Design of an Automated Power Generation Unit using Biomass

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***Abstract*— Power industry plays a crucial role in our society. It advances nation's economic growth and prosperity, it is a robust industry that contributes to the growth of society. However, with increase in population the demand for electricity is intensified. Present rate at which non-renewable resources are used for production is harmful to environment. Therefore, to generate electricity and to protect environment, energy extraction from renewable sources began to rise. Biomass- Cow urine being a renewable source of energy is used to generate electricity without impairing the environment. To generate electricity from cow urine copper and zinc electrodes are used as cathode and anode respectively, Cow urine that contains uric acid and water undergoes electrolysis and generate voltage. From one liter of cow urine 1V is generated. A system using 10 plastic containers, called cells, containing 1 liter cow urine each, was connected in series to generate 10V. The system is automated to discharge and refill the system with fresh cow urine periodically.**

Keywords— Renewable energy, biomass, low cost power, automation, sustainability.

I. INTRODUCTION

Electrical energy is derived from electrical potential energy or kinetic energy and it is one of the highly consumed energies. It plays a crucial role in development of the nation and societal welfare largely depends on sufficient and continuous supply of electricity. It is observed that global industrial development in the past century relied heavily on fossil fuels which not only caused concerns on depletion of non-renewable sources but also caused global warming due to greenhouse gases. According to recent studies demand for energy will double globally by 2050. Since biomass is the largest potential source of renewable energy providing 10% of current world's primary energy supplies. As a result development of energy from biomass and bio-waste is urgently needed.

A cow produces approximately 16 liters of urine every day, cow urine as a source does not produce methane gas, copper and zinc electrodes used in the system are cost effective. Also urine discarded from this process can be used as a fertilizer. Therefore, this system does not give out any waste nor damages the environment, electricity obtained through this method is produced and consumed at minimum cost.

II. COW URINE COMPOSITION

Cow urine is alkaline in nature and contains Nitrogen, Sulphur, Phosphate, Sodium, Manganese, Carbolic acid, Iron, Silicon, Chlorine, Magnesium, Urea, Gold acids, Calcium salts and it also contains Vitamin- A, B, C, D and E. A research states that cow urine maturated first (early morning) would have more macro and micronutrients along with other enzyme/ urea content that makes it more effective. [1][2][4]

Uric acid is a heterocyclic compound of carbon, nitrogen, oxygen, and hydrogen- $C_5H_4N_4O_3$. It forms ions and salts known as urates and acid urates. Therefore, uric acid when reacted with copper forms copper urate ions. Upon forming ionic bond in presence of zinc, these urate ions then start to produce voltage. [3][5][6]

III. EXPERIMENTATION PHASE

To obtain the desired voltage from urine, initially urine was tested with different types of containers, by stacking electrodes to check if thickness of electrodes can affect voltage generated, it was observed that decreasing area of cross-section increases voltage but increasing electrodes thickness does not affect rate of electrolysis. It was observed that upon connecting load to cells, urine could produce same voltage for 3 days undisturbed, electrodes could be used for 2 months with regular cleaning. After a series of experiments, 10V was obtained from 10 liters of cow urine and finally LEDs of 5V each were glowing continuously for 3 days and after 3 days used urine was replaced with fresh urine.

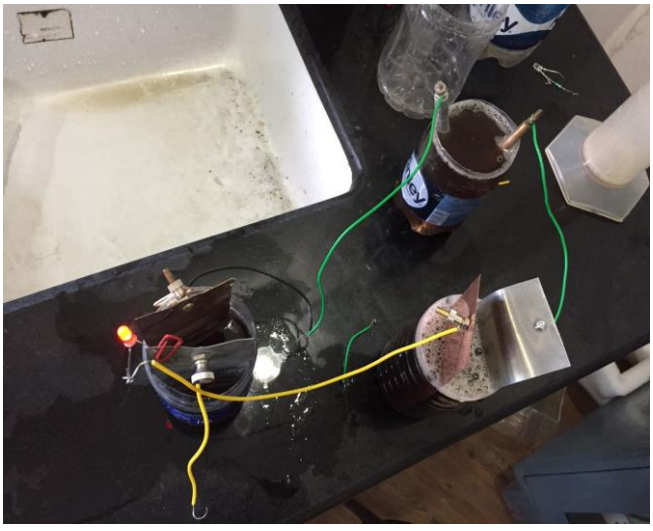

Fig. 1. Three plastic cells series system.

