A comparative Study between Lead Acid and PKL Battery

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ABSTRACT

The performance of cell is an important issue. There are some parameters through which we can measure the performance of the cell or battery. A brief outlines of key parameters used to characterize a cell or battery are discussed below. Also it is shown that how these parameters may vary with the operating conditions. The nominal voltage of a galvanic cell is fixed by the electrochemical characteristics of the active chemicals used in the cell. The actual voltage appearing at the cell terminals at any particular time depends on the load current and the internal impedance of the cell and this also varies with the temperature, the state of charge and with the age of the cell. The paper shows typical discharge curves for cells using a range of cell chemistries. The X axis shows the cell characteristics as a percentage of cell capacity. Each cell chemistry has its own characteristic nominal voltage and discharge curve. Some chemistry such as Lithium ion have a fairly flat discharge curve while others such as Lead acid have a pronounced slope.

Keywords: *PKL battery, Biomass energy, Lead acid battery, Comparative Study*

I. Introduction:

A cell is a single arrangement of two electrodes and an electrolytic solution capable of yielding electricity due to chemical action within the cell or of producing chemical action due to passage of electricity through the cell. Each cell is made of two electrodes, one liberates electrons and is called oxidizing electrode {i.e., at which oxidation occurs), while the other absorbs electrons and is called reducing electrode (i.e., at which reduction occurs). Examples are Daniel cell, Voltaic cell etc. Whereas A battery is a combination of two or more cells arranged in series or parallel. For example, the ordinary 6 volt lead storage battery is a combination of three 2 volt cells connected in series. The Classification of Electric Battery: Primary Battery: In a primary battery, the chemical action is irreversible. The electrodes and the electrolyte undergo changes during discharge which can not be reversed. Examples are Leclance cell, Daniel cell and dry cells are this type.Secondary Battery: In a Secondary Battery, the chemical reaction is reversible i.e., after discharge, the constituents can be restored to their original form by the process of charging. Examples are Lead acid and alkaline batteries belong to this category. These are also known as Storage batteries.The definition of Electrodes and Electrolytes: An e. m. f. is produced by chemical means whenever two dissimilar solid conductors known as electrodes are placed in a conducting liquid known as Electrolyte. In this case the electrodes are generally Zn and Cu plates whereas the electrolyte is PKL extract.

II A. Discharge Curves

The fig.-1 shows typical discharge curves for cells using a range of cell chemistries. The X axis shows the cell characteristics as a percentage of cell capacity. Each cell chemistry has its own characteristic nominal voltage and discharge curve. Some chemistry such as Lithium ion have a fairly flat discharge curve while others such as Lead acid have a pronounced slope.

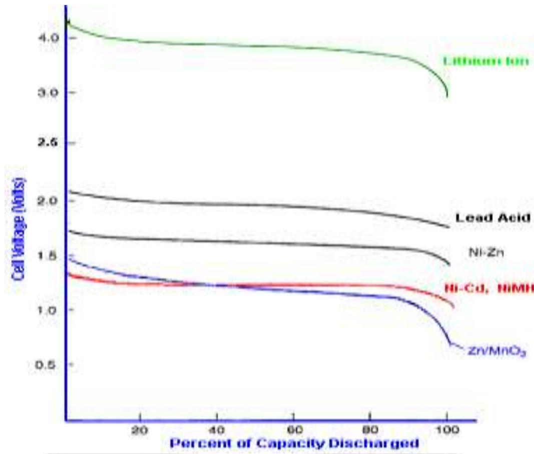

Fig. 1: Typical discharge curves for cells.

The power delivered by cells with a sloping discharge curve falls progressively throughout the discharge cycle. This could give rise to problems for high power applications towards the end of the cycle. For low power applications which need a stable supply voltage, it may be necessary to incorporate a voltage regulator if the slope is too steep. A flat discharge curve simplifies the design of the application in which the battery is used since the supply voltage stays reasonably constant throughout the discharge cycle.

