Development of a new theory for PKL electricity using Zn/Cu electrodes: per pair per volt

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Abstract

Energy is one of the most essential resources of the present world. We can not imagine the civilization without energy specially electrical energy. In broader sense we can divide electric energy in two types, one is non-renewable energy and the other is renewable energy. Due to the drawbacks of non-renewable energy and advantages of renewable energy, the use of renewable energy is increasing day by day. Eventually new sources and technology is coming out. One of the new technologies of renewable source is the production of electricity from Pathor Kuchi Leaf (PKL), the scientific name of that is Bryophyllum Pinnatum. We can easily produce electricity from PKL by immersing a Zinc and a Copper plate in to the juice of PKL. This system produces theoretically 1.1 volts per cell. So if we need higher voltage or higher current we need to combine more cells to get the desire power. To keep it in mind, In this paper a new approaches is presented to get more power from per cell of the PKL system which is out of traditional cell concept for per cell power.

Keywords: *New approach, PKL electricity, Utilization, Soil Pot, Per pair per volt.*

I. Introduction

A cell is an arrangement of two electrodes in an electrolytic solution capable of producing electricity. In a cell electricity is produced due to the chemical reaction within the cell between electrodes and electrolyte [1-9]. How much voltage will be produce in a cell depends mainly on the electrodes and electrolyte used. So for a particular set of electrodes this voltage is defined in the Table of Standard Reduction Potentials**.** As per the table half reaction potential for copper is 0.34 Volts and the

half reaction for zinc is -0.76 Volts[10-19]. So if we consider a cell with Cu and Zn electrode than the cell potential will be 0.34–(- 0.76) =1.1 Volt[20-29]. So if we need to produce 6 volts we need to connect six cells in series. Again if one cell can generate 0.5 ampere current and we need 2.0 ampere current then four Cells will be connected in Parallel[30-39]. So for a power of 12 watt with 6 volts from this type of cell we need to connect six cells in series to get 6 volts and to get 12 watt power we need 2 ampere current to flow through the circuit. Hence, it will be needed to connect 4 sets of 6 cells in parallel combination. For higher power we need to undergo same series parallel combination of cells, which makes the system more complex and lower the efficiency of the system[40-47].

II. Theory

II.A Effect of combination of PKL cells

The power produced by PKL cell is low. Moreover it has a high internal resistance. Due to this high internal resistance the voltage drop as well as power loss within the cell is high[48-57]. On the other hand we need to undergo series connection of several cells to get the desire voltage level from the system. When we connect several cells in series it also adds the internal resistances of individual cells[58-65].So the internal resistances of the combination of cells multiples and become higher. This high value of internal resistance is a very big barrier to get high power. For an example, let us consider a PKL cell with a cell voltage is 1.0 volt with a internal resistance 0.6 Ω[66-75]. To use this PKL power for a 6 volt system we need to connect 6 PKL cells in series. Also let us consider the load needs 0.5 Ampere current[76-85]. Figure 1 shows the connection for 6 PKL cells in series.

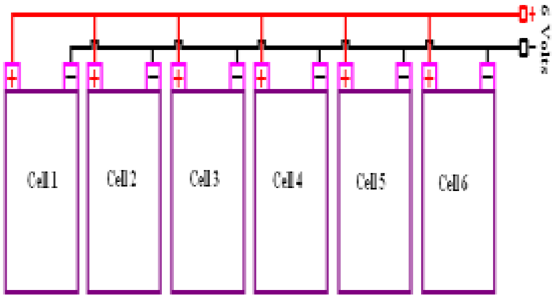

Figure 1: Six cells are connected in series for an output of six volts.

From the figure we can find that the total internal resistance of the PKL system is 0.6 × 6 = 3.6 Ω. If the system draws a current of 0.5 Ampere, the voltage due to internal resistance will be 0.5 × 3.6 = 1.8 Volts[86-95]. Therefore, 6.0 – 1.8 = 4.2 volts will be available at the output of the PKL system. Again if we draw 0.4 Ampere current from the PKL system the voltage drop due to internal resistance will be 0.4 × 3.6 = 1.44 volts and the output voltage will be 6.0–1.44 = 4.56 volts. It indicates that the voltage regulation of the system will improved if we draw less current. When the current is 0.5 ampere the voltage regulation will be [(6.0 – 4.2) ÷ 4.2] % = 43 %. Again when the current is 0.4 ampere the voltage regulation will be [(6.0 – 4.56) ÷ 4.56] % = 32 %. All these figures are very high values for a power supply system[96-105]. For a reliable power supply system output voltage should be keep stable and the voltage regulation should be as low as possible. For a stable system if we consider the maximum allowable voltage regulation for the PKL system will be 5 % then the above system should keep a output voltage 5.7 volts and in this condition it could be suitable for supply only 0.08 ampere current[106-115]. Therefore the high value of internal resistance of the PKL cell is the big barrier to draw the required power from it[116-120].

