A Review Of Hydrogen Generation By Dry Cell Electrolysis Method To Improve Fuel Economy And Emission Reduction In SI Engine By Cleaner Combustion

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Abstract: The vehicle emissions are controlled by introducing new techniques like after treatment method and in- cylinder treatment method i.e., RCCI (Reactive controlled compression ignition combustion), PPCI (Partially premixed compression ignition combustion), HCCI (Homogeneous Charge Compression Ignition Combustion), GDCI (Gasoline Direct Injection Compression Ignition) etc., The performance and emissions of SI engine can be improved by modifying the cubic capacity of engine, compression ratio, regulating the flow of air-fuel charge and air fuel ratio. Nowadays due to in-availability of crude oil and import of high level of crude oil to our country makes the fuel consumers to spend more money for fuel consumption. Our government has passed an order to introduce electric vehicle by the year 2020, to the entire vehicle manufacturer in order to reduce pollution, to adhere the BS-VI emission norms and to be free from fuel dependency. So, by considering all the above statements mentioned it is important to concentrate in reducing the vehicle emission and improving fuel economy of an IC engine. In this project, aims to reduce the emission from vehicle, improving fuel economy and performance of engine by injecting hydrogen along with carbureted gasoline in the intake manifold of the SI engine. The hydrogen generation can be achieved by using dry cell electrolysis method. During the injection of hydrogen in the intake manifold, the amount of gasoline supplied for ignition in normal running condition will be reduced and the reduced fuel level will be compensated by hydrogen supply. But the conversion of hydrogen gas into liquid form is a tedious process and a complicated one. To overcome these defects, the hydrogen gas generated from the dry cell is directly feed to the intake manifold along with the gasoline. The hydrogen generation will also be done in moving vehicle by electrolysis of distilled water. In future this will be tested in the GDI (Gasoline Direct Injection)engine with the help of ECU (Electronic Control Unit).

Index Terms: Emission, dry cell electrolysis, dual fueling, hydrogen generation.

1. INTRODUCTION

Air pollution with the exhaust emission is still a serious problem, and an international concern has been raised for its control and restriction. Therefore, energy conservation with higher efficiency and lower emission are important for the development of engine system. Recently, the engine which uses alternative fuels such as Natural gas (CNG, LNG), Liquefied Petroleum Gas (LPG), Di methyl Ether (DME), Gas to Liquid (GTL), and hydrogen is actively developed to solve these problems. Hydrogen has since been used extensively in the space program since it has the best energy to weight ratio of any fuel. As the present fuel resources are fast depleting it becomes mandatory to go for other alternative sources of energy. Moreover, the usage of fossil fuel is also increasing day by day which leads increase the cost of the fuel day by day and it emits more amount of harmful exhaust gases like CO, CO_2, HC, NO_X etc., Furthermore, current and future legislation place stringent
standard son the exhaust emissions. The interdependence and uncertainty of petroleum-based fuel availability have created a need for investigating the possible use of alternative fuels.

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In recent years, the emphasis has motivated the development and testing of several alternative fuels. The major pollutant which is coming from the SI and CI engine is NO_X, CO_2, HC, CO and Soot Particulates.Rising fuel costs and a focus on the reduction of greenhouse gases has necessitated increased thermal efficiency from the internal combustion engine, thereby increasing interest to search for the other alternative fuels. Various fuels have been considered as substitutes for the hydrocarbon-based fuel. The most suitable alternative fuels which replaces the fossil fuel is the alcoholic fuels, (ethanol, methanol and butanol) gaseous fuels (LPG, CNG, and H_2) and biodiesel is a long-term fuel and also it is renewable and emitting less pollution than conventional fuels. In this the development of hydrogen-based engine and its accessories plays a vital role in future.

2 PROPOSED SYSTEM

The transformer is used to supply the ac power supply of power source to dc power supply to the pwm circuit. The pwm circuit is used to supply the constant power flow into modulated pulse flow to the dry cell electrolyzer. The stainless steel plates are used as anode and cathode. The electron decomposition between electrodes splits up the hydrogen and oxygen from the electrolyte. The bubbler tank which has two purpose – as electrolyte holder and moisture separation from the HHO gas.

