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Alcohol as an Alternative Fuel in I.C. Engine: A Review

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***Abstract*— As we all know that we all are living in the age of science and science had made our life so simpler and easier that we can't imagine a few decade ago. As in the earlier time we took a couple of days or more to travel from one place to another. But now we can travel or can do any work in a second or in hours. But with the development of science we all are losing are fossil fuels. Which is going to create a serious problem in the upcoming generation? Burning of petrol coal and other harmful fuel is causing a tremendous effect on our environment.**

The enthusiasm for using alcohols as alternate fuels in internal combustion engines (ICE) has been accelerating since the middle of 1970 and reached its peak by the middle of 1980. This was due to the serious effect of the exhaust emissions from automotive engines powered with oil-derived fuels coupled with a market rise in the cost of oil-derived fuels.

This project leads to the idea of using alcohol in the internal combustion engine such that it reduces the demand of the petroleum products that is going to be extinct in near future. It includes about the emissions of harmful gases that can be reduced by the use of alcohol instead of petroleum products. Various fuels have been tested on IC engines for their suitability as alternate fuels. Expect few alcohols, CNG and LPG, not many fuels have been found to be matched with IC Engines requirements .Thus this project is an attempt for the use of an alternative resource such that it can prove to be useful for the peoples in near future

***Index Terms*— Alternative fuel, emission, thermodynamic approach, exhausts analysis, comparison, efficiency, alternate.**

I. Introduction

Alcohol fuels such as methanol (CH,OH), ethanol (C,H,OH), iso-butanol (C,&OH), methyl-tertiary-butyl-ether (MTBE), ethyl-tertiary-butyl-ether (ETBE), have proven to be excellent octane booster and blend with the traditional fuels, gasoline and diesel, and require minor engine modifications.

IN the present context, the world is facing difficulties with the crisis of fossil fuel depletion and environmental degradation. Conventional hydrocarbon fuels used by internal combustion engines, which continue to dominate many fields like transportation, agriculture, and power generation leads to pollutants like HC (hydrocarbons), Sox (Sulphur oxides), and particulates which are highly harmful to human health. CO 2 from Greenhouse gas increases global warming. Promising alternate fuels for internal combustion engines are natural gas, liquefied petroleum gas (LPG), hydrogen, acetylene, producer gas, alcohols, and vegetable oils. Among these fuels, there has been a considerable effort in the world to develop and introduce alternative gaseous fuels to replace conventional fuel by partial replacement or by total replacement. Many of the gaseous fuels can be obtained from renewable sources. They have a high self ignition temperature; and hence are excellent spark ignition engine fuels. And among these wide area of research, use of acetylene as internal combustion source in engine could be most appropriate field to research as alternative source of fuel and can be used as the synthetic fuel for transportation.

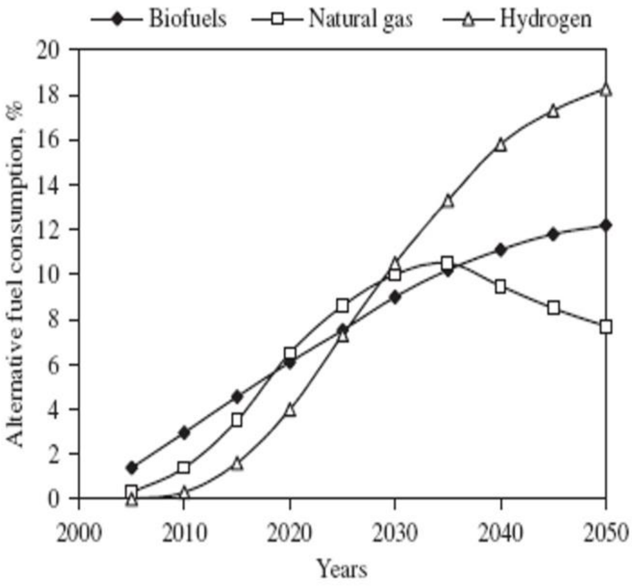

FIG.1.

