FABRICATION OF S.I. ENGINE TO USE ACETYLENE AS FUEL

SUYASH KAMAL SONI, RAHUL JAIN, ADARSH CHOBUEY, ABHINEET SHARMA

1,2,3,4 R.G.P.V., Bhopal (M.P.)
Email: suyashkamalsoni@gmail.com

Abstract—In the present statuesque where fossil fuel is on the verge to exhaust, the need of the hour is to search for an alternative fuel. and we have many choices like LPG, CNG with their drawbacks. Due to which it is complicated to use them among various options acetylene gas is a very good fuel for automobiles but it also has many shortcomings which are needed to be studied before using. the paper investigates the changes required to be done for running a IC engine on acetylene produced on-board by a decomposition reaction of calcium carbide with water in presence of aluminum powder. Thus reducing the running cost and minimum pollutant emission, which makes it fit for use on economic and environment standard? It is more eco-friendly fuel option.

Keywords—Alternative fuel, Emission, Exhaust analysis, Comparison, Efficiency.

I. INTRODUCTION

As we are well informed about the extinction of fossil fuels and its deteriorating effect on environment causing:

- Global warming
- Ozone depletion
- Respiratory ailments
- Acid rain

Due to the noxious exhaust produced during the combustion during the combustion of this conventional hydrocarbon.

But, due to a absence of a compatible and more eco-friendly fuel we are still depend on these hydrocarbon based fuel (Petrol, Diesel etc.). Acetylene which can be a better replacement for these fuels on environment and economic aspects still have certain obstacles which are dealt in this paper like:

- Production
- Storage
- Transfer
- Injection

The aim of this paper is to overcome the shortcomings which prevent the use of acetylene as a fuel in IC engine.

The aim of this paper is to overcome the shortcomings which prevent the use of acetylene as a fuel in IC engine.

Acetylene is produced by calcium carbide with water in following reaction:

Calcium carbide + water → acetylene + calcium hydroxide

Acetylene is produced by mixing calcium carbide with water in on-board tank. This acetylene on combustion burns to give carbon dioxide with water vapors. But as it has high ignition temperature certain engine modification are required.

II. CURRENT PRACTICES

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. CO2 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.

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.
Table 1: Comparison of alternate fuel with acetylene

III. ENVIRONMENTAL ASPECTS

The molecular weight of acetylene is 26 with two carbon atoms (C2H2 gas density = 0.068 lb/ft3 typically the Material and Safety Data sheet will provide this detail of information) while the molecular weight of CO2 is 44 with one carbon 66 atom. Given that each mole of acetylene, under complete combustion, will create two moles of CO2 (i.e., each pound of acetylene combusted will produce 3.38 pounds of CO2 (2x44/26)). Use the following conversion calculations to derive an emission factor for acetylene:

The result obtained from this calculation illustrates that the amount of CO2 emitted is fairly minimum and other emissions like NOx, Sox are highly negligible compared to CO2. This indicates that acetylene can be relatively more environmental friendly than gasoline.

<table>
<thead>
<tr>
<th>Physical and Combustion Properties of fuels</th>
<th>Acetylene</th>
<th>Hydrogen</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel</td>
<td>C2H2</td>
<td>H2</td>
<td>C2-C2b</td>
</tr>
<tr>
<td>Density (g/m³) (At 1 atm &amp; 20°C)</td>
<td>1.092</td>
<td>0.08</td>
<td>840</td>
</tr>
<tr>
<td>Auto-Ignition Temperature (°C)</td>
<td>303</td>
<td>372</td>
<td>237</td>
</tr>
<tr>
<td>Stoichiometric air fuel ratio, (kg/kg)</td>
<td>13.2</td>
<td>34.3</td>
<td>14.5</td>
</tr>
<tr>
<td>Flammability Limits (Volume %)</td>
<td>2.5 – 81</td>
<td>4 – 74.5</td>
<td>0.6 – 5.5</td>
</tr>
<tr>
<td>Flammability Limits (Equivalent ratio)</td>
<td>0.3 – 9.6</td>
<td>0.1 – 6.9</td>
<td>------</td>
</tr>
<tr>
<td>Lower Calorific Value (LJ/kg)</td>
<td>48,225</td>
<td>120,000</td>
<td>42,500</td>
</tr>
<tr>
<td>Lower Calorific Value (LJ/m³)</td>
<td>50,000</td>
<td>9000</td>
<td>------</td>
</tr>
<tr>
<td>Max deflagration speed (m/s)</td>
<td>1.5</td>
<td>3.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Ignition energy (MJ)</td>
<td>0.019</td>
<td>0.02</td>
<td>------</td>
</tr>
<tr>
<td>Lower Heating value of Stoichiometric mixture (LJ/kg)</td>
<td>3396</td>
<td>3999</td>
<td>2930</td>
</tr>
</tbody>
</table>

