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Triplet Deadly Combination of Renewable Energy Resources for Generation of Electric Power

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ABSTRACT

Now a day's cost effective and environment friendly power generation using renewable energy sources gain prominence. Engineers are looking towards the sources like solar, wind, geothermal, ocean and bio mass. In this paper, three different sources like solar, wind and microbial fuel cell were used to build up a hybrid system to generate the electric power. Hybrid systems can provide a steady community-level electricity service, such as village electrification, This can also upgraded to the grid connection in future. When one of the sources fails, the other two sources will continuously supply power without interrupt. In microbial fuel cell, vegetable waste was used to generate the power, so in the absence of sun and wind also this hybrid setup generates power for standalone applications. Simulink model was designed for each source and values were compared against the hardware set up.
Key terms: Microbial fuel cell, Renewable energy

1. INTRODUCTION

They are available in plenty and by far most the cleanest sources of energy available on this planet. Most of the renewable sources of energy are fairly non polluting and considered as clean. Different Energy Sources are:

- Solar Energy
- Wind Energy
- Biomass Energy
- Ocean Energy
- Biological hydrogen production.

Of the above energy sources, solar and wind energy are more reliable sources and are considered in this paper to produce electricity. Along with those sources, microbial fuel cell also designed to produce electricity.

1.1. Solar Energy

Solar energy, radiant light and heat from the sun, has been harnessed by humans since ancient times using a range of ever-evolving technologies. Solar radiation, wind and wave power, hydroelectricity and biomass, account for most of the available

renewable energy on earth. Only a minuscule fraction of the available solar energy is used due to the non availability of solar panels to all and the huge space occupied by it so it is not preferred but the solar energy can be used for different purpose such as solar heater, solar cooking, solar cooling, solar car etc. So the solar energy can be used for different purpose and the future applications are also possible.

The sun emits energy at an extremely large and relatively constant rate, 24 hours per day, 365 days per year. If all of this energy could be converted into usable forms on earth, it would be more than enough to supply the world's energy demand. However, this is not possible because the earth intercepts only a small fraction of the energy that leaves the sun; the earth rotates such that a collection device on the earth's surface is exposed to solar energy for only about half of each 24-hour period; and conditions in the atmosphere, such as clouds and dust, sometimes significantly reduce the amount of solar energy reaching the earth's surface[4].

1.2. Wind Energy

Wind is the motion of air masses produced by the irregular heating of the earth's surface by sun. These differences consequently create forces that push air masses around for balancing the global temperature or, on a much smaller scale, the temperature between land and sea or between mountains.

Wind energy is not a constant source of energy. It varies continuously and gives energy in sudden bursts. About 50% of the entire energy is given out in just 15% of the operating time. Wind strengths vary and thus cannot guarantee continuous power. It is best used in the context of a system that has significant reserve capacity such as hydro, or reserve load, such as a desalination plant, to mitigate the economic effects of resource variability.these landowners must carefully weigh the benefits and risks and research just what a wind turbine on their property would involve [3].

1.3. Microbial Fuelcell

It has been known for almost one hundred years that bacteria could generate electricity. But only in the past few years has this capability become more than a laboratory novelty. The microbial fuel cell (MFC) is a new form of renewable energy technology that can generate electricity from what would otherwise be considered waste. The reasons for this recent interest in using bacteria to generate electricity area combination of the need for new sources of energy, discoveries about microbial physiology related to electron transport, and advancement of fuel cell technologies. Microbial fuel cells produce electricity from organic matters.

Unlike conventional fuel cells, MFC have certain advantages like high energy conversion efficiency and mild reaction conditions. In addition, a fuel cell's emissions are well below regulations. MFCs also use energy much more efficiently than standard

combustion engines which are limited by the Carnot Cycle .In theory an MFC is capable of energy efficiency far beyond 50%. In fact, using the new microbial fuel cells, conversion of the energy to hydrogen is 8 times as high as conventional hydrogen production technologies .In an MFC, bacteria are separated from a terminal electron accept or the cathode so that the only means for respiration is to transfer electron to the anode. An MFC is thus a bio electro chemical system that derives electricity by mimicking bacterial interactions found in nature. Microorganisms catabolize compounds such as glucose, acetate or waste water .It is a device that converts chemical energy to electrical energy by the catalytic reaction of microorganisms [2].