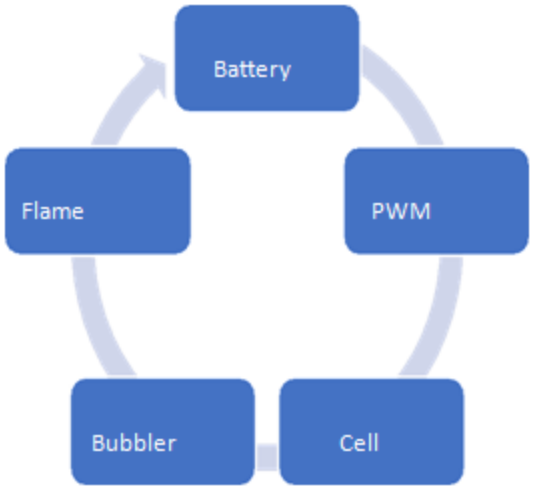


Fig 1. *Process Cycle*

3 TECHNICAL STUDIES

3.1 Battery

Batteries convert chemical energy into electricity. A battery comprises two electrodes, a positive cathode and a negative anode, which is separated by a liquid chemical, called electrolyte, which is capable of carrying charged particles. The quantitative elimination was done using a scoring matrix as guide. the following steps were followed.

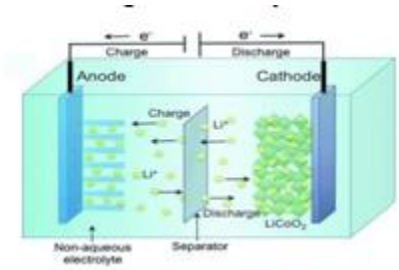


Fig 2. *Battery*

3.2 PWM

Pulse Width Modulation (PWM) is a technique to generate low frequency output signals from high frequency pulses. Rapidly switching the output voltage of an inverter leg between the upper and lower DC rail voltages, the low frequency output can be thought of as the average of voltage over a switching period. Besides that, there are also other several ways of generating pulse-width modulated signals, including analog techniques, sigma- delta modulation, and direct digital synthesis. One of the simplest methods of generating a PWM signal is to compare two control signals, a carrier signal and a modulation signal. This is known as carrier-based PWM. The carrier signal is a high frequency (switching frequency) triangular waveform. The modulation signal can be any shape. Using this approach, the output waveform can be a PWM representation of any desired waveform shape. With machines, sinusoidal and trapezoidal waveform shapes are among the most common.

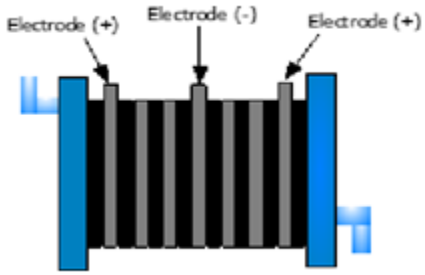


Fig 3. *PWM*

3.3 Dry Cell

An electrolyzer is a piece of scientific equipment that splits polarized molecules into its ions. In this case it will split water into hydrogen and oxygen gas. A dry cell electrolyzer is an electrolyzer that is completely enclosed; the other type is a wet cell electrolyze which can be two metal plates in a bowl of water which is shown in the figure 3.7. The selected design of electrolyzer's design consist of dimension area of about 100mm2, thickness of plate about 0.2 mm. the electrolyzer consist of one inlet and outlet for circulation of electrolyte. The cells were found to be in uniform structure with a capability to different power loads. Each plate was provided with gaskets in order to prevent the leakages and to make it free from atmosphere. The electrolyzer consist of one electrode (-) and two electrodes (+).

Fig 4. *Dry cell*

3.4 Bubbler tank

The selection of concept was done by scoring matrix. The generated concepts were evaluated relative to a reference concept using a scoring matrix. Instead of using a quantitative comparison approach, the selection was done through rating method. After screening out some of the concepts based on ranking, concept scoring was undertaken. In this method, the screened concepts were further analyzed in a detailed manner and a finer quantitative elimination was done using a scoring matrix as guide. the following steps were followed