In this experiment 2.3V was generated using 3 plastic containers as cells, as shown in Fig. 1., and by pouring 300 ml of urine in each container. A LED was connected at the output as can be seen in Fig. 1. This set up was left with the

LED glowing for observation, and it was observed that fall in voltage started on the fourth day.

Fig. 2. 10 tetra pack cells connected in series.

Later 10 cells with 1 liter urine in each cell was developed, as shown in Fig. 2, this system produced 10V. Two 5V LEDs were connected as load to this system and was left switched on for an overnight to observe the drop in voltage but for a day the drop was insignificant and upon continuous observation for 4 days it was noted that the drop was insignificant. After the 4th day, the voltage started to drop. It was also observed that the current generated was very negligible and the tetra packs were reacting to the electrolysis process. This reduced the efficiency of the system. Therefore to generate more current tetra packs were replaced with plastic containers and instead of series connection, to gain more current, series-parallel connection was employed, as show in Fig. 3.

Fig. 3. Eight plastic cell in series-parallel system.

The series parallel connection produced maximum 36.9 mA current for a 4 liter system. It was found that the current was not stable and was varying between 36.9mA and 11.6mA, as shown in Fig. 4. The system was scaled up to generate more current, and it was possible to charge a mobile phone as shown in Fig. 5. The rate of charging was low as compared to the rate of charging of a normal mobile phone charger. It took longer time to charge the mobile phone.

Fig. 4. Voltages for a series-parallel connection system.

Fig. 5. Charging of cell phone.

IV. System Design

Cow urine is used as electrolyte, Copper and zinc plates were used as cathode and anode, respectively. Fig. 6. show a cell that contains cathode (copper) and anode (zinc) as shown. To design a power generating unit, 10 such cells (containers in which electrolysis takes place) were designed. The size of cell is an important factor, as the rate of electrolysis is faster when the cell size is compact and the distance between cathode and anode is minimum, also, the output is maximum when electrodes are completely immersed into the electrolyte. In this project plastic containers used can accommodate 1 liter of urine, also the area of cross section is minimum which also helps in generating maximum voltage.

These cells are then assembled together and were connected in series-parallel to generate voltage, as shown in Fig. 7. The plastic tank is the reservoir, in which the urine is stored. From the reservoir, urine is transported to the cells through pipes as shown in Fig. 7. A manual valve is connected at the outlet of the reservoir to control the flow to the cells manually.

Fig. 6. Cell containing copper and zinc electrodes

Fig. 7. Complete system setup

V. SYSTEM AUTOMATION

A simple two point level sensor, as shown in Fig. 8, was designed to control the level of urine in each cell. The level sensor indicates minimum and maximum level of urine in the cell. A battery is connected through the board, also two wires are separately drawn from two points, and the output through these wires gives the level when circuit is closed.

To control the flow of cow urine from reservoir to inlet, a solenoid valve is used, in case of failure a manual valve is also placed and it is always open. The solenoid valve, shown in Fig. 9, used in this experiment is a 12V DC, normally closed solenoid valve that operates at 0.2-0.8 bar pressure and it requires about 200 mA current. Along with solenoid valve a fly back diode is also used to avoid spark from solenoid valve, when powered, as solenoid valve is an inductive load and on direct application of voltage a spark is produced.

Level sensor is interfaced with a microcontroller. Voltage obtained from level sensor is compared with the voltage obtained for maximum and minimum level in the cell through experimentation. At maximum level the solenoid valve is closed, and at minimum level the solenoid valve is opened. A relay is used to operate the valve.