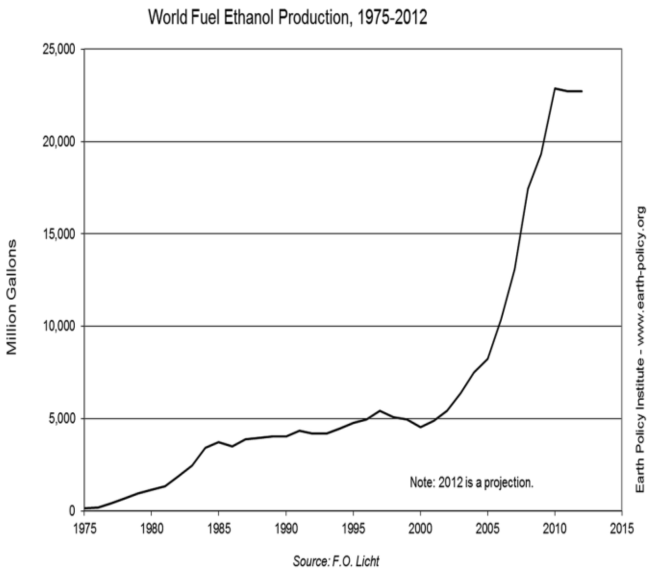

FIG.2.

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II. OVERVIEW

The principal objective and advantages of the present project include: providing a fuel comprising acetylene as a primary fuel for an internal combustion engine; providing such a fuel including a secondary fuel for eliminating knock which might otherwise arise from the acetylene.

Two main reasons justify the use of alternate fuels; the finite unrenewable supply of crude oil, and protection of the environment from the increasing ozone (photochemical smog) as well as the greenhouse effect. Since crude oil is cheap and available, demand for the use of alternate fuels will be realized in the long-term strategy. Protecting the environment is the short- term demand as was proven by the debate associated with the Clean Air Act Amendment in 1990. Use of alternate fuels in association with the new engine technology has the potential to reduce the harmful pollutants that cause damage to the environment.

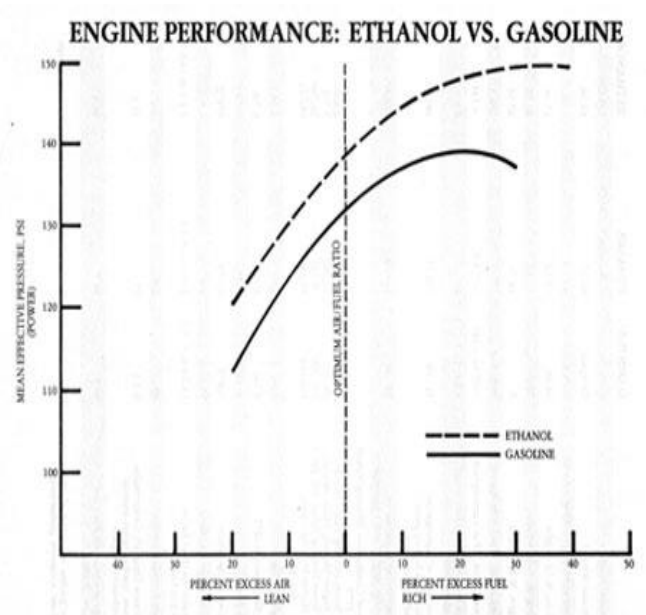

FIG.3.

III. WHAT IS AN I.C. ENGINE???

An internal combustion engine (ICE) is a heat engine where the combustion of a fuel occurs with an oxidizer (usually air) in a combustion chamber that is an integral part of the working fluid flow circuit. In an internal combustion engine the expansion of the high-temperature and high-pressure gases produced by combustion apply direct force to some component of the engine. The force is applied typically to pistons, turbine blades, or a nozzle. This force moves the component over a distance, transforming chemical energy into useful mechanical energy.

The first commercially successful internal combustion engine was created by Etienne Lenoir around 1859[1] and the first modern internal combustion engine was created in 1864 by Siegfried Marcus

The term internal combustion engine usually refers to an engine in which combustion is intermittent, such as the more familiar four-stroke and two-stroke piston engines.