II.B Difference Between Electrolytic And Pkl Quasi Galvanic Cells

Electrolytic Cell	**PKL quasi Galvanic Cell / Voltaic Cell.**
It requires a source of external energy.	it is a source of energy.
It converts electrical energy into chemical energy	Converts chemical energy into electrical energy
Has cathode as the negative electrode	Has cathode as positive electrode
Has anode as the positive electrode	Has anode as negative electrode
It involves oxidation at anode and reduction at cathode	It involves oxidation at anode and reduction at cathode

II C. Discharge Characteristics of PKL Cell

To measure the discharge characteristics of PKL cell a module of PKL was taken. It considered as 6 volts PKL system. We connected a constant incandescent lamp load of 6 volts. The arrangement of measuring is shown in Fig.2. For simplicity we show the PKL system as a unit cell.

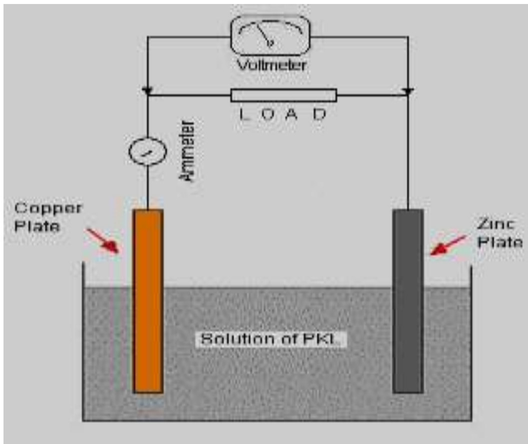

Fig-2: Arrangement of measuring discharge characteristics.

We observed the voltage and current as listed below in table-1. We continue the taking the load test 120 minutes i.e. 3 hours from beginning. It may be pointed out here that initially when we connected the load a substantial voltage drop occurs and this drop is 0.48 Volts which is around 8% of system voltage. We also show a column for power drawn by the load in the table multiplying voltage and current.

Table-1: Voltage and Current of PKL module under load condition.

Time duration (min)	**Load Voltage , V (Volt)**	**Load Current, I (A)**	**Power (W)**
0	5.52	0.76	4.2
5	5.51	0.75	4.1
10	5.51	0.74	4.1
15	5.50	0.73	4.0
20	5.50	0.72	4.0
25	5.50	0.71	3.9
30	5.49	0.70	3.8
35	5.49	0.69	3.8
40	5.48	0.68	3.7
45	5.46	0.67	3.7
50	5.45	0.66	3.6
55	5.45	0.65	3.5
60	5.44	0.64	3.5
65	5.43	0.63	3.4
70	5.41	0.62	3.4
75	5.39	0.61	3.3
80	5.37	0.60	3.2
85	5.35	0.58	3.1
90	5.32	0.56	3.0
95	5.30	0.54	2.9
100	5.27	0.52	2.7

105	5.25	0.48	2.5
110	5.23	0.48	2.5
115	5.20	0.46	2.4
120	5.18	0.44	2.3

Based on the observed result we plot three characteristics of PKL cell. These are for voltage, current and power graph for the load. All these are on same time frame. These graphical representation show how voltage, current and power changes with time.

Fig.- 3 shows the voltage verses time plot.

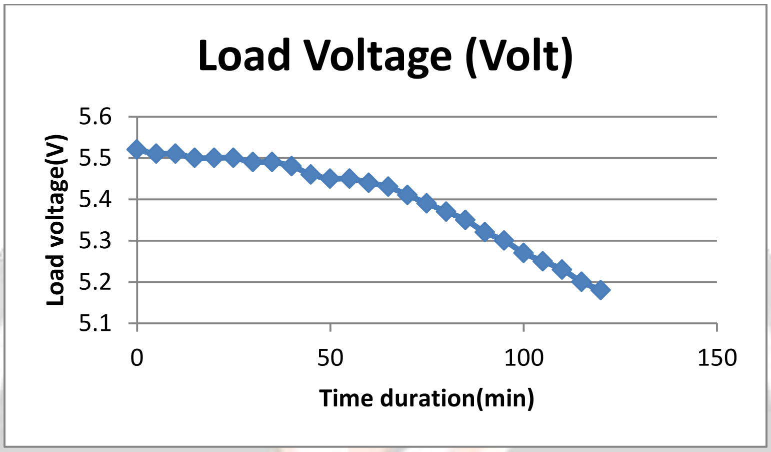

Fig.-3: Voltage vs time plot.

