Analysis over the Development of Hydrogen Engine -1

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Abstract— We know that the storage of the various type fuels in the earth will be finished after some time in which the petroleum oil is used at large scale because petrol, diesel, kerosene etc. are obtained by this oil. So in future the transmission may be effected critically and other essential activities also may be affected critically. To solve this problem such type fuel is required which will be available till the end of earth. The hydrogen is the solution of this problem which will be available always on the earth. Generally it may be obtained by water in large quantity. There are various methods to obtain the hydrogen from the water like by chemical reactions, by electric decomposition etc. In which the electric decomposition method is mostly used because by using this method the hydrogen and oxygen both are separated in ratio 2:1 by volume clearly and easily. Now further in hydrogen engine these both type gases are required in ratio 2:1 again so it will be a recycling process through which the obtained heat energy will be used to run the engine. Here to use the hydrogen as a engine fuel the spark ignition engine will be used like petrol engine but here some modifications are required in working and structure of this type spark ignition engine.

Keywords: Hydrogen Engine

I. INTRODUCTION

The hydrogen is a cheap and evergreen source of fuel of heat energy and easily may be obtained from water. The conventional spark ignition cannot be used for the combustion of hydrogen fuel because the water vapour is produced after combustion of the hydrogen in the engine cylinder which will create the big problem to start the engine. To solve this problem turn the cylinder piston mechanism by 90^0 right or left side and due to this the vapour produced as exhaust material comes outside completely when the piston comes towards the TDC in exhaust stroke.

II. METHODOLOGY OR LITERATURE SURVEY

A. Methodology Related to Source of Hydrogen:

Mostly the hydrogen is available on the earth in combined form as water. It is very light weighted gas in comparison with all other gases and due to this it escapes the environment. It may be obtained easily by electrical decomposition of water.

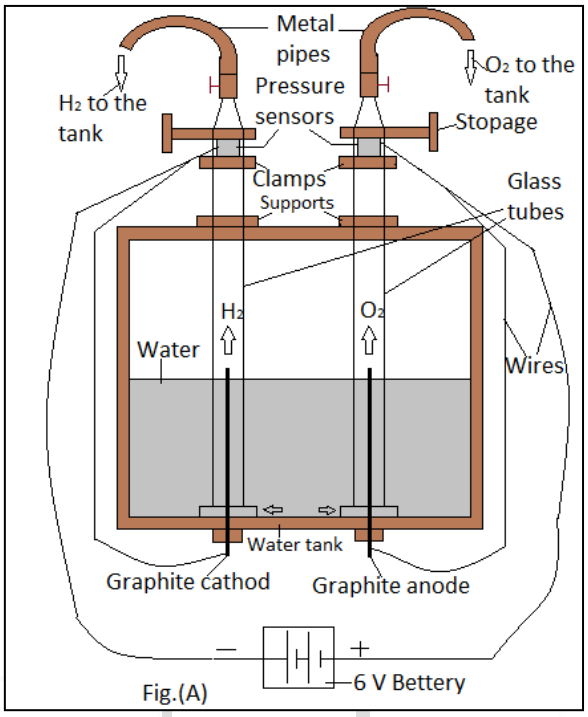

Fig. A:

Here according the given fig.(A) first fill the water in the tank and set the two graphite electrode (cathode and anode) vertically and then provide connections between battery, electrodes and pressure sensors. After this pass 1.23 V DC current through the water due to which the water is decomposed in hydrogen at cathode and oxygen at anode and further these are collected in their tanks.

The water decomposition reaction is given as following →

$$2H_2O \rightarrow 2H_2 + O_2$$

- Note – (I) Here the both glass tubes are put over the ring type stand through which the water may be entered into the glass tubes.
- Note – (II) Here a regulator is also attached with the battery to maintain the voltage of supplied DC current.

B. Methodology Related to the Modification in Spark Ignition Engine

To run the engine successfully the first improvement in conventional spark engine is that it should be turned by 90^0 left or right like fig.(B).By this the vapour created after combustion is easily extracted out in exhaust stroke and the cylinder becomes almost vapour or water less, it helps to start the engine easily.

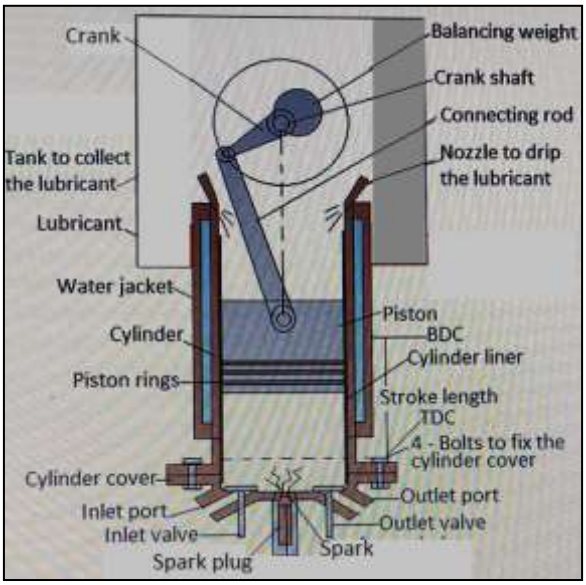

Fig. B: Hydrogen engine

Here forced type lubrication is possible due to this improvement provided to the engine. Here also the same four strokes are used as the spark engine. The gear box is arranged in same way as in spark ignition engine.

