Efficiency Improver Kit For IC engine

Gosalwad Dhananjay[1], Abhishek Ranjan[2], Suryavanshi Akash[3], Biju Deka[4], Assf. Prof. B. R. Chaudhari.[5]
[1,2,3,4,5]Department of Mechanical Engineering
[1,2,3,4,5] Sinhgad Institute of Technology,Kusgaon (BK), Lonavala

Abstract- *Today the world is facing three critical problems: (1) high fuel prices, (2) climatic changes, and (3) air pollution. Experts suggest that current oil and gas reserves would suffice to last only a few more decades. Bio-renewable liquids are the main substitutes to petroleum-based gasoline and diesel fuel. These fuels are important because they replace petroleum fuels; however, some still include a small amount of petroleum in the mixture. There are four alternate fuels that can be relatively easily used in conventional diesel engines: vegetable oil, biodiesel, Fischer-Tropsch liquids, and dimethyl ether. The main alternate fuels include (m) ethanol, liquefied petroleum gas, compressed natural gas, hydrogen, and electricity for operating gasoline-type vehicles. Bioethanol is an alternate fuel that is produced almost entirely from food crops. The primary feedstock of this fuel is corn. Bio-hydrogen is an environmentally friendly alternative automotive fuel that can be used in an internal combustion engine. Considering energy crises and pollution problems today much work has been done for alternative fuels for fossil fuels and lowering the toxic components in the combustion products. Expert studies proved that hydrogen one of the prominent alternative energy source which has many excellent combustion properties that can be used for improving combustion and emissions performance of IC Engine.*

Keywords- Hydrogen, IC Engine, Electrolyte

I. INTRODUCTION

There is a lot of concern nowadays about the efficiency of the internal combustion engine (ICE), and a lot of research is being done to improve it. But what exactly is the efficiency of the internal combustion engine and how do we measure it? The efficiency of any engine is simply calculated from the energy of the fuel supplied per unit time to do work and the output at the shaft of the engine after subtracting all losses. The input power of the fuel can be obtained from the mass of the fuel and its calorific value. The shaft output can be measured from a brake dynamometer. Simply put efficiency is Output/Input. The average ICE has efficiency between 20 to 30%, which is very low.

If we see a heat balance sheet of the internal combustion engines for a spark ignition or gasoline engine we find that the brake load efficiency is between 21 to 28%, whereas loss to cooling water is between 12 to 27%, loss to exhaust is between 30 to 55 %, and loss due to incomplete combustion is between 0 to 45%.

What is required is a simple and inexpensive system which overcomes the problems associated with the prior art devices. Most particularly, this system should include a sealed chamber, to prevent the electrolytic solution from being lost to effects other than electrolysis. In addition, the device should include electrodes which are located well beneath the surface of the electrolytic solution, to allow the electrolytic solution to be used up without exposing the electrodes. Further the system should include an automatic shut off switch to cause the unit to stop in the event the liquid level gets low enough to expose the electrodes. In addition, most preferably the device will conduct electrolysis in a low resistance electrolysis fluid, permitting it to operate at relatively low temperatures to prevent damaging heating and cooling cycles which can impair seal integrity. As well the device should have any joints or openings in the sealed chamber formed above the highest liquid level in the chamber. In this manner, even if a leak develops, the leak will simply allow additional air into the electrolysis chamber rather than leaking out electrolytic solution. Lastly, the system should preferably compensate for loss of liquid water to decomposition to prevent over concentration of the solution, which can lead to a higher resistance cell and excessive heat generation.

Around the world, this gas powers more than 5 million vehicles, and just over 150,000 of these are in the American usage is growing at a dramatic rate. The basic impact that the HHO gas (brown gas as it is also called) has on the gasoline is that it reduces drastically the size of the fuel droplets. With smaller size, the reactivity of the fuel greatly increases, resulting a more complete and efficient burn.

Electrolysis is considered as the .cleanest. way to produce hydrogen, when the required electricity is derived from renewable energy sources. In countries with a lot of waterfalls, hydroelectricity can be used as the energy source for water electrolysis. Other renewable sources that could be used for supplying electrolysis units are solar, Aeolic and geothermal energy. Photo electrolysis, in which the photovoltaic cells are also electrodes that decompose water to hydrogen and oxygen gas could be used for the production of hydrogen. These technologies could be used in order to store energy as hydrogen, which can be transformed to electricity in fuel cells, when the natural source of energy is not available. The production of hydrogen through electrolysis using renewable energy sources has the smallest impact on the environment. Combustible gases are then passed into the internal combustion engine to increase the efficiency.

