

A Review Paper on Hydrogen Gas as Alternate Fuel for Four Stroke IC Engine

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Abstract - 21century is automotive sector but is fairly scared with depletion fossil fuel (petrol). Researcher are working toward the find best alternate of fossil fuel and considering all parameter of automotive and fuel hydrogen is best on of them. Because it is easy to produce of hydrogen gas compare to other gases by some processes like electrolyte process. Hydrogen gas is pollution free gas and its efficiency is also high compare to other gases so hydrogen gas as best fuel to run the internal combustion in engine in the future. This paper present how hydrogen gas is important as fuel in IC engine. Analyzing the literature this article show what is effect of hydrogen gas in performance wise in IC engine and emission of gases.

Index Terms: Hydrogen gas, Electrolysis, Efficiency, Storage tank

I. INTRODUCTION

Current scenario mainly depends on non-renewable energy like petrol, diesel, natural gas, but in case of automotive sector which decreasing the non-renewable source and also increasing the air pollution which very dangerous to world and human being. therefor research finds the alternate source of non-renewable energy source. Hydrogen having good combustive property and clean energy that we can use in IC engine as renewable energy. This is because it is produce from water Some fuel has been tried to run IC engine and its include vegetable -oil but is cost high and alcohol but it has poor energy. Researcher work on hydrogen they found hydrogen property which effect on performance and efficiency of IC engine. Hydrogen diffusivity is high comparing to gasoline so its increase mixing process of fuel and air. Munds Gopal G, Dr. Dalu Rajendra S. discussed about alternate fuel which is CNG that can be used as fuel in IC engine because we get reduction in HC, CO, CO₂ emission 40-87%, 20-98%, 8-20% respectively by CNG. Main problem find in CNG is increasing of NOX .it can be reducing by adding some quantity of blending H₂ [1].

Advantages and disadvantages of hydrogen

Table 1. Use of hydrogen as a transportation fuel [10]

Advantages	Disadvantages
High energy yield(122kj/g)	Low density (large storage area)
Most abundant element	Not found free in nature
Produced from many primary energy sources	Low ignition energy
Wide flammability range	Currently expensive
High diffusivity	
Water vapor is major oxidation production	
Most versatile fuel	

II. NEED OF HYDROGEN AS FUEL

Hydrogen gas is the future fuel and its decrease the effect of nonrenewable fuel.to make clean environment and pollution less society hydrogen is one best option and some other reason like

- curtail in CO₂, CO, HO emission
- public health
- reduction in cost of petrol
- decrease in dependency on petrol
- Increasing of efficiency [2].

III. DISSECTION AND RESULTS

There is several important property of hydrogen that contributes to its use a combustibile fuel is its:

Wide range of flammability:

Hydrogen flammability range between (4% to 75% air) is very wide compare to other fuel so. Energy required to initiate the hydrogen is very less compare to other

fuel so first leads to obvious concerns over the safe handling of hydrogen [3].

Small quenching distance:

Hydrogen has a small quenching distance, smaller than gasoline. Consequently, hydrogen flames travel closer to the cylinder wall than other fuels before they extinguish. Thus, it is more difficult to quench a hydrogen flame than a gasoline flame [4].

Low density:

Hydrogen has very low density. This results in two problems when used in an internal combustion engine. Firstly, a very large volume is necessary to store enough hydrogen to give a vehicle an adequate driving range. Secondly, the energy density of a hydrogen-air mixture, and hence the power output, is reduced [4].

Auto ignition temperature:

Auto ignition temperature defines the temperature at which spontaneous combustion will occur. hydrogen gas having high auto ignition temperature around 585°C which is make to difficulty to burn it also some source required it [4].

High diffusivity:

Hydrogen contain high diffusivity so it has more ability to disperse in air to make combustible mixture of air and petrol and if hydrogen leak so its disperse rapidly so unsafe condition will be reducing easily [5].