Table: Exhaust Gas Composition Per Unit Mole

IV. WORKING

1. Acetylene storage tank In this calcium carbide reacts with water to produce acetylene and calcium hydroxide. Small amount of aluminum oxide is mixed to enrich the above reaction.
   - Specification of production tank Cylinder is made up steel which can withstand 2MPa pressure and dimension of tank are 33inch in length and 13inch in diameter. In this tank on board exothermic reaction takes place on which acetylene is formed through this reaction.

   \[
   \text{CaCO}_3 + 2\text{H}_2\text{O} \rightarrow \text{C}_2\text{H}_2 + \text{Ca(OH)}_2
   \]
This acetylene further moves to storage tank.

II. Storage tank
This storage tank is made up of steel and consists of pressure gauge to measure the internal pressure of acetylene. The inner lining of cylinder is made up of sponge which is shucked in acetone due to which it absorbs acetylene in large volume and maintains it in subcritical condition eliminating the condition of detonation and maintains its stability.

III. Vaporizer
It is very similar to carburetor, as carburetor mixes air and liquid fuel but vaporizer mixes air and gaseous fuel.
It consist of four valves:
- Water in
- Acetylene in
- Water out
- Gaseous fuel out
Quantity of outlet gas is controlled using this diaphragm mechanism. From this outlet fuel gas is moved to the engine for combustion process.

V. ENGINE MODIFICATION
i. Twin spark ignition After analysis of the efforts of researchers trying to run on acetylene we have came across the conclusion to use twin spark plugs in a single cylinder for acetylene due to this reasons. As there is no delay in combustion, the gas entering the combustion chamber burns instantly causing knocking effect. So twin spark for valve engine will reduce the knocking effect in engine also knocking wear and tear even distortion in the engine structure which would be reduced to produce negligible effect.

ii. Increasing swept volume By increasing length of connecting rod or by increasing diameter of cylinder which increases the combustion time. For this increasing the diameter of cylinder of cylinder would be better according to Indian aspects and oversized piston can be used in that case, while in case of western countries increasing length of connecting rod would be beneficial.

iii. Cam timing
Cam monitors the sequence and timing of opening and closing of inlet and outlet valves thus variation in design of cam would be for change in timing of inlet valve. The timing of inlet valve should be increased i.e. inlet valves should be open slowly and for longer time than normal.
VI. APPLICATIONS

- A good replacement for gasoline and petrol.
- It can be used in place of LPG directly with minor manipulation in engine.
- As it emits CO₂, so it is more eco-friendly thus its use can be beneficial in countries like India where in year 2050 fossil fuel will get depleted (shown by studies).

VII. ADVANTAGES

- Emission is non-polluting as only carbon dioxide and water vapors are emitted.
- Homogenous mixture is formed due to which complete combustion.
- Better efficiency.
- It is very cheap and available in abundance.
- It uses same handling system which is used in CNG and LPG cylinders.
- It has very low Photochemical Ozone creation Potential (POCP).
- An engine operated on such a fuel can be interchangeably utilized for indoor and outdoor operations without environmental concerns.
- The need for a three-way catalytic converter or other EGR device is eliminated.
- Due to reduced operating temperatures, there are fewer tendencies for viscosity breakdown of engine lubricants and less component wear.
- Due to cleanliness of the combustion process, buildup of carbon- and sulphur compounds are eliminated thereby substantially extending the time intervals between routine maintenance.

DISADVANTAGE

- Modification in SI engine is required
- Knocking possibilities.
- Decrease in power of engine.
- It cannot be available everywhere because there are no filling station as it is a new initiative.

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 as 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.

FUTURE SCOPE

- In nearby future, fossil future going to exhaust soon and at present we are facing acute scarcity of fuel due to which prices are rising day by day. On the other acetylene is cheap and is produced from calcium carbonate which is in abundance.
- Another advantage which justifies the use of acetylene in future is in the exhaust emission. On one hand fossil fuel during combustion produces CO₂, CO, NOₓ, Some unburnt hydrocarbon are produces but in case of acetylene carbon dioxide is produced with traces of water vapors.
- Acetylene being gas makes better homogenous mixture with air therefore better mixing of fuel which leads to better combustion; this is not possible with conventional SI engine fuel.

REFERENCES