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Oxyhydrogen Generator for Automobile Applications- A Review

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ABSTRACT: Greenhouse gases are the most cause behind the present global climate change and heating issue. The transportation sector generates the most important share of the greenhouse emission. To solve this issue of fuel used for internal combustion engine is one of the best ways through which we can get solution about fuel shortage and carbon emission of the engine. The unique combustion characteristics of hydrogen helps to scale back the carbon emission of the engine. In this oxy-hydrogen generator has been used to increase the fuel efficiency without major changes within the existing internal combustion engine. The production rate of HHO gas depend upon the various elements, i.e., input voltage, quality of water, temperature of water. An efficient HHO generator is meant to supply an outsized amount of HHO gas by employing a less amount of power. This HHO gas can be useas a secondary fuel on demand, in internal combustion engine (petrol and diesel) with no need of storage. Characteristics of HHO gas helps to enhance the combustion which ultimately reduces the engine emission. In this paper, we have study and reviewed some researchdone by people over a recent time on the use of HHOgas and its generationforICenginestoincreasetheefficiencyan dreducetheoveralluseofconventionalfuels

KEYWORDS: Greenhouse gas, HHO Generator, Electrolysis process, Enhanced Combustion, Efficient HHO Generator etc.

I. INTRODUCTION

Air pollution causing due the vehicle emissions is a major factor of concern and are also responsible for affecting air qualityindexinsomeurbanareasoveradecade.Overad ecadepassengers'vehicleswhichareusingpetrolanddi esel asafuelareoneofmajoracauseconcernforpollutioncon tributor, producingsignificantamountofCarbonDioxi des, NitrogenOxides,andotherpollutantgasesintotheatmo sphere,thatpromotesglobalwarmingwhichismajorca use of concern in current situation. Increasing world's population and excessive increased use of fossil fuels leads to the dominantincreasedinneedoffossilfuelsascomparedla stfewyears.BelowdatashowsWorldEnergyConsump tion byFuel.Theuseoffossilfuelssuchaspetrol,dieselandot hernon-renewablesourcesofenergyisincreasingdayby day. Due to which the companies which takes production steels and chemicals in industries is now considered as emissions-heavy sectors. But hydrogen powered technique is slowly changing things. The petrochemical as well as chemicals sector, which produces up to 1.25 to 1.50 gross tonnage of carbon emissions from 2010 to 2017, is turning to electrolytic hydrogen as a substitute for fossilfuels.

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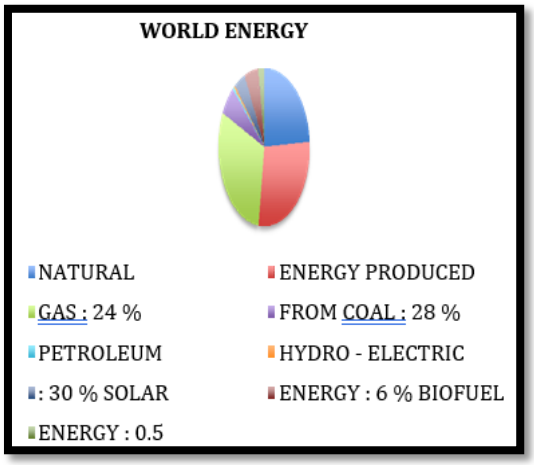

Fig.1: World Energy Consumption byFuel

Since HHO generator is considered as a one of best energy alternative according to a global demand. HHO generator is a device that can convert water into hydrogen gas and oxygen by using electrolysis process. HHO generator uses phenomenonofelectrolysistoseparateandextractboth hydrogenandoxygenoutofwaterandsupplyittocombu stion chamber. Hydrogen gas which will be produced from the electrolysis process will result in zero greenhouse gas [3]. When a HHO generator is added to a fuel-basedengine, then there is result will be obtained in the form of improved thecombustionefficiencywhichmeansthatitcansavef ueltoproducethesamemechanicalenergy.HHOgener ator increases fuel efficiency in such a way that when it is added to a air intake engine manifold of a system and injection into the cylinders of a system where HHO is going to mix with fuel, there is an increase in mileage of engine performance will be observed. To increase the fuel efficiency in a combustion engine by increasing the energy produced per mole of fuel, HHO generator is used [4]. The need of using hydrogen generator are, it provides supplemental fuel (gas) to conventional fuel in order to achieve efficient combustion of conventional fuels, decrease in amount of unburnt charge, increase in thermal efficiency, initially designed and used for welding and gas cutting operations.

Note:HHOgasisnotareplacementoralternativeforco nventionalfuelbutcanbeblendwithotherfuelsforeffici ency improvement.

