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Enhancing the Performance of IC Engine using Electrolysis and Air Preheater

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ABSTRACT

Today's IC engines have a maximum efficiency of only around 40%. This is due to a variety of losses which occur in the engine in the form of losses through exhaust, incomplete combustion, Incomplete combustion not only reduces engine efficiency, but also releases harmful gases like CO, CO_2, $NO_2$and SO_2 into the atmosphere which lead to devastating environmental phenomenon like green-house effect and global warming. For maximum combustion of fuel in engine and to avoid dangerous harmful gases from exhaust we propose a new concept of air preheating along with hydrogen gas by the process of electrolysis before fed into IC engine.

In our engine heat energy of exhaust gases is given to the pre heater and then it is absorbed by atmospheric air which is supplied to the carburettor. Hence this makes the reduction of hydrocarbon and increase the thermal efficiency of the engine. With the use of hydrogen along with the fuel, there will be reduction in fuel consumption as well as reduction in emission of harmful pollutants such as carbon monoxide and un burnt hydrocarbons.

Keywords-- Electrolysis, Hydrocarbons, IC Engine, Pre heater

I. INTRODUCTION

As the oil resources are depleting day by day with a rapid increase demand for energy, research is in progress to identify an alternative source. At the same time the present day equipments are being developed to give maximum output to conserve resources till an alternative is developed. In ordinary engine, the heat energy of exhaust gases which is lost through the silencer to atmosphere. In general heat exhausted is 30 percentage of total heat generated. As the most amount of heat is wasted in exhaust gases. It results in emission of harmful gases and increases temperature of atmosphere.

In our project, to save the exhaust heat energy we have mounted a heat exchanger over a silencer. The output heat energy of the engine exhaust gas is given to the input air which passes through the carburetor and then to the combustion chamber. By passing pre heated air to the carburet or a uniform mixture of air and fuel occurs and this unique mixture is send to the combustion chamber. In addition to the preheated air the hydrogen gas produced from the electrolysis is supplied at the inlet of carburetor. This mixture helps for the efficient burning and better combustion. The time taken by the fresh charge for combustion decreases, so that the proper ignition occurred. Thus it results in the increase in output power generated.

II. LITERATURE REVIEW

Krishna Perumal et.al used a separate expansion chamber surrounded by copper tubes to heat the fuel with the heat from exhaust gas. Rajesh Kumar Sahu concluded that the thermal efficiency is increased by increasing the inlet air temperature with the help of air pre heater. Dr. R. Sudhakaran studied the combined effect of air preheating and hydrogen gas from electrolysis. Dhananjay Babariya used a petrol with hydrogen gas and found reduction in carbon monoxide and hydrocarbon in exhaust emission. Prasad Kumar Putha studied the effect of hydrogen gas from electrolysis without any modification in engine. R. Vishal conducted experiment with air pre heater attached to Honda Activa engine and coupled with odometer in the laboratory for performance calculations. Rajasekar. D. used two setups peltier air preheating setup and exhaust gas recovery setup to analyze the effect of air preheating on the engine. Chirtravelan. M highlights the provision for incorporating a heating vessel for preheating air before admitting into the cylinder of diesel engine.

III. AIR PREHEATING PROCESS

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Air pre-heater is generally used to heat air before another process with the primary objective of increasing the thermal efficiency of the process.

The purpose of the air pre heater is to recover the heat from the system which increases the thermal efficiency of the system by reducing the useful heat lost in the flue gas. As a consequence, the flue gases are also conveyed at a lower temperature, allowing simplified design of the exhaust system. In simple language it is one of the types of heat exchanger, which is used to transfer the heat between solid object and a fluid, or between two or more fluids.

The double-pipe heat exchanger is one of the simplest types of heat exchangers. It is called a double-pipe exchanger because one fluid flows inside a pipe and the other fluid flows between that pipe and another pipe that surrounds the first. This is a concentric tube construction. Flow in a double-pipe heat exchanger can be parallel flow or counter flow. There are two flow configurations: parallel flow is when the flow of the two streams is in the same direction, counter flow is when the flow of the streams is in opposite directions.

As conditions in the pipes change: inlet temperatures, flow rates, fluid properties, fluid composition, etc., the amount of heat transferred also changes.

