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EXPERIMENTAL STUDY OF URINE POWERED INTERNAL COMBUSTION ENGINE

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Abstract

Use of fossil fuels like petrol and diesel have higher impact on our earth regarding the energy demand and pollutions. Many studies have been done as alternative methods for replacing fossil fuels with the use of renewable fuels biogas, hydrogen etc. This study proposes extraction of hydrogen and possibility of use in IC engine. In this work main focus is on hydrogen extraction from urine using electrolysis. The largest constituent of urine is urea, which is a significant organic source of H, C, O, and N. On electrolysis of urine, nitrogen and hydrogen gases are produced. An electrolytic cell potential of only 0.37 V is needed to electrolyze urea at standard conditions. This is significantly less than the 1.23 V required for electrolyzing water, theoretically generating 70% cheaper hydrogen. Nickel and copper are used as electrodes. Urine is reduced at the cathode producing valuable hydrogen. This hydrogen can be utilized as a gaseous fuel in IC engine. Mixing up of hydrogen to petrol can increase the millage and engine efficiency with lesser amount of carbon emissions.

Introduction

the urine powdered IC engine is a modification done on our conventional spark ignition engines with carburetor where, in addition to the air fuel mixture, a small amount of hydrogen is also compressed in the cylinder. This will enable powerful and complete combustion, thereby increasing the power obtained and reducing the emissions. This will also reduce fuel consumption as comparatively leaner mixture of fuel and air is required for combustion. The hydrogen

required for combustion is obtained by the electrolysis of urine. The utilization of waste water for useful fuel has been gathering recent attention due to society's need for alternative energy sources. Urine is the most abundant waste on earth. The largest constituent of urine is urea, which is a significant organic source of H, C, O, and N. There are numerous benefits of using urea/urine for hydrogen production. As urine is electrolyzed, it splits up into hydrogen, nitrogen and carbon dioxide.

Anode reaction: $CO(NH_2)_2 + 6OH^- \text{---->} N_2 + 5H_2O + CO_2 + 6e^-$
Cathode reaction: $6H_2O + 6e^- \text{----->} 3H_2 + 6OH^-$
Overall reaction: $CO(NH_2)_2 + H_2O \text{----->} N_2 + 3H_2 + CO_2$

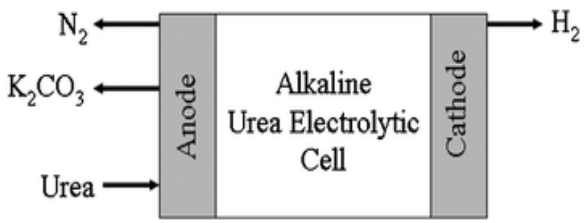

Fig. 1 Electro chemical reaction

These gases are passed through a water bath and only hydrogen given out. So, the obtained hydrogen is fed into the air filter chamber via a tube. In the engine intake system, the flow of air through the filter carries the hydrogen with it and mixes with the fuel, and is hence fed into the combustion chamber.

This gives:
1. Greater torque advantage
2. Greater mileage as fuel consumption is lower
3. Complete combustion and hence lower emission of waste gases

Rising fuel prices and harmful pollutant emissions from vehicles are two of the main problems faced by our society today. High prices of fuel and lower mileage levels causes travel and transportation costs to increase and hence it is in need of discovering a new way that could increase the efficiency of our conventional engines and also reduce pollutant emissions. So, we were having an idea so as to increase the mileage of a petrol engine. We had learnt that hydrogen is a highly combustible gas and is often used as fuel in some engines. But this is not directly applicable in our conventional SI engine, as the power of combustion obtained from burning of pure hydrogen is not enough to run the engine. So generally, hydrogen is mixed with petrol in SI engines.