Fig 5. *Bubbler tank*

4 SYSTEM WORKFLOW

4.1 Experimental setup

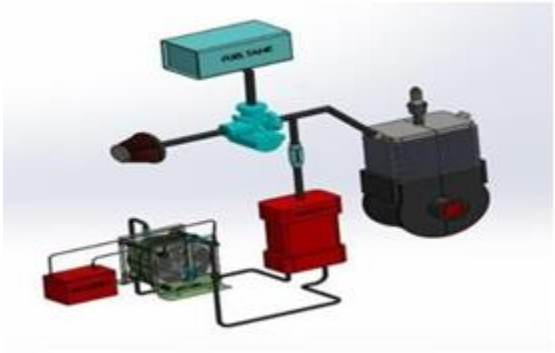


Fig: 6*. Experimental setup*

The moisture contents in gas gets extracted into electrolyte in the bubbler tank. Now the clean HHO gas gets extracted in container for use. A flash back arrester is used next to the bubbler to avoid the back fire.

The chemical reactions are mentioned below
Anode (oxidation): $2H_2O$ (l) → O_2(g) + 4H+ (aq) +4e-
Cathode (reduction): 2H+ (aq) + → 2e - + H^2(g)

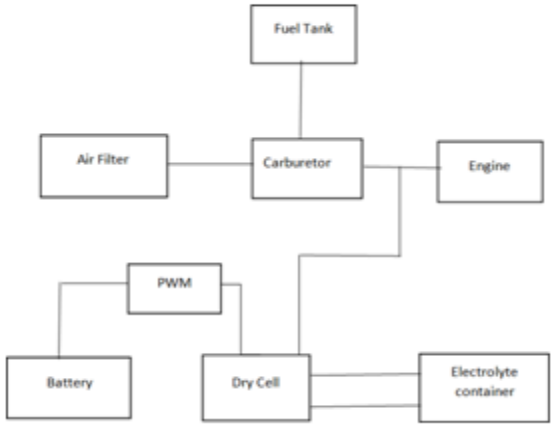
5 RESULT AND DISCUSSION

Hydrogen generation by water electrolysis using carbon nano tube anode Anode made of multiwalled carbon nanotubes results in enhancement of exchange current density comparing to graphite anode in a conventional alkaline water electrolysis cell. The hydrogen production rate with nanotubes were measured to be 375lh-1m-2 at PH 14 approximately which was nearly double of hydrogen obtained from traditional graphite carbon electrodes at same potential. This effect is due to defects on nanotubes which reduces the energy barrier for the dissociation of OH- into oxygen at the anode.

In an alkaline medium, the half reaction at anode is

$$4OH^- \rightarrow O2 + 2H_2O + 4e^-$$

The limitation of water electrolysis of hydrogen generation was poor kinetics of oxidation of hydroxyl ions to oxygen at anode. Hence, a high over potential is required for the reaction to take place at a reasonable rate. In case of over potentials of nearly 1.80 – 2.0V above theoretical value i.e., 1.23V approximately needed for generation of hydrogen by developed design of cell



the losses can be minimized. The electrode material selected should provide lower activation energies for the reaction in electrode in order to lowering of over potential due to activation of polarization at the electrode for reduction of water to hydrogen the oxidation reaction wise., oxidation of hydroxyl ions to oxygen at any conventional anode has a sluggish kinetics. A lower polarization is required for practical application of electrolysis for hydrogen generation for this efficient anode with high exchange current density is needed. The area of anode was 0. 785Cm^2.The electrode used in present study was 1.0m NaOH aqueous solution. Also 0.05m NaOH solution was used for measurement of exchange current density. Prior to experiment, the solution was coged with nitrogen for one hour to remove dissolved oxygen.

MWNT = Multi Walled Carbon Nanotubes

The MWNT were purified by acid treatment and washed with deionized water, filtered and dried at 1000C approximately for 1 hour. The MWNT were made as pellet using solution of polyvinyl 1 butyral and poly ethylene glycol in ethyl alcohol under hydraulic pressure, graphite pellete is also used.

Length ~ 2Cm
Diameter ~ 5mm
Wall thick ~ 0.3mm

Current density is significantly high, when MWNT was used as anode. Hydrogen generation measurement performed under anodic bias of ~ 1.0V through collection of hydrogen in an inverted burette by displacement of electrolyte solution. Similar to current density the hydrogen produced by MWNT anode is higher compared to graphite anode. The gases evolved at electrodes were cathode and anode at volumetric ratio of 1:2. The rate of hydrogen production was 375lh-1m-2 in MWNT and 200 lh-1m-2 at graphite anode approximately. Electrolysis is of water takes place at anodic voltage of ~ 1.0V. The production rate us ~ 170 lh-1m-2 for horizontal and ~ 173 lh-1m-2 for vertical orientation. Hence lowering of over potential is needed for electrolysis. The hydrogen (alkaline

medium) production rate was very insignificant when electrolyte was acidic in nature. The anode half reaction in acidic medium is,

$$2H_2O = 4H+ + O2 + 4e-$$

The exchange current densities were 10.1 and 5.4mAm-2 for MWNT and graphite pellete anode was calculated.