2. SIMULINK AND HARDWARE MODEL OF SOLAR PANEL:

A solar cell is basically a p-n junction fabricated in a thin wafer of semiconductor. The electromagnetic radiation of solar energy can be directly converted to electricity through photovoltaic effect. Fig 2.1 shows the Simulink model of solar cell. Fig 2.2 shows the output from the solar cell and it is obtained as 9.7 V.

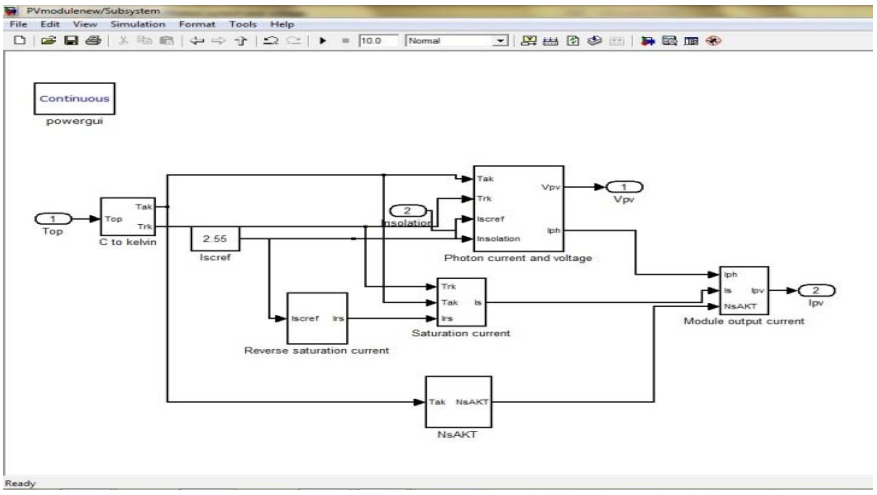

Fig 2.1:MATLAB model of solar panel

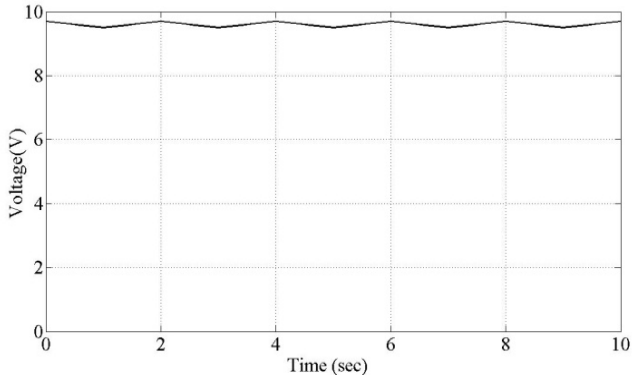

Fig 2.2: Output of solar panel

The solar panel is simulated in MATLAB and the results obtained are verified with the hardware results. Fig 2.1 shows the block diagram of solar cell voltage reading of 9.6v from solar panel having average rating of 6w and when the solar radiation falls on panel this is converted to electricity and stored in the battery of 6v.At the time of charging it is indicated by the glowing of led. In fig 2.3 the power stored in the battery is supplied to load .In this case the load used is CFL bulb.

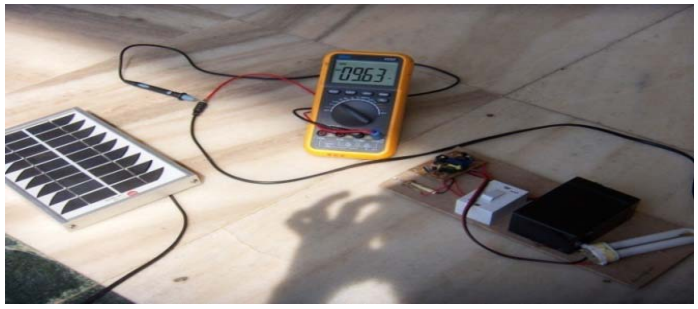

Fig 2.3: Multimeter showing Solar Panel output voltage

3. SIMULINK AND HARDWARE MODEL OF WIND TURBINE:

Wind turbines operate on a simple principle. The energy in the wind turns two or three propeller-like blades around a rotor. The rotor is connected to the main shaft, which spins a generator to create electricity. Wind turbines are mounted on a tower to capture the most energy. Fig 3.1 shows the block diagram of wind turbine which is implemented in MATLAB

