphric environment, 2003.
[5]. Fikret Yuksel and Bedri Yuksel "The use of ethanol-gasoline blend as a fuel in SI engine" Journal of renewable energy, 2004.
[6]. A.K. Agarwal, H.Karare, A. Dhar, "Combustion performance emissions and particulate characterization of a methanol-gasoline blend (gasohol) fuelled medium duty spark ignition transportation engine", Fuel Process. Technology, 2004.
[7]. I. Schifter, L. Diaz, R. Rodriguez, J.P. Gómez, U. Gonzalez "Combustion and emissions behavior for ethanol-gasoline blends in a single cylinder engine, Fuel, 2011.
[8]. A. Keskin, M. Guru "The effects of ethanol and propanol additions into unleaded gasoline on exhaust and noise emissions of a spark ignition engine", Energy Sources Part A-Recovery Util. Environ. Eff., 2011