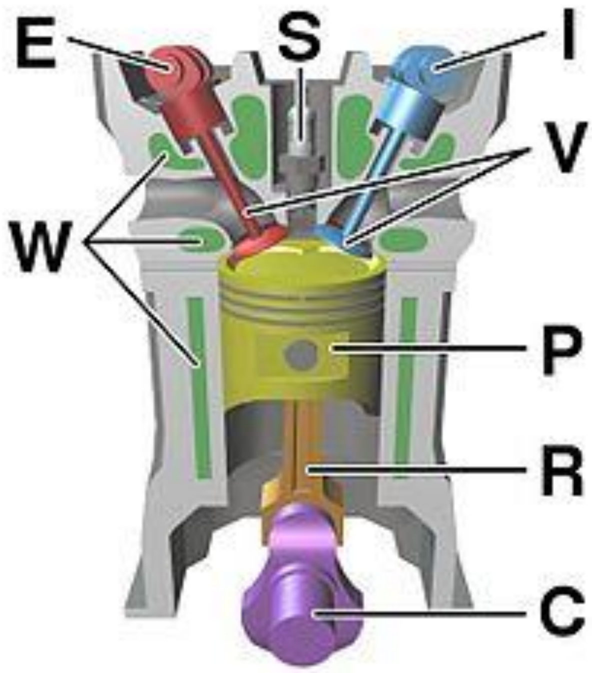

FIG.4.

Diagram of a cylinder as found in 4-stroke gasoline engines.

C – Crankshaft.
E – Exhaust camshaft.
I – Inlet camshaft.
P – Piston.
R – Connecting rod.
S – Spark plug.
V – Valves. Red: exhaust, blue: intake.
W – Cooling water jacket.
Gray structure – engine block.

Internal-combustion engine, one in which combustion of the fuel takes place in a confined space, producing expanding gases that are used directly to provide mechanical power. Such engines are classified as reciprocating or rotary, spark ignition or compression ignition, and two-stroke or four-stroke; the most familiar combination, used from automobiles to lawn mowers, is the reciprocating, spark-ignited, four-stroke gasoline engine. Other types of internal-combustion engines include the reaction engine (see jet propulsion, rocket), and the gas turbine. Engines are rated by their maximum horsepower, which is usually reached a little below the speed at which undue mechanical stresses are developed.

There are two types of IC engines: rotary and reciprocating engines. In rotary engines, a rotor rotates inside the engine to produce power. In the case of the reciprocating engines, a piston reciprocates within a cylinder. The reciprocating motion of the piston is converted into the rotary motion of the vehicle's wheels. In automobiles, reciprocating engines are used. They are the most widely used type of engine.

Reciprocating engines are classified into two types: spark ignition (SI) engines and compression ignition (CI) engines. Since reciprocating engines are the most widely used engines, they have become synonymous with the name IC engines. It is this reason that even the IC engines are broadly classified into two types: SI engines and CI engines.

IV. CAN: ALCOHOL BE A FUTURE FUEL IN I.C.ENGINE.

There is no miraculous, super fuel that will satisfy all the requirements of cost effectiveness, maximum thermal efficiency, and engine performance, and still remain clean enough to protect the environment. Every fuel has advantages and disadvantages, and selection of a particular fuel is a function of different parameters including the physical properties of the fuel as shown in Table 1 (3). If we start with the disadvantages of the alcohol fuels, they might be summarized as follows:

1. The economics of production. Unless the cost of alcohol production from renewable resources is made cost-effective, there will be no demand for it. These alcohols could be produced from biomass, coal, and natural gas.
2. Flame visibility of alcohol is difficult to be detected, which might be hazardous. The lack of visibility is due to the small number of carbon atoms present in the alcohol. Since there is very little carbon, there is no soot formation to give the flame color.
3. Cold storability problems. Due to their low vapor pressure, high latent heat of vaporization, and single boiling point, alcohols, especially ethanol, have difficulty meeting industry standards for starting in cold weather. The last two of these disadvantages, however, can easily be solved. By the addition of a small amount of gasoline to the alcohol mixture, a more visible flame will be produced and the effect of cold weather on engine storability can be brought well within the industry standards. Although there are a few minor disadvantages to the use of alcohol fuels, the advantages more than outweigh its easily solvable problems. The advantages are as follows:

1. Methanol can be made out of organic material such as biomass and municipal waste. In the long-term, it could even be made out of coal. The United States has 25% of the worlds' supply of coal, which will be abundant for years to come.
2. Alcohol combustion produces higher combustion pressures inside the combustion chamber of the ICE due to the higher molar products to reactants ratio, compared to gasoline, which improves power output and thermal efficiency of gasoline.
3. Increasing the compression ratio of the engine to 12: 1 or higher increases power and fuel efficiency by 20% and 15% respectively (38~4).
4. Alcohols have better combustion characteristics and performance due to the increased volumetric efficiency of alcohol fuels, which is why methanol is a preferred racing fuel. Acceleration time decreases with power increase.
5. In case of fire, alcohols have higher visibility for escape-rescue, low asphyxiation, produce cool flame and low heat output which causes low bums, low smoke damage residue is easily washed away, and are extinguishable with water and more readily by powders and foams.
6. In case of leaks and spillages, alcohols are miscible in water and could be washed Out with water for quick and easy removal. They are easily metabolized if absorbed by the ground.
7. Alcohol fuels have a lower evaporative emission. Not as many harmful byproducts will be released into the atmosphere by using alcohol fuels.
8. Since the carbon content in alcohol fuels is very small, a negligible amount of soot is formed and released to the atmosphere when burned in the ICE.
9. Alcohol fuels are liquids, which make them accessible using the same means of transportation and handling infrastructure of the conventional fuels with minor modifications.

V. USE OF ACETYLENE AS A FUEL IN I.C. ENGINE.

Acetylene is the colorless gas with garlic smell produced from the calcium carbide, which is obtained from calcium carbonate. Further the calcium carbonate is heated in lime kiln at about 8250c which forms calcium oxides (lime) liberating. Calcium oxide is then heated in electric furnace with coke to produce calcium carbide finally calcium carbide is hydrolyzed producing acetylene.

As acetylene is colorless gas and is highly combustible with high flame speed and fast energy release, it can be used as alternative fuel in IC engines. It has a very wide flammability range and minimum ignition energy required for ignition. Furthermore comparing with various other fuel properties, acetylene proved good to be used in internal combustion engines.

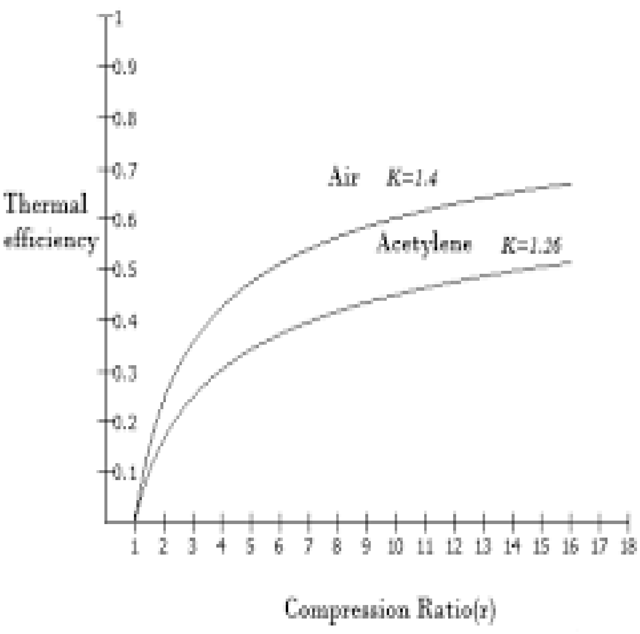

FIG.5

VI. CLASSIFICATION OF I.C. ENGINE.

1. Application
2. Basic Engine Design
3. Operating Cycle
4. Working Cycle
5. Valve/Port Design and Location
6. Fuel
7. Mixture Preparation
8. Ignition
9. Stratification of Charge
10. Combustion Chamber Design
11. Method of Load Control
12. Cooling.