IV. COMPARATIVE PROPERTY OF HYDROGEN WITH OTHER FUELS

Auto ignition temperature: 520 °C (968 0F)
 Density: 0.08342 (kg/m³)
 Diffusivity: 1.697 (m²/hr)
 Flame temperature: 2318 0C (4202.4 0F)
 Specific gravity: 0.6960 (air = 1)
 Specific volume: 11.99 m³/kg (191.98 scf/lb)

Table 2. Properties of hydrogen [2]

Properties	Gasoline	Diesel fuel	Methanol	Ethanol	CNG	propane	hydrogen
Chemical formula	C ₄ H ₁₀	C ₃ H ₈	CH ₃ OH	C ₂ H ₅ OH	C ₃ H ₈	C ₃ H ₈	H ₂
Molecular weight	58	142	32	46	44	44	2
Boiling temp, (°F)	100-150	370-650	149	172	-44	-29	-423
Octane no	90-100	....	107	108	112	....	130
Freezing pt, (°C)	-40	....	98	-115	-305.8	-296	-435
Flash pt, closed cup, (°F)	-45	165	52	55	100-150	30	....
Auto-ignition temp (°C)	257	315-460	422	422	454-510	540	565-580

V. STORAGE OF HYDROGEN

One is critical problem in hydrogen system is the storing of hydrogen gas because of hydrogen having low density so here is three solutions is given to storage forms of hydrogen 1) compressed gas 2) liquid 3) metal hydride.

Table 3. Possible storage forms for hydrogen [10]

Storage form	Advantages	Disadvantages
Compressed gas	Reliable Indefinite storage time Easy to use	Higher capital & operating cost Heat can cause container rupture
Liquid	High density at low pressure	High cost Low temperatures needed
Metal hydride	High volumetric efficiencies Easy recovery Very safe	Expensive materials Heavy storage tanks

VI. METHODS OF PRODUCING HYDROGEN

Table 4. Various methods to produce hydrogen [10]

Methods	Process	Implementation
Steam reforming of methane gas	In presence of nickel catalyst & at 700-1100°C: $CH_{4(g)} + H_2O_{(g)} \rightarrow CO_{(g)} + 3H_{2(g)}$ Next reaction at low temp. $CO_{(g)} + H_2O_{(g)} \rightarrow CO_{2(g)} + H_{2(g)}$	Current major source of hydrogen
Hydrogen from coal (gasification)	At high pressure and temperature $Coal + H_2O_{(g)} + O_{2(g)} \rightarrow Syngas$ $Syngas = H_2 + CO + CO_2 + CH_4$	Current method of mass hydrogen production
Electrolysis of water	Electric current passed through water $2H_2O_{(l)} \rightarrow 2H_{2(g)} + O_{2(g)}$	Not in widespread use due to cost of electricity
Solar-hydrogen system	Electric current pass through water $2H_2O_{(l)} \rightarrow 2H_{2(g)} + O_{2(g)}$	Not in widespread use due to cost of renewable energy resource

combustion cylinder at least 3 time faster than the gasoline form all direction and they are use HHO kit to split the hydrogen and oxygen. Also they were worked on design modification like cold rated spark plugs, RTD (Resistance temperature detector), relay.

N.V.Mahesh Babu Talupula, Dr.P.Srinivasa Rao, Dr.B.Sudheer Prem Kumar, Ch.Praveen[9].They were give review on alternate fuel. hydrogen is very good alternate fuel because it is free from emission like, CO, CO₂, HC air toxics benzene, PAH,1-3 butadiene and aldehydes. NO_x is the only pollutant of concern from hydrogen engines. Very low NO_x emissions are obtained with extremely lean engine operation ($\phi < 0.05$).hydrogen is also use as blending some traditional slow burning fuels like methane, bio-gas to improve the flame propagation rates, extend greatly the lean operational mixture range while reducing the emissions of CO₂.Hydrogen and air mixture burning is 10greater than the petrol and air .so it is effective in combustion engine .also Hydrogen has high self-ignition temperature but requires very little energy to ignite it.

Hardik P. Merchant1, Kiti A. Maurya , Bhumik J[7]. Patel they were worked on hero Honda street 4 stroke IC engine by using electrolysis process they generated HHO and mix with gasoline so fuel consumption is decrease which is show is chart. Also they get reduction in CO% was 3.2%when the engine run simple gasoline. The CO% was 2.6% when the engine runs on the HHO + Gasoline fuel. That means there is 23.99% decrease in CO emission.

