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

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Abstract - *The research for an alternative fuel is one of the requirements for sustainable development, energy conservation, performance and environmental preservation. Therefore, any try to minimize the consumption of fossil fuels possible alternative fuels is mostly preferable. Research activities were developed in order to study the IC 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 Petrol as a Secondary fuel. Minimum pollutant emission, this makes this project fit for use on economic and environment standard. Acetylene is effective and environment friendly alternative option*.

Key Words: **Alternative Fuel, Analysis, Comparison, Emissions**

1. INTRODUCTION

The world is fronting issues with the crunch of non-renewable fuel diminution and Environmental deficiency. Non-renewable hydrocarbon fuels used by IC engines, which continue to dictate many fields like transportation, agriculture, and power generation leads to pollutants like HC (hydrocarbons), Sox (Sulphur oxides) particulate which are extremely harm full to human healthiness. CO2 from Greenhouse gas increases global warming. Climatic changes and sea level rise. The hunt for an alternative fuel assurance a melodious connection with supportable development, energy conservation and management, efficiency and environmental conservation. Therefore, any effort to reduce the ingesting of petroleum built possible alternative fuels will be the most welcome.

Hence fuels which are non-conventional, clean burning and can be created effortlessly are being explored as alternative fuels. Over few eras, a lot of research has gone into use of alternative fuels in IC engines. Vegetable oils seem to be a forerunner as they are renewable and easily obtainable. In an agricultural country like India usage of vegetable oil would be cheap because of large efficiency and reduced dependability on import of petroleum products but because of high viscosity and poor atomization of straight vegetable oils leads to inappropriate mixing and causes inappropriate combustion. Further to reduce viscosity problem researchers went for biodiesels of vegetable oils. The cost of production and performance losses shows other alternative to use gaseous fuels as alternative fuels in IC engines.

One approach in this direction is to utilize the gaseous fuels like biogas, LPG (liquefied petroleum gas), LNG (liquefied natural gas), hydrogen and acetylene gas. They have a high self-ignition temperature; and are excellent spark ignition engine fuels. And amongst these comprehensive areas 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 artificial fuel for transportation.

2. ACETYLENE GAS

Acetylene (C2H2) is not only an air gas but also a synthesis gas normally produced from the reaction of calcium carbide with water. It was burnt in "acetylene lamps" to light homes and mining tunnels in the 19th century. A gassy hydrocarbon, has a strong garlic odor, it is colorless, is unstable, highly flammable, and produces a very hot flame (over 5400°F or 3000°C) when combined with oxygen. Acetylene is commonly produced by reacting calcium carbide with water. The reaction is continuously occurring and can be conducted without any sophisticated equipment or apparatus. Such produced acetylene has been utilized for lighting by street Vendors, 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, still, have been approximately absent. In modern times, the use of acetylene as a fuel has been largely limited to welding-related applications or acetylene torches for welding. In most such application, acetylene is used in solution form such as acetylene dissolved in acetone for example. 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.

CaCO3+C (graphite) CaC2

(i) CaC2+H2O

(ii) Ca (OH) 2+C2H2

Comparison of Physical and Combustion Properties of C2H2, H2 and CNG

Properties	Acetylene	Hydrogen	C.N.G.
Composition	C_2H_2	H_2	CH4: 86.4-90% C2H6:3-6% C3H8: 0.35-2%
Density Kg/m^3 (At 1 atm &20^{0}C)	1.092	0.08	0.72
Auto Ignition temperature (^{0}C)	305	572	450
Stochiometric air to fuel Ratio (Kg/Kg)	13.2	34.3	17.3
Flammability Limits (Volume %)	2.5-81	4-74.5	5.3-15
Flammability Limits (Equivalent ratio)	0.3-9.6	0.1-6.9	0.4-1.6
Lower Calorific Value (KJ/Kg)	48.225	1,20,000	45,800
Lower calorific Value (KJ/m^3)	50636	9600	——
Max. deflagration Speed (m/s)	1.5	3.5	——
Ignition Energy (MJ)	0.019	0.02	——
Lower Heating Value of Stochiometric Mixture (KJ/Kg)	3396	3399	——

