

Urine Hydrogen Power (U.H.P)

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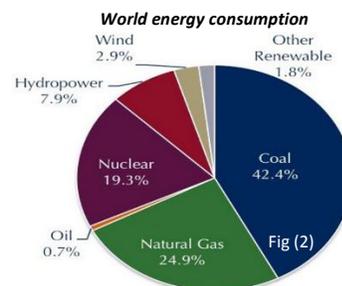
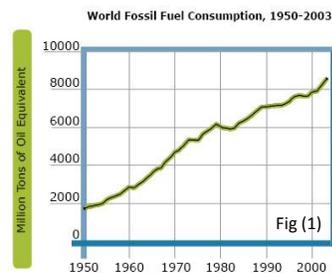
Key words: Alternative energy, fuel cell, urine, electrolysis, Hydrogen

Abstract

The whole world suffers from a huge problem which is the lack of energy whether it's because the insufficient production or the increasing consumption and there are consequences for this problem such as increasing the percent of pollutants and harmful gases in the environment because of using fossil fuel as a source of energy to compensate the lack of energy, so the whole tries to exploit alternative energies such as renewable energy because they're clean, cheap and will solve the problem of energy. (Urine Hydrogen Power) is believed to be a huge factor in solving the energy problem as urine is going to be used to generate electricity. It's an efficient, sustainable and economic solution since urine is produced everywhere, as humans alone are estimated to produce 6.4 trillion liters per year. The project will meet our grand challenge as we will work on renewable energy resources. This project is estimated to produce about 3 moles of Hydrogen with a weight of 6 grams from the electrolysis of one liter of urine, then the fuel cell is used to convert this hydrogen into energy to produce electricity by combining it with oxygen. A solution like that will not cost so much and would be efficient, so it meets the design requirements of any successful solution. In conclusion, the results of our tests which were much better than we expected showed that this project is a perfect solution to solve the problem of one of the world's largest demands which is energy.

Introduction

In all over the world the fossil fuels like coal and petroleum are being exhausted day by day as shown in fig (1) which make them in danger to reach end soon, so the whole world is going on the track of using new and clear resources of energy especially renewable resources like: Photovoltaic power, hydroelectric power, wind power and biomass despite that these resources still represent small percentage of energy used as shown in fig (2), so we still have to find other clean and low-cost resources to produce energy from Because of the high continuous consumption of energy. Despite pee and urine are considered wastes from our body, if we could exploit them correctly in producing energy they are going to rule the world in the future. As with the help of urine which I prefer to call it the fuel of the future, we can generate electricity and it will achieve the design requirements of any project, for example:



1- Cost

The cost of this project is reduced by using graphite in the electrolysis of urine to produce Hydrogen molecules instead of using platinum as platinum is so expensive metal. Also, electrolysis will be done to urine because a liter of urine needs 0.37 v to be electrolyzed instead of water that needs 1.42 v per liter to be electrolyzed, so 1.05 v is saved by liter which will play as a factor in reducing the cost of the project while applying it on a large area or a city.

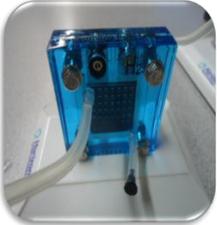
2- Production

In addition to choosing urine to reduce the cost, urine also has been chosen to be used in this project because it will increase the production as well. As the electrolysis process of 1 liter of urine will produce 3 moles of hydrogen which weight 6 grams, depending on the molecular mass rule: $\text{Molecular mass} = \text{mass of moles} / \text{number of moles (stoichiometry)}$, instead of electrolyzing water which gives us only 1 mole of hydrogen. Another advantage of using graphite in this project that it will play the role of a catalyst as it will boost the action and the reaction and reduce the time of them, so time is saved and production of electricity is increased.

3- Efficiency

PEM fuel cell is going to be used to turn Hydrogen into electricity instead of other fuel cells like Acid Fuel Cell (PAFC) because the efficiency of PEM fuel cells is between 40 % and 60 % unlike other fuel cells which have less efficiency such as PAFC as it's efficiency is between 36% and 42 % so the efficiency is going to be increased by at least 10 %.