C. Methodology Related To the Design of Vehicles

We know that the calorific value of hydrogen is 142 KJ/kg and calorific value of CNG is about to 42-55 KJ/kg. So it is clear that to obtain the same power as in hydrogen engine the three time mass of CNG should be burnt in the engine for value of H_2 only in chemical equation while for value of $2H_2$ in chemical equation the six time mass of CNG should be burnt in the engine .Besides it the air – fuel ratio by mass is provided 1:16 to 1:8 for this hydrogen engine which is almost same as in CNG engine. Besides it to obtain the more power the multi cylinders also may be used in this hydrogen engine. By this the overall size of the engine will be increased. Besides it the large sized hydrogen tank is also used to store the more volume of the gas at atmospheric pressure. It is very necessary to arrange this space properly in the vehicle. Generally the water decomposition arrangement and gas tanks should be fixed at back side of the vehicle with safety while the engine should be fixed at front side of the vehicle as in petrol engine. Besides it to increase the carrying capacity of the vehicle the self weight of the vehicle also should be low as far as possible. Means the vehicle should be made of strong fiber, light metals and alloys.

III. ANALYSIS

A. Analysis over the Safe Working of Water Decomposition and Safe Storage of the Gases (H_2 and O_2)

It is important to decompose the required quantity of water. Means the extra decomposition of water may create the storage problem of the gases. For this a pressure sensor is required which will be fixed over the glass tubes as fig.(A). Here when the both gas tanks are completely filled a pressure is applied upside by the gases on the glass tubes and by this the glass tubes lift up and provide the pressure or force on the pressure sensor and due to this pressure the pressure sensor disconnects the charge supply from battery to cathode or anode or to both and decomposition is stopped. When the pressure in the glass tube will be reduced the glass tube comes down and the pressure applied on the pressure sensor is stopped and the battery supply is connected again with the cathode and anode and decomposition starts. Now further to avoid any critical damage the spring loaded safety valves are also fixed over the both gas storage tanks which are opened when the pressure in the tanks is increased above the safety level. Here the volume of space available in the hydrogen tank should be double to the volume of space available in the oxygen tank.

- Note – (I) The arrangement should be provided such that the supply ratio of hydrogen and air is 1:14 minimum by mass at running condition or at middle speed. It will help to control the engine related activities and other activities also.
- Note – (II) Here the pressure sensor is a electric switch which works on the pressure applied.
- Note – (III) Here the engine cooling method will be same as in spark ignition engine.

B. Analysis over the Material Used For Various Parts of Cylinder Piston Mechanism

The material used for piston should be strong, tough, light weighted and good conductor of heat. For this it should be made of Alluminium – nickel alloy (Al -50% and Ni – 50%) to achieve these required properties. Its specifications are as following which are required also →

1) Good wear strength and good abrasion resistance
2) Good tensile strength (220 MPa).
3) Good compressive strength (340 MPa).
4) High value of melting temperature (1100^0 C).
5) High value of thermal conductivity(170 W/mk)
6) Light weighted (density 6 g/cm^3).
7) Good toughness.

The crank, crank shaft, connecting rod and various type pins are made of forged steel. While both the cylinder and cylinder cover are made of cast iron. The piston rings are made of nickel – chromium alloy (50 -50% quantities). The piston rings should be made by powder metallurgy method specially. To protect from oxidation the internal surfaces of the cylinder and cylinder cover are coated with the wear resistance materials like nickel, chromium etc.

C. Analysis over the Valve Timing Used For Hydrogen Engine

The valve timing diagram is some different to the valve timing diagram of the petrol engine as given fig.(C). This is a theoretical valve timing diagram, the actual valve timing diagram may be some different to it.