Background

In general, getting an internal combustion engine to run on hydrogen is not difficult. Getting an internal combustion engine to run well, however, is more of a challenge. This point out the key components and techniques required to make the difference between a hydrogen engine that just runs and one that runs well.
Changwei Ji, Xiaoyu Cong, Shuofeng Wang, Lei Shi, Teng Su and Du Wang investigated the performance of a hydrogen-blended gasoline direct injection engine under various second gasoline direct injection timings [1], The performance of a hydrogen-blended gasoline direct injection engine under various second gasoline direct injection timings is investigated on a modified commercial gasoline direct injection engine. All tests are carried out at a typically congested city-driving condition using lean burn and split gasoline direct injection modes. Results show that under pure gasoline fuel supply mode, brake mean effective pressure, brake thermal efficiency, flame development period, flame propagation period, and maximum in-cylinder pressure vary obviously with various second gasoline direct injection timings and the best second gasoline direct injection timing for engine performance is 130 CAD (crank angle degree) before top dead center.
M. Mohamed Ibrahim and A. Ramesh, investigated the effects of intake temperature and charge dilution in a hydrogen fueled homogenous charge compression ignition engine [2]. Efficiencies of hydrogen HCCI mode were higher than the conventional diesel mode with negligible level of NO emissions. Higher charge temperatures lead to knocking and advanced combustion. At any equivalence ratio the lowest possible charge temperature is the one that leads to the highest thermal efficiency.
Jungwon Kim, Won Joon K. Choi, Jina Choi, Michael R. Hoffmann and Hyunwoong Park studied [3] the hybrid electrochemical system for urea and urine treatment and simultaneous H_2 production using $BiOx–TiO_2$ anode and stainless-steel cathode couples with different electrolytes (NaCl vs. $LiClO_4$ vs. Na_2SO_4). In the presence of NaCl, urea electrolysis was found to enhance the cathodic H_2 production by a maximum of ca. 20% at low urea concentrations, yet reduce the H_2 production at high urea concentrations as compared to water electrolysis. The synergistic effect by the urea electrolysis disappeared when $LiClO_4$ and Na_2SO_4 were used as electrolytes indicating the crucial role of chlorine species in the hybrid reactions. In addition, the electrolysis of actual urine was found to successfully operate along with simultaneous generation of H_2 even in the absence of externally added electrolytes.

Shani Elitzur, Valery Rosenband and Alon Gany studied the production of hydrogen by the reaction of urine with aluminium [4]. A parametric investigation of hydrogen production is presented based on the reaction between urine and aluminum powder activated by an in-house patented process. Reaction rate and yield have been measured experimentally under different conditions. This technology may provide means for energy production and storage where fresh water supply is limited and there is no access to the grid.

Experimental Methodology

Electrolysis of urine is the cheaper and green method for the production of hydrogen as urine contains abundant quantity of urea which is the main source of hydrogen. From various sources, we came to know about the dry cell type of hydrogen cell and we came to know that it is more efficient than in the case of a wet cell. The construction of wet cell apparatus is simple (fig. 2). Nickel plates are of dimensions 4 x 4 inches. It is supported by the oil seals which are tightened by the protective frames. Two holes, one for inlet and other for outlet are provided on the exposure area of reaction. It is provided with connecting wires for electric supply. Nickel plates act as anode in the electrolysis process Copper plates are of dimensions 6 x 8 inches. It is supported by the oil seals and external nut and bolt system to the protective frames. Also, two holes, one for inlet and other for outlet are provided on the exposure area of reaction. It is provided with connecting wires for electric supply. Copper plates act as cathode in the electrolysis process. In between the plates the electrolyte which is urine is filled. Potassium hydroxide (KOH) is used as the electrolyte. Hence KOH is added with the urine and is supplied to the cell.

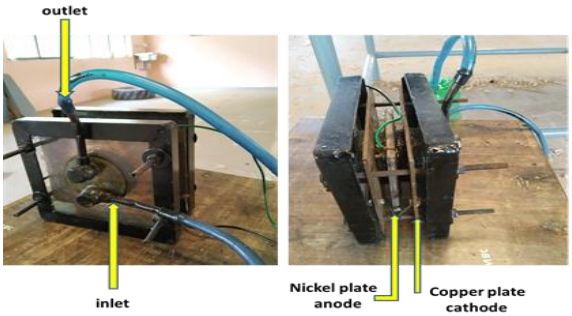

Fig.2 Dry cell apparatus

The general flow diagram of the hybrid package is as shown below (fig.3). There is a 12 V battery with an ignition switch. This is connected to the terminals of the dry cell on the nickel and copper plates. The water bath is always kept at an optimum height same as that of the electrolytic cell. This causes the urine to circulate due to pressure difference on both the ends of the dry cell. The inlet tube carries electrolyte from the separator into the electrolytic cell and outlet tube carries the mixture of hydrogen gas and contaminated gases to the water bath. In the water bath, contaminated gases got dissolved in the water and the pure hydrogen rises up through the tube and hence is carried to the carburetor. Here, the hydrogen first of all mixes with the air coming from air filter. This mixture is further mixed in the carburetor venturi tube with petrol. This mixture of air, fuel and hydrogen is then finally carried into the spark ignition engine as shown in fig. 3.

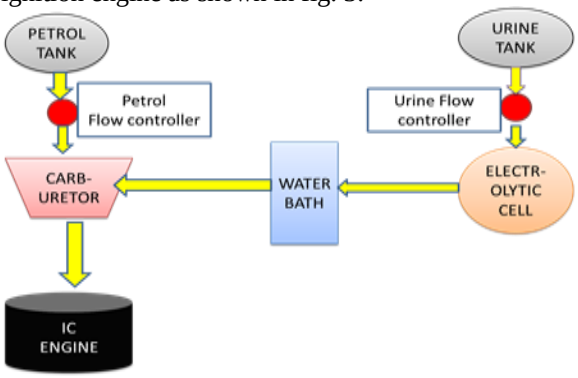

Fig.3 Schematic diagram

The electrolytic cell is fixed on the side foot rest of the motor cycle along with the urine tank. It causes no other discomfort to the rider and also, not much design modifications will be required. We used clamps to attach it to the foot rest as shown in Fig. 4. The water bath was attached to the same side of the motorcycle as shown. The separator was kept at a level same as that of the urine electrolytic cell. This height was critical since, if it was placed at a higher level, whole of the water in the water bath may flow into the cell. If kept at a lower level, it would have resulted in the failure of the circulation of urine.