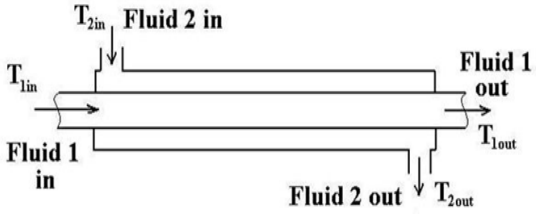

Fig 3.1 Parallel Flow Double Pipe Heat Exchanger

Fig 3.2 Heat exchanger mounted on silencer

IV. ELECTROLYSIS PROCESS

Electrolysis is process in which direct electric current is through an ionic substance that is either molten or dissolved in a suitable solvent, which produce chemical reactions at the electrodes and separation of materials is occurred.

The water can be decomposed into oxygen(O_2) and hydrogen(H_2) using electrolysis process by passing the current through it. The reaction has a standard potential of −1.23 V, i.e. to split the water potential difference 1.23V is required.

Two electrodes are used which is made of stainless steel. The positive terminal and negative terminal of the battery is connected to anode and cathode respectively. The anode and cathode is placed in water. The hydrogen is produced at cathode by loosing electron to water and oxygen is produced at anode. The amount of hydrogen generated is twice the amount of oxygen, and both are proportional to the total electrical charge conducted by the solution. In pure water at the negatively charged cathode, a reduction reaction takes place, with electrons (e^-) from the cathode being given to hydrogen cataions to form hydrogen gas. The half reaction, balanced with acid, is:

Reduction 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:

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

The same half reactions can also be balanced with base as listed below. Not all half reactions must be balanced with acid or base. Many do, like the oxidation or reduction of water listed here. To add half reactions they must both be balanced with either acid or base.

Cathode (reduction): $2\ H_2O(l) + 2e^- \rightarrow H_2(g) + 2\ OH^-(aq)$

Anode (oxidation): $4\ OH^-(aq) \rightarrow O_2(g) + 2\ H_2O(l) + 4\ e^-$

Combining either half reaction pair yields the same overall decomposition of water into oxygen and hydrogen:

Overall reaction: $2\ H_2O(l) \rightarrow 2\ H_2(g) + O_2(g)$

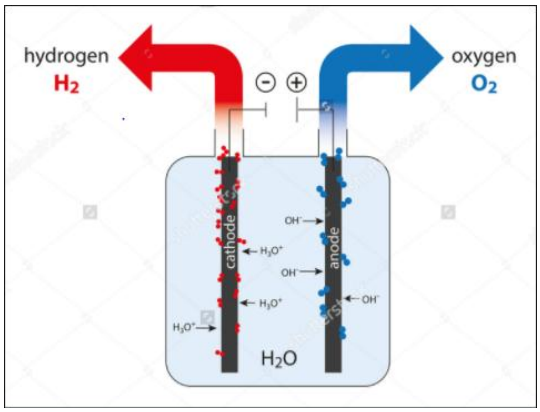

Fig 4.1 Electrolysis Process

The number of hydrogen molecules produced is thus twice the number of oxygen molecules. Assuming equal temperature and pressure for both gases, the produced hydrogen gas has therefore twice the volume of

the produced oxygen gas. The number of electrons pushed through the water is twice the number of generated hydrogen molecules and four times the number of generated oxygen molecules.

Fig 4.2 Hydrogen Generator

V. EXPERIMENTAL SETUP

Engine Specification

Type of fuel used : Petrol
Cooling system : Air cooled
Number of cylinder : Single
Number of stroke : Four Stroke
Arrangement : Horizontal
Cubic capacity : 97.2cc
Make & Manufacturer: Hero Honda Splendor

In this setup atmospheric air is preheated by using heat of exhaust gases coming out from silencer through engine. Hydrogen gas is mixed with this air which is obtained by electrolysis process of water. This mixture is send to the carburettor. In the carburettor preheated air, hydrogen and fuel get mixed and this mixture is send to perform its predetermined function.