1. APPLICATION.

1. Automotive :(i) Car
(ii) Truck/Bus
(iii) Off-highway
2. Locomotive
3. Light Aircraft
4. Marine: (i) Outboard
(ii) Inboard
(iii) Ship
5. Power Generation: (i) Portable (Domestic)
(ii) Fixed (Peak Power)
6. Agricultural: (i) Tractors
(ii) Pump sets
7. Earthmoving: (i) Dumpers
(ii) Tippers
(iii) Mining Equipment
8. Home Use: (i) Lawnmowers
(ii) Snow blowers
(iii) Tools
9. Others

2. Basic Engine Design:

1. Reciprocating (a) Single Cylinder
(b) Multi-cylinder (I) In-line
(ii) V
(iii) Radial
(iv) Opposed Cylinder
(v) Opposed Piston
2. Rotary: (a) Single Rotor
(b) Multi-rotor.
3. Operating Cycle
• Otto (For the Conventional SI Engine)
• Atkinson (For Complete Expansion SI Engine)
• Miller (For Early or Late Inlet Valve Closing type SI Engine)
• Diesel (For the Ideal Diesel Engine)
• Dual (For the Actual Diesel Engine)
4. Working Cycle (Strokes).
1. Four Stroke Cycle :(a) Naturally Aspirated (b)Supercharged/Turbocharged
2. Two Stroke Cycle: (a) Crankcase Scavenged
(b) Uni-flow Scavenged
(i) Inlet valve/Exhaust Port
(ii) Inlet Port/Exhaust Valve
(iii) Inlet and Exhaust Valve May be naturally Aspirated Turbocharged.

5. (a) Valve/Port Design.

1. Poppet Valve
2. Rotary Valve
3. Reed Valve
4. Piston Controlled Porting
5. (B) Valve Location
1. The T-head
2. The L-head
3. The F-head
4. The I-head: (i) Over head Valve (OHV)
(ii) Over head Cam (OHC)

6. FUEL.

1. Conventional: (a) Crude oil derived
(i) Petrol
(ii) Diesel
(b) Other sources: (i) Coal
(ii) Wood (includes bio-mass)
(iii) Tar Sands
(iv) Shale
2. Alternate: (a) Petroleum derived (i) CNG
(Total Replacement)
(ii) LPG.
(b) Bio-mass Derived (i) Ethanol
(ii) Vegetable oils
(iii) Producer gas
(iv) Biogas
(v) Hydrogen
Partial Replacement: 1. Blending
2. Dual fueling

7. MIXTURE PREPERATION.

1. Carburetion – perhaps soon to be obsolete.
2. Fuel Injection
(i) Diesel
(ii) Gasoline
(a) Manifold
(b) Port
(c) Cylinder.

8. IGNITION.

1. Spark Ignition - homogeneous charge
(a) Conventional
(i) Battery
(ii) Magneto
(b) Other methods
2. Compression Ignition – heterogeneous charge (conventional)
3. Compression ignition – homogeneous charge .

9. CHARGE STRARIFICATION.

1. Homogeneous Charge (Also premixed charge)
2. Stratified Charge
(i) With carburetion.
(ii) With fuel injection.

10. COMBUSTION CHAMBER DESIGN.

1. Open Chamber: (i) Disc type
(ii) Wedge
(iii) Hemispherical
(iv) Bowl-in-piston
(v) Other design
2. Divided Chamber: (For CI): (i) Swirl chamber
(ii) Pre-chamber
(For SI) (i) CVCC
(ii) Other designs.

11. METHOD OF LOAD CONTROL.

1. Throttling: (To keep mixture strength constant) Also called Charge Control Used in the Carbureted S.I. Engine.
2. Fuel Control (To vary the mixture strength according to load) Used in the C.I. Engine.
3. Combination Used in the Fuel-injected S.I. Engine.

