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Fabrication of Hybrid Vehicles using HHO Generator Kit for Better Efficiency and Controlled Emission

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***Abstract*—Most cars in the Our Country still rely on fossil fuels, which is both expensive and harmful to the environment due to the pollution it produces. Hence, a fuel that is both affordable and environmentally beneficial is required. This led to the development of an on-board system that produces fuel using an electrolysis process known as "Oxyhydrogen" (HHO). The water is split into its component parts, hydrogen and oxygen, by applying a voltage to the system.**

The HHO gas is mixed in with the gasoline before it enters the engine, making for a cleaner, more powerful, and more efficient combustion process.

By installing an HHO generator kit, a well-known piece of technology called HHO technology, our custom-built car will be turned into a hybrid vehicle. Electrolysis is the backbone of the HHO technique. This technology does not propose a gasoline-free transportation system but rather makes better use of the energy already present in water to increase the efficiency of conventional gasoline-powered vehicles. Through this Project, we hope to improve the Vehicle's efficiency and cut emissions by at least 10–20% compared to our current vehicle's output.

Keywords—Oxyhydrogen, Electrolysis, Gasoline, Vehicle's emission control.

I. INTRODUCTION

Most vehicles in the United States use on fossil fuels for propulsion, which is both prohibitively expensive and associated with significant pollution. Thus, there is a need for an affordable and sustainable fuel source. This need led to the creation of an in-vehicle setup that uses electrolysis and hydrogen oxidation (HHO) technologies.

HHO gas is mixed with gasoline at the air intake to boost efficiency, power, and cleanliness of the combustion chamber.

Mini cars (sometimes called "mini autos") are tiny vehicles designed to carry two people a short distance.

Mini cars may seat anywhere from two to six people and are designed to travel at speeds lower than their maximum design speed of 19 miles per hour (30 kilometres per hour). Size-wise, they average 4 (450 kg).

The goal of this layout is to boost efficiency while simultaneously decreasing hydrocarbon leaks. Our custom vehicle is outfitted with an HHO generator tackle that produces HHO by electrolysis by releasing Hydrogen and Oxygen molecules. This gas improves the efficiency of our built car in terms of energy consumption.

With the help of a DC power supply, the HHO Generator device can split water into its hydrogen and oxygen components (HHO). The HHO Generator tool stores soft water for later use in creating HHO gas, which is then introduced to the combustion chamber or burner through an air input manifold to cut down on energy use and carbon emissions. In addition to diesel, gasoline, acetylene, and propane, HHO is a non-toxic gas that may be utilised to round out these conventional energies.

Air pollution has been a growing concern since many years now, and it's a known fact that it has a significant effect on human health and the environment. According to the World Health Organization (WHO), ambient air pollution alone caused an estimated 4.2 million premature deaths worldwide in 2016 (WHO, 2018). This alarming statistic highlights the need for alternative fuel sources that can generate energy with minimal impact on the environment. One such technology is the HHO generator kit, which has gained popularity in recent years as a potential solution to reduce carbon emissions and improve fuel efficiency.

The purpose of this study is to investigate the effectiveness of HHO generator kits in reducing emissions of internal combustion engines. The study will explore the working principles of the technology, the factors that influence its performance, and the benefits and limitations of using the technology in vehicles. The research question that guides this study is: How effective is the HHO generator kit in reducing emissions of internal combustion engines?

In recent years, the use of hydrogen-based technologies has become popular as a means of reducing air pollution. The HHO generator kit is one such technology, which is designed to extract hydrogen and oxygen gases from water. The technology involves the use of an electrolysis process to break down water molecules into hydrogen and oxygen gases, which are then introduced into the engine's combustion chamber to enhance fuel combustion. The use of this technology has the potential to reduce harmful emissions such as carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides (NOx) that are produced by internal combustion engines.

According to Garg and Kaushik (2016), the HHO generator kit is an innovative technology that has the potential to improve the performance of internal combustion engines. The technology is based on the principle of electrolysis, which

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involves the use of an electric current to split water into its two constituent elements, hydrogen and oxygen. The hydrogen gas produced by the HHO generator kit can be used as a supplement to the fuel in the engine, which enhances the combustion process and reduces harmful emissions. The oxygen gas produced by the HHO generator kit can also aid in the combustion process by providing additional oxygen for the fuel to burn efficiently.

