iJRASET
International Journal For Research in Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 9 **Issue:** VI **Month of publication:** June 2021

**DOI:** https://doi.org/10.22214/ijraset.2021.35991

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VI June 2021- Available at www.ijraset.com

# Design, Development & Testing of Hydroxyl (HHO) Gas Generator by using Dry Cell

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***Abstract:*** ***Brown's Gas (HHO) has been introduced to the auto industry as a new source of energy. The motive of this project is to design and construct a simple HHO generation system and test it on suitable IC engine by introducing it with the conventional fuel. The effect of hydroxyl gas (HHO) addition into gasoline fuel will be evaluated on engine performance and emissions. The HHO cell should be designed, constructed and optimised for maximum productivity of the cell in producing HHO gas per input power. Literature studies show that the parameters on which the productivity of the cell depends are number of neutral plates, distance between them and type and quantity of solutes that is Potassium Hydroxide (KOH). The results are estimated as increment in power, reduction in fuel consumption, reduction in CO, reduction in HC and reduction in NOx. The addition of HHO gas into gasoline is an effective way of improving the engine performance and maintaining the exhaust emissions to an environment friendly limit compared to neat gasoline operations.***
***Keywords: Brown's Gas, gasoline fuel, exhaust emissions, IC engine.***

## I. INTRODUCTION

In the present scenario the growing concern of the people living in every part of society is the ever increasing price of fuel and the harmful effects caused due to higher level of pollutants in the atmosphere. The increasing demand for petroleum fuel associated with limited non-renewable stored quantities has resulted in a huge increase in crude oil prices. Consequently we have seen a shift toward automobiles that consume less fuel. We spend one third of our income for our vehicle fuelling and the vehicle gives harmful decomposed materials like CO, NOx, HC etc. in the form of smoke. These materials are all effects of the engine's performance and pollute the environment[1]. It is explicit that we use fuel in abundant amount and pollute the atmosphere. This has encouraged researchers to seek an alternative fuel that can be used in engines without the need for a dramatic change in the vehicle design. To avoid these drawbacks, a thought was given to add an alternative to improve the combustion efficiency of the engine, reduce operating cost and increase its productivity. The Secondary fuels that we use should have the same efficiency or greater efficiency of the engine when used with ordinary fuel. Contemporary research into secondary sources of energy for transportation focuses mainly on electric/battery, hybrid and hydrogen powered vehicles. Such focus assumes that the current technology has to be discarded and cannot be improved. However, it is possible to introduce interim technology to alleviate the current challenges arising from continued reliance on fossil fuels. Such challenges include increased greenhouse gas (GHG) emissions with consequent global warming and climate change impacts.

## II. PROBLEM STATEMENT

At present the automobiles or the IC engines work on conventional fossil fuels which yield less combustion efficiency and more harmful emissions. The goal of this project is to use hydroxyl gas (HHO) as an alternative or secondary fuel using On-board HHO along with primary fuel as petrol to identify its effects on combustion efficiency, harmful exhaust emissions and mileage of the vehicle. On-board HHO addition means HHO produced by taking a portion of the engines power to crack water into a small volume of HHO to be fed back into the air intake as a fuel saving additive. This study will experimentally verify the economy and emissions effects of adding small rates of HHO.

## III. OBJECTIVE

The experimental objectives of this project work include;

*1)* Study various methods of alternative fuels used in IC engine and there liability.
*2)* Experimentally test the effect on fuel consumption and exhaust emissions like HC, CO, $CO_2$, $O_2$ and $NO_X$ after adding HHOgas.
*3)* Record and discuss the effects of HHO on oxides of nitrogen (NOx) emissions.
*4)* Discuss the financial feasibility of on-board HHO, if HHO proves to reduce gasoline consumption.

## IV.LITERATURE REVIEW

Al-Rousan et al. [1] in his research explained that studies on the electrolytic separation of water into hydrogen and oxygen date back to the 19th century. More recently, there has been considerable research in the separation of water into a mixture of hydrogen and oxygen gases. These studies were initiated by Yull Brown in 1977 via equipment generally referred to as electrolysers and the resulting gas is known as "Brown's gas" or HHO. Also research and development, incentives and regulations, and partnerships with industry had sparked isolated initiatives. But stronger public policies likely determine which countries and companies seize the enormous political power and economic prizes associated with the hydrogen age now dawning.

Al-Rousan et al. [1] after reviewing the existing literature on acceptance, risk perception and customer satisfaction, described the development of a model that illustrates important aspects in influencing a person's attitude toward a new product. "Values", "wants" and "perception" are the three components found to influence acceptance. The consumers themselves are affected by "social background" and "experience". He also gave suggestions on how to use marketing methods, education projects and product exposure in order to maximize the likelihood of a successful introduction of hydrogen as an alternative fuel. His paper focused on the analysis of the main technological trends, the role of governments in steering the transition and the evaluation of the speed and direction of the transition to hydrogen. He showed that the interest in hydrogen is increasing rapidly and that overall the variety in research projects is increasing. Different governments play an active role in stimulating research and development, which broadens the variety of research topics.

El Kassaby et. al. [2] in his research work constructed a simple innovative HHO generation system and evaluate effect of hydroxyl gas HHO addition, as an engine performance improver, into gasoline fuel on engine performance and emissions. The HHO cell was designed, fabricated and optimized for maximum HHO gas productivity per input power. The optimized parameters were the number of neutral plates, distance between them and type and quantity of two catalysts of Potassium Hydroxide (KOH) and sodium hydroxide (NaOH). The performance of a Skoda Felicia 1.3 GLXi gasoline engine was evaluated with and without the optimized HHO

## V. METHODOLOGY

The rationale behind the work is to achieve objectives; derived from the research gap in testing hydrogen on board by other researchers, as well as the need to experimentally prove or disprove the validity of the claims of hydrogen on demand vendors. The rationale principle behind HHO generation is that HHO gas produced from splitting water into hydrogen and oxygen from electrolysis and allowing the gas to stay in a premixed state for use on-demand without the need for storage.

