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DEVELOPMENT OF SAFETY FEATURES OF HYDROGEN GAS ENGINE

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Abstract

In the present work, we discuss the four stock engine to develop a hydrogen gas engine in the four stock two wheelers most of people affected in the Traffic Jam CO_2 gas emission in the recent who research in World Health Organization [WHO]. We developed a safety feature of hydrogen gas in the sea water or salt water in the electrochemical reaction of the anode and cathode of the both electrode plates passing through a current in the steel or aluminum plate to produce a hydrogen gas in the positive terminal plate in the same negative terminal that has produced oxidation in the same electrochemical tank. But we need only hydrogen from the tank to attach another tank of pure water to fill in the area near the tank to dip both hydrogen and oxidation from the tank to split it into pure hydrogen in the tank. When hydrogen gas is fed directly into the engine, it completely backfires. As a result, we use a hydrogen and oxidation of the to split up tank to cut off a backfire from the engine. The engine was developed with a bi-fuel of the hydrogen gas in the modified engine and a carburetor to set a lean mix of the fuel in the carburetor to reduce the fuel flow rate, which is too low, and the air flow rate, which is too high, in the engine, resulting in a higher peak of torque at 13.2 Nm @ 3250 rpm in the hydrogen engine. But petrol engine is higher than the hydrogen engine of the torque is 19.2 Nm @ 2850 rpm to be the also in the also discussed in the paper.

Keywords: Backfire; Carburetor Manifold Injection; Hydrogen Engine;

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Introduction

Many cities around the world are experiencing dangerous levels of air quality deterioration, necessitating immediate action. The World Health Organization (WHO) estimates that outdoor air pollution is responsible for 3.7 million deaths each year. One of the main causes of the environment's degradation is car exhaust pollution. The vehicles' tail pipe emissions go farther from the vehicle and into heavily

In habited areas. The number of vehicles on the road has increased globally as a result of increased economic activity and population growth. Internal Combustion Engines (ICE), which have established their value as essential components of the transportation sector, now must comply with strict emission requirements. Internal combustion engines must be run on alternative fuels that burn cleanly. This makes hydrogen the special fuel with the ability to eventually free people from the fuel issue and environmental deterioration. One of the most sought-after fuels for internal combustion engines due to its distinctive qualities, including rapid flame speed, high diffusivity, etc. This characteristic allows the conventional ignition system to function even with a spark that has very little energy. On the other side, this characteristic makes the system vulnerable to pre-ignition, flashback, and high rates of pressure rise. It is possible to run a hydrogen engine in extremely lean settings with an equivalency ratio as low as 0.23 compared to stoichiometric conditions. However, engines are run at an ER range of 0.4-1 due to unstable combustion [2,3]. Ultra-lean operation is made possible by hydrogen's broad range of flammability, but its low minimum ignition energy and short quenching distance could have unintended consequences as ER conditions near stoichiometric ones.

One of the most significant problems with using hydrogen as an IC engine fuel, according to researchers, is the back fire. Backfire happens when a new charge of hydrogen is ignited in the intake ports. The flame produced by the combustion of a hydrogen air mixture escapes more easily past an even almost closed intake valve due to the hydrogen's shorter quenching distance. The low quenching distance and the low ignition energy requirement (0.02 mJ) have frequently been the cause of the new charge regularly becoming ignited and causing flame propagation via the Injection system, resulting in backfire. Backfires can be avoided by ensuring sure there isn't any unburned flammable mixture in the intake manifold. There are many ways to control backfire, including those Das listed: Utilizing leaner mixes, cooling intake air, reducing valve overlap, etc. The best approaches for eliminating backfire have been demonstrated to be appropriate fuel Injection techniques, as explained below.

Fuel Injection Methods

The frequency and intensity of backfire must be controlled by the fuel Injection system. The Fuel Injection Method (FIM) for a Spark Ignition (SI) engine can be categorized in a wide variety of ways, including Carburetion, Inlet Manifold Injection, Inlet Port Injection, and Direct Cylinder Injection. The carburetion technique—the simplest and oldest of these methods—uses a gas carburetor and is currently the most used.

Suwanchotchoung et al. claim that backfire occurs when fuel is continuously fed, as with a carburetor, and the entering fuel-air mixture regularly comes into touch with the hot reacting gases that are left over. The time of the hydrogen injection event can be precisely controlled by injecting hydrogen into the input manifold (TMI). Selecting the ideal injector location and injection timing is crucial for preventing backfire. Varde et al.'s [6] study of late injection backfire control permitted hydrogen to enter the combustion chamber only after some fresh air was introduced. The onset of the injection was fixed at 200 ATDC.

