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PERFORMANCE AND EMISSION ANALYSIS OF IC ENGINE BY USING ELECTROLYSIS AND PREHEATING PROCESS

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Abstract: **In recent researches, the petrol engine was modified in many ways like Supercharging, Turbo charging, Fuel ignition, Alternative fuels, etc.., and there were lot of changes in design of engine parts to control pollution and to increase the engine efficiency. It is very important to note that there were no changes made in inlet atmospheric air to be mix with hydrogen gas for efficient combustion process. In order to overcome the above statement we added hydrogen gas to the preheated atmospheric air for better combustion process. This will lead to increased efficiency of engine and also to control the amount of exhaust gases. In order to increase the efficiency of engine we use hydrogen gas along with the petroleum. We chose hydrogen as a fuel because H_2 has the highest gravimetric energy densities when compared to all other available fuels. Also hydrogen has the highest energy content per unit mass(143MJ/kg) which was 40% more than other. In order to get the more efficient performance of engine we have to preheat the inlet air for decreasing the combustion temperature. By pre-heating the inlet air to the carburettor for a considerable amount, the vaporization can be increased and in turn complete combustion is achieved.**

Keywords- Air Pre heater; Consumption Of Fuel; Emission Control; Engine Efficiency; Hydrogen Gas; Petrol Engine

I. INTRODUCTION

Our present fuel resources are not going to be around forever and with the ever increasing consumption their extinction is nearly unavoidable. Most of our fuel resources are not renewable in nature because they are made up of fossil fuels [2]. The consumption of fuel resources in our world is 1000 times faster than their natural production. According to the recent estimation, the demand for these fuels will surely outstrip their availability in centuries-or less.

In automobile vehicles, during the combustion process inside the engine, the fuel is converted into chemical energy and emits the some harmful gases like carbon monoxide, carbon dioxide, nitrous oxide and hydrocarbons. When these harmful gases come out from engine and mixed into the atmospheric air will leads to make a huge contribution to the greenhouse effect. Increase in amount of greenhouse gases will leads to the global warming. The other effects apart from global warming including ocean acidification, smog pollution, ozone depletion etc.., the carbon dioxide and hydrocarbons are released during burning of fossil fuels which is the main cause for global warming. In this paper, we have to combine the electrolysis and preheating process to reduce the amount of exhaust gases and enhancing the IC engine performance. The main objective of this paper is to conserve energy in IC engine by increasing its efficiency using innovative electrolysis [5] and preheating method [6].

II. PROPOSED METHODOLOGY

2.1 Electrolysis Process

It is the process of decomposition of water (H_2O) into oxygen (O_2) and hydrogen gas (H_2) due to an electric current being passed through the cathode and anode into water in the presence of electrolytic solution(NaCl).

An electrical power source (battery) is connected to two electrodes (cathode & anode), or two plates (metal such as platinum, stainless steel or iridium) which have to be placed in the water. The electrodes should preferably be made from material with high conductivity, resistance to corrosion and erosion during the electrolysis and able to catalyse the electrode reactions. Hence we use copper material for cathode and steel as anode. Sodium chloride (NaCl) is used as the electrolytic solution. In 12V battery,

positive charge was connected to the anode where the cathode was connected to the negatively charge. When the battery is switched ON, creating an electric potential through water causes positive ions, including the inherent hydrogen ions H_3O^+, to move towards the negative electrode (cathode) and negative ions, including the inherent hydroxide ions OH^-, to move towards the positive electrode (anode). At sufficient potential difference, this may cause electrolysis with oxygen gas being produced at the anode and hydrogen gas produced at the cathode. The amount of hydrogen produced is twice that the number of moles of oxygen, and both are proportional to the total electrical charge conducted by the solution.