II.B Producing higher power avoiding the higher value of internal resistance.

We know the power is the product of voltage and current. If we want big power we need to increase the voltage or current or both voltage and current. For an example if we want to generate a 3.0 watt power from the system we can generate it keeping the voltage 6 voltage and producing a current 0.5 ampere. So the product will be 6.0 × 0.5 = 3.0 Watt. Again we can produce the same 3.0 watt power producing a voltage of 12 volts and drawing a 0.25 ampere current[121-125]. Because, in this case, the product of voltage and current will be again 12 × 0.25 = 3.0 watt. In brief if we produce more voltage we need to draw lower current for the same power output.Again the internal resistance is the barrier on the way of flow of current only. Therefore if we draw less current the voltage drop due to internal resistance will be less. Hence it will increase the voltage regulation and hence system stability. For example in the first case when we produce 6.0 volts with a current of 0.5 ampere the voltage regulation will be 43 %. But in the second case when we produce 12 volts with a current of 0.25 ampere the voltage regulation will be 8 % only considering the same internal resistance 3.6 Ω in both the cases[126-130].

II.C Proposed Concept beyond the Cell Concept

In a Voltaic cell two half cell is connected with a salt bridge. Electric potential developed between each half cell produce based on the reaction of electrode and electrolyte. How much potential will be generated in a half cell depends on the electrodes and electrolyte used and for a particular set of electrode and electrolyte each half cell potential is listed in a **Table of Standard Reduction Potentials[**130-133**].** A short version of such table is given below

Table 1: Standard Electrode Potential

Reduction Half-reaction	Standard Potential
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$	+0.77
$I_2(l) + 2e^- \rightarrow 2I^+(aq)$	+0.54
$Cu^{2+}(aq)+2e^- \rightarrow Cu(s)$	+0.34
$Sn^{4+}(aq)+2e^- \rightarrow Sn^{2+}(aq)$	+0.15
$S(s)+2H^+(aq) + 2e^- \rightarrow H_2S(g)$	+0.14
$2H^+(aq) + 2e^- \rightarrow H_2(g)$	0.00
$Sn^{2+}(aq) + 2e^- \rightarrow Sn(g)$	-0.14
$V^{3+}(aq) + e^- \rightarrow V^{2+}(aq)$	-0.26
$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$	-0.44

$Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$	-0.74
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	-0.76
$Mn^{2+}(aq) + 2e^- \rightarrow Mn(s)$	-1.18

As per the table half reaction potential for copper is 0.34 Volts and the half reaction for zinc is -0.76 Volts. So if we consider a cell with Cu and Zn electrode than the cell potential will be 0.34 – (- 0.76) = 1.1 Volts. In PKL cell we need not to use separate half cell connected with salt bridge rather two half cell keep in the same container. The concept of salt bridge is absent in PKL cell. But the PKL produce the potential difference between the anode and cathode as per the standard reduction potential. It also follows the Nernst equation. We know to produce the higher voltage we need to connect required number of cells in series. The connection is as shown in figure 2.

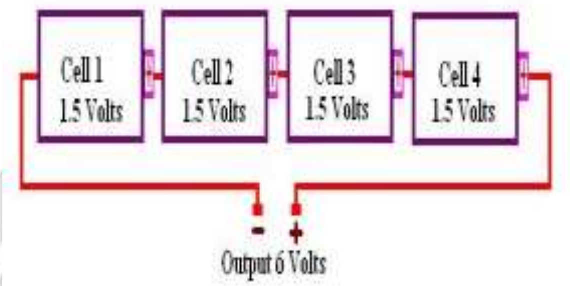

Figure 2: Cells are connected in series to provide higher output voltage.

For system voltage, $V_{System} = V_{Cell\ 1} + V_{Cell\ 2} + V_{Cell\ 3} + \dots\dots + V_{Cell\ n}$

i.e. $V_{System} = \sum_{n}^{x=1} V_{Cell\ x}$

For system current, $I_{System} = I_{Cell\ 1} = I_{Cell\ 2} = I_{Cell\ 3} = \dots\dots = I_{Cell\ n}$

Based on this concept following arrangement can be made in a same cell to produce higher voltage.

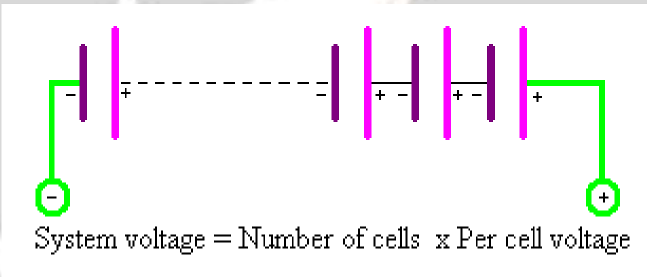

Figure 3: Series connection of cells.