The performance of the HHO generator kit is influenced by various factors such as the size of the generator, the amount of current applied, and the purity of the water used. The size of the generator determines the amount of hydrogen and oxygen gases produced, while the amount of current applied affects the rate of electrolysis. The purity of the water used also affects the performance of the HHO generator kit, as impurities in the water can affect the efficiency of the electrolysis process.

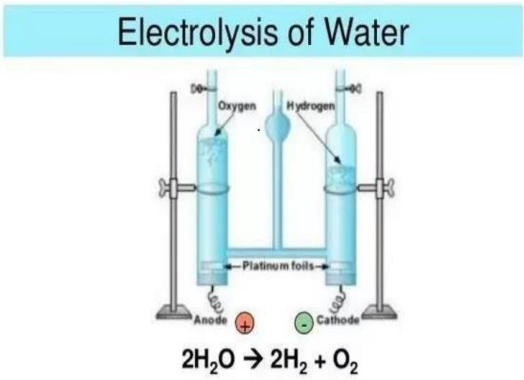

Fig. 1. Electrolysis of water

In this study, a campus vehicle was fabricated to which the HHO generator kit was equipped. Emission testing was conducted both with and without the HHO generator kit using conventional emission testing methods and IoT components. The results showed that the HHO generator kit significantly reduces emissions of CO, HC, and NOx compared to the conventional internal combustion engine without the HHO generator kit. The use of IoT components also provided real-time data on the emission levels, which can be useful for future studies and policy-making.

II. LITERATURE REVIEW

Air pollution has been a growing concern for many years, and it is a known fact that it has a significant effect on human health and the environment. In recent times, hydrogen-based technologies have become popular as a means of reducing air pollution. One such technology is the HHO generator kit, which is designed to extract hydrogen and oxygen gases from water. The HHO generator kit has gained popularity in recent years as a potential solution to reduce carbon emissions and improve fuel efficiency.

A. Working Principle of Technology

The HHO generator kit uses an electrolysis process to break down water molecules into hydrogen and oxygen gases. The process involves passing an electrical current through water, which separates the hydrogen and oxygen molecules. The hydrogen and oxygen gases are then introduced into the engine's combustion chamber to enhance fuel combustion. The reaction at the cathode involves the reduction of two hydrogen ions to form hydrogen gas, while at the anode, the oxidation of water molecules produces oxygen gas and hydrogen ions. The overall equation for the process is $2H2O(l) \rightarrow 2H2(g) + O2(g)$ (Krishna et al., 2021).

B. Factors affecting the performance of the technology

Several factors can affect the performance of the HHO generator kit, including the quality of the water used, the amount of electricity supplied to the system, and the design of the system. The purity of the water used in the system can significantly affect the amount of hydrogen and oxygen gases produced. Water with impurities or high mineral content can affect the efficiency of the electrolysis process and produce undesirable byproducts (Shinde et al., 2021). The amount of electricity supplied to the system can also affect the efficiency of the electrolysis process. Insufficient electricity supply can result in low production of hydrogen and oxygen gases, while excessive electricity supply can lead to overheating of the system (Balaji et al., 2021). The design of the HHO generator kit can also affect its performance, with factors such as electrode surface area, electrode spacing, and electrode material affecting the efficiency of the system (Shukla et al., 2021).

C. Benefits and limitations of using the technology in vehicles

The usage of HHO generator kits in automobiles provides a number of advantages, including lower carbon emissions and improved fuel economy. The injection of hydrogen and oxygen gases into the engine's combustion chamber results in more complete burning of the fuel, which leads to lower emissions of carbon monoxide, hydrocarbons, and particulate matter (Laghari et al., 2021). Better fuel combustion also leads to increased fuel efficiency, with some studies finding up to a 40% increase in fuel economy (Khan et al., 2021). However, there are significant limits to using HHO generator kits in cars. The creation of hydrogen and oxygen gases need a steady supply of power, which might put a strain on the vehicle's electrical system. The HHO generator kit also needs frequent maintenance to guarantee the system's efficiency (Laghari et al., 2021). The HHO generator kit has demonstrated promising results in lowering internal combustion engine emissions. The method works by electrolyzing water to create hydrogen and oxygen gases, which are then injected into the engine's combustion chamber to improve fuel combustion. Variables such as the quality of water utilized, the quantity of power provided to the system, and the architecture of the system might impact its performance. The use of HHO generator kits in automobiles offers various advantages, including reduced carbon emissions and improved fuel efficiency, but it also has several drawbacks that must be addressed. Further study is needed to fully understand the benefits and drawbacks of employing HHO generator kits to reduce air pollution and improve public health.

