

Emission and Performance Characteristics of Hydrogen-Acetylene Fuel in Ic Engine

¹N.SAMPATH KUMAR, ²B.GOWTHAM PRABHU, ³K.KALAI SELVAN, ⁴R.MAHESH KUMAR,
⁵K.MOHAN KUMAR

Dept. of Mechanical Engineering, Jay Shriram Group of Institutions. Tiruppur, Tamilnadu, India

ABSTRACT: In nearby future, fossil fuel going to exhaust soon and at present we are facing acute scarcity of fuel due to which prices are rising day by day. Many research activities were carried out in order to study the Internal Combustion Engines with alternative fuels. An environmentally clean dual fuel for an internal combustion engines, comprising of acetylene as a primary fuel and hydrogen as a secondary fuel (H-C₂H₂) serves as a replacement of conventional fossil-fuels. Since both can be produced from non-petroleum source (Coal, limestone and water). It is more effective and eco-friendly alternative fuel option. Acetylene and Hydrogen was evaluated in a single cylinder engine to investigate the performance and emission characteristics. Both results comprises significant improvements than conventional petroleum fuels.

KEYWORDS: Alternative Fuels, IC Engines, Dual Fuel, H-C₂H₂, Emission, Performance

I. INTRODUCTION

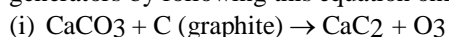
In the present perspective, the world is facing troubles with environmental degradation and the crisis of fossil fuel reduction. Conventional hydrocarbon fuels used by the internal combustion engines, which continue to lead many fields like power generation, transportation and agriculture leads to pollutants like particulates, HC (hydrocarbons) which are highly harmful to human health. CO₂ from Greenhouse gas increases global warming, sea level increase and Climatic changes. The search for an alternative fuel promises a harmonious correlation with energy conservation and management, sustainable development, efficiency and environmental protection. Therefore, any attempt to minimize the consumption of petroleum based possible alternative fuels will be the most welcome. Hence fuels which are clean burning, renewable and can be produced easily are being investigated as alternative fuels.

II. ACETYLENE GAS

Acetylene (C₂H₂) is not only an air gas but also a synthesis gas generally 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 gaseous hydrocarbon, has a strong garlic odor, it is colorless, is unstable, 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 continuously occurring and can be conducted without any sophisticated equipment or apparatus. 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.

REACTION FOR PRODUCTION

For production of acetylene, calcium carbide must 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.

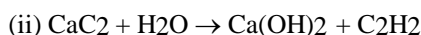


International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 3, March 2017



III. HYDROGEN GAS

Hydrogen is a most abundant element in the universe, making up 75% of mass of all visible matter in galaxy. The most hydrogen atoms, the nucleus consist of single proton although a rare form (or “isotope”) of hydrogen contains both a proton and a neutron. This form of hydrogen is called deuterium or heavy hydrogen. Hydrogen gas is highly flammable and burns in air at very wide range of concentrations between 4% and 75% of by volume.

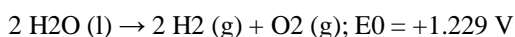
HYDROGEN PRODUCTION ELECTROLYSIS OF WATER

A DC Electrical power source is connected to two

Electrodes, or two plates which are placed in the water. Hydrogen will appear at the Cathode and Oxygen will appear at the Anode.

Electrolysis of pure water requires excess energy. The Efficiency of Electrolysis is increased through the addition of an Electrolyte (Salt, Acid or Base).

Electrolysis of Water is the Decomposition of Water (H_2O) into Oxygen gas (O_2) and Hydrogen gas (H_2) due to an Electric Current being passed through the Water. The reaction has a Standard Potential of - 1.23V, meaning it ideally requires a potential difference of 1.23V to split water. This technique can be used to make hydrogen fuel (Hydrogen Gas) and Breathable Oxygen. Electrolysis of water produces hydrogen.



FARADAY’S LAWS OF ELECTROLYSIS

FIRST LAW OF ELECTROLYSIS

In 1832, Michael Faraday reported that the quantity of elements separated by passing an electric current through a molten or dissolved salt is proportional to the quantity of electric charge passed through the circuit. This became the basis of the first law of electrolysis:

The alternator three phase AC supply is converted into DC supply using the Modified Rectifier unit. This DC supply is given to the HHO cell. The acetylene is formed in the reactor by mixing calcium carbide with water. After the gas formation both the HHO gas and acetylene fed into the Burn Back arrester. The blended gas is supplied to the engine carburetor through the Air Filter.

$$m = k q$$

Or

$$m = eQ$$

Where: e is known as electrochemical equivalent of the metal deposited or of the gas liberated at the electrode.