A practical arrangement of the proposed concept is shown in figure 3 below:

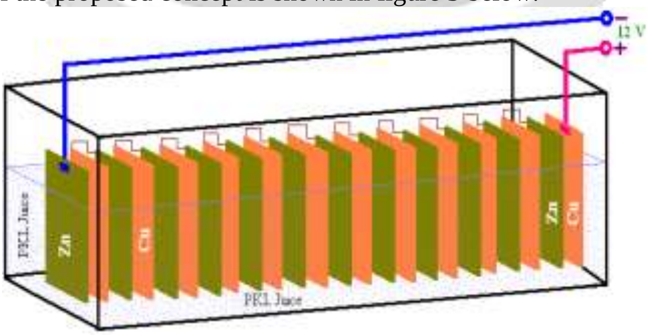

Figure 4: Proposed concept of producing higher voltage from a single cell.

Figure.5: An experimental set-up for producing higher voltage from a single cell.

Here Zinc plates and copper plates are put in sequence in the same container within the PKL juice. A Zine plate and a Copper plate form a micro cell. These two plates are connected physically. One such cell produces 1.1 volts. In this figure there are 12 such micro cells placed in the same container. There is no physical connection between the micro cells. But PKL juice itself acting as the connecting media between micro cells. Thus this combination will produce 1.1×12=13.2 volts. We can use this combination to get the desired voltage from a one cell. Practically let us consider this voltage is 12 V.

III. Advantages of the proposed concept

Some of the advantages of the proposed concept are listed below:

1. It can produce higher voltage in a single cell.
2. For the desired voltage output no need to go for separate cell connected externally.
3. No need to separate the cells.
4. Reduce the internal connection and hence reduce the internal resistance and loss.
5. We can get desired output increasing the area of plate.

IV. Further Study

The following studies have to be done for this new concept:

1. Internal resistance of this new PKL system with comparison to the traditional system.
2. Voltage Regulation of this new PKL system with comparison to the traditional system.
3. Energy efficiency of this new PKL system with comparison to the traditional system.
4. Voltage efficiency of this new PKL system with comparison to the traditional system.
5. Current efficiency of this new PKL system with comparison to the traditional system.
6. Pulse Performance of this new PKL system with comparison to the traditional system.
7. Self discharge characteristics of this new PKL system with comparison to the traditional system.
8. Discharge characteristics with load of this new PKL system with comparison to the traditional system.
9. Capacity the cell of this new PKL system with comparison to the traditional system.
10. Temperature effect of this new PKL system with comparison to the traditional system.
11. Variation of [Cu^{2+}] ions with the Variation of concentration of PKL juice of this new PKL system with comparison to the traditional system.
12. Variation of [Cu^{2+} ions with the Variation of concentration of PKL juice during self discharge of this new PKL system with comparison to the traditional system.
13. Variation of [Cu^{2+}] ions with the Variation of concentration of PKL juice during discharge Characteristics with load of this new PKL system with load with comparison to the traditional system.
14. Variation of [Cu^{2+}]ions with the Variation of distance between two plates for the constant PKL juice concentration of this new PKL system with comparison to the traditional system.
15. Variation of [Cu^{2+}]ions with the Variation of distance between two plates for the constant PKL juice concentration during self discharge of this new PKL system with comparison to the traditional system.
16. Variation of [Cu^{2+}] ions with the Variation of distance between two plates for the constant PKL juice concentration during discharge characteristics with load of this new PKL system with comparison to the traditional system.
17. Variation of [Zn^{2+}]ions with the Variation of concentration of PKL juice of this new PKL system with comparison to the traditional system.
18. Variation of [Zn^{2+}] ions with the Variation of concentration of PKL juice during self discharge of this new PKL system with comparison to the traditional system.

19. Variation of $[Zn^{2+}]$ ions with the Variation of concentration of PKL juice during discharge Characteristics with load of this new PKL system with load with comparison to the traditional system.
20. Variation of $[Zn^{2+}]$ ions with the Variation of distance between two plates for the constant PKL juice concentration of this new PKL system with comparison to the traditional system.
21. Variation of $[Zn^{2+}]$ ions with the Variation of distance between two plates for the constant PKL juice concentration during self discharge of this new PKL system with comparison to the traditional system.
22. Variation of $[Zn^{2+}]$ ions with the Variation of distance between two plates for the constant PKL juice concentration during discharge characteristics with load of this new PKL system with comparison to the traditional system.

V. Conclusion

This work is totally different from traditional Cell or battery concept. Experimentally we have to find and compare the following parameters: Internal resistance of the cell, Voltage regulation of the cell, Energy efficiency of the cell, Pulse performance of the cell , Discharge characteristics with load of the cell, Self discharge characteristics of the cell, Temperature effect of the cell and Life cycle of the cell. This work will be the guide line for future work.

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