.Fuel delivery can start later in the suction stroke using electronically controlled timed injection.

When adopting the intake port injection approach, hydrogen is injected close to the intake valve rather than at the intake manifold, but air and fuel still enter the combustion chamber during the intake stroke. All the advantages of late injection are present when hydrogen is injected directly into the combustion chamber.

Backfire risks are minimal because fuel won't be injected into the cylinder until the intake valve is shut.

Development of an engine system for hydrogen operation

The engine under study was a 97.2 cc single-cylinder gasoline naturally aspirated engine with a carburetor that had been modified to run on both gasoline and hydrogen while retaining the prototype car's functionality. The alterations made to the vehicle engine's operating parameters and other aspects are outlined below.

Spark Plug: The system's spark plug because a catalytic interaction with platinum can lead to a hot spot in the combustion chamber, iridium was chosen as the material for the system's spark plug. It was discovered through experimentation that 0.4 mm was the appropriate spark plug gap.

Flashback Arrestor: To prevent any backfires from making the flame reappear in the hydrogen gas supply system, a Fig.1 represents a flashback/backfire arrestor was fitted in the fuel line close to the fuel injector. Throughout the full engine operating range, the flashback arrestor installation delivered satisfactory results.

Fig.1. Backfire Arrestor

Electrolyzer: Water can be electrolyzed to separate its hydrogen and oxygen. This procedure is carried out in an electrolyzer. There are many different sizes of electrolyzers, ranging from compact, portable machines that work well for manufacturing hydrogen on a small scale at various sites to enormous, central production facilities that may be directly related to energy sources. Water is electrolyzed when electricity is applied to it, splitting it into hydrogen gas and oxygen in the positive terminal to create a hydrogen gas cathode plate in the cathode plate's negative terminal. When water reacts with the anode, oxygen and positively charged hydrogen ions (protons) are created. The electrons additionally flow through an external circuit in addition to the hydrogen ions randomly travelling through the PEM to the cathode.

When electrons from the external circuit combine with hydrogen ions at the cathode, hydrogen gas is produced in the electrolyzer as shown in the figure 2.

Fig.2. Electrolyzer

Battery: A battery is the thing that stores energy. Direct current, or DC, is the form that the stored energy is in. Wet-cell, dry-cell, and gel motorcycle batteries are the types of batteries used in two-wheelers. Wet cell batteries include conventional, lead-acid, and flooded cell batteries. Sealed-type and maintenance-free batteries under the dry-cell batteries category. Gel acid and gel-filled batteries are types of gel motorcycle batteries. A 6V battery is used for this experiment. It is a type of wet cell battery.

Specification of Battery

Capacity	12V and 20 Ah
Rechargeable battery one Battery type	lead – acid battery
Charge capacity	3x20=60 ampere hours.
Charging time	3-5 hour
Dimension	113 x 70 x 85 (MM)
Charging Current (max.)	0.3 Ampere

Experimental setup

In order to investigate how the equivalency ratio changed with engine speed when running on hydrogen and petrol, the engine speed was increased from 1200 to 3400 rpm with a 400 rpm increment. The lowest feasible equivalence was used to meet the minimum torque requirement and minimize NOx emission. Without using any after-treatment tools, the COx and NOx emissions were monitored as they exited the exhaust manifold with experimental setup pf the engine as shown in the figure 3.

Fig. 3. Experimental Setup with Gas Analyzer

Result and Discussion

A hydrogen-powered single-cylinder car engine was created. In figure 4 represents a hydrogen operation provided much less torque than petrol operation, particularly at higher speeds. Compared to the gasoline operation, the hydrogen operation provided more torque at lower speeds. Carburetion based on the venturi concept was used to introduce the fuel for petrol operation, while hydrogen injectors were used for operation. The hydrogen injector was installed between the carburetor and engine intake. As a result, at slower speeds, the power output decreased by the same amount. The maximum torque for the hydrogen operation was 13.2 Nm @ 3250 rpm, whereas the maximum torque for the petrol operation was 19.2 @2850 rpm.

