Electrical Performances of PKL (Pathor Kuchi Leaf) Power

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Abstract

It has been designed and developed an electrochemical cell by Pathor Kuchi Leaf (PKL) as a electrolyte and Zn/Cu has been used as an electrodes to product quality power for practical utilization. Constructing an affordable cost, environment friendly simplified electrical energy source with Pathor Kuchi Leaf (PKL) for power electrifications which will significantly upgrade the life style of 1.275 billion people in Bangladesh. 1.5 billion people in the world still lack access to electricity-well over of one fifth of the world's population. Some 85% (1.275 billion) of these people live in rural areas, mainly in Sub-Saharan Africa and South Asia (Bangladesh, India, Sri Lanka, Pakistan, Nepal and Bhutan). This innovative technology will meet essential requirements as lighting, telecommunication as well as information access. The studies on Bryophyllum Pinnatum (locally called Pathor Kuchi Leaf) showed that its pH is 4.8 with 10% water and 4.2 without water and Titratable acidity is 0.88%. Investigations showed that Electricity prepared by B. pinnatum (Bryophyllum pinnatum) leaf juice/Sap has significant performance and comparatively cheap with respect to another Renewable Energy Sources and the conventional gas based Electricity. Electrodes are put into the Bryophyllum Pinnatum Leaf (BPL) or Pathor Kuchi Leaf (PKL) sap and they produce substantially sufficient amount of electricity to power energy consumed electronics and electrical appliances. $CuSO_4.5H_2O$ *solution is used as a secondary salt. The role of* $CuSO_4.5H_2O$ *solution has been studied. The Energy efficiency for both engineering and chemical view has also been studied. The variation of PKL power efficiency with time has also been studied. This study on showed that, the energy efficiency is about 65%. It is not needed to charging the PKL cell uses external energy sources. The voltaic efficiency of the PKL cell is significant for the generation of electricity. . Most of the results have been tabulated and graphically discussed.*

Key words:-*PKL, Electrical, Performance, Power, Capacity.Efficiency*

Introduction

The efficiency of an entity (a device, component, or system) in electronics and electrical engineering is defined as useful power output divided by the total electrical power consumed (a fractional expression), typically denoted by the Greek letter small Eta (η).

$$\therefore \ \text{Efficiency}, \eta = \frac{\text{Useful power output}}{\text{total power input}}.$$

There are three types of efficiencies have been studied. These are voltage efficiency, current and energy efficiency. The efficiencies for both engineering and chemical view have been studied. The Lead Acid battery is not 100% efficient at storing electricity. The efficiency will depend on a number of factors including the rate of charging or discharging. The higher the rate of charge or discharge lowers the efficiency. Overall, an efficiency level of 85% is often assumed. The state of charge of the battery also affects charge efficiency. With the battery at half charge or less, the charge efficiency may be over 90%, dropping to nearer 60% when the battery is above 80% charged. However it has been found that if a battery is only partially charged, efficiency may be reduced with each charge. If this situation persists (the batteries never reaching full charge), the life of the battery may be reduced. It is generally understood that battery charge efficiency is high (above 95%) at low states of charge and that this efficiency drops off near full charge [24]

Theory for determination of PKL electrochemical Cell efficiency from the engineering view:

Battery is subjected to charge. A battery needs to charge before use. During charging it uses energy and during discharging we get energy from it. The efficiency of a battery is calculated as below: $\text{Energy Efficiency} = \frac{E_D}{E_C}$. Where, E_C= Total energy during charging, E_D = Total energy during discharging. Now if, V_C = Charging Voltage (Volt), I_C = Charging Current (Ampere),T_C = Charging time (Hour),Then $E_C = V_C I_C T_C$
Again if, V_D = Discharging Voltage (Volt),I_D = Discharging Current (Ampere)
T_D = Discharging time (Hour), Then $E_D = V_D I_D T_D$

Therefore, we can write, $$\text{Energy Efficiency} = \frac{V_D I_D T_D}{V_C I_C T_C}$$

or, $$\text{Energy Efficiency} = \left(\frac{V_D}{V_C}\right)\left(\frac{I_D T_D}{I_C T_C}\right)$$

or, $$\text{Energy Efficiency} = \left(\frac{\text{Discharge Voltge}}{\text{Charge Voltage}}\right)\left(\frac{\text{Discharge Ampere Hour (AH)}}{\text{Charge Ampere Hour (AH)}}\right)$$

or, $$\text{Energy Efficiency} = (\text{Voltage Efficiency})(\text{Coulomb Efficiency})$$

Where, $\text{Voltage Efficiency} = \left(\frac{V_D}{V_C}\right)$ and $\text{Coulomb Efficiency} = \left(\frac{I_D T_D}{I_C T_C}\right)$

At the beginning of charge cycle of a lead acid battery Coulomb Efficiency is near about 100%. But near end of charge cycle Coulomb Efficiency reduces due to electrolysis of water. If we consider the, Voltage Efficiency = 88% and Coulomb Efficiency = 90%. Then the Energy Efficiency = (88%) × (90%) = 79%.