II. LITERATURE SURVEY

Blumberga et el. (2015) conducted an experiment with the aim to produce hydrogen without chemical catalyst use in the electrolysis process. Three hydrogen measurements were taken with different weight of samples, voltage and time for the experiment. Two methods for hydrogen measurement were used. The first method was a hydrogen production measurement using mass change (weighting before and after experiment). The experimental apparatus was left for a 24h period on scales to determine mass changes, where 4 measurements were done in a 3 hour period. There were no measurements made from the evening of the first day evening until the morning of the next day. After 24h there was no mass change and hydrogen measurements could no longer be conducted.

Arnhold et el.(2015) proposed that Power-to-Gas (PtG) is a technology that has the potential to be a system solution to the fluctuating energy production that arises due to the increasing share of renewable energies. Despite the fact that the technology is mature, it has not penetrated the market, yet. Financial resources are, among others, often blamed for. To investigate the economics behind the first step of PtG, Power-to- Hydrogen (PtH2), we derive a microeconomic partial equilibrium Market model for water Electrolysis, MELY, with a temporal horizon up to 2040. The model accounts for multiple electricity markets and various hydrogen usage paths. Each combination of these represents a subsector of the model. Utilising surpluses from renewable energies in order to produce hydrogen for the mobility sector appears to be the most profitable subsector, yielding positive unit profits in 2027. Subsectors consuming electricity from other markets and serving the mobility sector will follow this lead. A one-factor-at-a-time (OFAT) sensitivity analysis reveals that the hydrogen price and parameters influencing the effectiveness of the factor input capital are most sensitive.

Zhang et al. (2015) proposed that Fe3+ is a sort of common metal ion contaminant for the solid polymer electrolyte (SPE) water electrolyser. In this paper, the effect of Fe3+ on the performance of SPE water electrolyser has been investigated by both in-situ and ex-situ characterizations. The electron probe microanalysis and ultraviolet test results showed that Fe3+ could migrate from the anode to the cathode and mostly be reduced to Fe2+ in the cathode rather than occurred underpotential deposition as described in the previous report. The in-situ dynamic contamination test showed that the anode voltage increased sharply as soon as the Fe3+was fed into the anode, while the cathode voltage kept constant until the contamination time was over 30 minutes, indicating the higher tolerance of the cathode than the anode for the Fe3+ contamination.

Zakroczymski et al. (2015) proposed that the activating effect of iron can be associated with the formation of highly reactive iron during cathodic reduction of oxide species (probably Fe (OH) 42_). The activating effect of prior anodic polarisation can be due to the formation of large amounts of oxide species which can undergo the reduction to reactive iron.

Dulger et al. (2004) concluded that NOx emission values generally increase with increasing hydrogen content. However, if a catalytic converter, an EGR system or lean burn technique are used, NOx emission values can be decreased to extremely low levels. HC, CO2 and CO emissions values decrease with increasing hydrogen percentage. Under certain conditions (30 BTDC and ~ 20% H2 percentage), efficiency value can be increased.

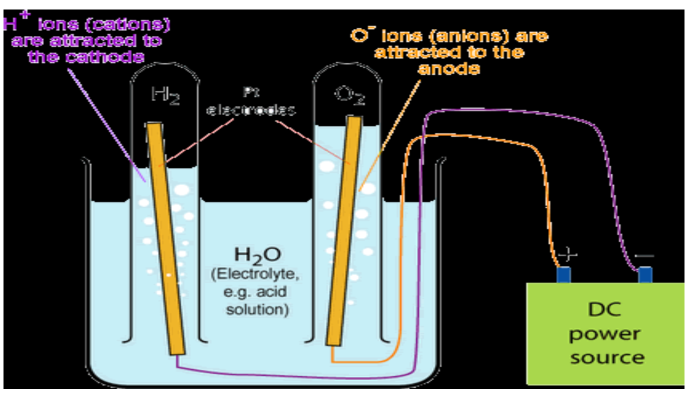
Bhaskar et el. (2013) found that the advantages of hydrogen as a fuel for spark ignited internal combustion engines and has shown that the hydrogen engine is growing up. An overview is given of the development by car manufacturers and also of the research at the laboratory of Transport Technology, Ghent University. Finally an extended overview is given of the design features in which a dedicated hydrogen engine differs from traditionally fuelled engines.