Materials

Materials used				
12v power supply device	PEM fuel cell	3 Liters of urine	50g solid Sodium Hydroxide	Two crocodiles
				
Two test tubes and a flexible pipe	Two Graphite Rods	Three beakers (250ml)	A voltmeter	A sensitive electronic balance
				

Methods

- 1- Putting the collected urine into a container
- 2- Putting the cathode and the anode (graphite) in opposite poles in the container
- 3- Putting Sodium Hydroxide (NaOH) in the urine to combine with the CO_2 produced after electrolysis to convert it to (NaHCO_3) to be used in many field later
- 4- Connecting the anode and the cathode with the power supply by using crocodiles
- 5- Set the power supply on 0.37v and turn it on to start the electrolysis process
- 6- Collecting the Hydrogen gas produced during the electrolysis at the cathode from the container by using tubes connected to the fuel cell
- 7- Hydrogen gas passes through the tube from the container to the fuel cell as shown in img (1).
- 8- Electricity is produced from the fuel cell



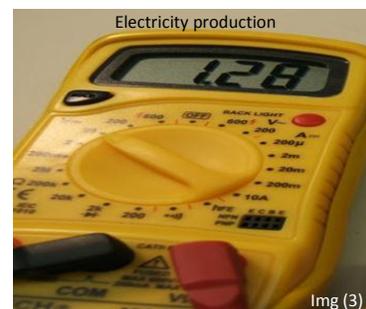
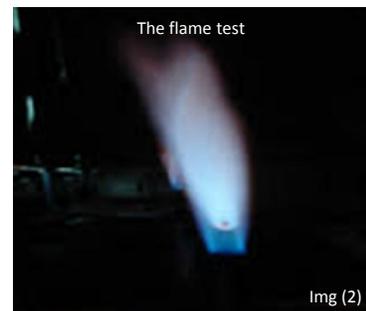
Test plan

Objective: Making sure of the productivity and the efficiency of the solution

Tools: 1- Lighter 2- Voltmeter

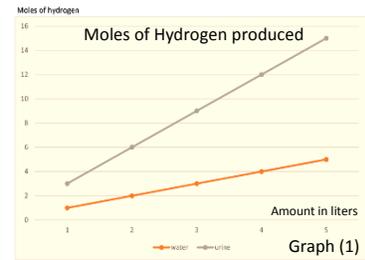
Procedures:

- 1- During the electrolysis of urine, removing the tube that transfers Hydrogen and turning on a lighter carefully at the slot where Hydrogen comes out from the container to make sure that Hydrogen gas is produced which is called the flame test
- 2- If Hydrogen gas is produced after opening the lighter, we will hear a pop sound and the color of the flame changes from red to white blue as shown in img (2)
- 3- After doing the flame test and making sure that Hydrogen gas is produced, we make sure that electricity is produced by connecting the fuel cell with a voltmeter and noticing the reading on the voltmeter
- 4- If the whole system is working properly, electricity is going to be produced out of the fuel cell and the reading on the voltmeter would be 1.28v per on liter of urine as shown in img (3).



Results

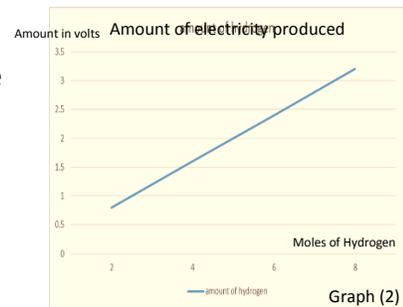
After Urine was used in this project instead of using water, the amount of hydrogen was calculated from both urine and water to compare between their production and it was found that urine gives us moles of hydrogen 3 times more than water as well as energy. Graph (1) represents the relation between urine, water and moles of Hydrogen produced. As shown in graph (1), there is a comparison between the number of moles of Hydrogen gas result from specific number of moles of water and the same number of moles but of urine. As a result from the graph we figure that 1 mole of water produces 1 mole of Hydrogen while 1 mole of urine produces 3 moles of Hydrogen. The same experiment was done many times to make sure of its accuracy and the results were nearly the same in each time with regard to the increase of the amount of urine and water used as shown in tab (2). Sometimes the results weren't exactly the same because as any experiment there was a measurement error of ± 0.06 v which is a small number because a sensitive balance was used in weighting urine and water, an accurate voltmeter was used in measuring electricity and the tubes were connected tightly to have the least percent of error possible which was one of the main goals. Graph (2) represents the relation between the moles of hydrogen enter the fuel cell and the amount of electricity produced from the fuel cell as energy (electricity) produced (v) = (0.4) * moles of hydrogen.



Comparison between water and urine

Moles of water	Moles of Hydrogen	Moles of urine	Moles of Hydrogen
1	1	1	3
2	2	2	6
3	3	3	9
4	4	4	12
5	5	5	15

Tab (2)



Analysis

There are many chemical reactions in this project, when we put urine to be electrolyzed, there are two reactions happen, one of them in anode and the other in cathode

First, anode reaction: $\text{CO}(\text{NH}_2)_2(\text{aq}) + 6\text{OH}^- \rightarrow \text{N}_2(\text{g}) + 5\text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g}) + 6\text{e}^-$