Energy Efficiency of PKL Power System from the Engineering View:

PKL system is a renewable source of electricity. This system need not to charge. So the conventional method of calculating energy efficiency is not applicable for the system. But we can easily measure the energy efficiency of a PKL system calculating the output energy and internal loss.
Let us consider the equivalent circuit of a PKL cell as shown in fig.1 below:

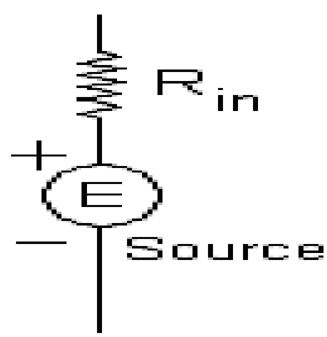

Fig.1: Equivalent circuit of a PKL cell.

According to this circuit there is only means of loss of energy is in the internal resistance. Therefore if we can calculate the energy loss in internal resistance R_{in} we can calculate the energy efficiency easily.

We know, $\text{Energy efficiency} = \frac{\text{Output}}{\text{Input}}$ **or,** $\text{Energy efficiency} = \frac{\text{Output}}{\text{Output} + \text{Losses}}$

Let us consider the circuit shown in fig.2 below:

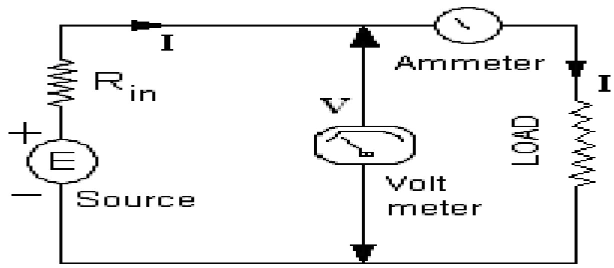

Fig.2: Circuit arrangement for measuring power

If I Ampere current flows through the output load, this current will also flow through the internal resistance R_{in} of the circuit. Now if V be the load voltage then
Output Power = V × I, Power Loss in internal resistance = I^2 R
Therefore, we can calculate the power efficiency as**:**

$\text{Energy efficiency} = \frac{\text{Output}}{\text{Output} + \text{Losses}}$ **or,** $\text{Energy efficiency} = \frac{V \times I}{(V \times I) + I^2 R}$

Energy efficiency generally represented as percentage value.

$$\text{Energy efficiency} = \frac{V \times I}{(V \times I) + I^2 R} \times 100\% \ .$$

Calculation of Energy Efficiency of PKL Power System from the Engineering View:

To calculate the efficiency we can consider, Load voltage = 1.1 Volt, Load current = 1 Ampere, Internal Resistance = 0.6 Ohm.
Therefore, we can find, the output Power = Load Voltage × Load Current
= 1.1 Volt × 1 Ampere = 1.1 Watt
Power loss in internal resistance of the cell = $(1 \text{ Ampere})^2 \times 0.6 = 0.6$ Watt

Therefore, the $\text{Energy efficiency} = \frac{1.1}{1.1 + 0.6} \times 100\%$. or, Energy Efficiency = 65% .

Calculation of voltaic efficiency of the PKL Power system from the Chemical View:

When a cell produces a current, the current can be used to do work to run a motor, for instance. Thermo dynamical principal can be employed to derive a reaction between electrical energy and the maximum amount of work W_{max} obtainable from the cell. The maximum amount of work obtainable from the cell is the product charge flowing per mole and maximum potential difference, E through which the is transferred,
$W_{max} = -nFE_{max}$ ……………. …………………………………..... (1)
Where n is the number of moles of electrons transferred and is equal to the valence of the ion participating in the cell reaction. F stands for Faraday and is equal to 96500 coulombs and E is the e.m.f of the cell [1].
The input work, $W_{max} = -nFE_{max}$ ………………………………………………… (2)
The output work, $W = -nFE$ ………………………………………………. …(3)

∴ Efficiency (η%) = $\frac{\text{useful power output}}{\text{toyal power input}} * 100\%$ = $\frac{-nFE_{max}}{-nFE}$*100%

= $\frac{E}{E_{max}}$* 100%............................ ……………………………….(4)

Here, the E_{max} = maximum cell potential is the potential without any load.