Physical and Combustion Properties of Petrol

Properties	Petrol
Formula	C8H18
Density (Kg/m^3)	800
Auto Ignition Temperature(0^{0}C)	246
Stoichiometric Air to Fuel Ratio (Kg/kg)	14.7
Flammability Limits (Volume %)	1.2-8
Lower Calorific value (KJ/Kg)	44,500

3. POSSIBLE ALTERNATIVE FUELS

So many fuels are readily available to replace the fossil fuels in IC Engines. Fuels can be Classified in to 3 forms, viz. solid, liquid and gaseous fuels.

3.1 Solid Fuels.

These fuels are nowadays using in trains and some external combustion

engines like boilers. Some examples for solid fuels are coal and coke.

3.2 Liquid Fuels.

Vegetable oils have been originated to be a possible alternative to diesel. They

have properties equivalent to diesel and can be used to run a compression ignition engine with minor modifications. Alcohols (methanol, ethanol) are also used as fuels in IC engines due to their high volatility.

3.3 Gaseous Fuels

Gaseous fuels are the best suited for IC engines since physical delay is almost nil.

However, as fuel moves equal amount of air the engines may have poor volumetric efficiency. There are quite few gaseous fuels that can be used as alternative fuels. Gaseous fuels are the most fitting requiring the minimum amount of management and simplest and most maintenance free burner systems. Gas is transported "on tap" via a delivery web and so is suited to a high populace or industrial density. However large customers do have gas holders and some produce their own gas. The following are the types of gaseous fuels:

(A) Fuels naturally found in nature:
Natural gas, Methane from coal mines
(B) Fuel gases made from solid fuel
Gases derived from Coal; Gases derived from waste and Biomass, from other industrial processes (Blast furnace gas)
(C) Gases made from petroleum Liquefied Petroleum gas (LPG), Refinery gases, Gases from oil gasification
(D) Gases from some fermentation process

3.4.1 The Merits of gaseous fuels:

i. Gaseous fuels burn very clean

ii. Generally very clean burning. Minute soot.

iii. Easy to burn No grinding or atomization. Brilliant mixing

iv. No problems with erosion or corrosion

v. No ash problems

vi the gas is easy to clean. E.g. if Sulphur is present,

it may be easily removed prior to combustion.

vii. Simplest combustion plant of all Burners

viii. Can be started up and shut down very easily and quickly.

3.4.2. The Demerits of Gaseous fuels:

Some of the demerits of gaseous fuels are as follows
i. Problems with distribution and storage
ii. Detonation risk and very volatile.
iii. Relatively costly. Offset by cheaper and more efficient plant.

4. METHODOLOGY

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

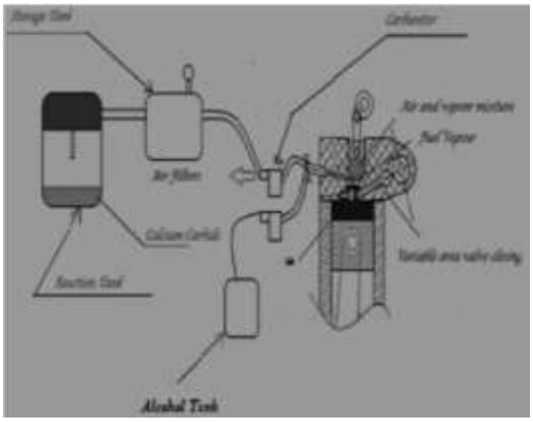
Step 1:

The first step involves the production of acetylene gas through the Calcium Carbide reacting with water in the reaction tank.

