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Hydroxy Fuel Assistance for Internal Combustion Engine

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***Abstract*: An approach is conducted to make the hydrolytic system integrate to the automotive, by extracting energy from the vehicle, making it self-sufficient. The rotation and torque produced by the engine, generated electricity to power battery, head lights and various other accessories. The same technology is used to extract current for the hydrolysis process. The produced elemental gases are mixed as fuel enhancer into the IC engine, thus improving its efficiency, in terms of brake horse power (BHP), reduced specific fuel consumption and reducing unburnt harmful exhaust. This paper projects the design of a system, that taps electricity from engine torque, produces hydroxyl gas, safely passing it into existing engine to assist the normal fuel combustion; this has been integrated into 2004 model of TVS Victor GX, which can be implemented to such bikes at low cost. It also reports the betterment in the automotive parameters such as 67% and 54% reduction in emission of partially burnt carbon monoxide and unburnt hydrocarbon respectively, at the engine exhaust.**

***Keywords*: Fuel, IC engines, Hydroxyl gas, Hydrolysis, Exhaust emission.**

1. Introduction

People always want to extend their capabilities, conveniently and efficiently. The advent of internal combustion engine has propelled locomotion to a new paradigm. This engineering marvel has a basic fuel requirement, but these materials are diminishing after being exploited for centuries. Since the dawn of fuel endangerment, researchers are looking for alternative sources. Even natural gases and fossil fuels are non-renewable. Hence, fuel price hikes make this machine very inconvenient for daily use. This necessity led to innovation of other sustainable mechanism such as solar, electric and hybrid vehicles, but these are very inefficient compared to their latter counterparts. Most of the present automotives are based on Internal Combustion engine, which is tuned for conventional fuels. Assisting this combustion with a sustainable combustible matter seems to be an appropriate solution, rather than changing the entire engine system, demanding significant time to be implemented.

Basically, hikes in fuel prices can be traced back to depleting natural resources. But what value would our project provide, if the assisting fuel is meagerly available, thus expensive. Fortunately, we found out a way to extract such assistance from the most common compound on the planet. Water is not just the most abundant but a very unique compound in nature. Though it functions as a coolant, its constituent elements are combustion supreme. Oxygen is the primary oxidizer and hydrogen has highest calorific value. Not just that, when compared to gasoline combustion hydrogen has a much less ignition energy, faster flame velocity, wider range of air-fuel ratio for combustion to occur, and the engine itself can have higher compression ratio, hence higher power, also higher diffusivity and lower quenching distance. The oxy-hydrogen mixture also called brown gas, produce from hydrolysis combust to form water back, hence no harmful or particulate pollutants exhaust. This fact is utilized in our endeavor. Water is decomposed and these elements are injected into the conventional IC engine to boost combustion, hence boost the existing mechanism, without any modification to the latter design. But the combustion outputs are too high to be tolerated by normal automotives. The use of neat hydrogen as a fuel in an IC engine appears to be a long-term prospect at this time, owing to its unfavorable qualities and consequently the dread associated with its use. It is evaluated that brown gas can be mixed with gasoline safely [1], and have been tested with different grades of petrol [2]. Blending hydrogen as fuel enhancer into CNG or other primary fuels can help increase the lean burn limit and create a tradeoff relationship between HC, CO, and NOx emissions [3].

This engine system has reported increase in the brake power ranging from 5.07% to 11.5%, hike in brake thermal efficiency has been observed in all cases, at 10.26% on average, reduction in specific fuel consumption of engine by almost 6.35% mean and drop in exhaust gas temperature by about 4% [4], also increased top speed of a motorcycle from 125 km/h to 170 kmph [5], engine efficiency hopped by 10 to 30% [6], and increasing mileage by about 26% [7].

This project deals with integration of a hydroxyl generator into a bike, and utilizing its production as a fuel enhancer to the internal combustion of the engine, running the entire system self-sufficiently.

2. Methodology

The steps undertaken to accomplish the project are as follows. Initially a basic hydrolytic prototype is made to test the

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production and effect of hydroxyl gas into the engine. Once the production and effect parameters are optimized, then actual model is made that can be perfectly integrated into the existing bike. Then the vehicle parameters are adjusted to optimize the benefits from this hydrolytic system. The entire automotive with the additional HHO setup is then tested to check the improvement is various performance parameters.