Experimental data

Table.1: An efficiency calculation is given below PKL module with a 3W LED light as follow:

Date	Time	Potential without load, E_{max}	Potential with load, E	Efficiency(η%) = $\frac{E}{E_{max}}$* 100%
28-08-13	5:00PM	6.16	5.85	94.97
28-08-13	9:30PM	6.12	5.80	94.77
29-08-13	12:00PM	6.02	5.70	94.68
29-08-13	3:30PM	5.91	5.45	92.21
29-08-13	7:30PM	5.82	5.30	91.69
30-08-13	3:00PM	5.73	5.24	91.44
30-08-13	8:00PM	5.65	5.13	90.79
31-08-13	7:00PM	5.61	5.08	90.55
02-09-13	4:00PM	5.55	5.00	90.00

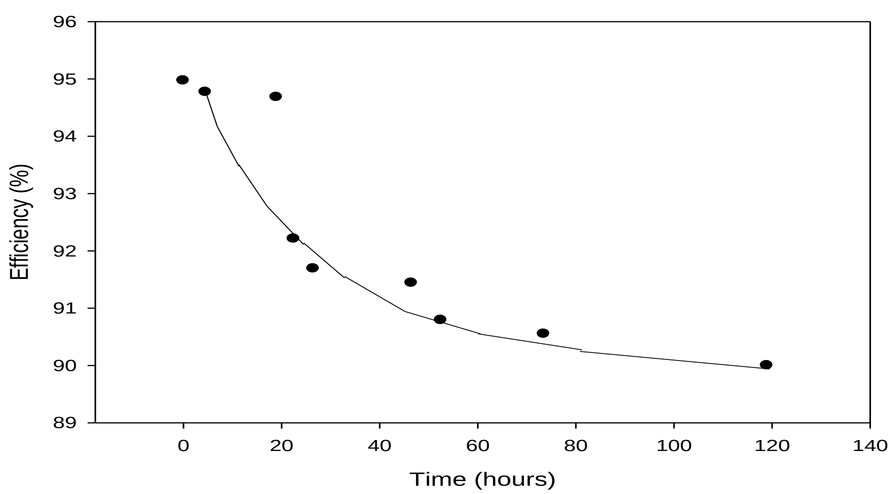

Fig.3: Variation of Efficiency (%) with the variation of time (hours).

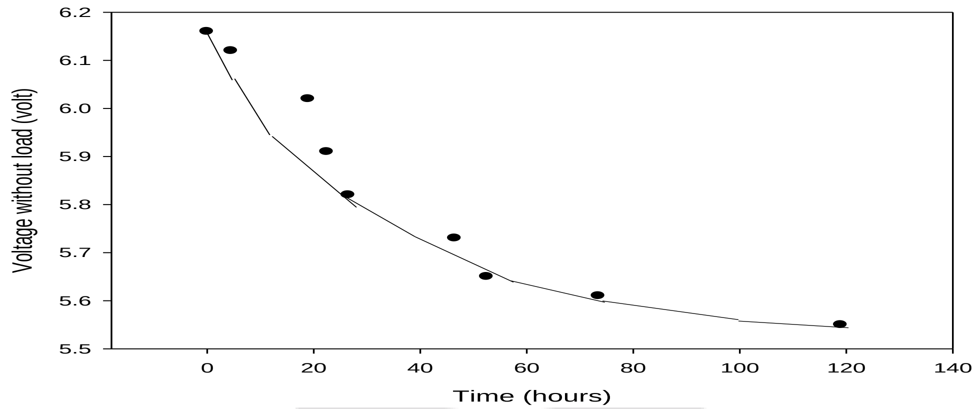

Fig.4: Variation of Voltage (without load) with the variation of local time (hours)