CaC2+2H2O
C2H2+Ca (OH) 2
The reaction tank constitutes two chambers:
• The water is kept in first (upper) chamber.
• The calcium carbide is kept in second (lower) chamber. The water from the first chamber is released in such a way to carry out the reaction spontaneously. The water is passed through the control valve. In the second chamber the calcium carbide is kept in desirable amount to react with water. Through second chamber a valve is connected to the storage tank where the gas produced while reaction is stored.

Step 2:

In this step the acetylene gas is stored in the storage 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 stowed to avoid moisture and the gas stored in storage tank is provided pressure through pressure gauge so the gas is of high concentration.

Step 3:

The gas is passed in the pipe in very sophisticated manner and then pipe is linked in the carburetor fitted with the filter, this then filters the air and then combines with petrol as secondary fuel which is added in very few amount (in about 10 to 15%) to prevent knocking for smooth operation of an engine. Then the mixture is passed in the engine.

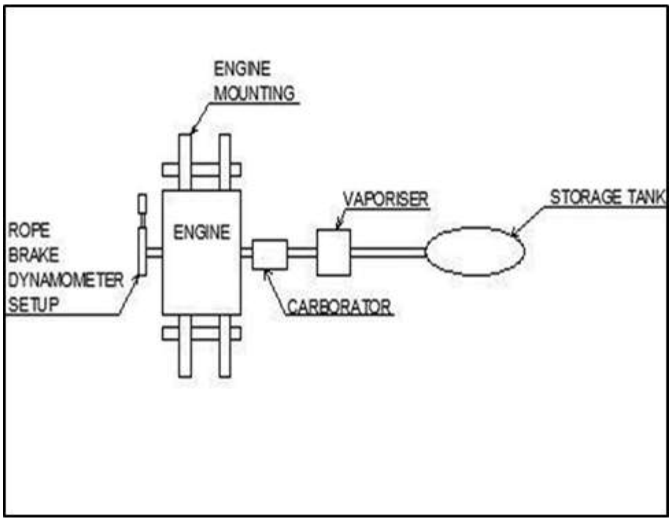
5. EXPERIMENTAL SETUP FOR TESTING

A Bajaj 4S champion engine is coupled with water brake dynamometer. Engine is loaded with the help of this water brake dynamometer. The measurement is carried out included brake power.

Experimental Setup for testing

The main components are as follows:

1. Engine
2. Engine mounting
3. Water brake dynamometer
4. Universal coupling
5. Vaporizer Kit
6. Gas storage Tank
7. Digital tachometer
8. Exhaust Gas Analyzer
9. Vacuum Plate
10. Mixer
11. Mixer Ring
12. Regulator
13. ON/OFF Valve



Schematic Diagram of Experimental Setup:

Type	Air Cooled Engine
Stroke (2/4)	4 Stroke
No. of Cylinders	Single Cylinder
Bore X Stroke	50 mm x 50.6 mm
Displacement	99.35 cc
Battery	12 v

OBSERVATIONS & CALCULATION

Measurement and result got by conducting trial using petrol, acetylene gas with the help of various apparatus are represented are represented in following table.

Sr. No.	Load (Kg)	Speed (RPM)	Time for 10 ml fuel(s)
1	1	800	75
2	2	800	65
3	3	800	50
4	4	800	47
5	5	800	45
6	6	800	41
7	7	800	38
8	8	800	35
9	9	800	30
10	10	800	26
11	11	800	23
12	12	800	20
13	13	800	18

Observation for Acetylene gas:

Sr. No.	Load (Kg)	Speed	Mass of Fuel X 10^{-4} (Kg/s)
1	1	800	0.89285
2	2	800	0.89435
3	3	800	0.89635
4	4	800	0.89885
5	5	800	0.90185
6	6	800	0.90953
7	7	800	0.90942
8	8	800	0.91400
9	9	800	1.09385

Calculation procedure for performance testing:

1. Brake power (kw): -

BP = (W*N)/K

Where, W = load in kg

N = dynamometer rpm

K=2719.2 = constant of dynamometer

2. Fuel consumption: -

Burette is provided for fuel measurement range of burette is 0-100 cc.