The dissociation of OH- to O2 has significantly decreased. When MWNT is used. (MWNT has better electrocatalytic activity comparing with graphite). In addition to lower activation energy, production rate also depends on effective surface area of electrode. The intrinsic electrocatalytic activity of MWNT is better due to lower activation energy of anodic reaction on MWNT as compared to graphite. The lower activation energy observed for MWNT when the electrolyte was alkaline may be taken to arise due to OH- ions adsorption on MWNT's surface. The hydroxyl functional group exhibit a peak at ~ 3230 – 3590Cm- 1.TPD of sample of MWNT show's peak at temperature of ~ 4100C which arise due to desorption of hydroxyl ions.

5.1 Concurrent desalination and hydrogen generation using microbial electrolysis and desalination cells

Microbial electrolysis and desalination cells are designed to desalinate salt water. Produce hydrogen and potential treat waste water. The reactor is divided into three chambers by inserting pair of ion exchange membrane. Each chamber for each process maintained above. With added voltage of 0.8V, lab scale batch study shows the highest H_2 production rate of 1.5m^3 by m^3d(1.6ml/h), from cathode chamber. Increasing current density from 87.2 to 140 A/m^3 loading to an improved H_2 production by 30%. Comparing to changes in desalination, H_2 production was more significantly affected by applied voltage cathode buffer capacity, cathode reaction where likely affected by the external power supply in addition to the anode microbial activity. Microorganism is used to catalyze the oxidation of organic and inorganic an electron donor in the anode chamber and to deliver electron to the anode. The electron is observed directly for current generation (or) for producing the energy carriers {Hydrogen and methane}. Microbial desalination cell does not require intensive energy or high-water pressure. Single chamber has high H_2 loss by microbial consumption compared to double chamber systems. Anion and cation exchange membranes are used. Hydrogen can be collected without any contamination and voltage fluctuation by this system.

MEDG → Microbial Electrolysis and Desalination Cell
MFC → Microbial Fuel Cells

Cathode chamber was filled with 50mm phosphate buffer solution. (Na2HPO414.58 g/l, NaH2PO4.H2O 2.45 g/l, PH = 7.0). The middle chamber filled with log/l. NaCl solution for desalination. Anolyte and Catholyte replaced for every 24 hours to avoid PH range. Hydrogen production and desalination was done after transferring the active MFC anodes into the assembled MEDC reactors.48.7 ml of H2was produced within 4 cycles (96h) at applied voltage of Eap=0.8V and 98.8% of salt water removed in the middle chamber for same 4 cycles. Maximum current density was 87.2 A/m3.Cathodic hydrogen recovery was 72%. Highest rate of H_2 production and desalination were both achieved at 8 to 4 of each batch. Maximum H_2 production rate equal to 1.5m^3/m^3d (1.6 ml/h). Desalination rate equal to 0.42 ms/cmb.PH declined continuously at 1 batch from 7 to around 5, while the anode ocp first decrease from - 44 -442 mv at beginning to -40mv at 10 h and increase to -428 mv attend. {OCP – Open Circuit Potential} The resistance increased from 70 – 250 ohms at beginning of 1 cycle to 850 – 1100 ohm at end of cycle. Corresponding concentration change of Cl- and Na+ (catholyte), in 24 – h cycle. It is known always more.