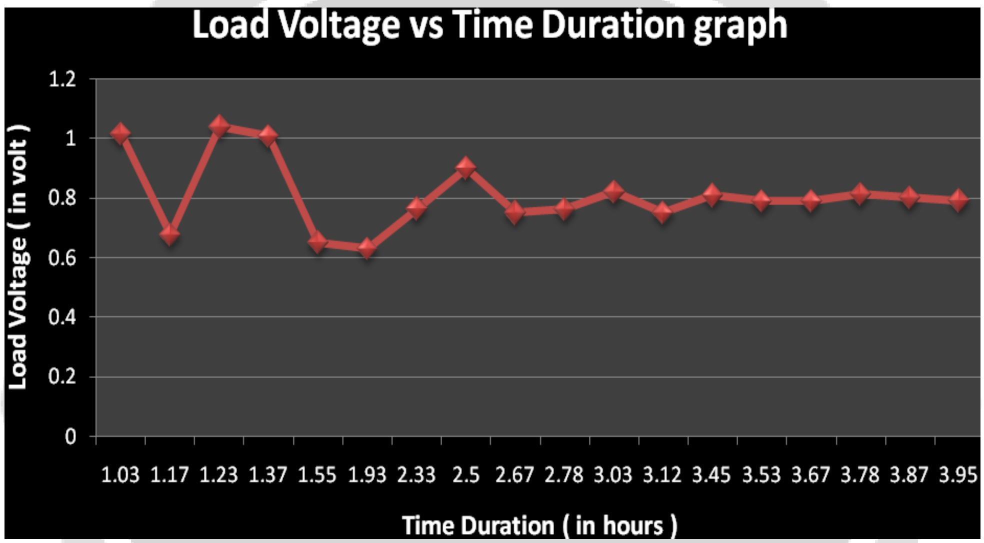

Fig.5: Load Voltage (V) vs Time Duration (hours) graph

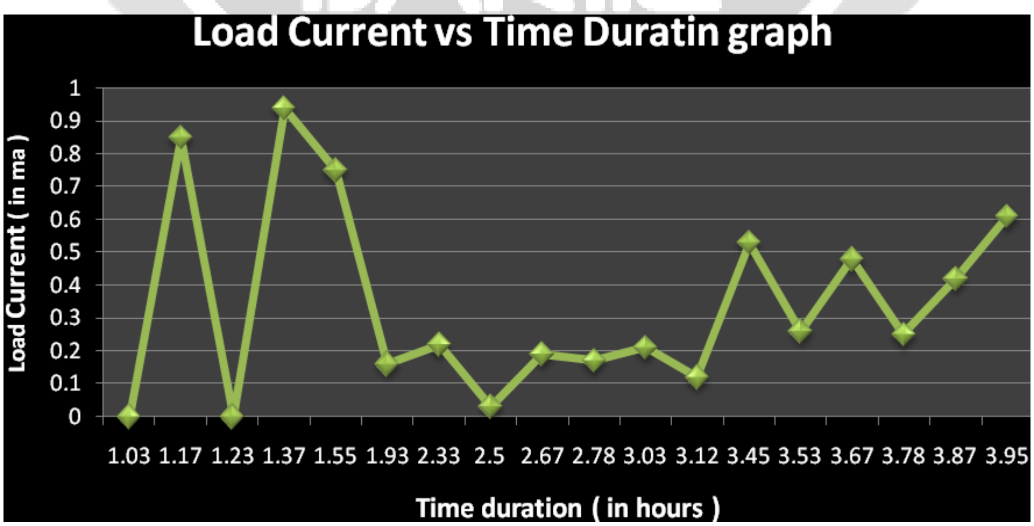

Fig.6: Load Current (mA) vs Time Duration (hours) graph

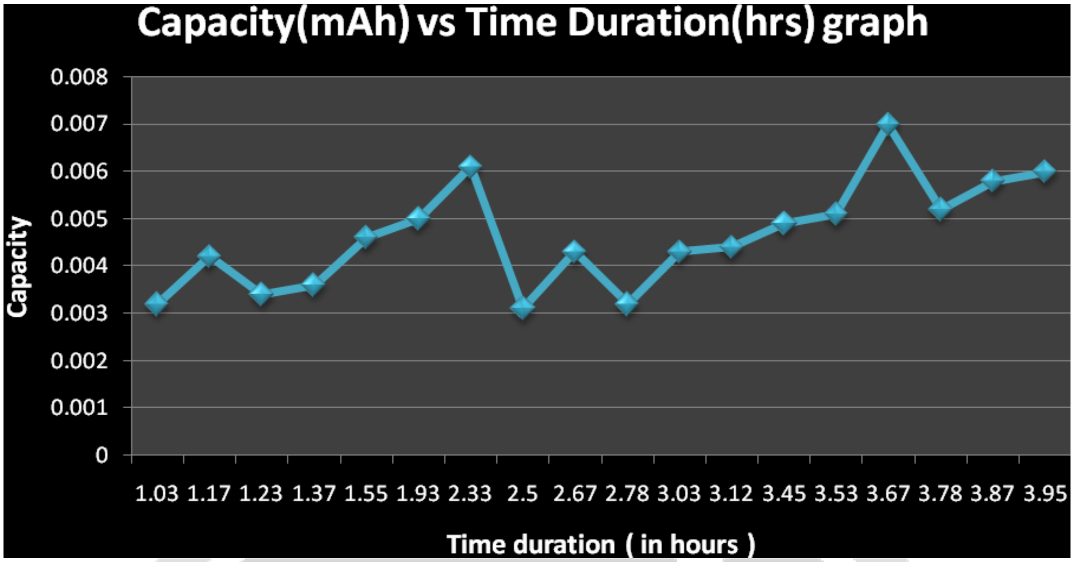

Fig 7: Capacity (mAh) VS Time duration (hours)

Results and Discussion

Fig.5 shows the variation of load voltage with the variation of time duration. It is shown that the load voltage fluctuated within the 2.5 hours and after that it was almost steady condition. The study was taken for around 4 hours. The steady of the PKL cell load voltage depends on the depth of the PKL extract that means immersion of the Electrodes and time duration. Fig.6 Shows the variation of load current (mA) with the variation of time duration (hrs). It is shown that the load current increased up to the 0.14 hours and after that it became almost zero. The study was taken for around 4 hours. It is shown that the load current did not become at the steady condition that means the load current was always fluctuated. It is also shown that within 4 hours the load current became tends to zero after 1.23 hrs and 2.5 hrs. After those condition it is also shown that the load current increased. So that it can be concluded that the PKL cell has a regain capacity for electricity generation. Although it is seen that the load voltage did not come to or tends to zero. It may happened due to some reasons like error of the instruments and lose connections of the circuit. It is known that the definition of the capacity of a PKL cell is " how much current you will get for how long time ". Fig.7 Shows the variation of load capacity (mAh) with the variation of time duration (hrs). It is shown that the load capacity (mAh) of the PKL cell lies between 0.003 mAh to 0.007 mAh. The immersion depth of the electrodes was 3cm,4cm and 5 cm. It is also shown that the capacity depends on the immersion depth of the electrodes. The maximum difference of the capacity was 0.003 mAh and the minimum difference of the capacity was 0.002 mAh.