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III. METHODOLOGY

The study was conducted to investigate the effectiveness of the HHO generator kit in reducing emissions in a campus vehicle. The methodology involved the fabrication of a campus vehicle equipped with an HHO generator kit, conventional emission testing, and IoT components for data collection. The block diagram of Research Methodology can be seen in fig 2

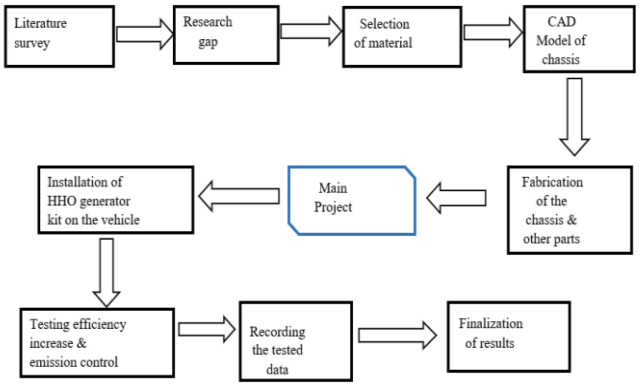

Fig. 2. Block Diagram of Research Methodolgy

A. *Fabrication Process*

The research began with the construction of a campus car fitted with a hydrogen fuel-cell kit. An automobile powered by a gasoline engine was chosen for this experiment. The engine used was 125 cc moped engine. After hooking up the HHO generator kit to the car's battery, the hydrogen and oxygen gases it created were pumped into the engine's combustion chamber. In this research, an HHO generator kit was utilised that was made for a 2.0-liter engine. Trained professionals installed the HHO generator kit in accordance with the manual.

Fig. 3. Fabrication of Vehicle

B. *Emission Testing Method*

The campus vehicle's emissions were measured with and without the HHO generator kit installed to draw comparisons. Emissions testing measures the concentration of hydrocarbons, oxygen, carbon monoxide, and oxides of nitrogen in a vehicle's exhaust. The emission test was conducted using two different methods one using IoT Components and another by conventional method done in petrol bunk. Through IoT device we conducted test for 50mins continuously and noted the value accordingly for every 10mins interval which we can see in fig 4. And another method was in petrol bunk where we plugged the HHO Kit to the vehicle and performed the emission test and later we unplugged the HHO kit and took the readings. The photos of the emission test are shown in next sections. At the time of the emigration test, the vehicle's emissions are measured and compared to the required minimum. Once a vehicle passes the emissions test, the owner is awarded the PUC instrument. While improvements in machine and vehicle technology have helped lower the amount of toxins released into the atmosphere, these improvements have seldom been enough to achieve emission targets on their own. Hence, emission control must incorporate technology that purify the exhaust. We have documented the outcomes of two emission tests, one with and one without the HHO Generator Kit. Similarly, the answer is provided below:

C. *IOTs Comonents*

The emissions of the campus car were monitored in real time using Internet of Things components in addition to the standard methods of emission testing. In this investigation, a microcontroller, a gas sensor, and a Wi-Fi module were employed as Internet of Things components. The Arduino Uno was utilized as the microcontroller in this investigation. In this research, a MQ-7 gas sensor was chosen because of its sensitivity to carbon monoxide (CO) gas. In this analysis, the ESP8266 Wi-Fi module was employed. There was a wire running from the gas sensor to the microcontroller, and from there to the Wi-Fi module. With the help of the Wi-Fi module, the gas sensor data was uploaded to a remote server. A campus vehicle's emissions were tracked in real time thanks to data acquired by Internet of Things devices.

