

# HYDROGEN AS A PETROL ADDITIVE IN 4 STROKE I C ENGINE

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**Abstract** - Brown's gas (HHO) has recently been introduced to the auto industry as a new source of energy. The present work proposes the design of a new device attached to the engine to integrate an HHO production system with the gasoline engine. The proposed HHO generating device is compact and can be installed in the engine compartment. This auxiliary device was integrated and tested on a gasoline engine. Pulsar DTSi 150cc four stroke single cylinder engine was procured for the project. Belt rope dynamometer, mounting frames and experiment setup were designed and fabricated. HHO gas kit was installed with engine. Performance analysis and emission analysis has been done by using Petrol and Petrol-HHO separately on engine. It has been found that around 10% reduction in fuel consumption is achieved by using petrol-HHO and appreciable amount of reduction in emission of pollutants such as CO, unburned hydro carbons and CO particularly during the idle 2 condition

combustion stroke where spark plug ignite the airfuel mixture and again piston moves B.D.C to T.D.C in exhaust stroke to exhaust the flue gases generated in combustion of air-fuel mixture which is one another revolution. So total two revolution of the crankshaft.

## 1. INTRODUCTION

This paper illustrates what is the effect of the partial inclusion of the HHO gas into the conventional S.I engine along with the petrol. As we know that current global economy faces problems in the fossil fuels and fossil fuels end in the nearest future. Another reason is that, these fossil fuels are also harmful for the environment. It affects the protection layer of the earth i.e. Ozone layer as well as global warming effect & greenhouse effects. Internal combustion engine in which the combustion of fuel takes place inside the cylinder is known as I.C engine, the procedure of combustion are directly the motive fluid. Petrol & Diesel engine are the examples of this type, where the working substance is the product of combustion.

In this project we are using Spark Ignition Four Stroke I.C Engine. Basic working of Four Stroke Spark Ignition (S.I) Engine: Mainly, S.I engine working fuel is petrol which also termed as Gasoline. Petrol engine takes air and petrol mixture at required proportion which is taken into the intake manifold of an engine and ignited spark plug when the charge is compressed. The four stroke S.I engine was introduced in 1876 by Nicolaus August Otto. Four stroke S.I engine has 4-stroke means two revolution of crank-shaft in which piston comes from T.D.C to B.D.C in suction stroke & B.D.C to T.D.C in compression which one revolution of crankshaft. Then piston goes again T.D.C to B.D.C in

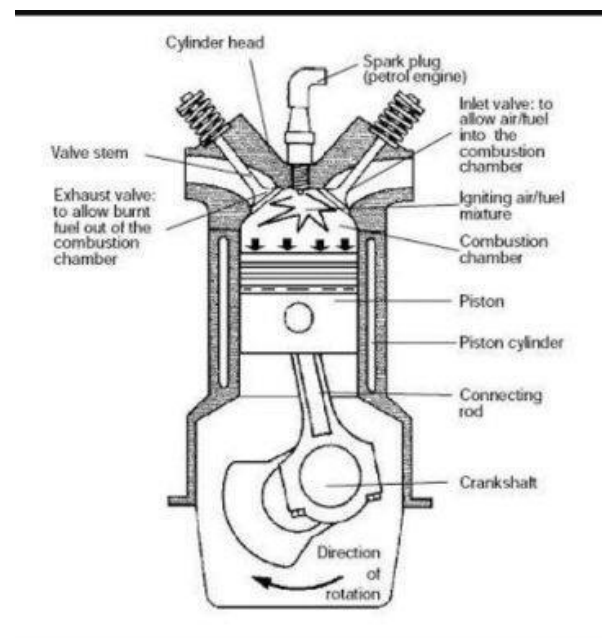


Figure 1: Four-stroke Spark Ignition Engine

### 1.1 Desirable Properties of Good I.C Engine Fuel

- High energy content per unit quantity of fuel.
- Good combustion properties.
- Availability in large quantities economically.
- Free from fire hazards.
- High stability with changes in temperature.
- Low pollution
- Easy to store & transport.
- Products of combustion in gaseous form and noncorrosive.

