

# Design and Fabrication of Hybrid Hydrogen Gasoline Kit: A Review

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**Abstract-**Conventional spark ignition (SI) engine uses gasoline primarily as a fuel, but the emissions from this engine are harmful for the environment. In this paper, the use of hydrogen is promoted as a primary fuel and gasoline as the secondary. The main aim is to develop a test rig or a hybrid hydrogen and gasoline kit which performs switching from hydrogen to gasoline and vice versa as well as blending of both the fuels in a ratio to minimize emissions drastically as compared to the conventional engines. This experiment setup has a provision which ensures three working stages allowing use of hydrogen and gasoline as a fuel individually or as a blended mixture. This variation is achieved by adjusting the acceleration of the engine in an innovative way, also to take a step towards reducing harmful emissions and minimizing the use of conventional fuels and using renewable fuels as primary fuels. The final outcome of the project is obtaining complete combustion of hydrogen and gasoline as fuels and thus reducing the CO<sub>2</sub> and CO emissions.

**Keywords-**Hydrogen, Gasoline, Engine, Hybrid hydrogen-gasoline, Renewable Energy.

## I. INTRODUCTION

The problem of energy crises in the world is a very critical one. Solving this problem is almost impossible if we keep implementing the conventional ways, thus to solve this issue we must change our perception to some non-conventional ways. Development of hydrogen engines is one of those non-conventional perceptions towards solving these problems. The main idea behind the research in this respective field is developing an engine which ultimately results in zero emissions. The CO<sub>2</sub>, CO and NO<sub>x</sub> emissions of the conventional SI engine are an important issue to be tackled. With the use of hydrogen gas as a fuel we can eliminate the CO<sub>2</sub> and CO emissions. The NO<sub>x</sub> emissions can be eliminated by using pure oxygen instead of air. Since using pure oxygen is economical suicide we solving and issue of CO<sub>2</sub> and CO emissions is our main objective. Using hydrogen as our primary fuel allows us to eliminate the harmful emissions since there is no carbon content in this case as compared to gasoline. Thus keeping in mind all the conventional engines and the properties of hydrogen gas as a fuel we have decided to develop a test rig which uses hydrogen and gasoline as fuels

and blending them in a suitable ratio which allows higher BMEP and higher brake thermal efficiency at reduced emissions. The use of hydrogen as our primary fuel has many benefits economically as well as from the environmental point of view.

## II. LITERATURE SURVEY

The research papers that were studied to obtain some conclusive ideas related to our topic are mentioned in the upcoming paper. The following are the conclusions drawn from each research paper:

- 1. Research paper:** Combustion and emissions characteristics of a hybrid hydrogen gasoline engine under various loads and Lean conditions.  
**Authors:** Changweiji, Shuofengwang, Bo zhang (2010)  
**Conclusion:** The Working conditions of a conventional SI engine with hydrogen as fuel. The changes in BMEP and Thermal Efficiency are observed with hydrogen as fuel. Use of hydrogen as boosting fuel for conventional SI engine is observed.
- 2. Research paper:** Can pure hydrogen (H<sub>2</sub>) replace HHO to increase MPG.  
**Authors:** Phillips company (2012)  
**Conclusion:** We can replace HHO by hydrogen and also there is an increase in MPG.32% increase. This is an effective generation setup with which hydrogen can be generated at low cost and higher efficiency.
- 3. Research paper:** Reaction of Aluminium with Water to Produce Hydrogen.  
**Authors:** John Petrovic, George Thomas (2008).  
**Conclusion:** This literature reflects the info about our H<sub>2</sub> generation setup using aluminium and NaOH. This is a cost effective setup.
- 4. Research paper:** Aluminium-Based Hydrogen Generator for a Mini-Type Proton Exchange Membrane Fuel Cell with an Innovative Flow Field Plate  
**Authors:** Shou-Shing Hsieh, Bing-Shyan Her, and Cheng-I Chen (2012).  
**Conclusion:** Thepaper shows design of a significant generation setup which generates highly pure hydrogen

gas at the cost of aluminium and sodium hydroxide as base. An innovative PEM method is developed to obtain the best of the results from the experiment.