12. COOLING.

1. Direct Air-cooling
2. Indirect Air-cooling (Liquid Cooling)
3. Low Heat Rejection (Semi-adiabatic) engine.

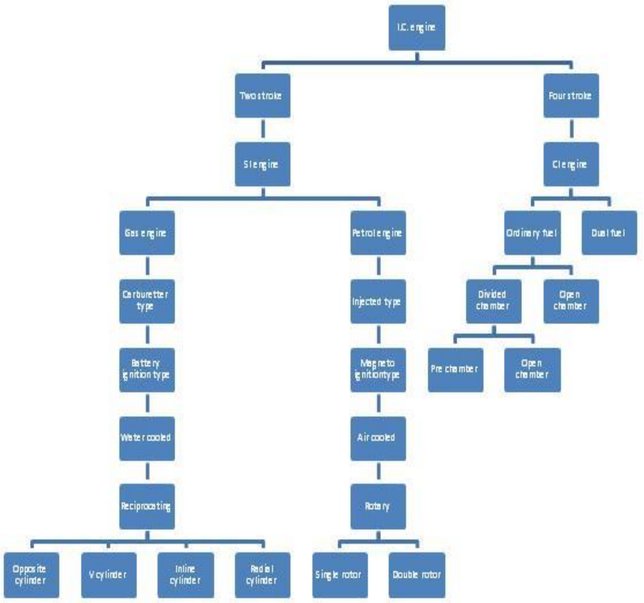

FIG.6

VII. OZONE LAYER DEPLETION

Despite playing a protective role in the stratosphere, at ground-level ozone is classified as a damaging trace gas. Photochemical ozone production in the troposphere, also known as summer smog, is suspected to damage vegetation and material. High concentrations of ozone are toxic to humans. Radiation from the sun and the presence of nitrogen oxides and hydrocarbons incur complex chemical reactions, producing aggressive reaction products, one of which is ozone. Nitrogen oxides alone do not cause high ozone concentration levels.

The total emissions vary greatly with fuel structure. Two factors have been identified for this large variation: diffusion and reactivity. Diffusion of fuel molecules from boundary layers near the cylinder wall into the hot core gas causing partial oxidation of this fuel may be a significant source of burn-up of HC species exiting crevices during the expansion stroke. Thus, higher molecular weight fuels, which diffuse more slowly, tend to exhibit higher emissions.

VIII. ENVIORNMENTAL ASPECTS.

Deterioration in air quality is a vital issue that needs to be seriously monitored and limited. The transportation system is a major air pollution contributor due to the exhaust emissions such as carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO,), carbon dioxide (CO,), and particulate matter (PM). The transportation system is estimated, by the U.S. Environmental Protection Agency (EPA), to produce up to 44% of the total hydrocarbons emissions inventory in the U.S. The evaporative emissions share 31%. and the balance of 13% is from exhaust gas emissions. Production rate of exhaust gases differ from one place to another based on different parameters such as the geographic locations, altitude, weather conditions, traffic congestion, population, maintenance availability, etc. The greenhouse effect, which is caused by the production of carbon dioxide, has been suspected to cause the global warming and its adverse effect on the biological system. Ozone production is due to the chemical reaction between nitrogen oxides, hydrocarbons, and sunlight, which is known as photochemical smog. LQS Angeles' polluted environment with photochemical smog is a good example, and is considered as one of the most non-attainment areas in the nation. Implementation of alternate fuels, in many pilot project over the nation, with dedicated and converted IC engines, has a positive effect on carbon monoxide and particulate matter reduction. Hydrocarbons emission, which is mainly "evaporative emission" is reduce when alcohol fuels are used. This trend is obvious in Table 2, which shows in-use emission measurements of regulated pollutants from jet A and neat methanol fuels, for similar vehicles and similar engines under transient test conditions. Hydrocarbons data do count the evaporative emissions which make up approximately 65% of the hydrocarbons emissions. In another study of carbon monoxide under steady-state conditions, wide open throttle (WOT), no load (NL), intermediate load (IL), and full load (FL) are shown in Table 3. Four different fuels-20% ,by volume iso-butanol -gasoline blend (BZO), 20% ethanol-gasoline blend (E20), ethanol-gasoline blend (20M), and base line gasoline (GAS)-were used. Carbon monoxide emissions from alcohol-gasoline blends were lower than that from gasoline, and M20 was the lowest.