## 2. THEORETICAL BACKGROUND

Hydrogen gas on the demand is burning hybrid hydrogen or HHO gas or Brown's gas along with gasoline or diesel due

to this reason there will be increasing in the mileage (kilometer per Litre). HHO gas is a supplement or as additive to conventional engine fuel system, it helps in combustion of the conventional engine fuels more efficiently & effectively. HHO gas is also called as Brown's gas or oxy-hydrogen gas, it is water break in to two parts by the help of the electrolysis process of water, and hence it is two mole of hydrogen & one mole of oxygen.

## 2.1 Properties of HHO Gas

There are many unique and unusual properties that HHO Gas possesses. Below is a list of some of the properties.

- Gas proves to be odorless, colorless and lighter than air.
- In the production of HHO Gas, there is no evaporation process at all, the electric energy used being insufficient for evaporation.
- The variable character of the energy content of HHO Gas is evidence that the gas has a unique structure with a chemical composition including bonds beyond those of valence type.
- HHO Gas does not follow the fundamental PVT Law for gases.
- HHO Gas demonstrates an anomalous adhesion to gases, liquids and solids. HHO Gas bonds to gaseous fuels (such as natural gas, magne gas fuel, and others) and also to liquid fuels (such as diesel, gasoline, liquid petroleum, and others).
- Santilli describes the creation of the gaseous and combustible HHO from distilled water at atmospheric temperature and pressure via a process structurally different than evaporation or separation, which suggests the existence of a new form of water.
- HHO is described to have the structure H-O-H where represents the new molecular bond and the conventional molecular bond. The transition from the conventional H-O-H configuration to the new H-O-H species is explained as being a change of the electric polarization of water caused by the electrolyzes.

## 2.2 HHO Gas Kit:

HHO gas kit is a device especially designed for the producing HHO gas by supplying 12 volts DC current. 12 volts DC current is supplied from the battery which has been already integrated with the vehicle this gas kit contains

- HHO cell
- Dryer
- Pulse modulator



**Figure 2:** HHO kit

## 2.3 HHO Cell

Two stainless steel electrodes are placed in the HHO cell and are connected with pulse with modulator circuit by external wiring. HHO cell is filled with electrolyte solution which contains mixture of water and electrolyte. The electrolytes used in the electrolytic solution are sodium hydroxide, potassium hydroxide and baking soda. Electrodes are dipped in the solution for passing the current.

## 2.4 Dryer

The bubbler is simply a container half filled with water. HHO gas is fed to the bottom of the bubbler with a hose from your electrolyte tank and allowed to bubble through the water.

## 2.5 Pulse with Modulator

This electronic device is used to regulate the fluctuation of current and to protect the wires from the undesirable heat.

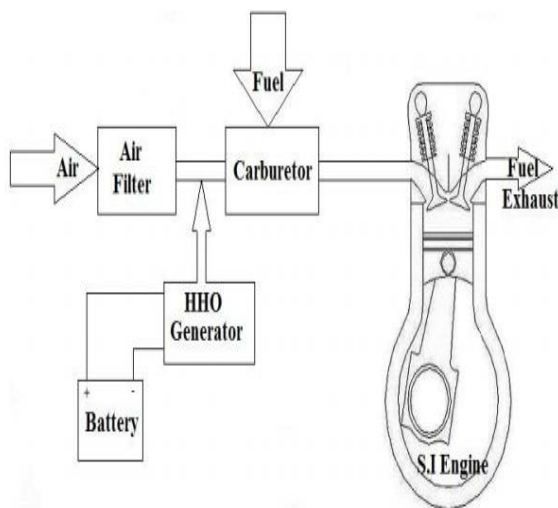
## 2.6 Measuring of Gas Flow Rate-Water Displacement Test

Pour enough water from your cup into the graduated cylinder to reach a height that will cover the sample. Read and record the volume. Slightly tilt the graduated cylinder and carefully place the sample into the water. Read and record the volume. Place the graduated cylinder upright on the table and place the tube inside the inverted cylinder and connect HHO to battery. After interval of 10 second find out the final reading. Find the amount of water displaced by subtracting the initial level of the water from the final level. This volume equal to gas flow rate for 10 second.

**Table 1:** flow rate of HHO gas at various current supply

Current(A)	Flow rate(ml/min)
1.5	18
2.12	25.8
3.12	43.2

### 3. EXPERIMENTAL SET-UP & ITS RESULT



**Figure 3:** An experimental set-up line diagram is shown as above

#### 3.1 Construction

Petrol-HHO engine set up consists of four stroke pulsar 150-CC, single cylinder engine. The engine is attached to the bed of the Petrol-HHO engine set up by the help of fasteners. A 12 volt DC battery is fixed in the frame and the power from the battery is used to self-start and to power HHO gas kit. The output of HHO gas is connected to hose pipe after the air filter and before the carburetor.

