Experimental Analysis of Acetylene Gas as an Alternative Fuel for S.I. Engine

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Abstract— The search for an alternative fuel is one of the need for sustainable development, energy conservation, efficiency, management and environmental preservation. Therefore, any attempt to reduce the consumption of petrol and diesel possible alternative fuels is mostly preferable. Many research activities were developed in order to study the Internal Combustion Engines with alternative fuels. Acetylene is one of the tested fuels. The present project includes: providing a fuel comprising acetylene as a primary fuel and Alcohol as a Secondary fuel avoiding knocking for an internal combustion engine. The paper investigates working of IC engine on acetylene minor changes required to be done. Thus reducing the running cost and minimum pollutant emission, this makes it fit for use on economic and environment standard. It is more effective and eco-friendly alternative fuel option.

Key words: Alternative Fuel, Efficiency, Analysis, Comparison, Emission

I. INTRODUCTION

In the present days, the world is facing difficulties like environmental degradation and crisis of fossil fuel depletion. Internal combustion engines are used in many fields like agriculture, transportation and power generation leads to pollutants like particulates matters, HC (hydrocarbons), SOx (Sulphur oxides) and which are highly harmful to human health. $CO_2$from Greenhouse gas increases global warming. Climatic changes and sea level rise.

A lot of research from few decades has gone into use of alternative fuels in IC engines. Vegetable oils are preferred mostly because they are renewable and easily available. So to reduce the consumption of petroleum based possible alternative fuels will be the mostly preferable. Hence fuels which are clean burning, renewable and can be produced easily are being investigated as alternative fuels.

The cost of performance losses and production shows other alternative to use gaseous fuels as alternative fuels in IC engines like biogas, LPG (liquefied petroleum gas), LNG (liquefied natural gas), hydrogen and acetylene gas. Acetylene gas has a high self-ignition temperature and hence is excellent spark ignition engine fuels. Use of acetylene gas in internal combustion source as alternative source of fuel is most appropriate field to research and can be used for transportation as the synthetic fuel.

The principal objective and advantages of the present project includes: providing a fuel comprising acetylene as a primary fuel with minor fabrication and performance analysis for an internal combustion engine.

II. ACETYLENE GAS

Acetylene (C_2H_2) is a synthesis gas but not an air gas, but generally produced from the reaction of calcium carbide with water. It was burnt for many applications such as to light homes and mining tunnels in the 19th century. A gaseous hydrocarbon is unstable, colorless, has a strong garlic odor, is highly combustible, and produces a very hot flame (over 5400°F or 3000°C)when combined with oxygen.

Acetylene is generally produced by reacting calcium carbide with water. The reaction is carried out spontaneously and can be conducted without any sophisticated equipment or apparatus. Such produced acetylene has been utilized for street vendors, lighting in mine areas etc. People often call such lighting sources “carbide lamps” or “carbide light”. Industrial uses of acetylene as a fuel for motors or lighting sources, however, have been nearly nonexistent. In modern times, the use of acetylene as a fuel has been largely limited to acetylene torches for welding or welding-related applications. In most such application, acetylene is generally handled in solution form such as acetone.

A. *Reaction for Production*

Calcium carbonate reacts with graphite in nature and forms as calcium carbide rocks. These reactions (i & ii) 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.

$$CaCO_3+C(graphite)\rightarrow CaC_2 \quad (1)$$

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

Properties	Acetylene	H_2	CNG	Petrol
Composition	C_2H_2	H_2	CH_4: 86.4-90%; C_2H_6: 3-6% C_3H_8: 0.35-2%	C_8H_{18}
Density kg/m^3 (At 1 atm& 20 ^{o}C)	1.092	0.08	0.72	800
Auto ignition temperature (^{o}C)	305	572	450	246
Stoichiometeric air fuel ratio, (kg/kg)	13.2	34.3	17.3	14.7
Flammability Limits (Volume %)	2.5 –81	4 – 74.5	5.3 – 15	1.2-8
Flammability Limits (Equivalent ratio)	0.3-9.6	0.1 – 6.9	0.4-1.6	
Lower Calorific Value (kJ/kg)	48,225	1,20, 00	45800	44500
Lower Calorific Value (kJ/m^3)	50,636	9600	--------	
Max deflagration speed (m/sec)	1.5	3.5	--------	

Ignition energy (MJ)	0.019	0.02	--------	
Lower Heating value of Stoichiometeric mixture (kJ/kg)	3396	3399	--------	

Table 1: Comparison of Physical and Combustion Properties of C_2H_2, H_2, CNG and Petrol[9]

III. METHODOLOGY

A. *Acetylene Gas as SI Engine Fuel*

Prabin K. Sharma et al.: The overview of project to use Acetylene as an Alternative Fuel in IC Engine followed by three steps is as below.