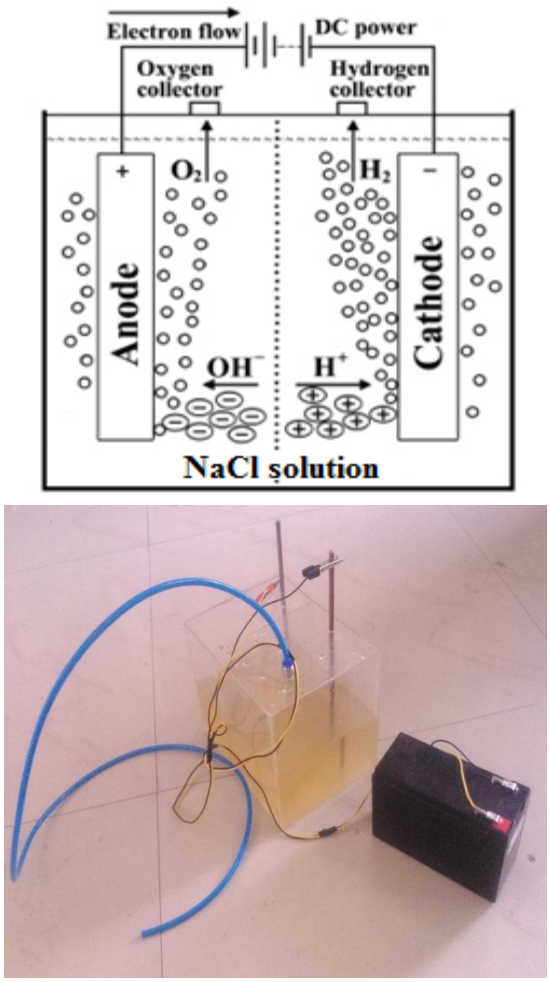


Fig 2.1 Electrolysis Process

In pure water at the negatively charged cathode, a reduction reaction takes place, with electrons (e^-) from the cathode being given to hydrogen cat ions to form hydrogen gas (the half reaction balanced with acid.

At cathode: $2\ H^+(aq) + 2e^- \rightarrow H_2(g)$

At the positively charged anode, an oxidation reaction occurs, generating oxygen gas and giving electrons to the anode to complete the circuit:

At anode: $2\ H_2O \rightarrow O_2(g) + 4\ H^+(aq) + 4e^-$

2.2 Preheating Process

An air pre heater (APH) is a device used to heat air before another process which was the primary objective of increasing the thermal efficiency of the process. To enhance the efficiency of a four stroke petrol engine it was need to pre-heat the inlet air which was flowing through the carburettor. The petrol vaporization in the carburettor was affected by the humidity presence in the atmospheric air. Therefore, the inlet air was to be pre-heated before it entered into the carburettor. This will lead to the complete combustion was achieved inside the engine. Therefore it was need to selecting a suitable material for the pre heater design purpose. It should be noted that the selected material should have the properties like low cost, good thermal conductivity, high resistant to chemical corrosion In order to satisfy the above considerations, we select aluminium as a pre heater.