5.2 Principle and perspectives of hydrogen production through bio catalysed electrolysis

Unsustainable substrates for hydrogen generation can be converted with this technology. Bio catalysed electrolysis archives this by using electrochemically active-micro-organisms that are capable of generating current from oxidation of organic arterial. Theoretically bio catalysed electrolysis needs applied voltage as low as 0.14V by rears of conventional electrolysis but practically above 1.6V of applied voltage is needed. At applied voltage of 0.5V produces ~0.02M3H2/M3 reactor liquid volume/day and overall η is about 53±3.5%. Higher amount of H_2 can be extracted from waste water through fermentation. η of carbohydrate waste waters fermentation has technologies about less than 15%. Thermo dynamical limitation are reasons for low yield & majority of substrate is converted to by products (eg. acetate, burate) instead of H_2. For this thermo dynamical barrier instead of dark fermentation, photo fermentation (in presence of sunlight) is used. Also, microbial fuel all over comes the barriers by small input of electric energy and makes the process independent on surface area and benefit's economical feasibility. Acetate is used as model compound for the bio catalysed electrolysis, the conversion of H2 from acetate is shown.

$$CH_3COO- + 4H_2O \rightarrow 2HCO-3 + H+ + 4H_2$$

H2 generation needs input energy of about 104.6kJ/mol under normal condition & 0.14v sufficient theoretically. At PH7 this corresponding to ↔ potential for the oxidation of 1mol /1cal acetate and -0.28 and -0.42V of proton reduction. Practically 0.14V is needed to proceed the reaction. already H2 generation is possible around 0.22V.

Methods of H_2 generation are,

1. Electro chemical cell
2. Radium preparation
3. Electro chemically active micro organism

N2 gas is used to flesh the cylinder for process. Applied voltage increase from 0 to 0.75V at rate of 0.1 V/h. The anode chamber was continuously flushed with nitrogen for mixing & cathode is flushed prior to experiments. For create ↔ between head space volume and bulk liquid, the head space is recycling rate of 280ml/min. Total cathode head space volume was 275ml.303K temperature is maintained throughout the process & pressure 1bar maintained. The current generation was moisture by period. 5 days open squares 3day closed squares at controlled anode potential. Without bio catalysis no current generated. For enhancing current generation an increased applied voltage is needed. Current generation at applied voltage of 016V& also continuous nitrogen purging clears old H_2 generation. Without acetate in radium at 0.15V

the system maintained for 4 hours. In this cause current generation & H2 production does not happens. With acetate in radium (anode) generation takes place. Average current density was 470 ± 74.3 MA/M2 after 4 hours 0.38±0.13m mol (20 ± 3.2) of hydrogen was produced. Volumetric production rate of hydrogen/day is 0.02M3H2/M2 reactor liquid volume due to methane producing bacteria in anode. The columbic falls slightly. Cathodic hydrogen efficiency must to be only 57 ± 0.1%. Based on generation current 100% cathodic hydrogen efficiency could yield 35 ± 3.6 mol of hydrogen gas.15ml of hydrogen was lost during experiment H2 between 19 to 26ml could have diffused to anode due to loss in cathodic efficiency the overall efficiency is about is about > 53 ± 3.5%

Caloric η (acetate to e-) 92 ± 6.3
Cathodic H_2 η (e- to H_2) 57 ± 0.1
Overall H_2 η (acetate to H_2) 53 ± 3.5

100% η corresponds to,
Acetate → 8e- → $4H_2$

Most of over voltage is consumed by cathode. Even at current density exceeding 10000 A/M2 the over voltage for hydrogen evolution reaction is low as 0.025V. lower potential losses should be possible at low current densities(1-10A/M2).

5.3 Production of hydrogen from glucose by La Fe O3 based photo catalytic process during water treatment

Different La Fe O_3 catalyst was prepared by solution combustion synthesis, starting from lithium nitrate and iron nitrate aqueous solution. And for organic fuel different citric acid was increased from 0.86 to 2.15g specific surface of perovskite was increased from 4 to 24 M2/g, with crystallite size of 38 and 60m. Up to 1.6m mole/g cat, after 4h of UV radiation corresponds to 16% of hydrogen yield. Simultaneously degradation of glucose was 73% results encouraging possibility to produce hydrogen during photo catalytic treatment of sugar – containing water by using photo catalysis in absence of noble Metals. H2 generation from water through photo catalytic is friendly environment and potential method. Photo catalytic are mixed oxidise and perovskites type oxide and have general formula ABO3,