**5. Research paper:** Catalytic Carbon and “How CC works”

**Authors:** Phillips company (2012)

**Conclusion:** A generation setup was developed which uses heated water and aluminium and catalyst carbon for obtaining hydrogen gas as an output which can be generated at very high rates. This prototype can be scaled as required to obtain a desired rate of generation with mere requirements.

**6. Research paper:** A comparative evaluation of the performance characteristics of a spark ignition engine using hydrogen and compressed natural gas as alternative fuels

**Authors:** L.M. Das, R. Gulati, P.K. Gupta (2000).

**Conclusion:** A comparative study was carried out between CNG and Hydrogen as alternate fuels for the engine. The study was carried out using the same automatic fuel injection system with merely any changes in the hardware for both CNG as well as Hydrogen. The Brake thermal efficiency was found higher for hydrogen than that of CNG.

**7. Research paper:** The usage of hydrogen for improving emissions and fuel consumption in a small gasoline engine.

**Authors:** Murat Kosar, BulentOzdalyan, M. BahattinCelik (2011)

**Conclusion:** This experiment specifically mentions use of hydrogen as the primary fuel for small engines. The analysis shows that NO<sub>x</sub> emissions were reduced by 57% and the CO<sub>2</sub> and CO emissions were nearly zero. Also the issue of backfire can be eliminated by using lean mixtures i.e. providing excess air. These experiments also show that following above procedure the emissions are reduced drastically and the backfiring issue is avoided when the tests were carried at 2200rpm.

**8. Research paper:** Effects of Various Fuel Blends on the Performance of a Two stroke Internal Combustion Engine

**Authors:** Staša Puškarić1, DamirOros (2012)

**Conclusion:** This paper depicts the analysis of combustion of a two stroke engine for various types of fuel blends like hydrogen peroxide and ethanol as additives. The paper shows that there can be use of these blends to obtain desired outputs from the two stroke IC engine.

**9. Research paper:** Hydrogen use in internal combustion engine a review

**Authors:** Murat Ciniviz1, Hüseyin Köse1 (2012)

**Conclusion:** This experiment highlights the different problems associated with hydrogen as fuel in SI engines. The paper also depicts the method to overcome these problems. The ultimate solution of direct injection is projected through this analysis.

**10. Research paper:** Study of Air Fuel Ratio on Engine Performance of Direct Injection Hydrogen Fuelled Engine

**Authors:** M.M. Rahman, M. M. Noor, K. Kadirgama, M. R. M. Rejab (2009)

**Conclusion:** This particular research actually depicts the performance of the CI engine at different air fuel ratios. The analysis was carried out from air fuel ratio of 27:1 to 171:1 and it was found out that the maximum efficiency is obtained at 29:1 or at 30:1. This also shows that beyond certain air fuel ratio the performance of the engine is unacceptable.

**11. Research paper:** Study of Cyclic Variability in Diesel Hydrogen Dual Fuel Engine Combustion

**Authors:** Widodo Budi. Santoso, Rosli Abu. Bakar, SugengAriyono, and NurCholis (2012)

**Conclusion:** This research paper shows the detailed analysis of cycle by cycle changes in a dual fuel CI engine. The changes in cyclic performance were observed with respect to hydrogen enrichment.

**12. Research paper:** Using hydrogen as a fuel in automotive engines – an investigation

**Authors:** SR. Premkartikkumar, K. Annamalai, A.R. Pradeepkumar (2013)

**Conclusion:** This paper mentions the various properties of hydrogen gas and thus the way in which these properties affect the combustion. The flame speed and high ignition energy of hydrogen gas act as opposite properties. This paper mentions that the reduction in NO<sub>x</sub> emissions and 80% reduction in CO<sub>2</sub> and CO emissions. Using hydrogen as a fuel results in increased brake thermal efficiency than diesel.