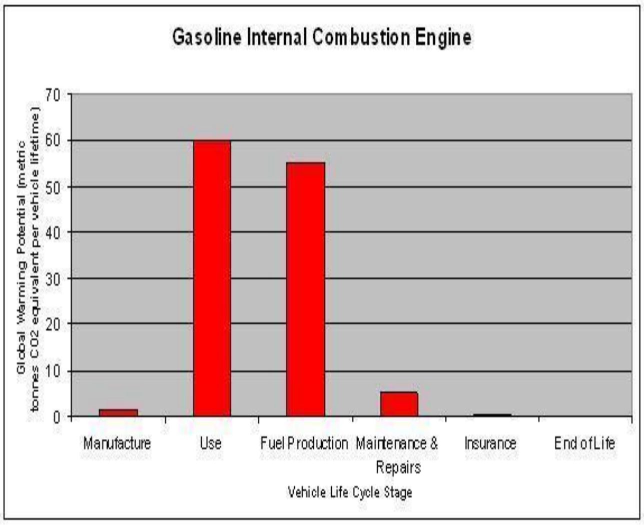

FIG.7

IX. CONCLUSION

This paper include the fact that acetylene can be a good fuel for the country like Nepal where calcium carbonate are abundant in nature as it is already discussed above. Despite of being, good fuel for IC engine, there are some of the control measures and safety precautions that are involved in gas phase reactions that can cause serious damages.

Why are alcohol fuels still alternate fuels? Apparently, since production and use cost of conventional fuels (gasoline and diesel) are very cost-effective, nobody will use alcohol fuels except the Federal and State Governments because of the CAAA and EPACT through the AFV's programs.

An internal combustion engine is compact and lighter. An internal combustion engine can be started immediately. An internal combustion engine has higher efficiency than external combustion engine. Each type of engines has some advantages over the other one. Thus, the selection of the appropriate engine requires determining the conditions of application. A vast research has to be done in this sector to More Efficiency Less Fuel Combustion, Least Pollution .Use Bio Fuels A European Union-funded project, called 'New integrated combustion system for future passenger car engines', or 'NICE', aiming to develop a new integrated combustion system.

REFFERENCE

[1] https://www.google.co.in/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=0ahUKEwj7puKHt-vKAhWXW44KHQyXDVIQjRwIBw&url=http%3A%2F%2Fwww.intechopen.com%2Fbooks%2Fhydrogen-energy-challenges-and-perspectives%2Fuse-of-hydrogen-methane-blends-in-internal-combustion-engines&psig=AFQjCNEdvkDwSQppMPh6ceSSoofG1UmUCw&ust=1455132989389405

[2] https://www.google.co.in/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=0ahUKEwiynoLnt-vKAhVBt44KHUvqBTIQjRwIBw&url=http%3A%2F%2Fpubs.rsc.org%2Fen%2Fcontent%2Farticlehtml%2F2015%2Fra%2Fc5ra12735a&psig=AFQjCNEdvkDwSQppMPh6ceSSoofG1UmUCw&ust=1455132989389405

[3] https://www.google.co.in/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=&url=http%3A%2F%2Fjourneytoforever.org%2Fbiofuel_library%2Fethanol_motherearth%2Fme1.html&psig=AFQjCNEdvkDwSQppMPh6ceSSoofG1UmUCw&ust=1455132989389405

[4] https://en.wikipedia.org/wiki/Internal_combustion_engine

[5] https://www.google.co.in/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=0ahUKEwik88TxuOvKAhXGJI4KHVryBhQQjRwIBQ&url=http%3A%2F%2Fku.edu.np%2Frenewablenepal%2Fimages%2Fpublications%2Fvol1-5.pdf&psig=AFQjCNEbmCPYVnOqPTwmftxyOOdVEt9aHQ&ust=1455133497272460

[6] https://www.google.co.in/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=&url=http%3A%2F%2Fworld4engineers.com%2Fi-c-engine%2F&psig=AFQjCNHXWmxy3F7eKolAsuwyO8UZQxQWFw&ust=1455133593221435

[7] https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwjoycLTuuvKAhUPBI4KHVsaAnkQFggoMAE&url=https%3A%2F%2Fweb.anl.gov%2FPCS%2Facsfuel%2Fpreprint%2520archive%2FFiles%2F39_2_SAN%2520DIEGO_03-94_0299.pdf&usg=AFQjCNHBMk-DbkXvKap44D6vxDV46S5TQg

[8] https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&cad=rja&uact=8&ved=0ahUKEwi7otaNu-vKAhVGCo4KHexpAZUQFggoMAQ&url=http%3A%2F%2Fweb.iitd.ac.in%2F~ravimr%2Fcourses%2Fmel345%2Fclassification.pdf&usg=AFQjCNE2pQ0ZWPcFTJYCCKc14rHFzaP70Q&bvm=bv.113943665,d.c2E