

Urine-The Source of Energy

Amruta Matkar, Tanmay Mhetre, Ashish More, Neha Gangraj

Abstract: *The proposed work is all about electricity generation, whilst cleaning the urine 'fuel' and producing clean water in addition to fertilizer, and is focusing on small-scale MFC units, which have been shown to be more efficient and energy-dense. The continuous flow nature of the MFC technology facilitates continuous growth of the constituent biofilm organisms, which clean the input, and can be subsequently used as fertilizer. In essence, the more powerful the MFC is, the greater are the rates of urine utilization. A microbial fuel cell is a device that uses natural biological processes of 'electric' bacteria to turn organic matter, such as urine, into electricity. These fuel cells are efficient and relatively cheap to run, and produce nearly zero waste compared to other methods of electricity generation. In practice, urine will pass through the microbial fuel cell for the reaction to happen. From here, electricity is generated by the bacteria which can then be stored or used to directly power electrical devices. Microbial fuel cells could be a great source of energy in developing countries, particularly in impoverished and rural areas. To have created technology that can potentially transform the lives of poor people who don't have access to, or cannot afford electricity, is an exciting prospect. I hope this will enable those in need to enjoy a better quality of life as a result of our research. For more details, please download TEMPLATE HELP FILE from the website.*

Index Terms: ACID (Anode Current Into Device), CCD (cathode current departs), MFC (Microbial Fuel Cell), CH_4N_2O (Molecular Formula of Urea), $C_5H_4N_4O_3$ (Uric Acid), Oxidant (Oxidizing Agent).

I. INTRODUCTION

In all over world the fossil fues like coal are being exhausted day by day. And due to this we are going for alternate sources like solar, wind, Biomass, geothermal energy. All this generations require high capital cost. So because of that there are some many research is going on for low-cost energy generation. Some scientist found a fuel which is called as the fuel of future that is nothing but urine. With the help of urine we can generate electricity in very simple manner as we all consider pee as waste from our body but we don't know that is going to rule the world in future. Here in the below pie chart we can see how much of

electricity is generated from our energy resources. MFCs are devices that use bacteria as the catalysts to oxidize organic matter and generate current. Bacteria produce electrons by breaking down organic matter and transferring the electrons to the anode (the second electron acceptor after the bacteria), and then to the cathode when the external circuit is completed. Oxygen molecules (the terminal electron acceptor) accept the electrons, which flow from the anode to the cathode. However, MFCs are still largely at the research level, and there are challenges and bottlenecks to overcome before they become commercially viable and widely adopted.

The rate at which bacteria can oxidize a substrate, and transfer electrons from the substrate to the surface of the anode has a significant effect on power generation. While having more bacteria typically means a higher oxidation rate, the concentration of bacteria could reach saturation beyond a certain level. The microorganism and substrate concentrations are the main elements in the dynamics of power generation in MFCs.

II. OBJECTIVE OF PROJECT

To investigate the urea in urine as source of electricity from previous related work literature. To develop a bio battery that generates electricity from urine utilizing urea as its catalyst to supply load such as lead light and small electronic equipment.

III. WHY WE USED HUMAN URINE?

Humanity struggles to catch the easiest wave out of the crisis in entered, caused by its own, self-designed processes. Just like you're hooking onto any branch of any tree when you're in a free fall, scientists are hooking on anything that can give us more energy at a comfortable price. Now is the time of using urine. I know – it sounds gross, but obtaining hydrogen from urea is actually cheaper than obtaining it from water, through the same electrolysis process. The study is being led by Gerardine Botte of Ohio University and it all started from an idea to recycle the wastewater. Urine's major constituent is urea, which incorporates four hydrogen atoms per molecule – importantly, less tightly bonded than the hydrogen atoms in water molecules. Botte used electrolysis to break the molecule apart, developing an inexpensive new nickel-based electrode to selectively and efficiently oxidise the urea. To break the molecule down, a voltage of 0.37V needs to be applied across the cell – much less than the 1.23V needed to split water.

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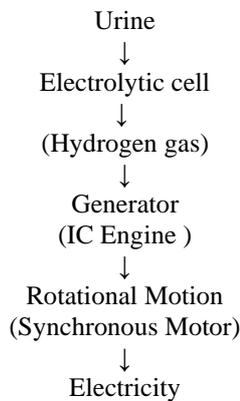
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IV. DESIGN LAYOUT

The main components required for the generation of electricity is as follows:

1. Electrolytic Cell
2. Generator
IC Engine and Synchronous Motor



A. Electrolytic Cell

An electrolytic cell is an electrochemical cell that undergoes a redox reaction when electrical energy is applied. It is most often used to decompose chemical compounds, in a process called electrolysis. When electrical energy is added to the system, the chemical energy is increased. Similar to a galvanic cell, electrolytic cells usually consists of two half cells. An electrolytic cell has three component parts: an electrolyte and two electrodes (a cathode and an anode). In this the raw urine contains urea. The chemical formula of urea is CH_4N_2O . By this electrolytic cell we can produce the hydrogen gas by applying the electrical energy to the electrolytic cell.