II. LITERATUREREVIEWS

Themainpurposeofliteratureofreviewistogi veanoverviewonHHOgenerator(Oxy–HydrogenGenerator),Its importance, Process of production of hydrogen i.e., Electrolysis process carried out in HHO generator and its fabricationetc. Arinola B. Ajayi elat. (2013) [1], researchers have successfully fabricated HHO generator which includes a closed container containing six electrode rods and an aqueous electrolyte with electrodes being connected to two terminals of the battery. The generator housing is fabricated with low density plastic with Perspex for rigid support. The current supplied to the generator is 60 amps for 30 mins and volume of HHO gas produced during electrolysis is calculated using Faradays Law. It was found that 27.379 liters of HHO gas was produced in during the above-mentionedruntime.Onemainadvantageofhydrogenis theeaseofstoring,shipping,andusing.Thismeans that other foreign countries having little space for solar and wind equipment will still be able to take advantage from carbon freeenergy.

Milind et al. (2011) [2], researchers describe the two different methods of oxyhydrogen gas generation and theirImplementationontheengine.Theresonanceispr oducedinsidewatermoleculesbetweentheelectrodesb yDC pulses (typically square wave output). This causes enormous electrical force to break the bond between the hydrogen andtheoxygenandtheyfreedasgasmoleculeswhichare magneticallycoupledtoeachother.Inthisstudyinstead of using plastic container a 304 stainless steel container of same capacity is used which itself acts as cathode during the process of electrolysis. It was observed that presence of water in the combustion chamber decreases the temperature ofcombustionchamber,reducesdetonation,anddoesn otallowdepositionofcarbononthecylinderwall.Electr olysis ofwateristhebeneficialmethodwhichisusedtoproduc ehighqualityhydrogengas.Inthewaterelectrolysispro cess water is split up into hydrogen and oxygen by means of electric current, this process is also described as a hydrogen generation. This Process consist of three main components Two conducting electrodes, Container having suitable electrolyte and Power source. The electrolyte used a type of chemical substance containing free ions which carries electric current. In an electrolyser, an electrolyserseparates into cathode and anode. Due to the various types of ionic speciesandelectrolytematerialtheyconduct,different electrolysisworkindifferentways.Inrecentresearchw hich is done on hydrogen and wind systems based on the electrolysis of water with energy generated using wind is used to generate the electricity required by this method which uses a renewable source of energy in the form of wind energy. In this regard, sources which includes energy generated

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using wind are used as a renewable energy option. Using this technique, renewable energy-based electricity can be converted to hydrogen, which is also considered as environment friendlymethod.

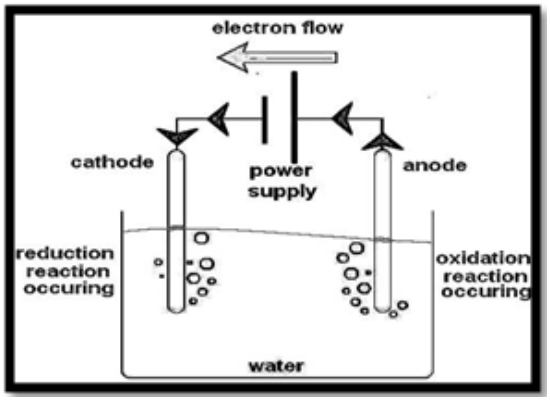

Fig.2: Electrolysis Process

Desilvaetal. (2015)[3],authordescribestheresearchdoneontheproductionofHHOgasusingdrycellHHO generator.Theelectrolyte-catalystcombinationusedisdistilledwaterandpotassiumhydroxide(KOH).Twoseparate implementationswerecarriedoutusingtwoandthreeelectrodesrespectivelytoevaluatetheeffectofdistancebetween theplatesaswellasthenumberofelectrodesused.Ithasbeenconcludedthatthemostconvenientandefficientdesign methodology for optimal generator is three electrodes with minimum platedistance.

M.M. El-Kassabyet al. (2015) [4], author describes the experiments conducted on Skoda Felicia 1.3 GLXi gasoline engine with and without HHO generator at engine speeds 1500rpm, 200rpm and 2500rpm. In addition, the emissionsweremeasuredusingTECHNOTESTexhaustgasanalyzerTE488.Theoptimizedparameterswere number of plates, distance between the plates and type and quantity of the electrolytes. It was found that 6 g/L of KOH as catalystgiveshighestefficiencyatdifferentmotorspeedscomparedto4g/LofNaOH.HHOgastothefuel/airmixture haspositiveimpactonoctanerating ofgasolinefuel.Therefore,theenginecompressionratiocan beraisedandmore gaininthethermalefficiencycanbeobtained.Theresultsshowsthatenginethermalefficiencywasimprovedby 10%, reducingthefuelconsumptionupto34%.TheconcentrationsofNOx,COandHCgases hasbeenreducedtoalmost 15%, 18% and 14%respectively.