Hamdan et al. found that in this work, an experimental investigation has been conducted to examine the effect of the presence of hydrogen supplement on the performance of dual fuel diesel engine. The hydrogen is introduced to the engine at atmospheric conditions by injecting the hydrogen to the air-intake manifold. It is found that the presence of 4 LPM hydrogen supplement boosts the engine efficiency for engine speed range of 1080 RPM to 1800 RPM. Also the engine efficiency at engine speed of 1260 RPM keeps increasing with the increase of hydrogen supplement flow rate. The engine run smoothly with the presence of hydrogen and no knocking is detecting during above testing conditions.

Cascales et el. concluded that the fuel consumption of FCV prototypes and the mix of energy resources existing in Spain, the hydrogen generated by electrolysis in Murcia could only supply hydrogen to roughly 25% of the total number of vehicles that exist in Murcia today. This result contrasts with the situation for electric vehicles, for which 100% of the cars existing in Murcia could be replaced by EV. However, setting local plants of renewable energy at hydrogen stations, the capacity of hydrogen generation could be increased to reach a substitution ratio similar to that calculated for EV.

Kumar et el. concluded that the addition of hydrogen helps in improving Bmep. The maximum Bmep obtained at 20% blend of hydrogen for an engine operating at 3000 rpm speed. The addition of hydrogen is effective on improving engine brake thermal efficiency. An increase of brake thermal efficiency was observed till a hydrogen fraction of 20%. Beyond this, the brake thermal efficiency is declined due to reduction in air quantity. The volumetric efficiency decreases as the percentage of hydrogen increases as hydrogen tends to replace air from the mixture. HC and CO emissions reduces with the increase in percentage of hydrogen mainly due to increase in the cylinder.

III. METHODOLOGY



Principle:

An electrical power source is connected to two electrodes, or two plates (typically made from some inert metal such as platinum, stainless steel or iridium) which are placed in the water. Hydrogen will appear at the cathode (the negatively charged electrode, where electrons enter the water), and oxygen will appear at the anode (the positively charged electrode).

Hydrogen kit works on the principle of electrolysis of water.Where hydrogen gas produced is used to combust the petrol in the engine and hence increases the fuel efficiency of the vehicle.

The electrolysis of sodium chloride solution (brine) and molten sodium chloride:

Electrolysis (of sodium chloride) is a way of splitting up (decomposition) of the compound (sodium) using electrical energy. The electrical energy comes from a d.c. (direct current) battery or power pack supply. A conducting liquid, containing ions, called the electrolyte (molten or aqueous sodium chloride) must contain the compound (sodium chloride) that is being broken down. The electricity must flow through electrodes dipped into the electrolyte, to complete the electrical circuit with the battery.

CHEMICAL REACTION

1] Electrolysis of molten sodium chloride gives silvery sodium metal and pale green chlorine gas.

This is a simpler electrolysis situation where the ionic compound sodium chloride on melting provides a highly concentrated mixture of positive sodium ions and negative chloride ions. It also illustrates the difference sometimes, between electrolysing the pure molten salt and its aqueous solution in water. Here there is no possibility of hydrogen being formed.

(i) molten sodium formed at the negative cathode electrode which attracts the positive sodium ions

$\mathbf{Na^{+}_{(l)} + e^{-} ==> Na_{(l)}}$ a **reduction** electrode reaction (electron gain)

positive ion reduction by electron gain

Sodium ion reduced to sodium metal atoms: typical of electrolysis of molten chloride salts to make chlorine and the metal

(ii) Chlorine gas formed at the positive anode electrode which attracts the negative chloride ions

$\mathbf{2Cl^{-}_{(l)} - 2e^{-} ==> Cl_{2(g)}}$

Or $\mathbf{2Cl^{-}_{(l)} ==> Cl_{2(g)} + 2e^{-}}$ **an oxidation** electrode reaction (electron loss) negative oxidation by electron loss.