Fuel is supplied from the petrol tank to burette with the help of valves and the fuel from the burette is supplied to the carburetor, from the carburetor the intake of petrol + HHO + air is supplied to the engine cylinder during the suction stroke.

During power stroke the crank shaft is driven by the piston and the crank shaft is coupled to the gear box by the help of clutch. A sprocket is attached at the output of the gear shaft. With the help of chain drive brake drum is driven by the gear shaft sprocket. Brake drum and sprocket is mounted on the shaft which is made up of MS.

The shaft is simply supported at the two ends by bush bearings. The bush bearings are mounted on the inverted V frame, top face of V frame slots are made for adjustment of

bush bearings in case of chain sprocket center distance is to be changed. One end of shaft is center drilled and the engine purpose of center drill is to take speed of output shaft by the help of tachometer. The flat belt is attached to the brake drum to apply the load by to and fro motion of lead screw while rotating the hand wheel. The applied load is shown in the spring balance. Two spring balances are attached to the belt one at the tight side and another at the slack side and tangential to the brake drum.



**Figure 4:** Following is the Experimental Set-up which we used to take experiments & result analysis

**Table 2:** Engine specification

Engine Type	4 stroke single cylinder natural air cooled
Bore*Stroke	58.5mm*56.40mm
Engine Displacement	149.01 cc
Maximum net power	14.09bhp @8500 rpm
Maximum net torque	12.76Nm @6500rpm
Compression ratio	9.5+/-0.5:1

#### 3.2 Observation Table

Engine running on petrol without HHO kit

**Table 3:** Constant load and Varying speed

Load(in kg)	Speed(in rpm)	Time taken for 50 ml fuel consumption(in second)
1	85	97
	115	95
	155	80
2	115	93
	155	76
	185	66
3	115	90
	155	68
	190	60

Engine running with HHO kit

**Table 4:** Constant load and Varying speed

Load(in kg)	Speed(in rpm)	Current(in ampere)	Time taken for 50ml fuel consumption(in second)
1	120	1.50	95
		2.12	98
		3.12	102
2	115	1.50	92
		2.12	96
		3.12	98
3	110	1.50	88
		2.12	92
		3.12	94

### 3.3 Results

**Table 5:** Performance of 4 stroke petrol engine without HHO kit

Load (in kg)	Speed (in rpm)	Time taken for 50ml fuel consumption(in second)	Total Fuel Consumption (Kg/hr)	BP (in W)	Thermal Efficiency (in %)
1	160	95	1.2	11.5	2.3
2	150	90	1.45	21.5	4.09
3	135	86	1.52	30	5.22

**Table 6:** Performance of 4 stroke petrol engine without HHO kit (varying speed and varying load)

Load (in kg)	Speed (in rpm)	Time taken for 50 ml fuel consumption(in second)	Total Fuel Consumption (Kg/hr)	BP (in W)	Thermal Efficiency (%)
2	115	93	1.4	16	2.9
	155	76	1.7	22	3.1
	185	66	1.96	26	3.6
3	115	90	1.37	24	4.2
	155	68	1.9	32	4.5
	190	60	2.157	40	5.01

**Table 7:** Performance of 4 stroke petrol engine with HHO kit

Load (in kg)	Speed (in rpm)	Current (in ampere)	Time taken for 50ml fuel consumption(in second)	Total Fuel Consumption (Kg/hr)	BP (in W)	Thermal Efficiency (in %)
1	120	1.50	95	1.36	8.6	1.6
		2.12	98	1.25		1.8
		3.12	102	1.15		2.04
2	115	1.50	92	1.45	16	3.11
		2.12	96	1.38		3.37
		3.12	98	1.25		3.5
3	110	1.50	88	1.5	23	4.0
		2.12	92	1.42		4.2
		3.12	94	1.35		4.66

### 3.4 Calculations

Formulae used

- 1) Brake Power, BP =  $2\pi NT / 60$
- 2) Total Fuel Consumption(for 50ml)=  $(50*3600* \text{density of fuel}) / (t*1000)$
- 3) Specific fuel consumption =  $(TFC/BP)$
- 4) Brake thermal efficiency =  $(BP) / (C_v * TFC)$