Senthil Kumar elat. (2019) [5], author describes about fabrication of the optimal hydrogen generator using stainless teel 216K electrodes, low density polyethylene (LDPE) container, SMPs and sodium hydroxide as electrolyte. The different materials for successful fabrication were considered during the design and their favorable properties were stated.

Bambang Sudarmanta et al. (2016) [6], Dry cell HHO gas generator performance optimization was done by varying the duty cycle of pulse width modulation, PWM on the Sinjai spark ignition engine port injection, 2-cylinder 650 cc with gas inlet mechanism using a venturi. Variations performed on HHO gas generator is the duty cycle of PWM,i.e.,20%,40%,60%,80%and100%(orthesameasnonPWM).Sinjaienginepeformanceoptimization done on setting ignition timing for minimum advance for best torque, MBT mechanism. The results show that optimum performanceofHHOgasgeneratorisgeneratedbyPWMsystemwith40%dutycyclewithparameterssuchasspecific energy input of 33,121 MJ/kg, generator efficiency of 20,064% and generator temperature can be maintained below 60 0C. Application of HHO gas generator in point above on standard ignition timing Sinjai engine produce in an increaseofperformancesuchastorque,power,BMEPandthermalefficiencyrespectivelyof2.27%,2.76%and 3.05% andadecreaseofbsfc7.76%.Retardedignition timingisadjustedtoMBTcanincreaseperformancesuchastorque, power, thermal efficiency, respectively 6.55%, 7,65%, 15,50% and a decrease of bsfc 22,06 %. Figure showing Experimental Setup of Dry Cell HHO Generator is as follows,

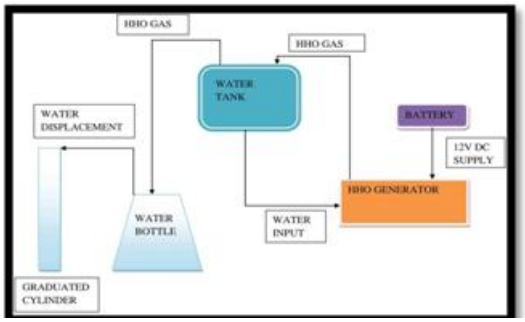

Fig.3: experimental setup of dry cell hhogenerator

Jeremiah elat. (2017) [7], hydroxy gas was produced by the electrolysis process using different electrolytes such as KOH. NaOH, and NaCl with various electrode design in a leak proof plexiglass reactor. The testing was carriedout0nTVSSperXL,aircooled69.9ccgasolineengine.Resultsshowedthatconstantflowrateatlowengine speeds(criticalspeed2800rpm)hasadverseeffectsone

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ngineparameters.Thesolutiontothiswasfoundbydesigning a Hydroxy Electronic Control Unit (HECU) which decrease the flow rate of the HHO gas by decreasing voltage and current automatically. Increase in engine torque by an average of 19% and reduction in CO and HC gases were recordedas13.5%and5%respectively.For100mlgasolineconsumptionwithoutHHOvehiclecovered4.8Km while with HHO gas the distance covered was 7.2km.

KolbeJoyetal. (2019)[8],authordescribesthetwodifferentapproachestofeedtheHHOgasintotheengine produced by the wet cell HHO generator. The wet cell design is more complicated, expensive, and complicated to fabricate. But since effectiveness and rate of HHO gas produced is higher the design was selected to further optimization.Milespergallons(MPG)comparisonwithandwithoutHHOwastabulatedwhichshows25%decrease in fuel consumption. The physical parameters which are consider for production of hho gas using wet cell type are Material of the electrodes, Number of electrodes, Spacing between the electrodes, Type of electrolyte, Amount of electrolyte, Quality of the electrical wiring,etc.