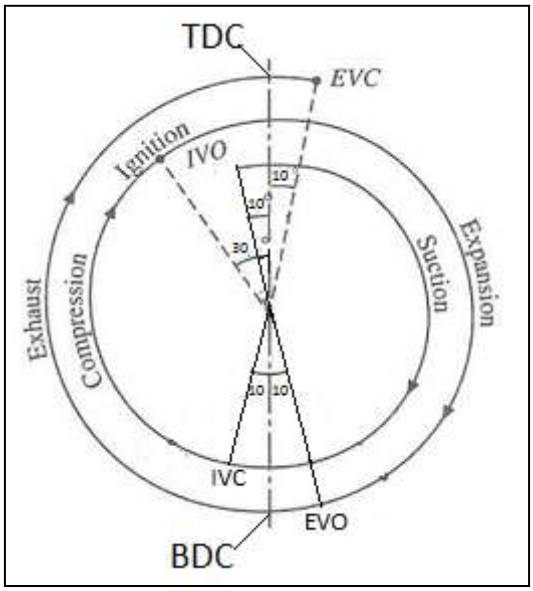

Fig. C:

TDC – Top dead centre.
BDC – Bottom dead centre.
IVO – Inlet valve opens 5º to 10º before TDC.
IVC – Inlet valve closes 5º to 10º after BDC.
EVO – Exhaust valve opens 5º to 10º before BDC.
EVC – Exhaust valve closes 5º to 10º after TDC.
Ignition starts at 30º to 40º before TDC.

The working cycle of this engine will be almost same as the petrol engine cycle. The theoretical P – V diagram is given like fig.(D). The actual P – V diagram may be different to the to the actual P –V diagram for petrol engine.

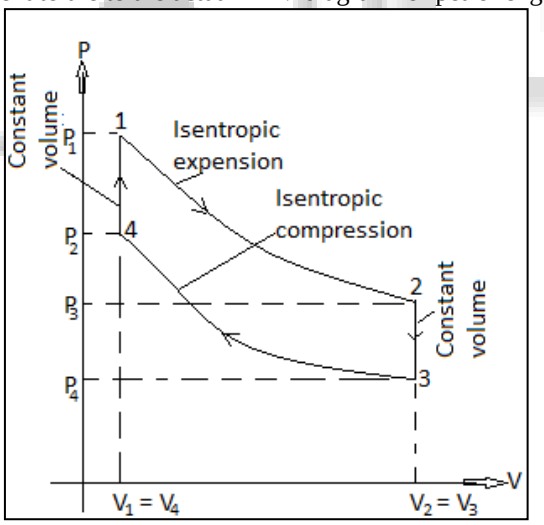

Fig. D: Theoretical P – V Diagram.

Analysis over the power developed and thermal efficiency –We know that the calorific value of hydrogen is 142 KJ/kg and calorific value of petrol is about to 45.0 KJ/kg.

$$2H_2O \rightarrow 2H_2 + O_2$$

So it is clear that to obtain the same power as in hydrogen engine the three time mass of petrol should be burnt in the engine for value of $1H_2$ only in chemical equation while for value of $2H_2$ in chemical equation the six time mass of petrol should be burnt in the engine. Besides it the air – fuel ratio by mass is provided 16:1 to 8:1 for this hydrogen engine which is almost same initially as in petrol engine. Besides it to obtain the more power the multi cylinders also may be used in this hydrogen engine.

D. Analysis over the Supply Chain of the Hydrogen in This Hydrogen Engine

Here according fig.(E) it is clear that first the hydrogen should be stored in a storage tank after decomposition. After this the hydrogen and air both are mixed in a mixer then this mixture of air and hydrogen is supplied to the hydrogen engine. Here the hydrogen engine should be placed above always to the hydrogen storage tank.

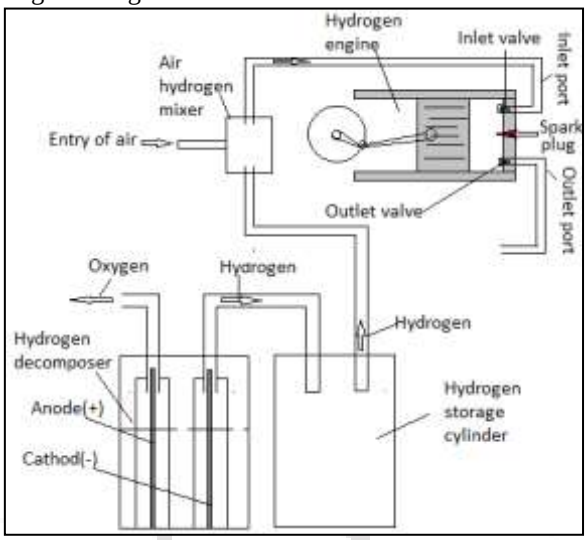

Fig. E: Supply chain

IV. FINAL RESULT

It will be great achievement if the hydrogen engine is developed like that. Some important engine tastings and practicals are required to search the various specifications related to the compression ratio, temperature at the end of compression, temperature after combustion, valves timing, power developed and proper working of decomposition etc.

V. CONCLUSION

In resultant we can say that after required modifications the hydrogen engine may work like a gas engine.

– Note – To maintain the economic balance the hydrogen gas may be produced separately at the other stations and may be used as fuel filling stations like CNG, petrol and diesel stations.

REFERENCE OF BOOKS

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[3] Internal combustion engine by M.L Mathur and R.P Sharma.