3. Working Theory

The electrolytic chamber is the womb of the system, as it generates the crucial Hydroxyl gas. Significant advancements in this technology occurred in the last few decades, distinguishing it from prior predecessors that were inefficient, and required a large amount of electricity. Researchers have devised a new method for extracting hydrogen from seawater that uses aluminum and a liquid gallium-indium-tin alloy. Princeton University chemists have discovered a novel catalyst (iron-doped nickel oxide) that hastens the process. Scientists from the University of Buffalo have demonstrated that spherical silicon particles of nanoscale may react with water to make hydrogen nearly instantly. Another innovation is the development of a new form of the solar-powered electrode that generates an electric current that separates water into its constituent elements [8]-[11]. HHO gas may also be produced very effectively using innovative HHO reactor topologies and sophisticated electronic circuits, making it the energy source in near future.

To avoid complexities, we worked with available hydrolytic technology that could be easily created. A prototype was created using a simple air-tight box, installing stainless steel plates fitted with bolts as electrodes. A basic electrolytic solution was used to have found that they produce more hydrogen, which is a significant aspect of our methodology. This model was also provided with an inch diameter inlet for electrolyte and a small vent using tube valve, for gas outlet.

Fig. 1. Electrolytic chamber prototype

In an alkaline reaction, the water molecule binds electrons (e^-) and divides into hydrogen gas (H_2) and OH^- anions, which occur near the cathode. Following that, the OH^-anion is drawn to the anode side, where it is split into oxygen gas and H_2O molecules.

Since potassium ion (K^+) tops the reactivity list of cations and hydrogen ions have a higher potential as an electrode ion standard than K^+, potassium hydroxide (KOH)aqueous solution was chosen as the electrolyte. Anion in the electrolyte and hydroxide compete with one another to liberate electrons during the electrolyte process (oxidation). While cations with electrode potential standards greater than hydrogen ions will undergo reduction, no hydrogen gas will be created, and an anion with electrode potential standards smaller than hydroxide ions will be oxidized, resulting in the absence of oxygen gas. Another reason is that the KOH electrolyte is more affordable and effective.

Decomposition Reaction:

$$H_2O \rightleftharpoons H^+ + OH^-$$
$$KOH \rightleftharpoons K^+ + OH^-$$

At the Cathode:
$$H^+ + e^- \longrightarrow H$$
$$H + H \longrightarrow H_2$$

At the Anode:
$$OH^- - e^- \longrightarrow OH$$
$$OH + OH \longrightarrow H_2O + O$$
$$O + O \longrightarrow O_2$$

Complete Reaction:
$$2\,H_2O \xrightarrow[\text{Electric Current}]{\text{KOH}} 2H_2\uparrow + O_2\uparrow$$

The reduction reaction occurs at the cathode in an alkaline reaction, where the water molecule binds electrons (e^-) and splits into hydrogen gas (H2) and OH- anions. The OH-anion is subsequently drawn to the anode side, where it is divided into oxygen gas and H2O molecules.

Initially, we tried the process with a good amount of electrolyte, KOH, as our previous study instilled greater concentration leads to better conductivity, hence better electrolysis. But in practice, the gas produced formed foam as the solution was soapy, due to the saturated base. This hindered the production of gas out of the chamber due to a jump in pressure, across the foamy surface. We also ran into the concept of over-potential concentration, which actually drops the production due to the over crowd of charged particles, towards the electrodes.

The produced hydroxyl gas was passed through a pipe from the vent and was tested directly using a flame. But the flame ran back into the production chamber and led to an explosion of this prototype. This led to the addition of another component, a bubble chamber that would act as a flame arrestor. For prototyping, this was made from a water bottle. The gas output was dipped into water and the gas was extracted from above the water level, as it bubbled and filled the air space.

This entire system can be attached to any system with suitable support. The output of gas from the bubble chamber is inserted into the engine along with the air filter. This hydroxyl gas is composed of hydrogen and oxygen, with atmospheric air. Due to higher calorific combustion of hydrogen and excess oxygen, fuel also combusts better. Thus, there is a higher power, at lesser fuel, and lowered exhaust of unburnt and partially burnt compounds.

4. Design

The entire system can be neatly integrated into the automotive; hence the design depends on the chassis of the system. Our design is based on the 2004 model of TVS Victor GX. We decided to replace the air filter with our hydrolytic chamber, integrated with a filter. The virtual design was produced using DS Solid Works. The chamber was 3D printed with 70% infill of polycarbonate material, to withstand water and electrode weights.