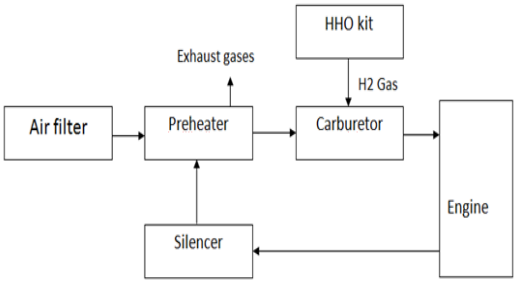

Fig 5.1 Block Diagram of Experimental Setup

As shown in Fig.4.2 The pre heater is mounted on the silencer to transfer the heat from exhaust gases to atmospheric air. Two ports are given to the preheater, one for inlet of atmospheric air and one to transfer the preheated air to the carburetor through hose.

Electrolysis kit is mounted on one side of frame. Supply for the electrolysis kit is given by battery which is mounted on the stand. Hydrogen gas coming out from the process is send to the carburetor through small pipe. Fuel tank is attached to the frame which supply the fuel to carburetor.

Fig 5.2 Experimental Setup

The experiment is also carried on a conventional bike. Hero the test is carried on hero Honda splendor 100cc. Electrolysis kit is mounted with CDI to the battery of bike. Pre heater chamber is mounted on silencer. The outlet of Pre heater is connected to carburattor with help of tube which allow to enter hot air into carburattor .

Fig 4.3 Practical Setup

Hydrocarbon emissions result when fuel molecules in the engine do not burn or burn only partially. Hydrocarbons react in the presence of nitrogen oxides and sunlight to form ground-level ozone, a major component of smog. Ozone irritates the eyes, damages the lungs, and aggravates respiratory problems. A number of exhaust hydrocarbons are also toxic, with the potential to cause cancer.

is to reduce Hydrocarbon and other dangerous gases from exhaust in Internal Combustion Petrol Engine by maximum combustion of fuel air mixture in the engine. Heating the air by preheating and hydrogen gas is not only for maximum combustion but also to achieve more thermal efficiency of the engine.

VI. OBSERVATIONS

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The test was conducted carried on both experimental setup and practical setup.

Experimental setup

The test carried on experimental setup for 50ml fuel. Following are the observation for 4 different condition.

Condition	Time(min)
Normal	4.17
With Preheater	4.39
With H_2 gas only	5.17
With Preheater anH_2	5.45

Practical setup

The road test is carried out on test vehicle for 50 ml fuel. The following are the observation for 4 different condition.

A. Speed range = 0-40 km/hr.

Condition	Distance(km)	Time(min)
Normal	2.3	4.17
With Preheater	2.7	4.39
With H_2 gas only	3.2	5.17
With Preheater and H_2	3.5	5.45

B. Speed range = 40 -50 km/hr

Condition	Distance (km)	Time (min)
Normal	2.1	3.54
With Preheater	2.3	4.05
With H_2 gas only	2.8	4.22
With Preheater andH_2	3.1	4.51

B. Speed range = 50 -60 km/hr

Condition	Distance(km)	Time(min)
Normal	2	3.34
With Preheater	2.3	3.43
With H_2 gas only	2.4	3.55
With Preheater andH_2	2.7	4.10

Exhaust gas observations

Exhaust gases are analyzed by gas analyser

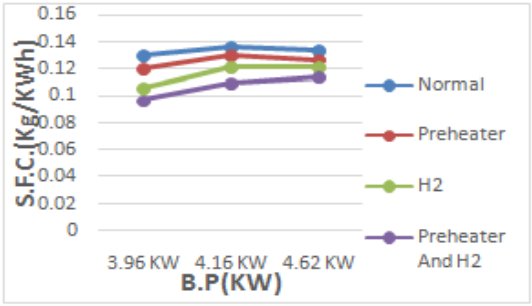
Condition	CO (%vol)	HC (ppm)	CO_2 (%vol)	O_2 (%vol)
Normal	2.32	464	3.20	14.01
With Preheater	2.24	488	2.60	15.48
With H_2 gas	2.17	322	3.40	15.92
With Preheater and H_2 gas	2.20	459	2.80	15.69

VII. RESULT AND DISCUSSION

The results of test are shown in graph for experimental and practical setup respectively