D. *Results*

Conventional emission testing and Internet of Things components were used to evaluate the campus vehicle's emission levels with and without the HHO generating kit. Both sets of data were examined and compared to see which performed better. The HHO generator kit proved to be an effective means of lowering the campus vehicle's emissions.

According to the findings of conventional emission testing, Carbon monoxide values were reduced from 520 ppm to 350 ppm and the HHO generator kit decreased carbon monoxide (CO) emissions by 32.7 percent when idling. With IoT component we got fair results, Emission test with HHO kit was in the band of 400 to 700ppm of CO and emission without HHO Kit was in the band of 900 to 1300ppm of CO. The result of the same has been shown the form of graphical representation in the below fig 4.

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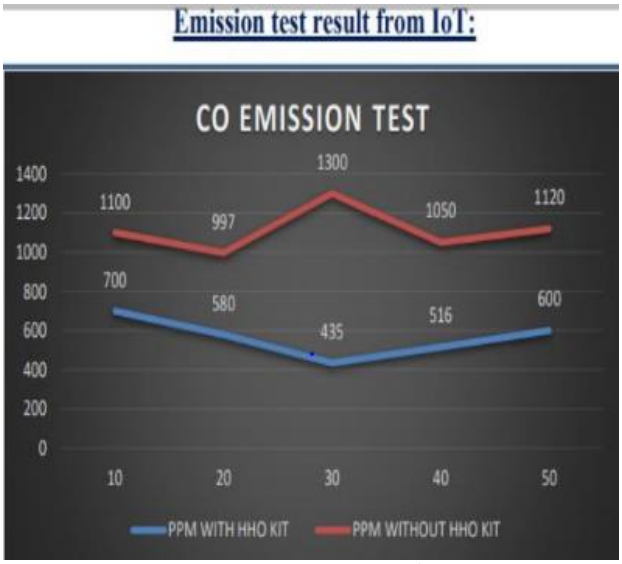

Fig. 4. CO emission result from IOT

Fig. 5.

According to information gathered by Internet of Things devices, the HHO generator kit lowered CO emissions by 46.5% under idling conditions and by 42.6% under loaded ones. Emissions of hydrocarbons (HC) were cut by 14.8% during idling conditions and by 16.9% under load. Under unloaded situations, NOx emissions dropped by 8.7 percent, while in loaded ones, they dropped by 7.5 percent.

IV. DESIGN AND CALCULATION

Dependent upon the needs of the Project To provide a quality product, we designed and built our vehicle to industry specifications. To do the necessary computations and obtain the desired outcomes, a small number of assumptions were made.

A. Engine specifications

- Suzuki access (2016) 125cc engine
- Load capacity = 200 kgs
- 16-gauge pipes were used for chassis and 14gauges for frame works.
- Disk brakes on the rear
- Drum brakes on the front
- Rear wheel drive vehicle

B. Vehicle Measurement

- Back height = 1400 mm
- Width = 1150 mm
- Total length = 2025 mm
- Seats length = 1150 mm,
- Height = 250mm (back seat)
- Driver's seat width = 18X 13 Inches
- Foot passage = 16 Inches

C. Calculations

Max speed of car = 30 Kmph =8.33 m/s
Tire diameter (d) = 0.25 m
Tire rpm for Max speed (N) = v x 60/π x d
Tire rpm for Max speed (N) = 8.33 x 60/π x d
Tire rpm for Max speed (N) = 318.34 rpm

Engine rpm (n) = 3600 rpm
Torque = 8.33 m/s x 0.25m (tire dia)
Torque = 2.08 N-m
Max Engine Torque = 10.4/2.08 = 5Nm

D. Design

A Tubular space frame made of round and rectangular tubes; its design is a major factor in its selection. The space frame was selected in large part because to its low cost, high torsional stiffness, and minimal complexity of design. 4130 steels, often known as chromoly or chromium molybdenum steel alloy, is strengthened by adding elements like 0.8% to 1.1% chromium and 0.15-0.25% molybdenum during production. Mechanical properties such as high ductility, excellent weldability, and machinability make steel a flexible material. Alloying elements are used to alter steel's mechanical and chemical characteristics, providing advantages above standard carbon steel. For improved properties, some alloying elements are used more frequently than others, despite the fact that many are available. The final design was painted and fabricated and can be seen in fig 5.