SECOND LAW OF ELECTROLYSIS

Faraday discovered that when the same amount of current is passed through different electrolytes/elements connected in series, the mass of substance liberated/ deposited at the electrodes is directly proportional to their equivalent weight.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 3, March 2017

IV. PROPOSED WORKING MODEL

The Block Diagram of the proposed working model is shown in fig.

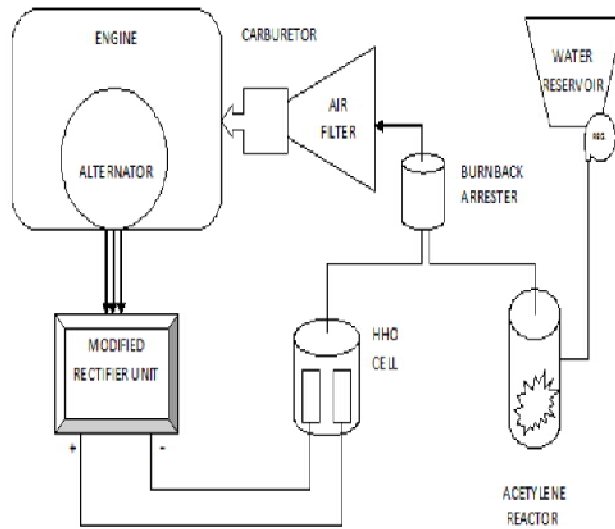


Fig. 1: Block Diagram of Proposed methodology

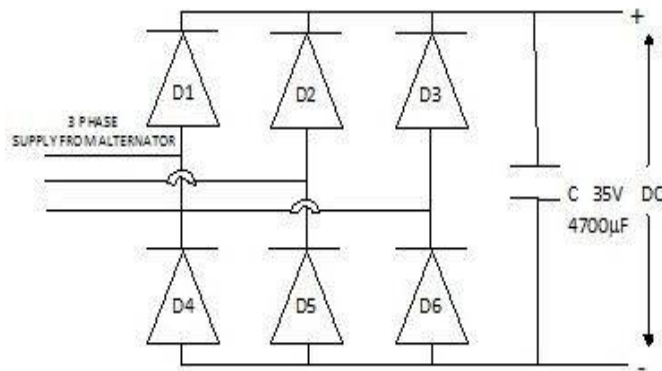


Fig. 2: Modified Rectifier Unit

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 3, March 2017

Properties	Acetylene	Hydrogen	Petrol
Composition	C ₂ H ₂	H ₂	C ₈ H ₁₈
Density kg/m ³ (At 1 atm & 20°C)	1.092	0.08	800
Auto ignition temperature (°C)	305	572	246
Stoichiometric air fuel ratio, (kg/kg)	13.2	34.3	14.7
Flammability Limits (Volume %)	2.5-81	4-74.5	1.2-8
Flammability Limits (Equivalent ratio)	0.3-9.6	0.1-6.9	-
Lower Calorific Value (kJ/kg)	48,225	12,000	44,500
Lower Calorific Value(kJ/m ³)	50,636	50,600	-
Max deflagration speed (m/sec)	1.5	3.5	-
Ignition energy(MJ)	0.019	0.02	-

Properties of alternative fuels

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 3, March 2017

V. ENGINE SPECIFICATIONS

Type	Air Cooled Engine
Stroke	4 Stroke
No. of Cylinders	Single Cylinder
Displacement	99.26 cc
Model	Bajaj CT100

OBSERVATIONS OF ACETYLENE GAS

S.No.	Load(kg)	Speed(rpm)	Time for 10 ml Fuel(sec)	Mass of Fuel x 10 ⁻⁴ (kg/sec)
1.	1	800	75	0.892
2.	3	800	50	0.896
3.	5	800	45	0.901

VI. WORKING

There are two stages involved in this process

- Hydrogen Production Stage
- Acetylene Production Stage

ACETYLENE PRODUCTION STAGE

At first the water regulator or tap is opened to allow the water drops fill into the Acetylene Reactor. Due to the mixing of water with the Calcium Carbide liberates Acetylene Gas and Lime water. The Produced acetylene gas is introduced in the Air Filter that is allowed to the carburetor and engine where the combustion occurs.