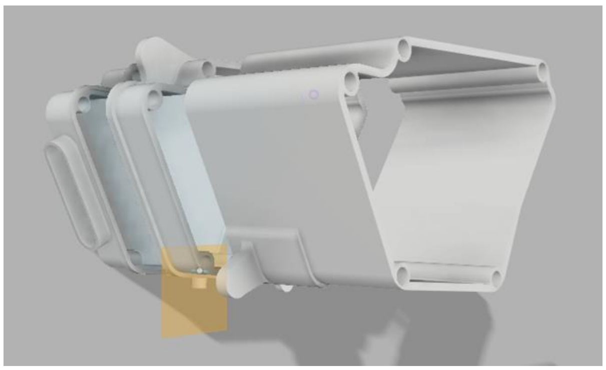

Fig. 2. 3D model of air filter integrated hydrolytic chamber

The hydrolytic system can be functionally split into two components. The electrodes are made up of stainless steel 316L plates grinded for greater active surface area. They were held by bolts through the chamber and selectively heat shrunk to provide necessary power supply to appropriate plates, for optimum production. A hybrid type of electrolytic cell is created that contains dry cell in a liquid electrolyte. 2mm MB rubbers were used as gaskets across bolts and vents. A basic solution is used, investigated to be optimized at 6g of KOH per liter of distilled water. To make the added system self-sufficient, we obtained the current required for electrolysis from the engine dynamo itself. Except spark plug supply, the remaining two dynamo outputs were tapped in parallel to extract higher current, which provides higher electron rate, for faster electrolysis. This AC current was rectified into DC using a buck convertor.

Fig. 3. Flame arresting bubble chamber model

The produced gas is output from a vent, through a pipe which is passed through air filter then bubble chamber made up of PVC pipe and caps, with inlet below the water level and output above. This is injected into the IC engine as air input, which combusts as fuel assistant.

5. Results, Discussion and Conclusion

The model integrated into the basic model of bike has proved to hike automotive performance, by various tests. The emission test was done at a government-authorized emission test center, before and after the installation of our hydroxyl system. All fuels are basically hydrocarbons, and the amount of combustion is the level of power output. We found 76.52% unburnt hydrocarbons respectively. The specific fuel consumption also dropped; hence mileage has pumped from 43 to 59 kmpl, i.e., 37.2% increment.

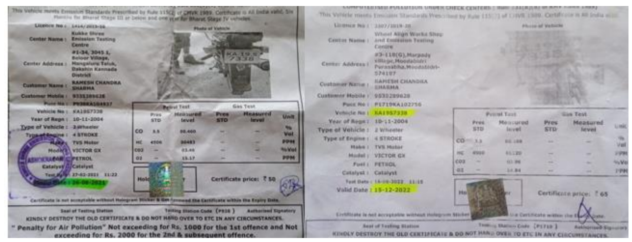

Fig. 4. Emission test results before and after installation of HHO system

6. Future Scope

The system can be improved by increasing the amount of electric current for hydrolytic purpose, by providing an additional dynamo and splitting the power from engine output as in series-parallel hybrid vehicles.

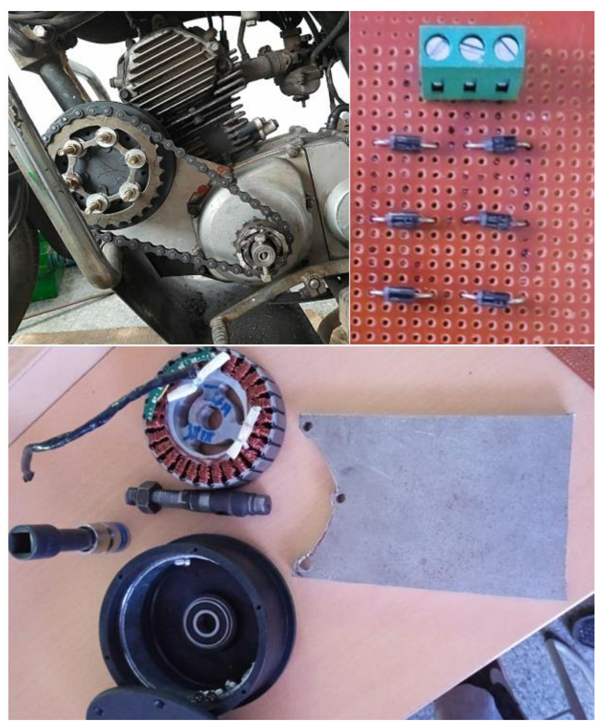

Fig. 5. Developmental components, basic design and electronics

A shaft is designed for this purpose that taps engine torque.

A 24V BLDC motor is inversely used as a 3-phase dynamo, fitted into the chassis of the bike over a thick stainless-steel plate, bolted with the engine, to suppress relative vibrations. The torque can be transmitted using chains providing suitable gear ratios, for higher torque at dynamo, extracting less power from the engine. This challenging task can be simplified by integrating the dynamo setup into the engine dynamo, by making necessary alterations.

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