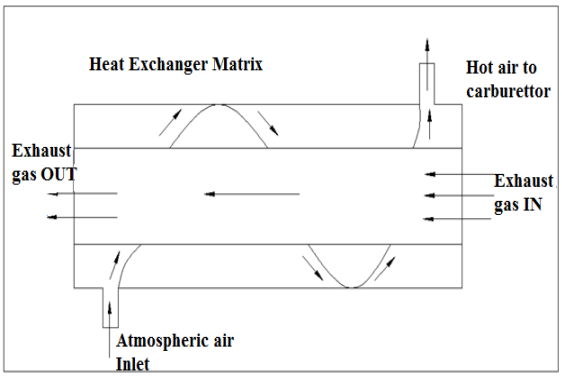


Fig 2.2 Preheating Process

III. EXPERIMENTAL SETUP

An electrolysis kit is placed over the vehicle with 12V battery supply. Inside the kit, there will be a mirror was placed which separated the hydrogen and oxygen gas. In that electrolysis kit, there will be a tube was fixed above which was used to take away the hydrogen gas from water during electrolysis process. Another side of tube was fixed to the pre heater. A pre heater is fixed between the air filter and carburettor. The pre heater is designed as to have two inlets. The inlets are the hydrogen gas tube from the electrolysis kit and the tube which receives the heat from the silencer or engine heat removal hose. The pre-heating of inlet air to the engine can be achieved by fixing a heat exchanger before the carburettor. The atmospheric air is sucked by the air filter and then passed through the heat exchanger to the carburettor. The air which is flowing though the heat exchanger will be heated by the engine exhaust gas. This will be able to reduce the presence of water vapour in the inlet air and also increase the temperature of the inlet air. The increase in temperature will causes complete combustion inside the engine and it is also more suitable for warming up the engine in cold conditions.

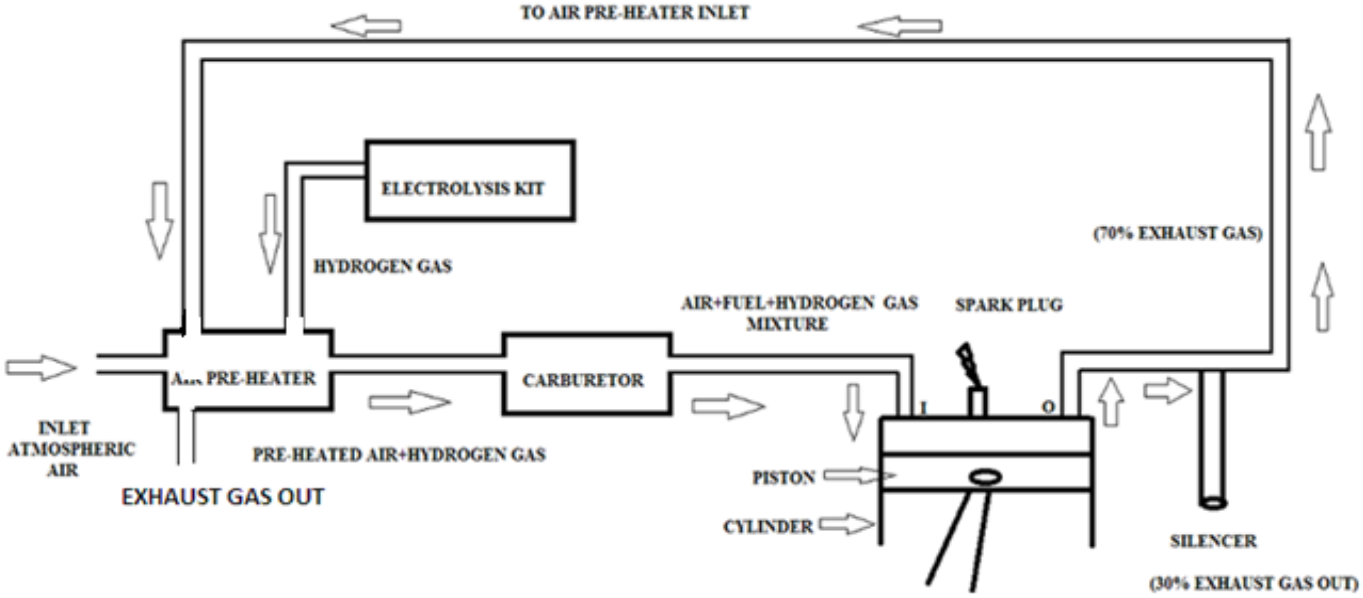


Fig 3.1 Layout of overall setup

Fig 3.2 Experimental setup

IV. RESULTS AND DISCUSSIONS

4.1 Road Test

The road test was conducted in TVS victor bike for 100ml of fuel and its observation had to be taken before and after installation of the electrolysis kit and pre heater setup. After the installation of our setup we found that the average distance covered by the vehicle was 6.2km(for 100ml of fuel).This shows that after installing of our setup, the distance covered by the vehicle was increased by nearly 0.9km(for 100ml of fuel) This was equivalent to increase in distance covered by vehicle was 9kmpl. Hence the presence of hydrogen gas and preheated air will result in the increase in mileage of the vehicle.