Engine running without HHO kit:

- 1) For m=2kg, N=115rpm  
 $BP = (2 * \pi * 115 * 9.81 * 2) / 60 = 16W$   
 $TFC = (50 * 3600 * 0.719) / (76 * 1000) = 1.7kg/hr$   
 Thermal efficiency=  $(0.016 * 3600) / (13.138 * 1.7) = 2.5\%$

- 2) For m=3kg, N=110rpm  
 $BP = (2 * \pi * 110 * 9.81 * 3) / 60 = 23W$   
 $TFC = (50 * 3600 * 0.719) / (94 * 1000) = 1.37kg/hr$   
 Thermal efficiency=  $(0.023 * 3600) / (13.138 * 1.3) = 4.9\%$

Engine running with petrol and HHO kit:

At 18ml/min flow rate of HHO gas

- 1) For m=2kg, N=115rpm  
 $BP = (2 * \pi * 115 * 9.81 * 2) / 60 = 16W$   
 $TFC = (50 * 3600 * 0.719) / (92 * 1000) = 1.42kg/hr$   
 Thermal efficiency=  $(0.016 * 3600) / (13.138 * 1.42) = 3.08\%$

- 2) For m=3kg, N=110rpm  
 $BP = (2 * \pi * 110 * 9.81 * 3) / 60 = 23W$   
 $TFC = (50 * 3600 * 0.719) / (88 * 1000) = 1.47kg/hr$   
 Thermal efficiency=  $(0.023 * 3600) / (13.138 * 1.47) = 4.27\%$

At 25.8ml/min flow rate of HHO gas:

- 1) For m=2kg, N=115rpm  
 $BP = (2 * \pi * 115 * 9.81 * 2) / 60 = 16W$   
 $TFC = (50 * 3600 * 0.719) / (96 * 1000) = 1.35kg/hr$   
 Thermal efficiency=  $(0.016 * 3600) / (13.138 * 1.35) = 3.25\%$

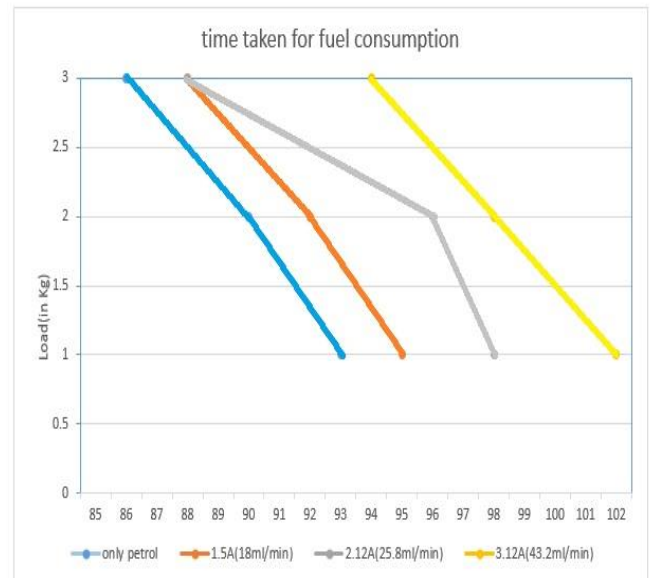
- 2) For m=3kg, N=110rpm  
 $BP = (2 * \pi * 110 * 9.81 * 3) / 60 = 23W$   
 $TFC = (50 * 3600 * 0.719) / (92 * 1000) = 1.4kg/hr$   
 Thermal efficiency=  $(0.023 * 3600) / (13.138 * 1.4) = 4.5\%$

At 43.2ml/min flow rate of HHO gas

- 1) For m=2kg, N=115rpm  
 $BP = (2 * \pi * 115 * 9.81 * 2) / 60 = 16W$   
 $TFC = (50 * 3600 * 0.719) / (98 * 1000) = 1.3kg/hr$   
 Thermal efficiency=  $(0.016 * 3600) / (13.138 * 1.3) = 3.4\%$