A + rare earth ion
B + transition metal ion

La Fe O_3 has special physical and chemical properties Like application for solid oxide fuel cells catalysts chemical sensor, photo catalysts and bio sensor. Perovskites can promote H2 generation via water splitting in presence of sacrificial agents such as ethanol and noble metals as catalyst. H_2 from glucose can be low by steam gasification fast pyrolysis and super critical conversion but high energy duty is required. No significant impurity phases have been observed in the XRO spectra. The increase in the amount of citric acid result did not influence the band gap energy, resulting about 2oev for all the photocatalysts all samples band in the range of 100-1000CM-2 and all associated to La FeO3 structure. The modes caused by La vibrations are present below 200CM-1 at153 and 176CM-1. The bands in the range of 400-450CM-1are due to the oxygen octahedral bending vibrations. The production of hydrogen and oxygen increased with increase in irradiation time. More over the H2/O2 ratio was about 2 for all samples

$$2H_2O \rightarrow 2H_2=O2$$

In dark phase a decrease in glucose concentration due to adsorption on the catalyst surface was observed. Best glucose degradation for La FeO3-B photocatalyst is high as 73% after 4 hours of irradiation.

5.4 Number of moles of gluconic acid:

Gluconic acid would shows a decrease citation reaction takes place. Amount CO_2 produced is less and occurs in liquefied extent.

5.5 Hydrogen production through steam electrolysis model based steady state performance of cathode supported intermediate temperature temperature Solid oxide eletrolysis cell

Hydrogen production via steam electrolysis needs less electrical energy conception than other low temperature conventional method. Here the gas composition is taken to be 50mol% H_2 ,50mol % of H2O and 100mol % O_2. At 1273K almost 30% of total energy consumption can be satisfied through the supply of thermal energy alone. The temperature increase decreases the opens: ve catalyst need for low temp electrolyzes. to ensure sufficient rate of H_2 production an SOEC system must consist of several repeating cell assembled in stacks. The pressure drops along the operating pressure of 0.1 Mpa. The unite cell consist of four chambers namely

→ Cathode → anode gas streams
→ Solid structure → input connect

Different between O_2 concentration at TPBS and that in the bulk stream has been assumed negligible. Reaction are generally rapid and activation over potentials tend to be small at high temperature. Due to the oxidising environment pure steam would great at elevated temperature and gas composition is not recurrence for the cathode stream in an SOEC. The selection of operation conditions for an SOEC can significantly influence the irreversible losses, altering the cell potential required for electrolysis. The predicted 1.30v equates to an electricity consumption around 250.1 KJmol-1 H2 (or) Kwh/normal M^2

5.6 Hydrogen production using single chamber membrane free microbial electrolysis cells

At in mixed culture H2 generation rate of 0.53M3/dayM3 at 0.6V with current density of 9.3 A/M2 at PH7 and 0.69 M2 /day/m3 with a current density of 14 A/M2 at 5.8 membrane is also generated along with H_2 in mixed culture. the development of advantage technologies for producing hydrogen from renewable energy resources that minimize environmental impacts is now given high priority. low energy consumption is one multiplied advantages of this system over water electrolysis. Membranes were employed in all the studies reported up to date to separate anode and cathode. The anode (3.5×4CM2) and cathode (4×5CM2) were held together by plastic screws with electrode spaced 2CM apart. The anode and cathode (both in 3×3Cm2) in this system were separated by a layer of J-cloth to avoid short circuit (4×4 first brand corporation, USA) The voltage output of the MFCS