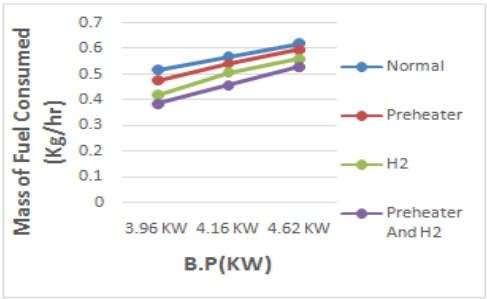
Results for practical observation

A. Graph of Brake power vs Specific fuel consumption



As shown in the graph specific fuel consumption is increases with increase in brake power. For normal condition, specific fuel consumption is higher than the other conditions. Use of preheater and electrolysis kit will reduce the specific fuel consumption as shown in graph.

B. graph of brake power vs mass of fuel consumption



As shown in the grap hit is seen that Fuel consumption is increases as increase in Brake Power. But when the pre heater and electrolysis kit is connected to the engine, mass of fuel consumption decreases.

C. Graph of brake power vs brake thermal efficiency

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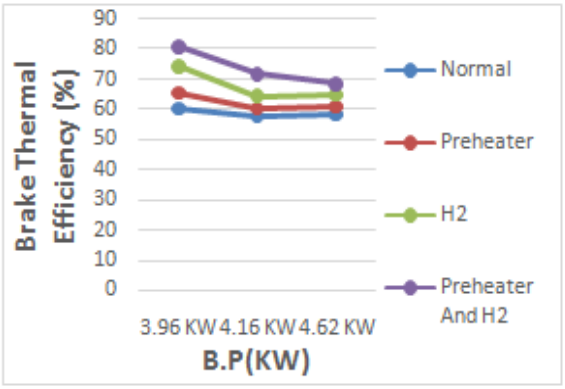
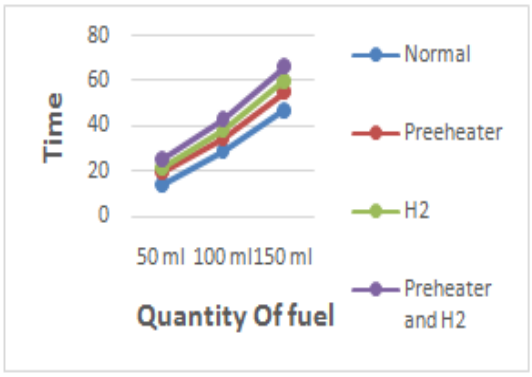


In normal condition brake thermal efficiency of the engine is low as shown in graph. When the preheater and electrolysis kit connected to the setup, mass of fuel is reduced. It is directly affected to the efficiency i.e. increase in brake thermal efficiency.

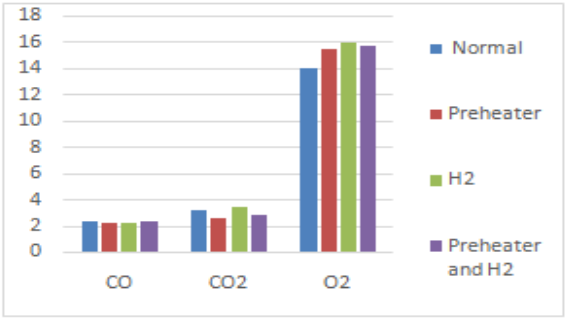
Results for experimental setup

A graph of quantity of fuel and time



When test is carried out on experimental setup, obtained result is shown in graph. From above graph for the same quantity of fuel, running time of engine increases upto 10 minutes by implementing the preheater and electrolysis kit.

Exhaust gas result



The above graph shows slightly reduction in CO (% volume) by connecting the preheater and electrolysis kit. It also shows reduction in CO_2 and slightly increase in oxygen by implementing combined unit of preheater and electrolysis kit.

VIII. CONCLUSION

From the above experimental and practical analysis, following conclusions are made,

- As the temperature of inlet air increases, the fuel consumption reduces and brake thermal efficiency increases
- Carbon monoxide content in the exhaust gases slightly reduces with increase in inlet air temperature and passing the hydrogen gas into the combustion chamber.
- As the temperature of inlet air increases, oxygen content in the exhaust gas increases which doesn't have harmful effects as compared to HC and CO.

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