## VI. FUTURE WORK

However, the problems associated with the production and storage of pure hydrogen currently limits the application of pure hydrogen in internal combustion engine.

In addition increasing cell temperature also increases the production of HHO. In the proposed approach the amount of current flows through the generator increases with the temperature of the generator which makes the battery to drain fast. Taking this fact into consideration, future research will focus on limiting the current flow through the generator to obtain an optimal rate of HHO production.

## VII. CONCLUSION

Actual experiments were carried out to investigate the effect of HHO gas on TVS Apache RTR 160 engine. A new design of HHO fuel cell has been performed to generate HHO gas required for engine operation. The generated gas is mixed with a fresh air in the intake manifold. The exhaust gas concentrations have been sampled and measured using a gas analyzer. The following conclusions can be drawn

1) The use of HHO in gasoline engines enhances combustion efficiency, consequently reducing fuel consumption and thereby decreasing pollution. HHO cell can be integrated easily with existing engine systems.
2) The concentration of CO gas has been reduced to almost 15-30 % on an average.
3) The concentration of HC gas has been reduced to almost 5-15 % on an average.
4) The mileage of the of the engine was seen to be improved by about 21.22%.
5) The proposed design for reservoir cum bubbler takes into consideration the safety precautions

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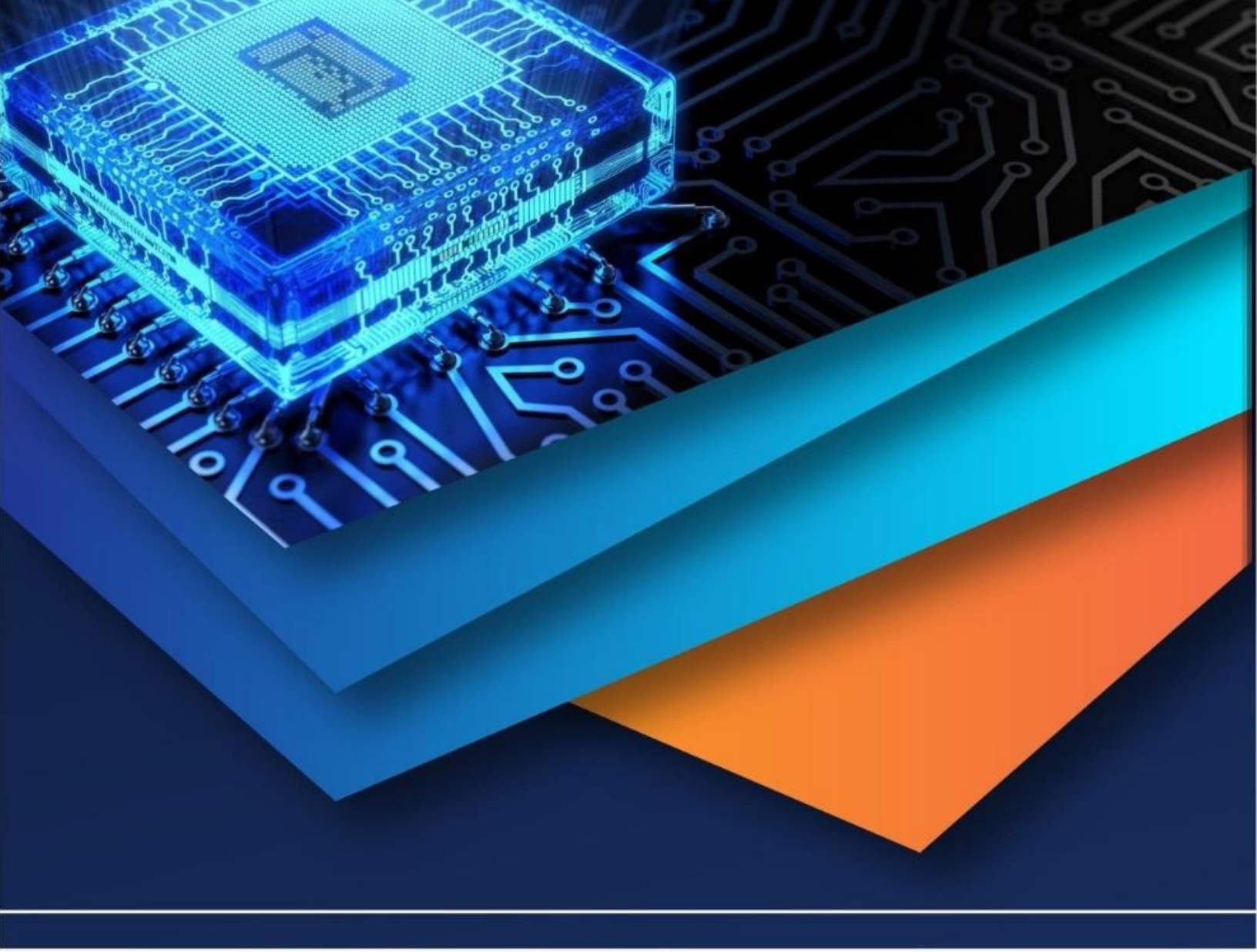

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