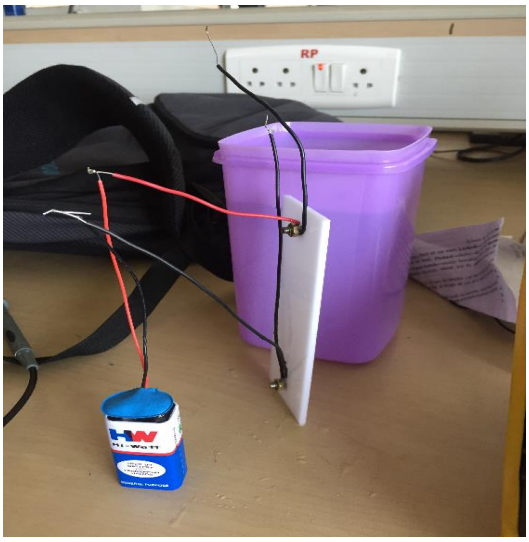

Fig. 8: Level sensor

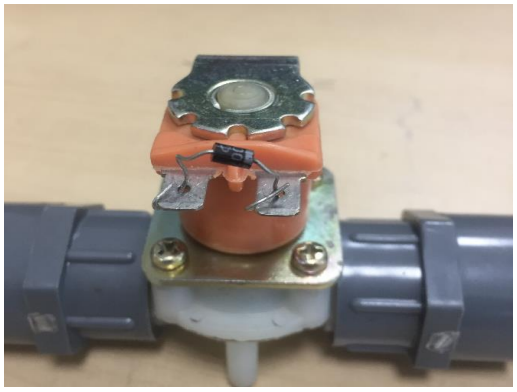

Fig. 9. Solenoid valve

VI. RESULT ANALYSIS

Fig. 10. Show the variation of voltage generated from 930ml of cow urine over a period of 1 hour. It can be observed that the voltage remains almost constant with very negligible variation. The electrodes used were of small cross-sectional area.

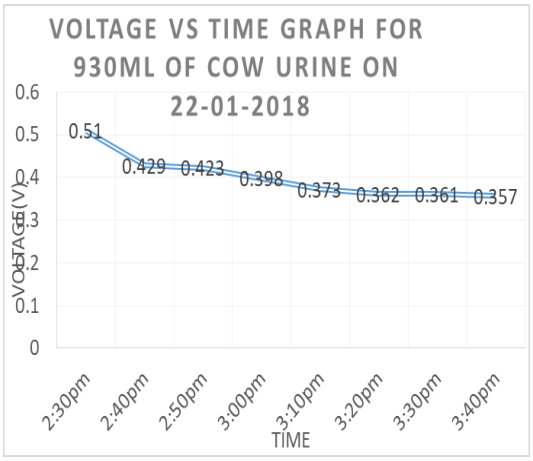

Fig. 10. Voltage variation for 930ml cow urine.

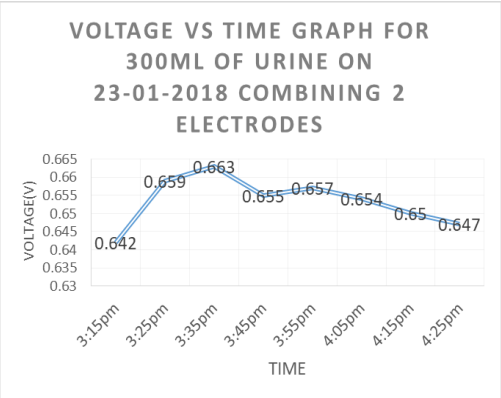

Fig. 11. Voltage variation for 300ml cow urine using a higher cross-section electrode.

Fig. 11. Show the response for higher cross-section electrode. It can be observed that as the area of cross-section of the electrode is increased there is an increase in the voltage generation.

Later two electrodes were combined and the thickness of the electrode was increased. The voltage generated with thicker electrode was not as significant as was for the electrode with increased area of cross-section. The voltage generated with thick electrode from 1000ml cow urine is shown in Fig. 12.

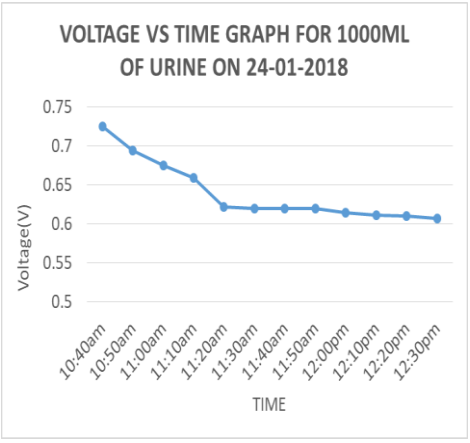

Fig. 12. Voltage variation with thicker electrode.

VII. Conclusion

In this project a cost effective power generation unit using a renewable source was developed. Cow urine, which is abundantly available, free of cost, in rural areas, was used as the renewable source. Once the system is setup, there is no recurring expenditure on the resources for generation of electricity.

Electrolysis process was used to generate electric potential, copper and zinc electrodes were used as cathode and anode respectively and produced voltage, and then to make it a power generating unit. An automatic power generating systems was designed and developed.

Using cow urine as source batteries, cars that run through battery and appliances that run using batteries can be built, this reduces consumption of fossil fuels as source to generate electricity. A power generation unit can be developed in large scale using cow urine as the source, this system can be enhanced and can be used for both rural and urban applications.

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