Table 5. Fuel Consumption [7]

LOAD	NORMAL ENGINE	HYDRA ENGINE
0	0.0005263 (kg/s)	0.0004166 (kg/s)
12	0.000833 (kg/s)	0.0004347 (kg/s)
20	0.00090909 (kg/s)	0.0007143 (kg/s)

VII. LITERATURE REVIEW

There are so many researcher work on hydrogen gas as alternate fuel and they get positive and negative result on basis of brake thermal efficiency, emission level, storage, so there so many researchers are working HHO gas so few of them working concept is given in this paper.

Aaditiya , abhishek, ajay, vipin [5] .they were worked on splendor 4 stroke IC engine and they use hydrogen gas which mix in the petrol so effect in increasing the brake thermal efficiency and reduction is emission level. The hydrogen explosion is so fast that is fill

50	1675	25	67
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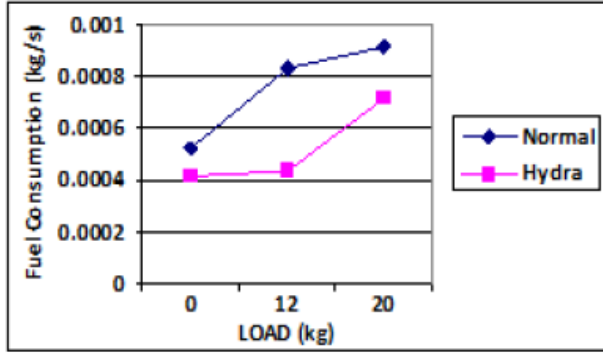


Figure.1. Fuel Consumption [7]

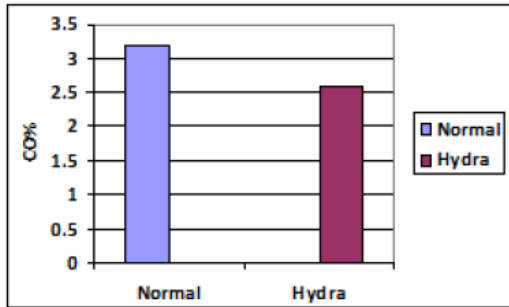


Figure.2. Effect on CO% [7]

Mr.DeorukhkarSairaj R, Prof.Bhosale M.R, Mr.Salunkhe M.R, Prof.Gulavane TS[8]. they also worked on 4 stroke ic engine and they have used H2 kit. The result was increasing in performance, mileage increasing about 9 to 10% with using petrol. And also decreasing in emission level like hydrocarbon, carbon monoxide, as show in figure (without H2 kit) and show figure (with H2) kit.by this data we can say that how hydrogen effect on performance.

Table 6. Fuel Average Performance (with H2Kit) [8]

Road speed KMPH	Dist. covered m	fuel consumed CC	Average KPML
40	1880	25	75.2
50	1850	25	75

Table 7. Fuel average performance (without H2 Kit)

Road speed KMPH	Dist. covered m	fuel consumed CC	Average KPML
40	1681	25	67.24

Yogendra G. Nandagaoli, Rasika R. Kakade^[2].study on the urine engine because in urine there are some hydrogen particles present in it. Braking of urine molecules as much easier to braking of water molecules by electrolyzing of urine produced hydrogen and air mixture from it. The purified hydrogen gas is then pushed into the engine. The urine contains urea (NH₂)₂CO and whose bond is weaker than the hydrogen and oxygen bonds so it is only required 0.38V.

VIII. CONCLUSION

By deep study of hydrogen as fuel .it is fuel that more valuable in future automotive sectors. Because hydrogen has good property compare to other fuels like wide range of flammability, high diffusivity, low ignition energy, and it makes pollution less environment to reducing the carbon monoxide, carbon dioxide, nitrogen oxides. so that hydrogen gas as fuel is important also increasing for next generation of automotive sector.

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