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Analysis of Emission and Power Using Acetylene Gas in SI Engine

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Abstract: *Studies uncover that Acetylene gas created from calcium carbide (CaC2) is inexhaustible in nature and displays comparable properties to those of hydrogen. A trial examination has been completed on a solitary chamber, Spark start (SI) motor tried with unadulterated petroleum and petroleum Acetylene double fuel mode with diethyl ether as oxygenated added substance. Tests were led to review the execution attributes of petroleum motor in double fuel mode by suctioning Acetylene gas in the channel complex, with petroleum diethyl ether mixes as a start source. Fixed amount of Acetylene gas was suctioned and Blend of diethyl ether with petroleum was taken and afterward readings were taken at different burdens. From the definite review it has been reasoned that the acetylene gas give gives less discharge than petroleum. Double fuel activity alongside expansion of diethyl ether brought about higher warm productivity when contrasted with flawless petroleum activity. Acetylene desire diminishes smoke and exhaust temperature.*

***Keywords**: SI engine, Acetylene gas, Emission, Power tests*

I. INTRODUCTION

In the gift context, the world is confronted with the dual crisis of fossil gas depletion and environmental Degradation. Conventional hydrocarbon fuels utilized by inner combustion engines, which preserve to dominate many fields like transportation, agriculture, and energy era ends in pollutants like HC (hydrocarbons), SOx (Sulphur oxides), and particulates which are enormously harmful to human fitness. CO2 from Greenhouse fuel increases global warming. This crisis has stimulated energetic studies interest in non-petroleum, a renewable and non-polluting gasoline, which has to vow a harmonious correlation with sustainable development, strength conservation, efficiency, and environmental upkeep. Promising alternate fuels for internal combustion engines are herbal gasoline, liquefied petroleum fuel (LPG), hydrogen, acetylene, manufacturer gas, alcohols, and vegetable oils. Among these fuels, there has been a large attempt within the international to broaden and introduce alternative gaseous fuels to update conventional gasoline by partial alternative or by using overall replacement. Many of the gaseous fuels can be obtained from renewable sources. They have a high self-ignition temperature; and hence are outstanding spark ignition engine fuels. They can't be used at once in petrol engines. However, Petrol engines may be made to apply a considerable amount of gaseous fuels in twin gasoline mode without incorporating any fundamental modifications in engine production. It is possible to hint the beginning of the dual fuel engines to Rudolf Petrol, who patented an engine going for walks on essentially the dual-gasoline principle. Here gaseous fuel referred to as number one gas is both inducted together with air consumption, or injected directly into the cylinder and compressed, but does now not vehicle-ignite due to its very high self-ignition temperature. Ignition of homogeneous aggregate of air and fuel is finished by way of timed injection of small quantity of petrol known as pilot fuel near the cease of the compression stroke. The pilot petrol gasoline automobile-ignites first and acts as a deliberate source of ignition for the primary gas air aggregate.

The combustion of gaseous gasoline happens through flame propagation Similar to SI engine combustion. Thus, twin gas engine combines the capabilities of each SI and SI engine in a complicated way. The dual fuel mode of operation ends in smoother operation; decrease smoke emission and the thermal efficiency are almost similar to the petrol model at medium and at high hundreds. However, principal downside with those engines are higher Knox emissions, terrible element load performance, and higher ignition postpone with positive gases like biogas and hard engine operation near complete load due to high charge of combustion. In the prevailing statuesque where fossil gasoline is at the verge to exhaust, the need of the hour is to look for an opportunity gasoline and we've got many picks like LPG, CNG with their drawbacks.

II. ACETYLENE GAS

Acetylene (C2H2) is colorless gas used as a fuel and a chemical building block. As an alkyne, acetylene is unsaturated because its two carbon atoms are bonded together in a triple bond having CCH bond angles of 1800. It is unstable in pure form and thus is usually handled as a solution. Pure acetylene is odorless, but commercial grades usually have a marked odor due to impurities.

In 1836 acetylene identified as a "new carburet of hydrogen" by Edmund Davy. The name "acetylene" was given by Marcelin Berthelot in 1860. He prepared acetylene by passing vapors of organic compounds (methanol, ethanol, etc.) through a red-hot tube and collecting the effluent. He also found acetylene was formed by sparking electricity through mixed cyanogen's and hydrogen gases.

III. ACETYLENE GAS PRODUCTION BY CALCIUM CARBIDE

It was first prepared by the hydrolysis of calcium carbide, a reaction discovered by Friedrich Wohler in 1862.

$$CaC_2 + 2H_2O \rightarrow Ca\,(OH)_2 + C_2H_2$$

Calcium carbide is manufactured from lime and coke in 60:40 ratios and Calcium carbide production requires extremely high temperatures, ~20000C, in an electric arc furnace.

IV. MANUFACTURING METHODS OF ACETYLENE GAS BY CALCIUM CARBIDE

There are two methods

1. Wet process
2. Dry process

In the wet process, calcium carbide is added to large quantity of water releasing acetylene gas and calcium hydrate as residue. Later is discharged in the form of lime slurry containing approximately 90% water. Amount of water is added to CaC2 (1:1 ratio) in a generator.