1) Step 1: The production of acetylene gas is carried out in first step 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 two chambers:

- In first (upper) chamber the water is kept.
- The calcium carbide is kept in second (lower) chamber.

The water from the first chamber is released in such away to carry out the reaction spontaneously. The water is passed through the control valve. The calcium carbide is kept in the second chamber react with water in desirable amount. Through second chamber a valve is connected to the storage tank where the gas produced during reaction is stored.

2) Step 2: In this step the acetylene gas is stored in the storage tank and the pressure is measured by the pressure gauge.

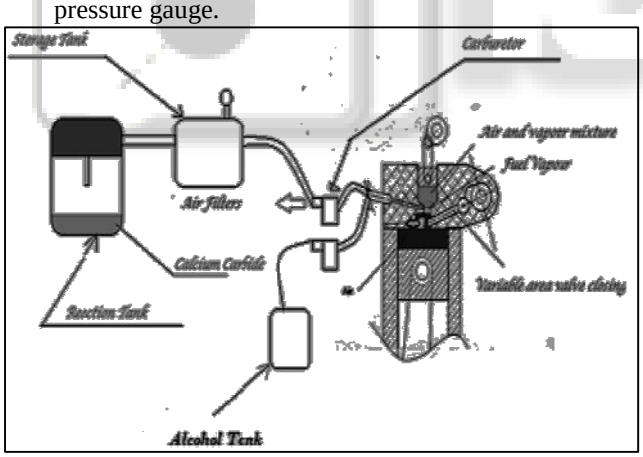

Fig. 1: Overview of the project[7]

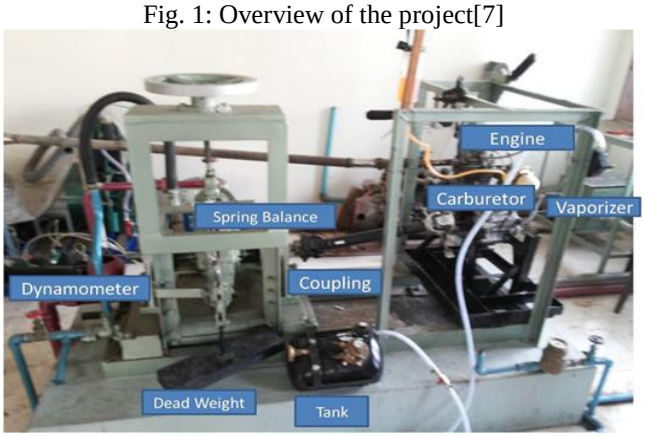

Fig. 2: Experimental Setup for testing

In this step the produced gas is stored in a tank and is passed through the pipes. To avoid moisture the gas is stored in storage tank and is provided through pressure gauge so the gas is remain at high concentration.

- Step 3: The gas is passed in the pipe in very sophisticated manner and then the gas pipe is joined to the carburetor fitted with the filter, then it filters the air and combines it with petrol as secondary fuel which is added in small amount (in about 10 to 15%) to prevent knocking for smooth operation of an engine.

IV. OBSERVATIONS AND RESULT

Sr No	Load (kg)	Speed (rpm)	Time for 10ml Fuel (sec)	Brake Power (kW)	BSFC (Kg/kW-hr)	Brake thermal eff. η_{bth} (%)
1	1	800	75	0.2942	1.3051	6.19
2	2	800	65	0.5884	0.753	10.74
3	3	800	50	0.88261	0.6526	12.39
4	4	800	47	1.1768	0.5206	15.53

Table 2: For Petrol

Sr. No	Load (kg)	Speed (rpm)	Mass of fuel (Kg/sec)	Brake Power (kW)	BSFC (Kg/kW-hr)	Brake thermal eff. η_{bth}(%)
1	1	800	0.89285	0.2942	0.2942	6.83
2	2	800	0.89435	0.5884	0.5884	12.64
3	3	800	0.89635	0.88261	0.88261	23.41
4	4	800	0.89885	1.1768	1.1768	27.14

Table 3: For Acetylene gas

V. CONCLUSIONS

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 is less costly than conventional fuel as acetylene is produced from calcium carbonate which is in abundance.

From above results shows that Brake thermal Efiiciency of Acetylene Gas is more than Petrol.

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