2] The electrolysis of sodium chloride solution (brine) Aqueous solutions with inert electrodes (carbon or platinum)

(a) The negative cathode electrode reaction for the electrolysis of brine (sodium chloride solution)

The negative **(–) cathode** attracts the Na^+ (from sodium chloride) and $\mathbf{H^+}$ ions (from water). Only the hydrogen ions are discharged at the cathode. The more reactive a metal, the less readily its ion is reduced on the electrode surface.

The hydrogen ions are reduced by electron ($\mathbf{e^-}$) gain to form hydrogen molecules at the negative electrode which attracts positive ions.

$$\mathbf{2H^+_{(aq)} + 2e^- ==> H_{2(g)}}$$

positive ion reduction by electron gain other equations

$$2H_2O_{(l)} + 2e^- ==> H_{2(g)} + 2OH^-_{(aq)}$$

or $2H_3O^+_{(aq)} + 2e^- ==> H_{2(g)} + 2H_2O_{(l)}$

Nothing happens to the sodium ion, but it is still important (see after the anode reaction has been described).

In fact, if sodium was released (which it isn't), it would immediately react with water to give hydrogen, the same product you get from the reduction of the hydrogen ion.

Test for the cathode gas - colourless gas gives a squeaky pop with a lit splint – **hydrogen**

(b) The positive anode electrode reaction for the electrolysis of brine (sodium chloride solution)

The **positive anode** attracts the negative hydroxide OH^- ions (from water) and chloride $\mathbf{Cl^-}$ ions (from sodium chloride). Only the chloride ion is discharged in appreciable quantities i.e. it is preferentially oxidised to chlorine.

The chloride ions are oxidised by electron loss to give chlorine molecules at the positive electrode which attracts negative ions.

an **oxidation** electrode reaction

$$\mathbf{2Cl^-_{(aq)} - 2e^- ==> Cl_{2(g)}}$$

or $\mathbf{2Cl^-} ==> \mathbf{Cl_{2(g)} + 2e^-}$ negative ion oxidation by electron loss.

IV. CONCLUSION

From the above performed experiments we found that there is good evolution of hydrogen (H2) and oxygen (O2) at the electrodes but we also found that chlorine (cl2) gas is evolved in abundance which is not good for humans.

ACKNOWLEDGMENT

The authors would like to thank to Department of Mechanical Engineering, Sinhgad Institute of Technology, Lonavala 410401. We are also grateful towards a square innovatives, research and trainings for their support.

REFERENCES

[1] Lauka, D. and Blumberga, D., Electrolysis process analysis by using low carbon content additives:a batch test study, *International Scientific Conference “Environmental and Climate Technologies – CONECT 2014* “, 2015, pp.196- 201.

[2] Lemke, C. , Grueger, F. and Arnhold, O., Market Model for Water Electrolysis – Electrolysis ‘Economic Potential given its Technological Feasibility, *9th International Renewable Energy Storage Conference*, IRES 2015, pp.59- 68.

[3] Wang, X. , Zhang, L. and Li, G., The influence of Ferric ion contamination on the solid polymer electrolyte water electrolysis performance, *Electrochimica Acta*, 2015, pp.253-257.

[4] Flis, J., Sun, Y. and Zakroczymski, T., Hydrogen evolution on plasma carburised nickel and effect of iron deposition from the electrolyte in alkaline water electrolysis, *Electrochimica Acta*, 2015, pp.61–68.

[5] Bhaskar, VVN., Durga Prasad, D. and Hari Prakash, R., Hydrogen Fuelled IC engine-An Overview, International Journal of Innovative Technology and research Volume No1, Issue No. 1, 2013, pp.46-53.

[6] Hamdan, M. O., Mohamed, Y.E., Elnajjar, E. and Salah, A.B., Hydrogen supplement co-combustion with diesel in compression ignition engine, Renewable Energy 82, 2015, pp.54-60.

[7] Cascales, J.J., Juan-Segovia, M.C. and Vivo Vivo, P.M., Environmental impact associated with the substitution of internal combustion vehicles by fuel cell vehicles refueled with hydrogen generated by electrolysis using the power grid. An estimation focused on the Autonomous Region of Murcia (Spain), Renewable Energy 77, 2015, pp.79-85