The heat of reaction (166 Btu/ft3 of acetylene) is used to vaporize the excess water over the chemical equivalent. In the dry process, in order to eliminate the waste of calcium hydrate equal, leaving a substantially dry calcium hydrate which is suitable for reuse as a lime source. The temperature must be carefully controlled below 1500C at 15psi pressure throughout the process because the acetylene polymerizes to form benzene at 600C and decomposes at 7800C.Further with air-acetylene mixture explodes at 4800C.The crude acetylene gas containing traces of H2S, NH3 and phosphate (PH3).

V. SAFETY AND HANDLING

Acetylene is not especially toxic but when generated from calcium carbide it can contain toxic impurities such as traces of phosphine and arsine. It is also highly flammable. Acetylene can explode with extreme violence if the absolute pressure of the gas exceeds about 200kPa (29 psi). The safe limit for acetylene is 101kPag or 15 psi.

VI. 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. Here are some of the comparisons of POPC between several compounds.

Table 1. Physical and Combustion Properties of Acetylene Gas

Properties	**Acetylene**
Formula	C_2H_2
Density kg/m3 (At 1 atm& 20^0 C)	1.092
Auto ignition temperature (^{0}C)	305
Stoichiometric air Fuel ratio, (kg/kg)	13.2
Flammability limits (volume %)	2.5 – 81
Flammability limits (equivalent ratio)	0.3 – 9.6
Lower Calorific Value (Kj/kg)	48,225
Lower calorific Value (kj/m3)	50,636
Max deflagration Speed (m/sec)	1.5
Ignition energy 3333(MJ)	0.019
Lower heating Value of stoichiometric mixture (kj/kg)	3396

Before testing acetylene, its properties and their implications relative to the safety of test personnel were analyzed. Some of these properties, for both acetylene and unleaded reference gasoline (clear Indolence), are shown in Table I. Those characteristics which represent a hazard are discussed below, whereas the remainder are provided for information only. There are basically two ways of providing acetylene for use in a vehicle. The fuel can either be carried in pressurized tanks or it can be generated on board. Hazards of these two approaches, and safety problems common to both, will be presented in the following paragraphs. The greatest danger associated with pressurized acetylene storage is the fuel's potential to decompose explosively. Acetylene can, even in the absence of oxygen, decompose rapidly by the process.

$$C_2H_2 = 2C + H_2 + 230\ Kj$$

If this decomposition occurs, and either the fuel tank or fuel lines rupture, fire will likely follow. As a result, U.S. Department of Transportation regulations limit the maximum pressure of shipped acetylene cylinders to 1825 kPa. A pressure this high is permissible only because the acetylene is dissolved in a stabilizing agent (acetone) absorbed in a filler The filler is designed to divide the tank into small cells in which decomposition would be quenched. When acetylene is removed from the tank, most of the acetone remains behind. To avoid explosion at this time, the delivery pressure must not be raised above 205 kPa Since the delivery pressure must be kept low, itis not possible to meter acetylene into an engine using critical flow. One way to avoid some of the dangers inherent to storing high pressure acetylene aboard a vehicle is to generate it on board at relatively low pressures. The calcium carbide-water reaction.

$$CaC_2 + 2H_20 = C_2H_2 + Ca\ (OH)_2$$

could be used for this purpose. Depending on the purity of the calcium carbide, toxic gases such as arsine and phosphine might also be produced. If calcium carbide comes in contact with human skin, the above reaction will occur, leaving a residue of calcium hydroxide which is caustic and may cause skin burns. Even if this problem is minimized by careful handling procedures, the large amount of calcium hydroxide produced in the acetylene generating process would present a disposal problem.

Production of Acetylene Gas

Calcium carbonate reacts with graphite in nature and forms as calcium carbide rocks. These reactions are taking place naturally. For production of acetylene, calcium carbide should mix with normal water. So anyone can produce acetylene gas if one can have a gas collecting container and storage device. In welding shops acetylene is producing in acetylene gas generators by following this equation only.

$$CaCO_3 + C(graphite) \rightarrow CaC_2$$

$$CaC_2 + H2O \rightarrow Ca\ (OH)_2 + C_2H_2$$

Use of Acetylene as an Alternative Fuel in IC Engine the overview of project in steps is as follows

Step 1: The first step involves the production of acetylene gas through the Calcium Carbide reacting with water in the reaction tank. $CaC_2+2H_2O \rightarrow C_2H_2+Ca(OH)_2$. The reaction tank constitutes of calcium carbide.

Step 2: The water from the water tank is released in the reaction tank and the reaction occurs spontaneously. The water is passed through the control valve. In the reaction tank the calcium carbide is kept in desirable amount to react with water. Through reaction tank a valve is connected to the supply line.