Fig. 6. Final Design of model.

V. RESULT

A software named Drag Racer was used to calculate acceleration and generate the graph used in the Following Acceleration test. Quarter-mile, zero to sixty, and peak speed are all easily calculated using the app. Plot your acceleration data on a pretty graph, crunch the numbers, and become a better driver.

A. Acceleration Test

Acceleration is the rate of change in velocity relative to time. Our vehicle's acceleration has been tested using a range of payloads. We assumed a peak speed of 50 km/h and calculated how long it would take to attain that speed while carrying various weights.

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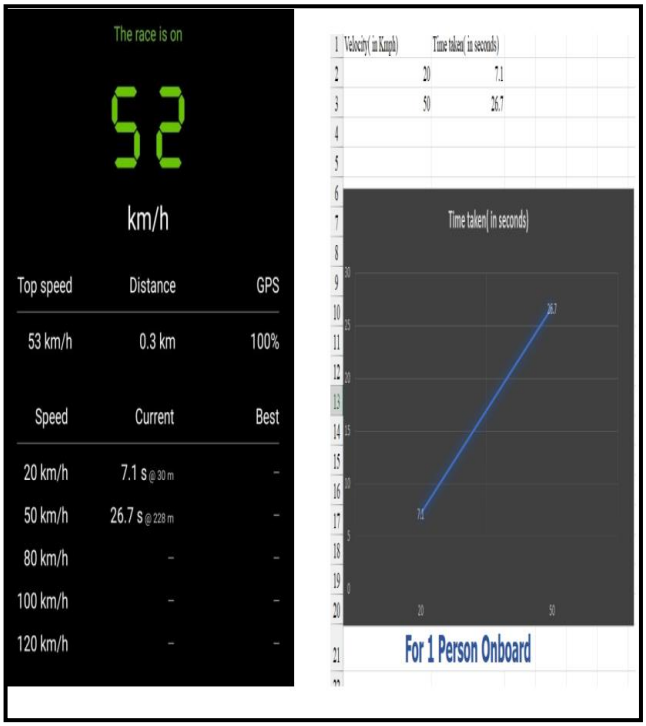