From the point of Engineering View, it is found that the Energy Efficiency of the PKL cell = 65%. It may be noted here that this value of the efficiency is for a particular time. Because, both of voltage and current will change with time. Therefore efficiency will also change. If we want to measure the efficiency for a period of time it is better to measure the power in Ampere- Hour (AH).We have,

$$\text{Energy efficiency} = \frac{\text{Output}}{\text{Output} + \text{Losses}}$$

$$\text{or, Energy efficiency} = \frac{V \times I \times H}{(V \times I \times H) + I^2 R \times H}$$

$$\text{or, Energy efficiency} = \frac{V \times (AH)}{[V \times (AH)] + I^2 R \times H}$$

Where, H = Hour of use and AH = total Ampere Hour used. If we use the system for 2 hour (H = 2 Hours) as the above example with the same value as, Load average voltage = 0.8 Volt , Load average current = 0.9 Ampere

And Internal Resistance = 0.6 ohm. Then, the

$$\text{Energy efficiency} = \frac{0.8 \times 0.9 \times 2}{0.8 \times 0.9 \times 2 + 0.9^2 \times 0.6 \times 2} \times 100\%$$. or, Energy Efficiency = 60%.

From the Chemical View, Fig.3 shows the initially efficiency of PKL cell was 94.97% and finally the efficiency of PKL cell was 90% and the average efficiency of PKL cell was 92.34%. It shows that the efficiency remains almost same and then it decreases (from 94.97% to 92.34%) exponentially. From Fig.4, the initial voltage (without load) of PKL cell was 6.16V, the Voltage (without load) at the decreasing point of PKL cell was 5.55V and the average voltage(without load) of PKL cell was 5.86V. It shows that voltage (without load) decreases is linearly and then it decreases (from 5.91V to 5.55V) exponentially. Finally, it can be concluded that the potential efficiency of the PKL Cell is sufficient for the motivation of electricity.

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