Table 1 Before installation of setup

S.NO	FUEL USED (ml)	SPEED (rpm)	ODOMETER READING (Km)		DISTANE COVERED (Km)
			Initial	Final	
1	100	0-50	2	8.2	6.2
2	100	0-50	8.3	14.4	6.1
3	100	0-50	14.5	20.9	6.4
4	100	0-50	20.9	27.1	6.2

AVERAGE=6.2kms (for 100ml of fuel)

Table 2 After installation of setup

S.NO	FUEL USED (ml)	SPEED (rpm)	ODOMETER READING (km)		DISTANCE COVERED (km)
			Initial	Final	
1	100	0-50	30	37.1	7.1
2	100	0-50	37.2	44.1	6.9
3	100	0-50	44.2	51.3	7.1
4	100	0-50	51.4	58.4	7.0

AVERAGE=7.1kms(for 100ml of fuel)

4.2 Emission Test

The emission test was conducted for before and after installation of the electrolysis kit and pre heater setup at two different emission testing centre. By our methodology, the amount of exhaust gases coming out from the engine was considerably reduced. The amount of CO was reduced from 1.309% to 0.085% and also the amount of hydrocarbons was reduced from 1168PPM to 780PPM.Hence our proposed method is very effective to control the amount of exhaust gases which leads to reduce the pollution.

Table 3 Before installation of setup

Parameter	Regulation Limit	Actual
Co (% by vol)	3.5	1.309
HC (PPM)	4500	1168
Co_2 (% by vol)		13.92
O_2 (% by vol)		0.86

Table 4 After installation of setup

Parameter	Regulation Limit	Actual
CO (% by vol)	3.5	0.085
HC (PPM)	4500	780
CO_2		13.20
O_2		0.44

4.3 Laboratory Test

4.3.1 Technical Specification

Drum radius = 58mm

Belt radius = 3mm

Fuel = Petrol

Table 5 Load test on 4-stroke petrol engine before installing the H_2O kit

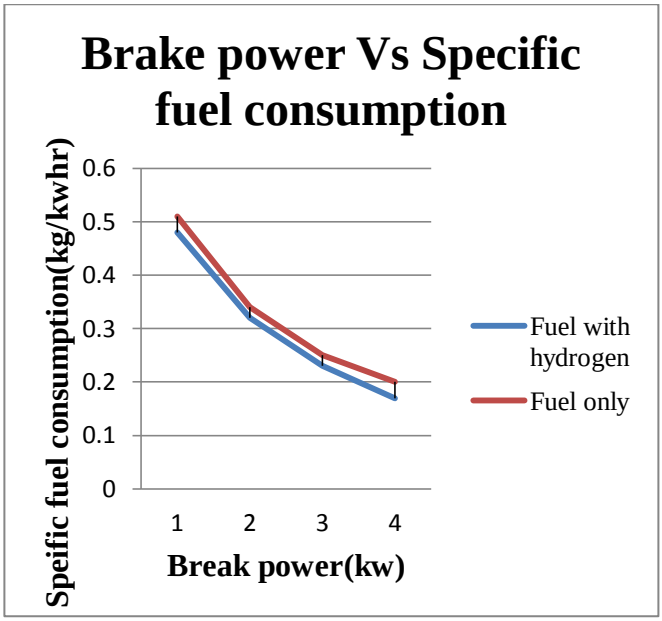
S.NO	Load(W) in kg W1-W2	Speed (N) rpm	Time for 10cc fuel consumption	TFC Kg/hr	BP KW	FP KW	IP KW	SFC kg/KW-hr	η_{mech}	$\eta_{overall}$	$\eta_{thermal}$
1	2	2946	32	0.88	0.83	0.12	0.96	1.06	86.4	8.2	9.6
2	4	2919	32.67	0.86	1.65	0.24	1.89	0.52	87	16.83	19.3
3	6	2890	33.78	0.83	2.42	0.36	2.78	0.34	87	26.5	29.6
4	8	2868	34.8	0.80	3.2	0.48	3.68	0.25	87	34.82	40
5	10	2844	36.2	0.78	3.96	0.59	4.56	0.20	87	45	51.6