- 2) For m=3kg, N=110rpm  
 $BP = (2 * \pi * 110 * 9.81 * 3) / 60 = 23W$   
 $TFC = (50 * 3600 * 0.719) / (94 * 1000) = 1.37kg/hr$   
 Thermal efficiency=  $(0.023 * 3600) / (13.138 * 1.37) = 4.6\%$

### 3.4 Charts



Charts 1: Time taken for 50ml fuel consumption (with and without HHO gas)

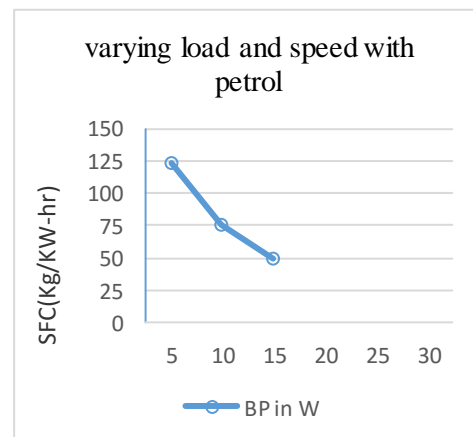
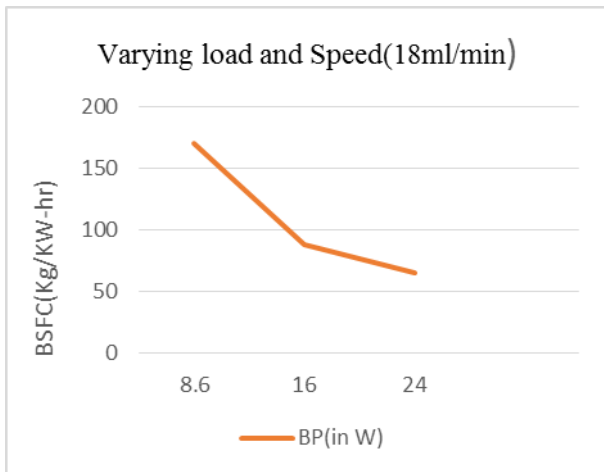
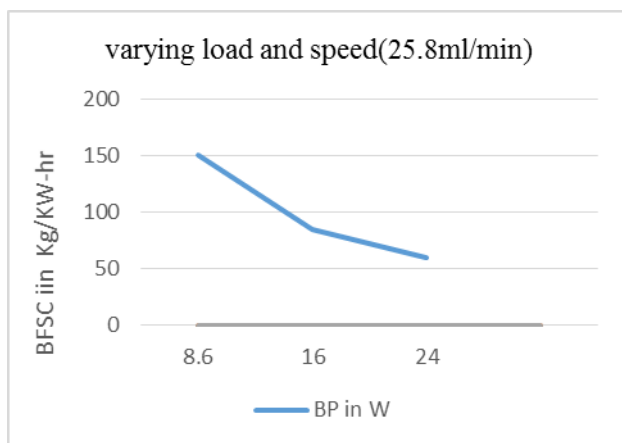


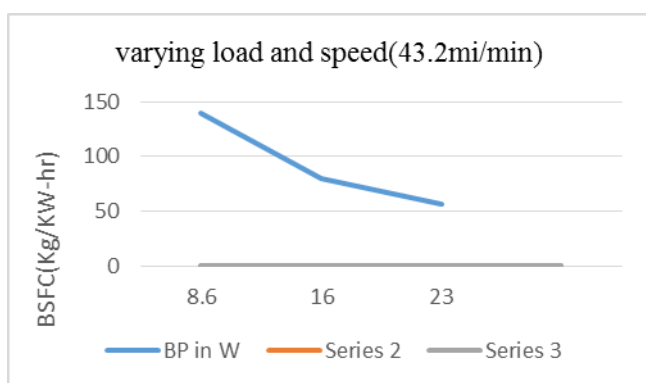
Chart 2: Varying speed and load without HHO kit