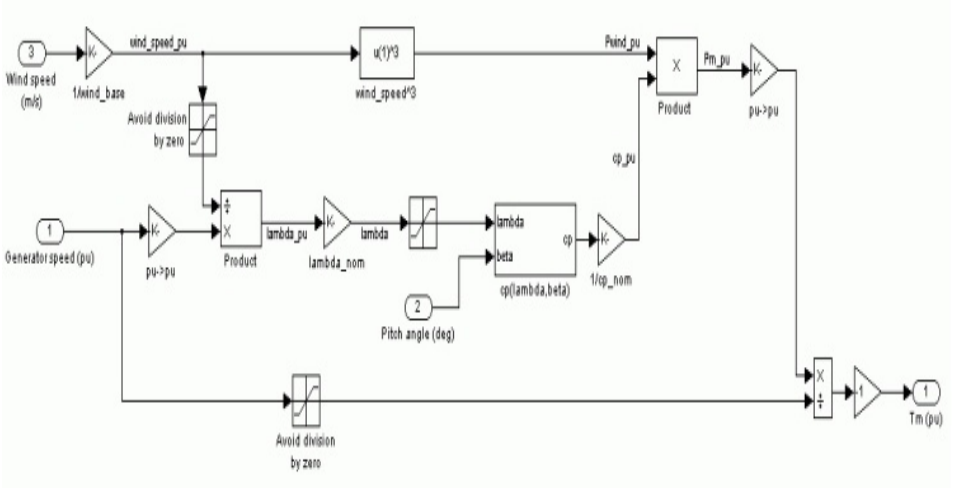

Fig3.1:MATLAB model of wind Turbine

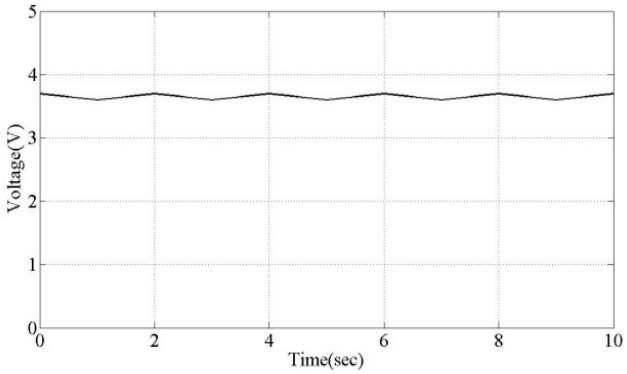

Fig 3.2: Output of wind turbine

Fig 3.1 shows the block diagram of wind turbine implemented in MATLAB and Fig 3.2 shows the output voltage from wind turbine which is 3.9V. Fig 3.3 shows the hardware arrangement of wind turbine and the output voltage obtained to be 3.84V. By the inflow of the wind the blades rotate and the output obtained is DC voltage and this DC voltage is converted to AC voltage by using inverter, finally this voltage is stored in the battery indicated by the glowing of led as shown above. In Fig 3.4 the voltage stored in the battery is being supplied to load.

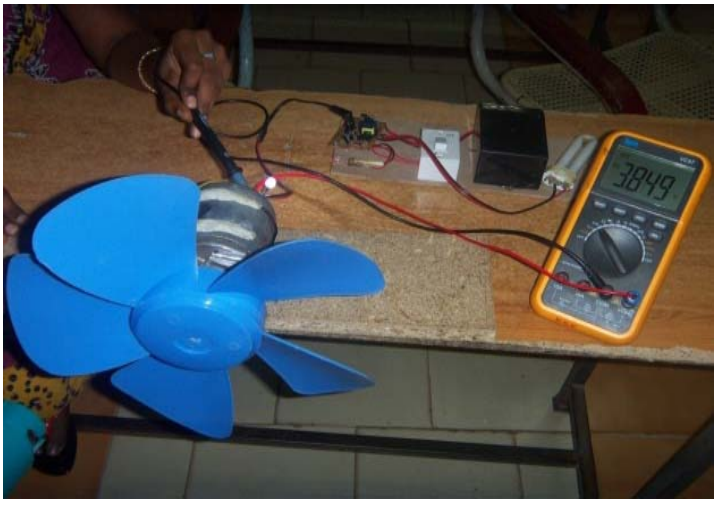

Fig 3.3: Multimeter showing output voltage of wind turbine

4. SIMULINK AND HARDWARE MODEL OF MICROBIAL FUEL CELL:

Energy from the microbial fuel cell has a very high potential to replace the fossil fuel. It is also potential contributor to low greenhouse gas emissions. Energy conversion in this process uses the raw material from agricultural and forest product residues or fermented depending on the product and the desired carrier product.