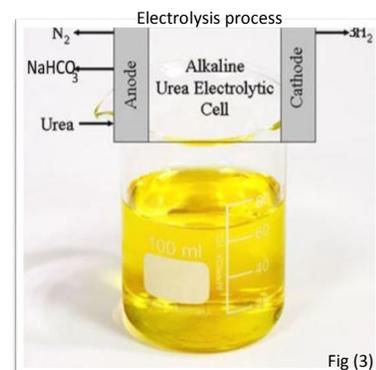
At the anode, when 1 mole of urea ($\text{CO}(\text{NH}_2)_2$) reacts with 6 moles of hydroxide (6OH^-) it produces 1 mole of nitrogen, 5 moles of water and 1 mole of carbon dioxide

Second, cathode reaction: $6\text{H}_2\text{O} + 6\text{e}^- \rightarrow 3\text{H}_2 + 6\text{OH}^-$

At the cathode, water will be oxidized and will produce 3 moles of hydrogen and 6 moles of hydroxide

Overall reaction: $\text{CO}(\text{NH}_2)_2 + \text{H}_2\text{O} \rightarrow \text{N}_2 + 3\text{H}_2 + \text{CO}_2$ (as shown in fig (3))

This reaction produces CO_2 which harms the environment so Sodium Hydroxide (NaOH) which is added at the beginning of the electrolysis will combine with CO_2 produced from the electrolysis to form Sodium bicarbonate



(NaHCO₃) which can be used in food industry, pharmaceutical industry, fire extinguishers, soap and detergents so the project is considered to be eco-friendly. The chemical equation of turning CO₂ to NaHCO₃ by using NaOH is: CO₂ + NaOH → NaHCO₃.

Then the hydrogen produced is pushed into the PEM fuel cell and reacts at the anode according to the following equation: 3H₂ → 6H⁺ + 6e⁻

Then hydrogen ions move to cathode across proton exchange membrane that allows only positive ions to move across it and when they arrive at the cathode the following reaction occurs: 6H⁺ + 1.5O₂ + 6e⁻ → 3H₂O

which in the end will produce 1.2 v from 1 liter of urine. Both the results and the analysis showed that this project solves other grand challenges such as: pollution and increasing the industrial base besides solving the main challenge which is lack of energy.

Conclusion

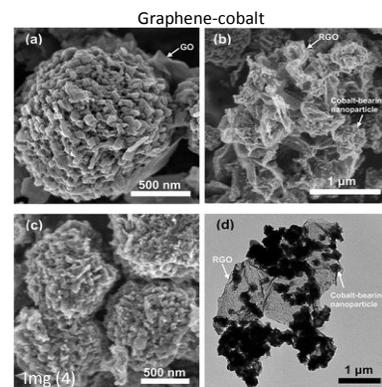
After specifying the grand challenge and the consequences of it, a lot of researches have been done in order to find a suitable solution which has low cost, high efficiency and high production to solve this grand challenge which is lack of energy. A solution has been chosen and a prototype has been constructed, to make sure that this solution meets the design requirements. After performing the test plan on the prototype and analyzing the results, it appeared that the solution succeeded in achieving the design requirements of producing renewable energy with the least possible cost and with high efficiency from 60% to 80%. The results showed that the urine and the Hydrogen power produced from it which is turned to electricity later are able to solve the energy problem that invades the whole world.

Recommendation

After making sure that the project had achieved all of the design requirement, as any successful project there are some recommendations for the future:

1- The cathode and the anode is going to be changed as graphene-cobalt is going to be used in the electrolytic cell instead of platinum as shown in img (4) to reduce the cost and to improve the efficiency as the efficiency of graphene-cobalt is 70% while the efficiency of platinum is 40%, so the efficiency is going to be increased by 30 %, graphene-cobalt wasn't used in the current project because it wasn't available in the place of constructing the prototype so graphite was used instead as it gives nearly the same efficiency of graphene-cobalt and it's also cheaper than platinum

2- The project can also be applied on a large area (centralized) by making new sewage system and there will be a big box of electrolytic cell nearby the city or the country to make electrolysis of urine to separate it into hydrogen and nitrogen and all urine of the people in the city will be pushed in this box and there will be a system of fuel cells as shown in img (5) that converts hydrogen into electricity and for every 1 liter of urine it will provide 1.2 v which equals 1.2 watt.



Depending on researches every human is estimated to produce from 1.5 to 2 liters of urine every day and there are nearly 7.5 billion person, so the whole world produces about 13.125 billion liters per day, so the world produces about 4790.625 billion liters each year which will provide 5748.75 GW per year. The world consumes about 8090 GW per year which means that only urine can handle more than 70% of the world electricity usage so with using other resources there won't be any problem related to energy in the future, conversely there will be an excess of electricity in the world that can be stored so making this project centralized all over the world will play a huge factor in solving the worldwide energy problem.



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For further information

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