**13. Research paper:** Analysis of a hydrogen fuelled internal combustion engine.

**Authors:** ErolKahraman (2005)

**Conclusion:** This experiment covers almost every issue related with hydrogen as fuel. The experiment shows that the problem of backfire can be solved with the help of water nozzle near the inlet valves. The NO<sub>x</sub> emissions were reduced by 10 times the original. The CO and

CO<sub>2</sub> emissions were negligible. The direct injection system is used as used in the LPG kit.

**14. Research paper:** Impact of variable valve timing on power, emissions.

**Authors:** S. Verhelst, J. Demuynck, R. Sierens, P. Huyskens (2010)

**Conclusion:** The variable valve timing is applicable to control the quantitative as well as qualitative needs of the engine. This ensures proper combustion at low as well as at higher speeds. The cam phasing also shows significant results when the throttle is wide open.

**15. Research paper:** The effect of the initial charge temperature under various injection timings on the second law terms in a direct injection SI hydrogen engine

**Authors:** V. Fathi, A. Nemati, Sh. Khalilarya, S. Jafarmadar (2011)

**Conclusion:** This paper shows that by changing initial charge temperature, change in the work availability and heat loss availability is less than combustion irreversibility and exhaust gas availability. By finding an optimum initial charge temperature and hydrogen injection timing, it is possible to achieve a good balance between the second law terms, which leads to the better engine design.

### III. SUMMARY OF RESEARCH

The above research depicts the properties of hydrogen gas and the effect of these properties on combustion characteristics of the engine. It also depicts the generation methods and the possibilities of developing a generation setup of a desired scale. The issues related to use of hydrogen as a primary fuel and the solutions to those problems are depicted in the above discussion. It clearly depicts that use of hydrogen as primary fuel is very beneficial economically as well as environmentally.

There has been a lot of development in the field of hydrogen energy and thus there are many problems which we are known of. The solutions of these problems are present and there has been some work done with respect to all the problems. The main aim is to develop an engine or a system which is problem free and it works just like a conventional IC engine or a system.

### IV. CONCLUSION

This literature survey resulted in a distinctive set of conclusions which were useful for us to carry out with our further design. These conclusions gave us a perspective

towards hydrogen gas as a fuel in the conventional SI engine.

The following were the general conclusions from the research:

- Use of hydrogen gas in SI or CI engine results in the drastic reduction in the emissions. The CO<sub>2</sub> and CO emissions are minimized to a negligible amount. The NO<sub>x</sub> emissions on the other hand can be reduced by 10 times the original. Thus the use of hydrogen as an alternative fuel is the best option when environmental issues are considered.
- With the help of the above stated generation methods we can make sure that the generation of hydrogen gas can be done in abundance and also in a very economical way. Thus we can have fuelling stations as well as generation setups so that we can run the engine on a lower cost than that of the gasoline, diesel, CNG or any other fuel for that matter. Thus this fuel is the most economical fuel for the future.
- The use of hydrogen gas as a primary fuel results in higher brake thermal efficiency and higher BMEP compared to any conventional fuel.
- The issues like back fire or premature ignitions can be controlled using some techniques like an effective direct injection system which will ensure the complete combustion of the fuel and minimizing the back fire
- Hydrogen gas has high ignition energy which makes it a knock free fuel.
- The storage issues remain unsolved though since hydrogen has a very low density and takes up more volume. Liquidification of hydrogen is an economical stupidity since the sole purpose of making engines economical will be ruined. The problem of storage can be overcome with a spontaneous generation setup near the engine itself which provides hydrogen on demand.
- The issue of safety is of a major concern when the quick flame speed and the low density of the gas is considered. This can be solved by using a flame arrestor or a flashback arrestor after the generation setup or a storage unit.

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