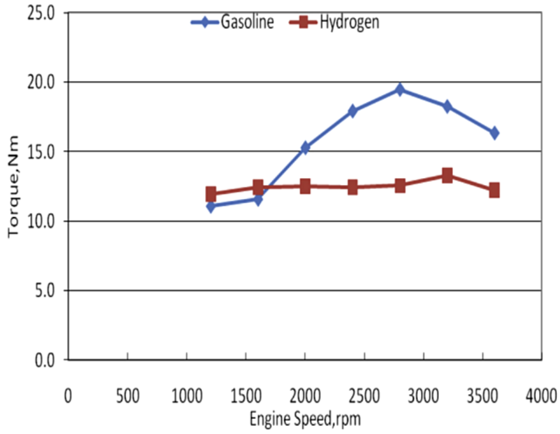

Fig.4 - Variation of Torque Vs Engine Speed

Although the torque produced when using hydrogen satisfied the minimum torque requirement for the vehicle, it was less than that produced when using petrol (at higher speeds).

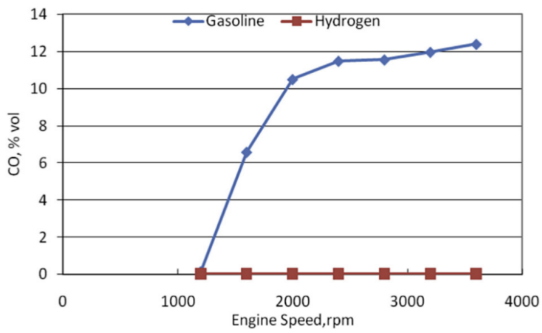

Fig.5 - Variation of CO Emission Vs Engine Speed

Despite the fact that hydrogen is a fuel that releases no carbon, some HC and CO emissions were discovered to be present, as shown in the figure 5 and figure 6. Rich operating at high speeds caused the HC and CO emissions for petrol operation to increase with engine speed.

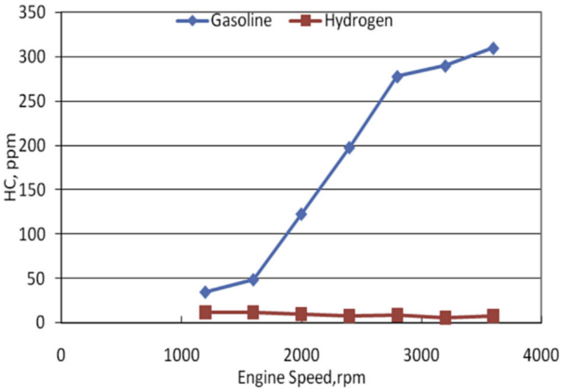

Fig.6. Variation of HC Emission Vs Engine speed

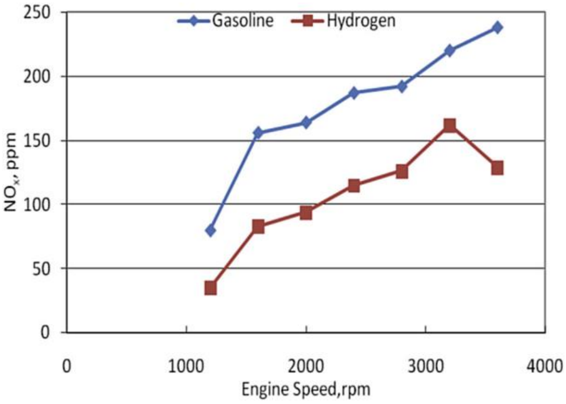

Fig.7 Variation of NO Emission Vs Engine speed

In figure7, the nitrogen oxide (NOx) level whether operating with petrol or hydrogen, when using hydrogen, the only significant pollutant is NOx, which is created during combustion at high temperatures within the cylinder. Comparing the lean operation to petrol operation, the NOx output was incredibly low.

Conclusion

The single-cylinder vehicle engine was adapted for use with hydrogen. Given the existing scarcity of hydrogen dispensing facilities, the engine was designed with bi-fuel operation in mind. The hydrogen engine's maximum torque as a result is 13.2 Nm at 3250 rpm. However, the torque of the hydrogen engine, which is lower than that of the petrol engine, is around 19.2 Nm @ 2850 rpm for the hydrogen gas engine. Under lean burn conditions, hydrogen engines have shown to be particularly successful at preventing backfire and reducing NOx emissions, and NOx was the only significant pollutant. By using hydrogen, the NOx emission was controlled below 170 ppm.

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