Rate of fuel consumption=

(cc/sec) *(sp.gravity*1000)….. (Kg/sec)

3. Brake specific fuel consumption (kg/KW-hr):-

$$\frac{\text{=Fuel consumption (kg/sec) *3600}}{\text{Brake power}}$$

4. Heat supplied by fuel (kJ/hr):

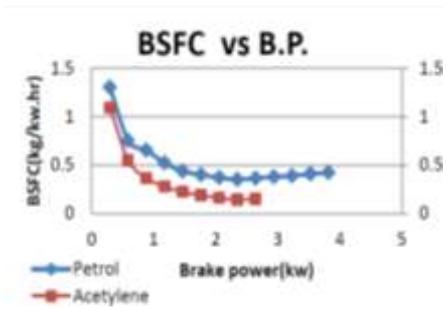
calorific value of fuel *fuel consumption…. (kJ/hr)

5. Brake thermal efficiency: -

$$\eta bth = \frac{\text{Heat equivalent of bp/hr}}{\text{Heat supplied by fuel /hr}}$$

RESULT:

Effect of BSFC and B.P. [N=800rpm]



The graph shown in fig. is BSFC vs Brake power. Initially as brake power increases BSFC decreases & then constant, at the end it is increases for petrol as well as acetylene but brake specific fuel consumption for petrol is greater than acetylene.

Effect of Brake thermal efficiency [N=800rpm]

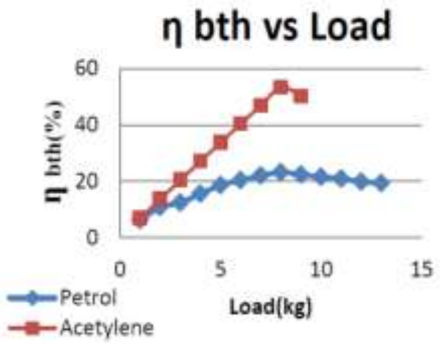
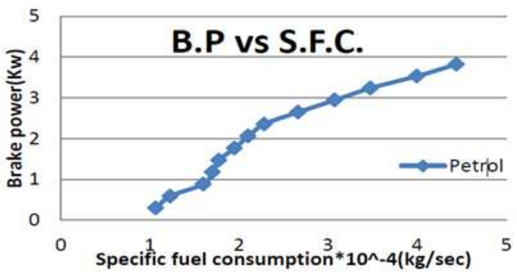


chart -1:

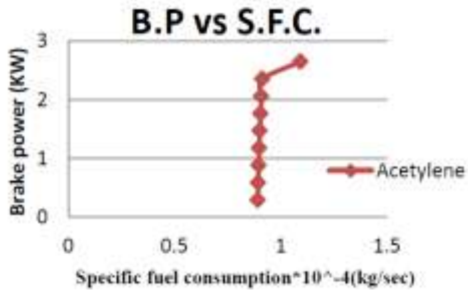
As load increases brake thermal efficiency increases and then decreases. Brake thermal efficiency for acetylene is greater than petrol. Thermal efficiency is minimum at low load and maximum at high load.

B. P. VS S.F.C for Petrol [N=800rpm]



Break power increases with increase in specific fuel consumption for petrol.

B.P vs S.F.C for Acetylene [N=800rpm]



7. CONCLUSIONS

The study highlights the use of acetylene as a fuel for S.I engine; this fuel can be used with conventional S.I engine with minor fabrication and manipulations.

As acetylene has wide range of merits on economic as well as environmental grounds. It is less costly than conventional fuel as acetylene is produced from calcium carbonate which is in large quantity.

From above results shows that

1. Brake specific fuel consumption for petrol is greater than acetylene

2. Brake thermal Efficiency of Acetylene Gas is more than Petrol.

3. Break power increases with increase in specific fuel consumption for petrol.

4. Break power increases with increase in specific fuel consumption for petrol.

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