Step 3: In this step the acetylene gas is stored in the reaction tank and the pressure is measured by the pressure gauge. In this step the produced gas is stored and is passed through the pipes. Here the gas is stored to avoid moisture and the gas stored in reaction tank is provided pressure through pressure gauge so the gas is of high concentration.

Step 4: The gas is passed in the pipe in very sophisticated manner and then pipe is joined in the carburetor fitted with the filter, this then filters the air and then combines with air.

Table 2. Physical and combustion properties of fuels

Properties	Acetylene	Petrol	Diesel
Formula	C2H2	C8H18	C8—C10
Density kg/m^3 (At atm&20°C)	1.092	800	840
Auto ignition temperature(°C)	305	246	257
Stoichiometric air fuel ratio (kg/kg)	13.2	14.7	14.5
Flammability Limits (Volume %)	2.5-81	1.2-8	0.6-5.5
Flammability Limits (Equivalent ratio)	0.3—9.6	--	-----
Lower Calorific value(kJ/kg)	48,225	44500	42,500
LowerCalorific value(kJ/m^3)	50,625	-	-
Max deflagration speed (m/sec)	1.5	-	0.3
Ignition energy (MJ)	0.019	----	-----
Lower Heating value (kJ/kg)	3396	-	2930

VII.BASIC COMPONENTS OF PROJECT

- Storage tank
- Vaporizer
- Pressure gauge
- Pressure relief valve
- S I engine
- Base frame

Engine Modification

After successful run of engine with acetylene gas we came to know that engine has knocking. Knocking in internal combustion engines occurs when combustion of some of the air/fuel mixture in the cylinder does not result from propagation of the flame front ignited by the spark plug, but one or more pockets of air/fuel mixture explode outside the envelope of the normal combustion front. The fuel-air charge is meant to be ignited by the spark plug only, and at a precise point in the piston's stroke. Knock occurs when the peak of the combustion process no longer occurs at the optimum moment for the four stroke cycle. The shock wave creates the characteristic metallic "pinging" sound, and cylinder pressure increases dramatically. Effects of engine knocking range from inconsequential to completely destructive. Knocking should not be confused with pre-ignition they are two separate events. However, pre-ignition is usually followed by knocking. Due to the large variation in fuel quality, a large number of engines now contain mechanisms to detect knocking and adjust timing or boost pressure accordingly in order to offer improved performance on high octane fuels while reducing the risk of engine damage caused by knock while running on low octane fuels. So to eliminate this knocking property we had to options, either modify the engine or else degrade the fuel properties. Modification of Engines includes.

Emission Test

The variation of smoke level with brake power is seen. The exact mechanism of smoke formation is still unknown. Generally speaking, smoke is formed by the paralysis of HC in the fuel rich zone, mainly under load conditions. In petrol engines operated with heterogeneous mixtures, most of the smoke is formed in the diffusion flame. The amount of smoke present in the exhaust gas depends on the mode of mixture formation. The combustion processes and quantity of fuel injected occur before ignition. The smoke level increases with increase in petrol flow rate, and at full load it is 7 BSU in case of petrol fuel operation. Dual-fuel operation with any gaseous fuel proved to be a potential way of reducing the smoke density as compared to petrol operation. A reduction in smoke level is noticed.

Table 3. Emission Test

Fuel mode	Carbon Monoxide in %	Hydrocarbon In PPM	Nonmethane HC %	Reactive HC
Acetylene gas	2.759	272	--	--

VIII.CONCLUSION

The study highlights the use of acetylene as a fuel for SI engine; this fuel can be used with conventional S.I. engine with minor fabrication and manipulations As acetylene has wide range of merits on environmental as well as economic grounds. It produces only carbon dioxide during combustion and is less costly than conventional fuel acetylene is produced from calcium carbonate which is in abundance. Acetylene have proved out to be better fuel due its non – polluting nature and more economic.

References

[1]S. Swami Nathan, J.M. Mallikarjuna, A. Ramesh. "Effects of charge temperature and exhaust gas re-circulation on combustion and emission characteristics of an acetylene fuelled HCCI engine." Fuel 89, (2010) 515–521

[2] Mr. Rushikesh D. Jadhav, Mr. Vivek U. Mitkari. "Experimental Analysis of Acetylene Gas as an Alternative Fuel for S.I. Engine." International Engineering Research Journal (IERJ) Special Issue Page 208-215, June 2016, ISSN 2395-1621

[3] Suyash Kamal Soni, Rahul Jain, Adarsh Choubey, Abhineet Sharma. "Fabrication of S.I. Engine to Use Acetylene as Fuel." IRF International Conference, 15th February (2015)

[4] Mehmet Ilhan Ilhak, Selahaddin Orhan Akansu, Nafiz Kahraman, Sebahattin Unalan. "Experimental study on an SI engine fuelled by gasoline/acetylene mixtures." Energy, (2018)

[5] Prabin K. Sharma, Harihar Kuinkel, Praveen Shrestha, Suman Poudel. "Use of Acetylene as an Alternative Fuel in IC Engine" Rentech Symposium Compendium, Volume 1, (2012)