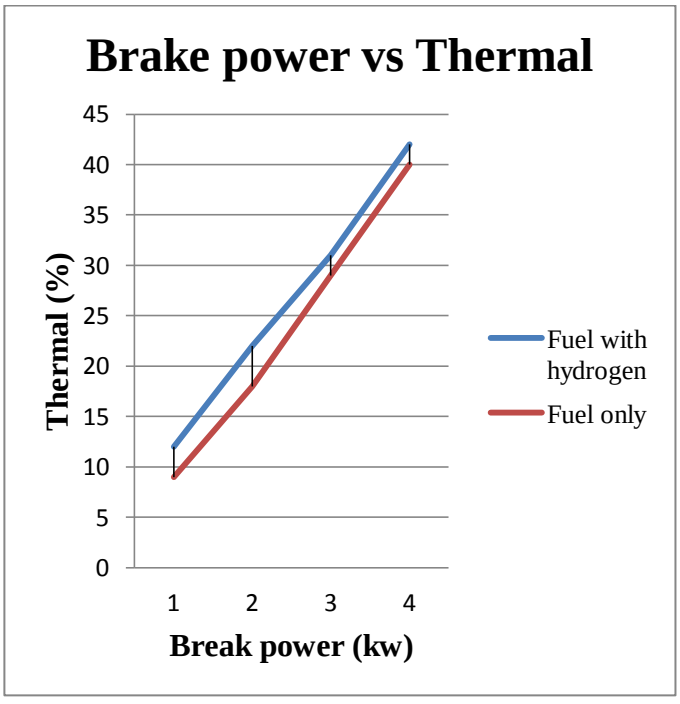
Table 6 Load test on 4-stroke petrol engine after installing the H_2O kit

S.NO	Load(W) in kg W1-W2	Speed (N) rpm	Time for 10cc fuel consumption	TFC Kg/hr	BP KW	FP KW	IP KW	SFC kg/KW-hr	η_{mech}	$\eta_{overall}$	$\eta_{thermal}$
1	2	2984	34	0.83	0.83	0.12	0.96	1	86.4	9	10.2
2	4	2934	24.5	0.81	1.67	0.25	1.92	0.48	86.9	18	20.7
3	6	2898	34.92	0.8	2.43	0.36	2.8	0.33	87	26.5	30.5
4	8	2886	35.2	0.79	3.22	0.48	3.7	0.24	87	35.4	41
5	10	2852	37.12	0.75	4.02	0.60	4.62	0.18	86.9	47	53.7

4.4 Result Analysis

The load test is carried out in the four stroke petrol engine for both before and after installation of the overall setup. The thermal efficiency, mechanical efficiency and overall efficiency were calculated from the corresponding formulae. Here we compared the value of brake power with specific fuel consumption, overall and thermal efficiency. From these analysis we found that the overall efficiency of the engine there was increased by 0.8 to 2% and also specific fuel consumption was reduced to considerable amount.





V. CONCLUSION

Hydrogen is one of the good energy carriers which can be replaced for fossil fuel and also be used as fuel in an IC engines and as a fuel cell in vehicles. In order to use hydrogen as a fuel of IC engine, its design should be considered for avoiding abnormal combustion. As a result it can improve engine efficiency, power output and reduce emissions. From the investigation it has been found that the thermal efficiency of single cylinder four stroke petrol engine was increased by 1-2.5% using the hydrogen gas along with the petroleum. Also specific fuel consumption was decreased by 0.03kg/kw-hr. Hence there was an effective potential to used hydrogen gas as a motive power in petrol engines which results in the increase in thermal efficiency and decrease in fuel consumption.

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