B. Generator

Thus the hydrogen pushed out from the electrolytic cell is then given to generator that is in our project use generator as a combination of IC engine and synchronous motor. This generator uses the hydrogen gas as the fuel and it produces the electricity.



V. METHODOLOGY

Urine - the Energy Source-

Urine is a liquid produced by the kidneys to remove waste products from the bloodstream. Human urine is yellowish in color and variable in chemical composition. The human urine consists primarily of water, with organic solutes including urea, creatinine, uric acid, and trace amounts of enzymes.

Characteristics of Urine-

1. Quantity: The quantity averages 1500 to 2000 ml in an adult man daily. It may vary with the amount of fluid taken. In fact it is linked with the protein metabolism higher is the protein intake higher will be the urinary output, the urea produced from the protein needs to be flushed out from the body. Higher is the urea production in the body, the higher is the volume of urine to excrete it.
2. Colour: The colour should be clear pale amber without any deposits. However, a light flocculent cloud of mucus may sometimes be seen floating in the normal urine.
3. Specific gravity: It varies from 1.010 to 1.025 specific gravity is determined with urinometer.
4. Odour: The odour is aromatic.
5. Reaction: The reaction of normal urine is slightly acidic with an average pH of 6.0.

Composition of Urine-

Urine is mainly composed of water, urea and sodium chloride. I an adult taking about 100 g protein in 24 hours, the composition of urine is likely to be as follows:



1. Water: Near about 95%

2. Solids: About 5% (urea 2% and other metabolic products 3%). Other metabolic products include: uric acid, Creatinine, electrolytes or salts such as sodium chloride, potassium chloride and bicarbonate). Urea is one of the end products of protein metabolism. It is prepared from the deaminated amino-acid in the liver and reaches the kidneys through blood circulation (The normal blood urea level is 20-40 mg/dl). About 30 gram urea is excreted by the kidneys daily.

3. Uric Acid: The normal level of uric acid in blood is 2 to 6 mg/dl and about 1.5 to 2 gram is excreted daily in urine.

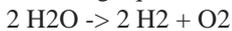
4. Creatinine: Creatinine is the metabolic waste of creatin in muscle. Purine bodies, oxalates, phosphates, sulphates and urates are the other metabolic products.

Urine Reaction-

Urine is composed of about 95% water.

Let's take water for now:

1 liter of Water weighs 1 kilogram. 1 kilogram of water (H₂O) gives hydrogen and oxygen when electrolyzed in the following equation:



2 mol of H₂O decomposes to give 2 mol of H₂.

That means 1 mol of H₂O gives out 1 mol of H₂.

1 kg of water is around 55.6 mol, 55.6 mol of H₂ was produced.

Since,

$$n = m/\text{Ar}$$

$$55.6 \times 2.0 = m$$

m = 111g of H₂ will be produced (which under RTP, occupies 1330 dm³ of volume)

So, if you take a litre of urine and assuming that only the water in it gets electrolyzed, you can reasonably expect 106g H₂ that could be extracted (which occupies 1270 dm³ of volume) However, these is only a theoretical yield.

VI. ELECTROLYSIS PROCESS

An anode is an electrode through which electric current flows into a polarized electrical device. The direction of electric current is, by convention, opposite to the direction of electron flow. In other words, the electrons flow from the anode into, for example, an electrical circuit. A commonly used mnemonic is ACID (Anode Current into Device).

A cathode is an electrode through which electric current flows out of a polarized electrical device. The direction of electric current is, by convention, opposite to the direction of electron flow thus, electrons are considered to flow toward the cathode electrode while current flows away from it. This convention is sometimes remembered using the mnemonic CCD (cathode current departs). The chemical reactions in this source cause a build-up of electrons at the anode. This results in an electrical difference between the anode and the cathode. We can think of this difference as an unstable build-up of the electrons. The electron wants to rearrange them to get rid of this difference. But they do this in a certain way. Electrons repel each other and try to go to a place with fewer electrons. In this system, the only place to go is to the cathode. But, the electrolyte keeps the electrons from going straight from the anode to the cathode within the battery. When the circuit is

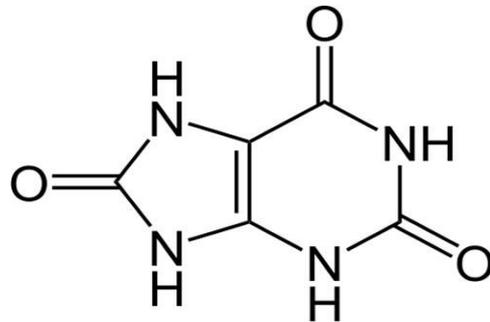
closed (a wire connects the cathode and the anode) the electrons will be able to get to the cathode. This is one way of describing how electrical potential causes electrons to flow through the circuit. However, these electrochemical processes change the chemicals in anode and cathode to make them stop supplying electrons. So there is a limited amount of power available in output.