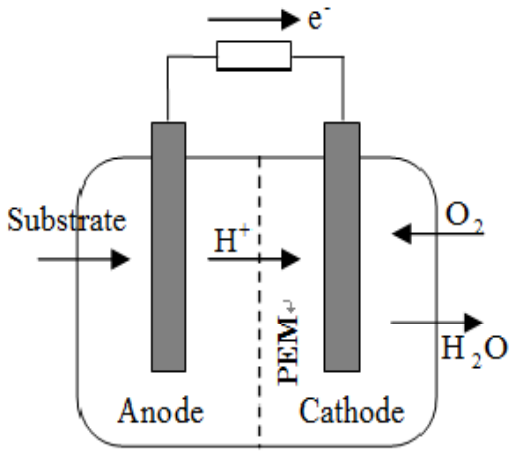

Fig 4.1: Basic structure of class two chamber MFC

Fig 4.2: Hardware set up of MFC

In the above Fig 4.3 a typical two compartment microbial fuel cell (MFC) has an anodic chamber and a cathodic chamber connected by a PEM, or sometimes a salt bridge, to allow protons to move across to the cathode while blocking the diffusion of oxygen into the anode. The concept behind MFC is similar to biomass. So the MFC can be implemented in MATLAB as bioreactor. Electrons produced by the bacteria from these substrates are transferred to the anode (negative terminal) and flow to the cathode (positive terminal) connected by a conductive material containing a resistor, or operated

under a load (i.e., producing electricity that runs a device) .Hence by electrolysis electricity is produced with voltage of 1.6v.