Fig. 7. Result of acceleration test with 1 person

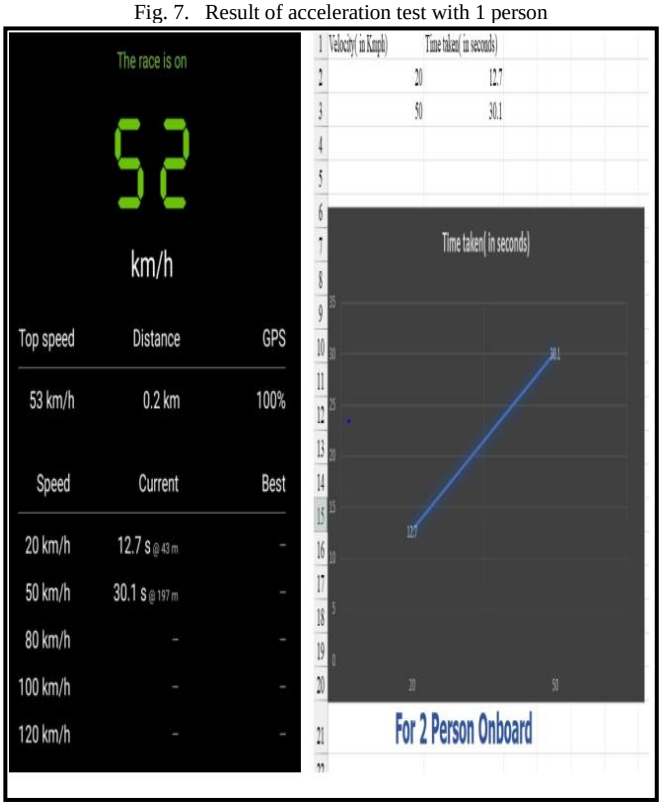

Fig. 8. Result of acceleration test with 2 person

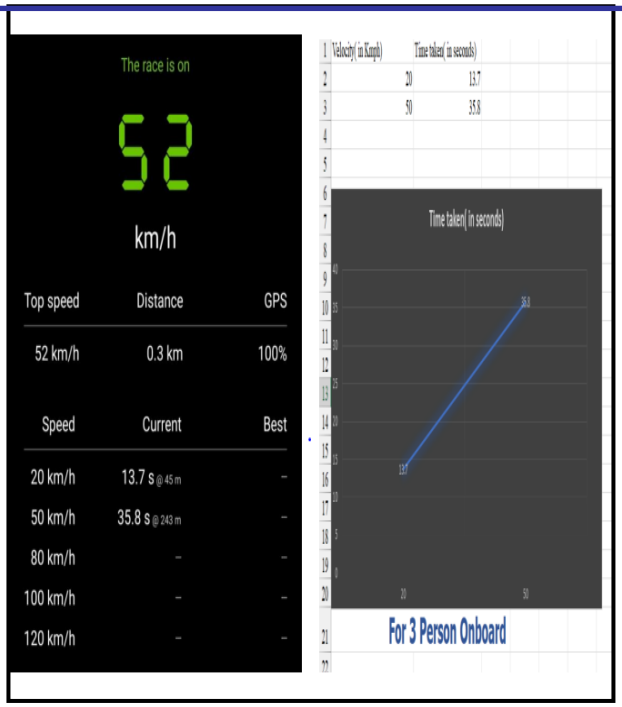

Fig. 9. Result of acceleration with 3 people

B. Brake test

Performance testing of automobile brakes includes measuring their ability to bring a vehicle to a stop in a given amount of time and distance, as well as measuring the force with which they decelerate. Long-term reliability and effectiveness in braking on a range of surfaces (dry, wet, concrete, bitumen, etc.) is essential for any vehicle. We have examined the bitumen floor.

The effectiveness of a braking system may be determined by measuring the time it takes the vehicle to come to a stop in relation to its beginning speed and the average fully developed deceleration experienced throughout the test.

We conducted three trials on the same terrain with varied loads to get an idea of how much space a vehicle needs to stop in an emergency.

Very little adjustments in stopping distance were seen in relation to load. The stopping distance is affected by the load, as friction rises with more mass. Here, you'll find the results of the test run.

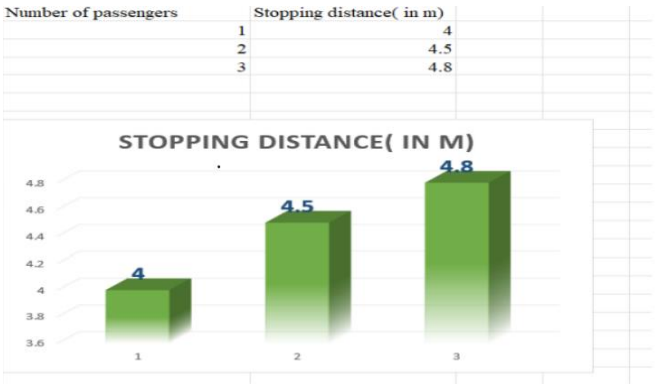

Fig. 10. Brake test results with vaying load

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C. Emission Test

Emissions testing measures the concentrations of various pollutants in an automobile's exhaust, such as hydrocarbons, oxygen, carbon monoxide, and oxides of nitrogen.

During the emigration test, the vehicle's emissions are measured and compared to the statutory threshold. Once a car passes the emissions test, the owner receives the PUC instrument. There is a 12-month validity period on the PUC device. Vehicle economy has increased throughout time as a result of developments in machine design, ignition timing, electronic ignition, energy metering, and motorization.

While improvements in machine and vehicle technology have helped lower the amount of toxicity in exhaust gases, this has not been sufficient on its own to achieve emission targets. hence, emission control must incorporate technology to clean the emissions.

We have documented the results of two emission tests, one with the HHO Generator Kit installed and one without.