Fig.4 Implementation of dry cell in motorcycle

Results and Discussion

The experiments are carried out and hydrogen is supplied to the carburettor from urine electrolysis. Here hydrogen mixes with gasoline. Gasoline supply is controlled by using flow valve. Initially the engine starts using gasoline only, then hydrogen is given and gasoline supply reduces gradually. We found out that at a point the engine works smoothly without knocking with limited supply of gasoline. Hence our study point out that ic engine can work by blending gasoline and hydrogen.

The specification of bike used
- Brake Power = 7.6 bhp =5.66 KW
- Cubic Capacity = 105 cc
- Weight = 119 Kg
- Radius of wheel = 8.5 inch = 21.25 cm

Without Hydrogen
- For .05 liters of Petrol
- Time taken = 390 sec
- Total Fuel Consumption
- TFC $= \frac{x*\rho*3600}{t*1000}$

$$= \frac{50*700*3600}{390*1000} \text{ g/hr}$$

= .323kg/hr

- Specific Fuel Consumption
- SFC$= \frac{TFC}{BP}$

$$= \frac{.323}{5.66}$$

= .057 Kg/KWhr

With Hydrogen

- For .05 liters of Petrol
- Time taken = 690 sec
- Total Fuel Consumption

TFC $= \frac{x*\rho*3600}{t*1000}$

$$= \frac{50*700*3600}{690*1000} \text{ g/hr}$$

= .182 Kg/hr

- Specific Fuel Consumption
- SFC$= \frac{TFC}{BP}$

$$= \frac{.182}{5.66}$$

= .032 Kg/KWhr

The fuel efficiency can be increased about 50% based on the experiments done.

The major concern with previous work was that the large amount of foam production along with hydrogen. The cause behind foam production is carbon dioxide produced along with hydrogen. In this work we are using KOH (potassium hydroxide) as electrolyte and carbon dioxide from urine reacts with KOH and deposits as potassium carbonate in the cell hence foam production is reduced to an extent.

$$2KOH + CO_2 \longrightarrow K_2CO_3 + H_2O$$

Conclusion

It is evident from the emerging trends that the diesel and gasoline powered engines will be history in the near future. In the scenario of electric powered cars, the hydrogen powered engines can be also considered a potential option if used with utmost care. The electric powered cars are considered as the best replacement for conventional fuels but they come with their own problems of waste disposal.

Here, hydrogen fuelled engines can come into the main frame and efficiently be used if proper precautions are taken care of. Generally, hydrogen is produced by water electrolysis. Urine electrolysis is cheaper than water electrolysis. Human urine contains abundant quantity of urea which is a hydrogen carrier. Hydrogen can be produced by the electrolysis of urine which is cheaper and green method. Hydrogen gas produced from this process is pure and, as such, does not require further purification. Potassium hydroxide can be used as an effective electrolyte in urine electrolysis.

Hydrogen as a fuel plays a great role in the reduction in exhaust emissions in both SI as well as CI engines in the present scenario of stringent emission norms. The emission control technologies for both engines have reached to their maximum level using various

techniques and hydrogen can have a greater potential considering future emission norms.

Although use of hydrogen reduces carbon related emissions considerably, care must be taken to reduce NOx emissions to a significant level. There is a good scope of research work in this area. The main problem with hydrogen as a fuel in IC engines is the safety aspects and storage problems. If a good method of storage can be implemented then there will not be any other concern that will be able to stop hydrogen from replacing the conventional duo of gasoline and diesel.

Reference

[1] **Changwei Ji, Xiaoyu Cong, Shuofeng Wang, Lei Shi, Teng Su, Du Wang** (2018) *Performance of a hydrogen-blended gasoline direct injection engine under various second gasoline direct injection timings.*

[2] **M. Mohamed Ibrahim, A. Ramesh** (2014) *Investigations on the effects of intake temperature and charge dilution in a hydrogen fueled HCCI engine.*

[3] **Jungwon Kima,Won Joon K. Choib, Jina Choia, Michael R. Hoffmanna, Hyunwoong Parkc** (2011) *Electrolysis of urea and urine for solar hydrogen.*

[4] **Shani Elitzur,Valery Rosenband, Alon Gany** (2016) *Urine and aluminum as a source for hydrogen and clean energy*