reached over 0.5V at 1000 Ohm eternal resistor. the anodes were removed and placed in MECS containing a PH7 medium solution. The medium solution contained following (per litter) NaH2Po4 ,10.2g: Na2 HPo4 ,33.8g: NH4 Cl,0.31g; and mineral (12.5Ml) and vitamin (12.5Ml) solution as reported sodium creates was used as carbon source for all experiments with mixed cultures. The MEC without microorganisms was first purged with hydrogen for 10min. infected CO_2 to reach 25% in the headspace and then operated at an applied voltage of 0.6v. boiling the anodes from MFCS at 100 c for 15min before placing them in MECS. the MECS were then inoculated with 40ml cell solution and operated at an applied voltage of 0.6V. The hydrogen yields based on the consumed substrate should be higher than the reported H_2. Accumulation of methane negatively affected hydrogen production when its content was beyond 1.5%. At applied voltage at 0.53 to 0.25 M 2 /day /m3 at the 43rd hour where the methane content was about 1.1% as the energy efficiency based on voltages input (ηw) were 204% and 267% at an applied voltage at 0.6 and 0.4V, respectively. Methane produced in previous tests could be resulted from anaerobic methano genesis using acetate or H_2 /CO_2 as substrates. This experiment studies have been carried out using a single cylinder and stationary CI engine with a rated down is 5.2 kW at constant speed or 1500 rpm. A remote tank is used for bio diesel with for indicator to measure using manometer. The efficiency of diesel used engine 20% loading condition is 16.68%. In fuel used condition, have these efficiencies is 31.69%. The minimum rate the nar 32.23% with dominate biodiesel. Brake thermal efficiency is 42.72%. Investigation of hydrogen addition on the performance and exhaust emission of dogma donate biodiesel fuelled compression ignition engine. Fossil fuel are major fuel source and more sustainable. Biodiesel are efficient alternative fuel. Hydrogen is attractive alternative compare the other fossil fuel. Low emission are hydrogen and improved engine performance. In this journal investigate performance and emission characterise on single cylinder compression ignition engine using hydrogen induced fuel. The experiment conducted dissent identity of hydrogen in intake manifold. Deformation of bio diesel combined with hydrogen variable mass flow compared with diesel and increase of 3.24% to biodiesel at 80% loading condition. The emission of HC decreased by BDC decreased by 0.02% by volume and CO_2 decreased by 3.8% by volume of biodiesel with induction is hydrogen 10LP is to that of heat biodiesel of load conditions.

6 CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

Alkaline water electrolysis is one of the simple forms of producing hydration. The main disadvantage of this process is loss efficiency, in order to coidespure use of this system. Thermodynamic analysis is used to analysis the energy requirements theoretical of actual resistance offered by the system also discussed with different efficiencies. The lyre problem is way to the improvement of H_2 production. The limnetic analysis is used to indicate the reaction rate is alkaline, solution electrolytes on production be order to improving this application to research have to consider for reduction in electro chemical reaction resistance low cost electrodes, electrolytes of its additives for ionic mass transfer, corrosiveness resistive of electrolyses for durability to reduce surface tension of mass importantly, manaily, the gas bubble resistance to the anode, find catalyst alternative to replace scarce iridium or unstable lithium will be considered a great achievement. For the cathode improve the stability of the catalyst. Use new innovation technologies to produce new materials, catalysts of electrode system. Advanced member synthesis method will result in electrolyte synthesis method will result in electrolyte with higher proton transfer of lower gases crossover and the durability is high for production. The above can be achieved by using composite members or introducing molecular barrier to the electrolyte. For these barriers the future research should be proceeded with PEM electrolyzer which is reliable, cost effective solution related with renewable energy. High temperature electrolysis method is tested with various cathode of anodes material are compared with give a great deal of performance enhancement. Although the above result is increasing but the study is requiring to completely understand the effect of product mixing. Decrees in terminal potential of electrode corrosion must be studied in this summary, this review shows that for the development of new generation of alkaline system electrolysis system based on high temperature of pressure operation for the high production H_2 production plants. production in system completely also remains the major challenges

6.2 Future Scope

With new regulations of emissions aiming to reduce the NOx levels for the SI Engine, electrolyzer invention could have a substantial influence in various industrial applications. Countries like India, France, UK, USA, Russia, Finland, Japan, Korea and most of the countries in Europe have a severe attention towards reducing vehicular emissions. Also, for utilize hydrogen as primary fuel in SI engine, the engine should be modified to withstand high temperature, transmit heavy torque, better combustion of fuel. Future research will focus on limiting the current flow through the generator to obtain an optimal rate of hydrogen production. Next step of this project is to connect the hydrogen generator with an internal combustion engine, i.e. a spark ignition engine and measure the efficiency of fuel in vehicle and also to measure the reduction of emission of air pollutant such as CO, CO_2, etc. As a development of this project we are going to calculate flow rate of hydrogen for different input voltages and mixed catalyst like methanol sodium hydroxide. We have a plan to try different catalyst for electrolyte with various concentration.

The battery supplies power to dry cell electrolyzer. The dry cell is powered electrically by two anode and one cathode. When current flows, electron decomposition reaction takes place between anode and cathode. Now the electrolyte splits up into hydrogen and oxygen due to electron decomposition. The generated gas gets exhausted to bubbler through transfer lines.

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