**Chart 3:** Engine running with HHO gas as petrol additive (flow rate-18ml/min)

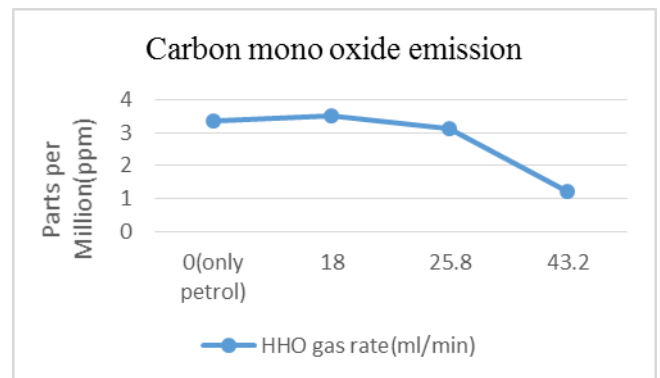


**Chart 4:** Engine running with HHO gas as petrol additive (flow rate-25.8ml/min)

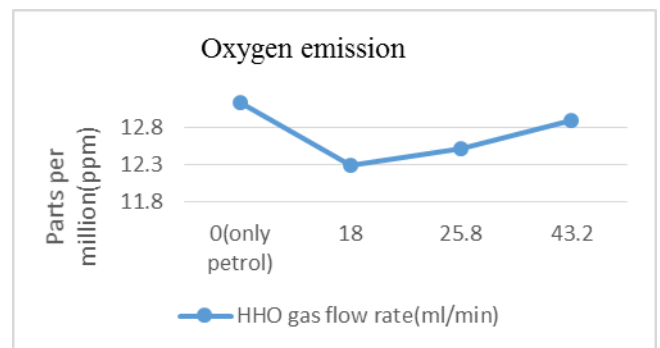


**Chart 5:** Engine running with HHO gas as petrol additive (flow rate-43.2 ml/min)

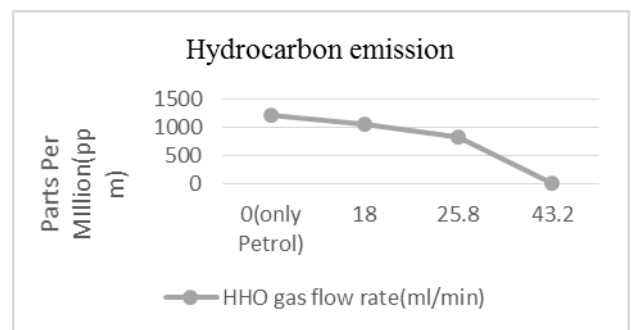
### 3.5 Emission test



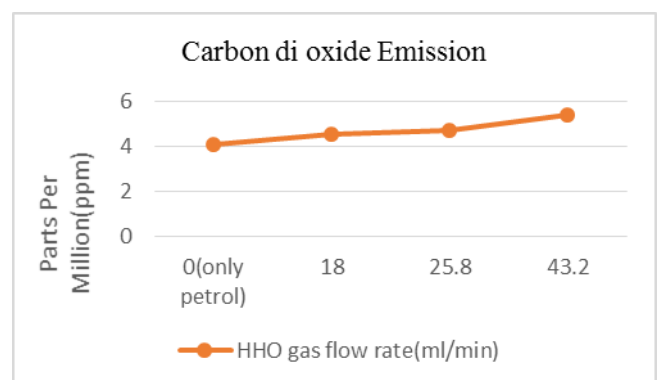
**Chart 6:** Carbon mono oxide emission



**Chart 7:** Oxygen emission



**Chart 8:** Hydrocarbon emission



**Chart 9:** Carbon di oxide emission

#### 4. CONCLUSION

The impacts of using a small amount of H<sub>2</sub>/O<sub>2</sub> mixture as an additive on the performance of a four-cylinder petrol engine were evaluated. The required amount of the mixture was generated using electrolysis of water considering on-board production of H<sub>2</sub>/ O<sub>2</sub> mixture. Hydrogen which has about three times higher flame speed than petrol has the ability to enhance overall combustion generating higher peak pressure closer to TDC resulting in more work. The fuel consumption reduced to 7 to 10%. The emissions of HC, O<sub>2</sub> and CO were found to be reduced to 53%, 1.8% and 64.3% due to better combustion due to the higher temperature reached during the combustion. It is advantageous to use HHO gas (Brown's gas) enriched air as a fuel in internal combustion engines. Significant impact on brake thermal efficiency and brake power is observed upon the addition of HHO gas (Brown's gas) enriched air. Fuel consumption and exhaust emissions are reduced to considerable amount. Hydrogen fuel generated from electrolysis (utilizing automotive alternators) has been promoted for use with gasoline powered and diesel trucks. This project will help our society to be fuel efficient and eco-friendly.

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