A. Reaction of Mechanism in the MFC-

The source we made from cow urine through is mostly evaluated by chemical composition of urine. Actually, from chemical composition we perceived that when copper and zinc plates come in contact with uric acid movement of electrons begins, generating electricity.

B. Uric Acid –

Uric acid is a heterocyclic compound of carbon, nitrogen, oxygen, and hydrogen with the formula C₅H₄N₄O₃. It forms ions and salts known as urates and acid urates such as ammonium acid urate. Chemical Bond of Uric acid is given below:



C. Chemical Concept of Electricity Generation –

Uric acid is a hetero cyclic compound of carbon, nitrogen, and hydrogen with the formulated of C₅H₄N₄O₃. Copper with the presence of water will be reacted with Uric acid. Then oxidation reaction will be happened as a result uric acid will be oxidized by Cu and produced Cu urate. This is basically a salt solution and can be made ionic bond then this bond will be contacted with zinc plate. So, from this reaction it can be realized that, when copper and zinc plates come in contact with uric acid movement of electrons begins, generating electricity.

VII. GENERATOR

A. Working Principle of IC Engine-

The principle of working of both SI and CI engines are almost the same, except the process of the fuel combustion that occurs in both engines. In SI engines, the burning of fuel occurs by the spark generated by the spark plug located in the cylinder head. The fuel is compressed to high pressures and its combustion takes place at a constant volume. In CI engines the burning of the fuel occurs due to compression of the fuel to excessively high pressures which does not require any spark to initiate the ignition of fuel. In this case the combustion of fuel occurs at constant pressure.

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Both SI and CI engines can work either on two-stroke or four stroke cycle. Both the cycles have been described below:

1. *Four-stroke engine*: In the four-stroke engine the cycle of operations of the engine are completed in four strokes of the piston inside the cylinder. The four strokes of the 4-stroke engine are: suction of fuel, compression of fuel, expansion or power stroke, and exhaust stroke. In 4-stroke engines the power is produced when piston performs expansion stroke. During four strokes of the engine two revolutions of the engine's crankshaft are produced.

2. *Two-stroke engine*: In case of the 2-stroke, the suction and compression strokes occur at the same time. Similarly, the expansion and exhaust strokes occur at the same time. Power is produced during the expansion stroke. When two strokes of the piston are completed, One revolution of the engine's crankshaft is produced. In 4-stroke engines the engine burns fuel once for two rotations of the wheel, while in 2-stroke engine the fuel is burnt once for one rotation of the wheel. Hence the efficiency of 4-stroke engines is greater than the 2-stroke engines. However, the power produced by the 2-stroke engines is more than the 4-stroke engines.



B. Synchronous Motor

A synchronous electric machine can be either a motor or a generator depending on the amount of torque being applied to the synchronous machine. If the torque exceeds the amount of power required to keep the synchronous machine spinning at rated frequency when connected to a grid supplying a load (motors, lights, computers, etc.) then the synchronous machine is a generator, converting the excess torque into amps which are being transmitted over wires to motors and the other types of loads (lights, computers, etc.).

When the amount of torque being applied to the synchronous machine is less than amount required to keep the machine spinning at synchronous speed then the synchronous machine becomes a motor, drawing amps from the grid to maintain speed and actually "driving" the prime mover (turbine, reciprocating engine, etc.)--which can be very damaging to the prime mover.

There are very large hydro-electric facilities called "pumped storage" facilities that serve as synchronous generators

during the day allowing water to run "down" through the turbine driving the synchronous machine. Then at night, the synchronous machine is used as a motor to drive the turbine which becomes a pump and pumps the water back "up" to a storage lake where it's ready to be used to drive the machine as a generator the next day. Some large heavy duty gas turbines employ the synchronous generator as a motor during starting and acceleration. There are many formulae that can be found at sites like wikipedia.org to describe how motors convert amps into torque and how generators convert torque into amps.



VIII. ADVANTAGES

1. There is no cost of fuel.
2. There is no evolution of green house gases.
3. It is pollution free equipment.
4. Maintenance cost is very low
5. It is an ecofriendly product.
6. It is non toxic with the nature.
7. It generates more electricity when compared to other generators by consuming less amount of fuel.

IX. DISADVANTAGES

1. The major disadvantage is hydrogen poses' explosive risk.
2. The installation of this complete equipment is a little bit cost.
3. Before generation some external electricity is required for electrolysis process.

X. APPLICATION

1. In the public toilets.
2. In the College, cinema halls, commercial areas.

XI. CONCLUSION

Now a day the power generation from diesel, petrol, coal, water decreases day by day so we need to produce electricity from other type of power plants. When compared with the other generators it is pollution less and it does not affect the environment.

It produces much electricity compared with other types of power plants and mainly the waste Urea is used (it is cost less). In present generation this is the best way to produce power from this type of pee powered generator.

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