Tamer Nabil etal. (2019) [9], author investigated the engine performance and gas emission for two different engines;150CColdenginewithcarburetorand1300CCnewenginewithElectronicControlUnit(ECU).According totherequiredamountofHHOgasandavailableelectricpowersourcethenumberofcellsandstacksaredetermined; also,theeffectiveareaoftheplatesiscalculated.Inthisstudy,differentgeneratorsaredesigned,fabricated,andtested; 5, 7, 9 plates single stack generators, 13 plates two stacks (2 negative and 1 positive plates) generator and 19 plates 3 stacks (2 negative and 2 positives plates) also 7 plates single stack generator was tested with different electrolyte concentrations (sodium hydroxide, NaOH). It is observed that, a directly proportion relationship between the electrolyte temperature and the cell amperage, which is considered generator obstacle. The increased current through the cell causes the generator to become hotter which is a closed loop results in bad efficiency. The generator with 5 plateshasabnormalbehaviorduetothecellvoltagehas3Vwhichisverylargevaluecomparedtothestandardcell voltage that results in high temperature and amperage. It is suggested that the face area of the plates between 2 to 4 in2 per ampere of current. Results showed reduction 14.8 % and 16.3 % in fuel consumption, 33 % and 24.5 % reductioninCO,27.4%and21%reductioninHCandobviousreductionintheexhaustgasestemperaturefor150CC and 1300CC engines respectively. Also, 17.9 % and 22.4 % increase in brake power and 15.7 % and 22.4 % increase in thermal efficiency were recorded for 150CC and 1300CCrespectively.

Heavilydependentonfossilfuelsforenergy,thetransportationsectorcontributestoastaggering20percentofcarbon dioxide emissions globally. Hydrogen-powered vehicles could be the answer to this problem, as fuel cell vehicles, which use hydrogen gas to power an electric motor, emit only heat and water asby-products.

III. PERFORMANCE BASED COMPARATIVE STUDY

1. The most convenient way of building up efficient HHO generator and is built by conceding distance between plates, materials used, catalyst used, also number of electrodes used during the process of electrolysis. The idea which proposed is that, when the amount of current will flow through the generator with increase in temperature of generator will make battery drain in less amount of time. Considering this situation, future research will mainly focus on limiting the amount of current flow through the generator in order to obtain maximum amount of HHO production and next step will take into consideration is to connect the HHO generator which will be proposed is used along with an IC engine i.e. a spark ignition engine and will measure the efficiency of fuel in vehicle and reduction in emission of air pollutants such as carbon dioxide and carbon monoxide [3].
2. HHO gas consists of nature of implosion due to the atomic structure, when a gas burnt continuously the vacuum is created suddenly which is responsible for this implosion. Flame temperatures of HHO gases are varied according to receipting materials. HHO gas flame is awfully directional and having properties like odorless, colorless, and lighter than air. HHO gas does not need oxygen externally during combustion as it already contains oxygen internally. Due to this reason and wide range of flammability, high burning velocity (100 time greater than petrol vapor), the HHO gas used for lean air fuel mixture with considerable emissions and combustion efficiency [9].
3. Quality of air and fuel mixture influences thermal efficiency of system. By adding HHO gas into the system, there will be an increase in magnitude of thermal efficiency. The engine thermal efficiency has been increased up to 10% when HHO gas has been introduced into the air/fuel mixture, consequently reducing fuel

consumption up to 34%. This obtained results indicates that HHO gas which added on engine is consists of dual function, i.e., hydrogen gas has higher calorific value. Due to the presence of oxygen process of mixing and oxidation becomes easier. Since we can conclude Hydrogen gas which isused in HHO generator will easily replace gasoline in small the concentration of NOx, CO and HC gases has been reduced to almost 15%, 18% and 14% respectively on average. Therefore, HHO generator can be integrated easily with existing engine systems [4].

4. When HHO is introduced into the system. electric power generators especially in India, where demand for utility of power is more. This HHO generator which makes use of hydrogen gas will easily replicated. Since,making use of renewable energy will become far easier [8].

IV. CONCLUSION

Fromtheabovestudies,researchandexperimentswhicharedoneonHHOgeneratorfollowingconclusionscan be made,

1. H.H.O.generatorcanincreasethefuelefficiencyin acombustionenginebyincreasingtheenergyproduced per mole of fuel during the ignition process and thus increase in the fuel efficiency can beobserved.
2. InEurope,USA,andAustraliatheHHOgenerator gasconversionkitsarebeingofferedtoactualuse.But in Indiathereisaneedofdetailstudyinmakingthiskittouseinnormalvehicle,sinceonlyoverviewstudyhas been done.
3. Due to increase in demand of electricity, HHO can be used in combination with coal or oil to increase the electricity generation and to meet the requirement of energy production increasing efficiency of energy production system.
4. HHO with coal can reduce coal consumption. Due to the addition of HHO up to 1 kg will lead to the saving of 7.3 to 7.9 kg for Indian lignite and 5.1 to 5.4 kg for sub bituminous. These advantageous things mainly come from the high GCV of HHO which enables the system for more efficient combustion in theboiler.
5. Various researchhas been done on the use of HHO gas in IC engine to reduce carbon emissions and increase fuel economy and efficiency by studying various parameters (e.g., loading conditions use of electrolytesnumberofplateselectronicmaterialsetc.Butthereisthescopeofresearchonsomeotherfactors such as compression ratio, effect of using different ignition systems [9].

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