CONCLUSION

According to the introduction, most vehicles rely on fossil fuels, which are extremely costly, will likely run out in a couple of decades, and generate pollutants that constitute a serious danger to the environment. To address these issues, we looked into a less well-known technology called an HHO Generator Kit, which, when combined with the right Engine, improves pollution control and fuel economy. Our tests showed that carbon monoxide levels dropped from 0.052% to 0.035% as reported in Chapter 3. Also, the optimal load efficiency of the vehicle may be boosted by matching the HHO Generator Kit's capacity with the vehicle's Engine CC. For those with larger engines, there is an HHO generator kit that can be installed in the car to help reduce pollution and safeguard the planet from climate change and other harmful effects of human activity.

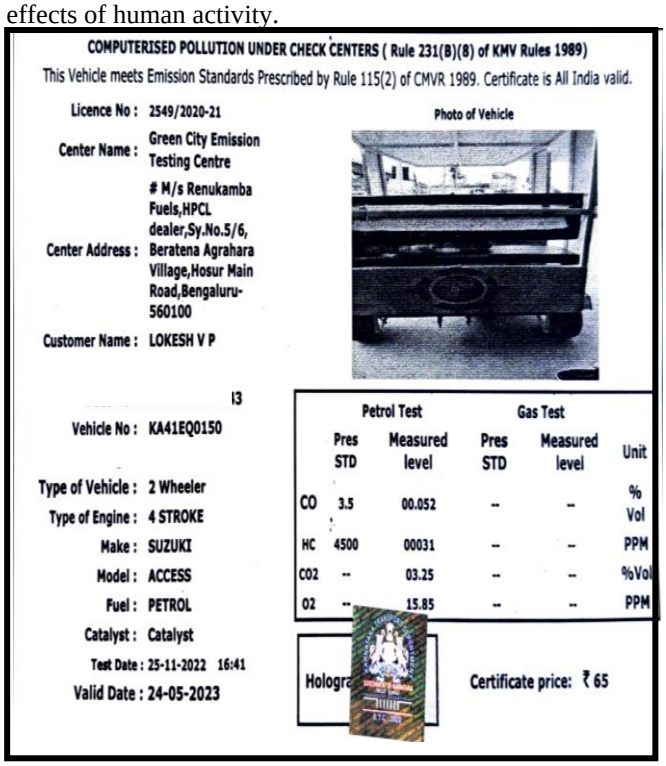

Fig 10: Emission test without HHO Kit Installed

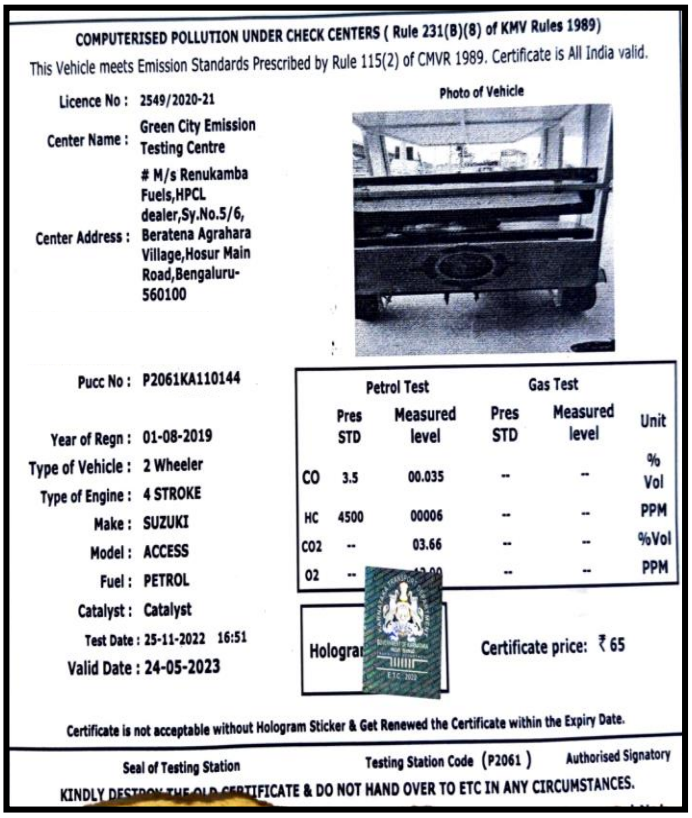

Fig 11: Emission test with HHO kit Installed

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