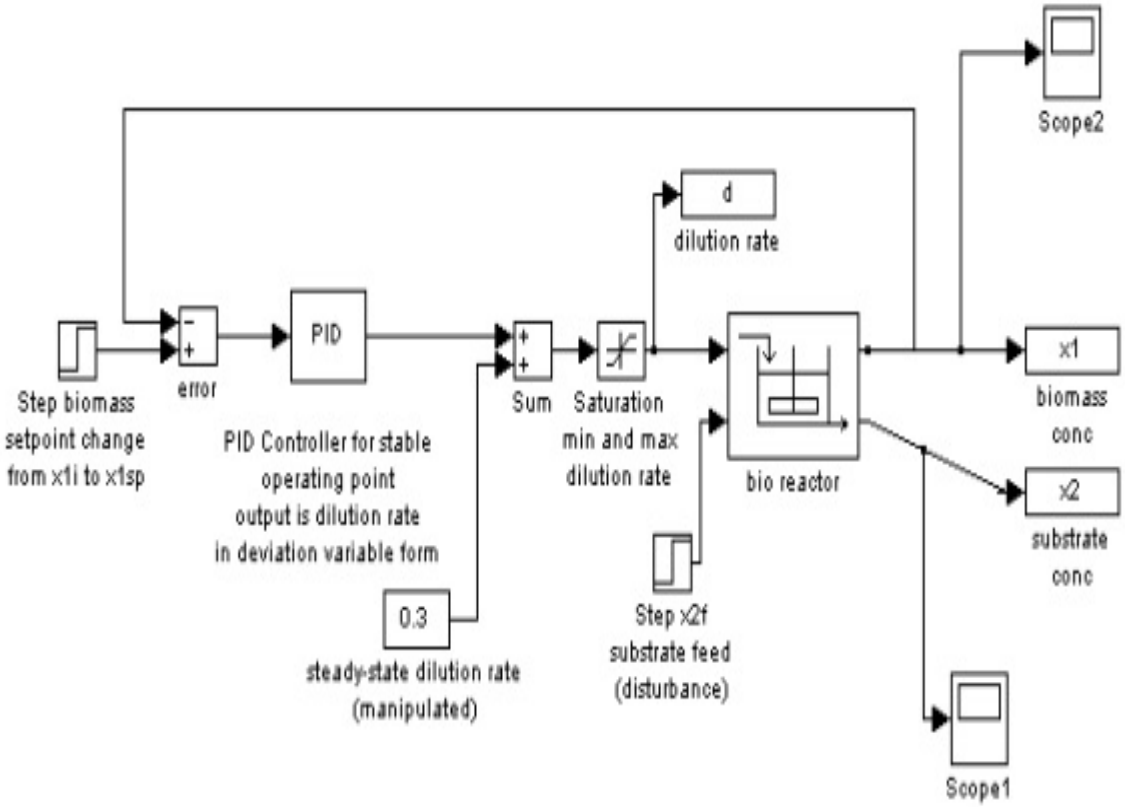

Fig 4.3: Simulink model of MFC

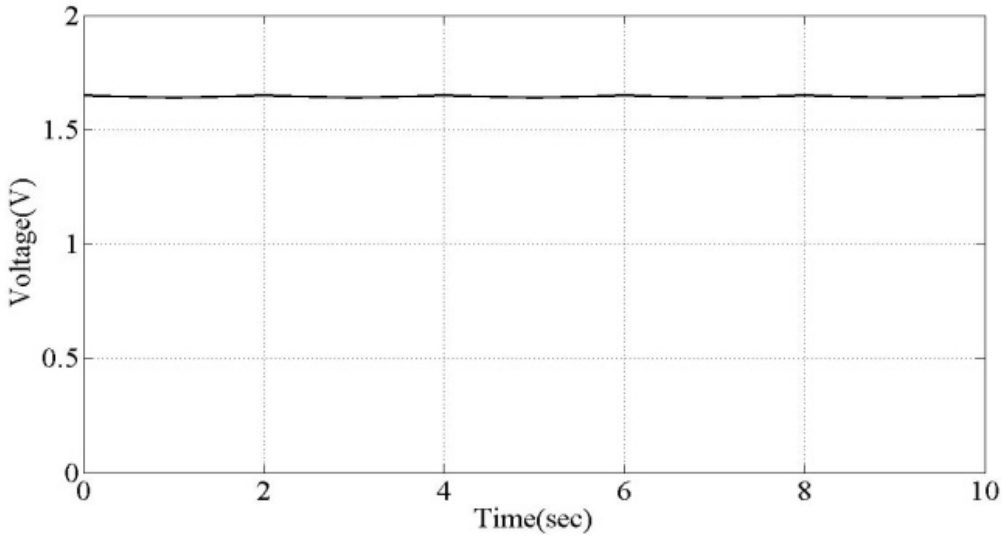

Fig 4.4: MATLAB output from above arrangement

5. COMPLETE HARDWARE MODEL AND ITS OPERATION:

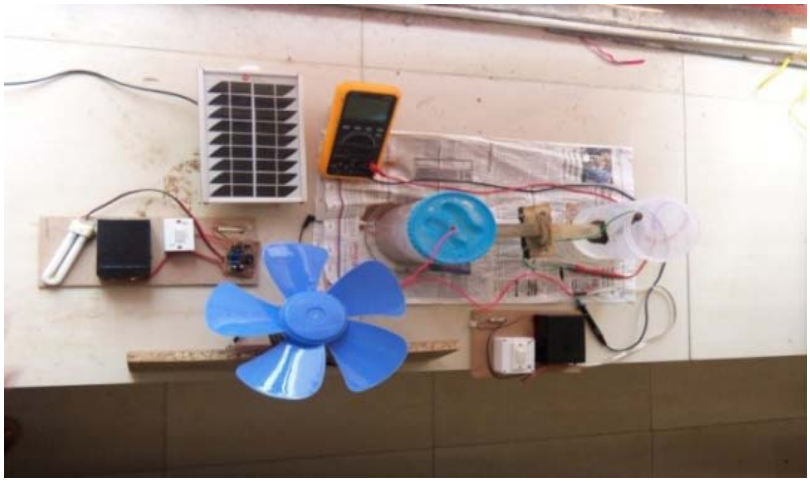

Fig 5.1: Hardware model of solar, wind and microbial fuel cell

When Sun radiations fall on the solar panel then it converts the solar energy in to electricity, this is stored in the battery. The battery while charging is indicated by glowing of led. When Wind flows, this activates the rotor and blades. This rotor and blades spin the shaft and gear box, this shaft spins the generator resulting in the electrical output. The output produced is of AC voltage, this is converted to DC voltage by using rectifier. This DC voltage is now stored in the battery. Similarly waste material in microbial fuel cell produce electricity and stores in battery. This waste material may be vegetable waste, sand, mud. The battery stores the DC voltage, but the loads need AC so we use inverter to convert this DC voltage in to AC voltage and is supplied to load.

6. CONCLUSION AND FUTURE SCOPE

Here, as we use Solar, Wind and Microbial fuel cell, they are eco friendly to atmosphere. Effect of green house gases reduces and hence heating of earth's surface reduces. Even though the initial cost is high, running cost reduces with utilization of renewable sources. At present we designed the sources for small ratings. If these are designed with high ratings it is capable of supplying power even to large industries continuously as we store the energy in batteries for future use. Of the three sources Microbial Fuel Cell produce less voltage here, but if the arrangement is modified we can get large voltage.

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