HYDROGEN PRODUCTION STAGE

The alternator coupled with the engine flywheel produces three phase AC voltage. The AC voltage is converted into Dc voltage by using rectifier unit. In this project we use da modified rectifier unit to get more power output. The output voltage and current range varies according to the throttle position. Initially the engine starts only with the acetylene fuel after 5-

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 3, March 2017

10 seconds the HHO cell unit works and gives HHO gas that is blended with the acetylene. The blending varies according to the throttle position.

VII. OBSERVATIONS & CALCULATION OBSERVATIONS FOR PETROL

CALCULATION PROCEDURE FOR PERFORMANCE TESTING:

1. Brake power (kw) :-

$$BP = (W*N)/K \text{ Where}$$

W = load in kg

N = dynamometer rpm

K=2719.2 = constant of dynamometer

2. Fuel consumption (kg/sec):-

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

$$\text{Rate of fuel consumption} = \text{cc/sec} * (\text{sp.gravity} * 1000)$$

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

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

Brake power

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

$$= \text{calorific value of fuel} * \text{fuel consumption}$$

5. Brake thermal efficiency:-

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

Heat supplied by fuel /hr

VIII. EMISSION CHARACTERISTICS

S.No	Speed (km/hr)	Mileage(km)
1.	30	71
2.	35	73.5
3.	40	74.3

Pollutants	Petrol	H-C ₂ H ₂ Blend	Standard Allowance
CO	0.75	0.4	< 3.5
HC	109	75	< 4500
CO ₂	0.9	0.6	-
O ₂	24.1	29.94	-

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 3, March 2017

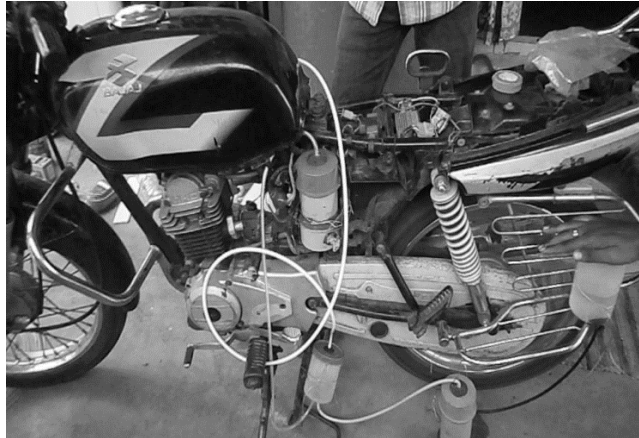


Fig. 3: Experimental Setup

IX. RESULTS AND DISCUSSION

1. Brake specific fuel consumption for petrol is greater than H-acetylene.
2. Brake thermal Efficiency of H-Acetylene Gas is more than Petrol.
3. Break power increases with increase in specific fuel consumption for petrol.
4. Reduced Emissions than Gasoline.

X. ADVANTAGES

1. Very cheap and available in abundance.
2. An engine operated on such a fuel can be interchangeably utilized for indoor and outdoor operations without environmental concerns.
3. Reduced emission than conventional fuel.
4. Complete combustion of fuel.
5. Better Efficiency.
6. Reducing the maximum use of gasoline.

XI. CONCLUSION

The study highlights the use of H-C₂H₂ as a fuel for IC engines, this fuel can be used with conventional S.I engine with minor modifications. As Hydrogen and 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 as acetylene is produced from calcium carbide and water which is in abundance. Also hydrogen produced from water Hydrogen and Acetylene have proved out to be better fuel due its non-polluting nature and more economic. There is significant improvements in performance and Emission control that is discussed earlier.

REFERENCES

- [1] J. B. Heywood, Internal Combustion Engine Fundamentals, McGraw-Hill, Inc., New York, 1988.
- [2] Chigier N (1981) "Energy, Combustion and Environment", McGraw Hill
- [3] J. Wulff, W.Hulett, L. Sunggyu, "Internal combustion system using acetylene fuel". United States Patent No 6076487.
- [4] T.Lakshmanan, G.Nagarajan(2009), Performance and Emission of Acetylene-aspirated diesel engine, Jordan journal of Mechanical and industrial engineering,3
- [5] S.Swami Nathan, J.M.Mallikarjuna, A.Ramesh(2010), Effect of charge temperature and exhaust gas re- circulation on combustion and emission characteristics of acetylene fuelled HCCI engine Fuel ,89,pp.515-521

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 3, March 2017

- [6] G.Nagarajan, T.Lakshmanan(2010), Experimental Investigation on Dual Fuel Operation of Acetylene in a DI Diesel Engine, fuel processing technology,91, pp.496-503
- [7] www.wikipedia.com
- [8] www.youtube.com