As per this graph it is seen that the voltage is reducing gradually as time passes. If we compare it with other cells we find this change is relatively rapid. Fig.- 4 shows the current graph for the same system.

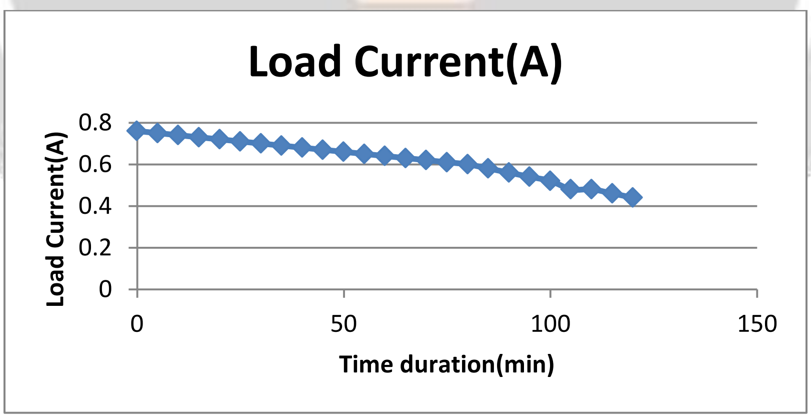

Fig.-4: Current vs time plot.

As per this graph it is seen that the load current is reducing gradually as time passes. If we compare it with other cells we find this change is relatively rapid. Fig.-5 shows the power graph for the same system.

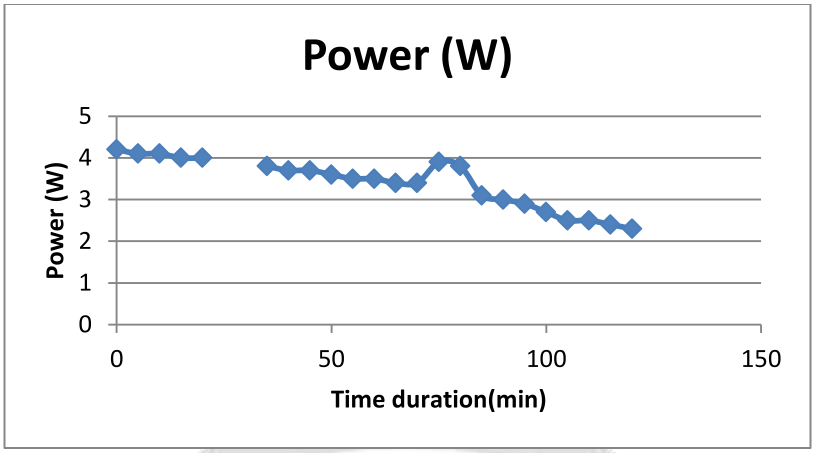

Fig.-5: Power vs Time plot.

We know, Power, P = V × I W, Where, V = Voltage (volt), I = Current (A)
Since voltage and current are reducing with time therefore as per this graph it is seen that the load power is also reducing gradually as time passes. For a sustainable system this going down process shall be lower.

II.C Self Discharge Characteristics

The self discharge rate is a measure of how quickly a cell will lose its energy while sitting on the shelf due to unwanted chemical actions within the cell. The rate depends on the cell chemistry and the temperature.

The following shows the typical shelf life for some primary cells:

- Zinc Carbon (Leclanché) 2 to 3 years
- Alkaline 5 years
- Lithium 10 years or more

Typical self discharge rates for common rechargeable cells are as follows:

- Lead Acid 4% to 6% per month
- Nickel Cadmium 15% to 20% per month
- Nickel Metal Hydride 30% per month
- Lithium 2% to 3% per month

The Fig. 6 below shows typical self discharge rates for a Lithium Ion battery.

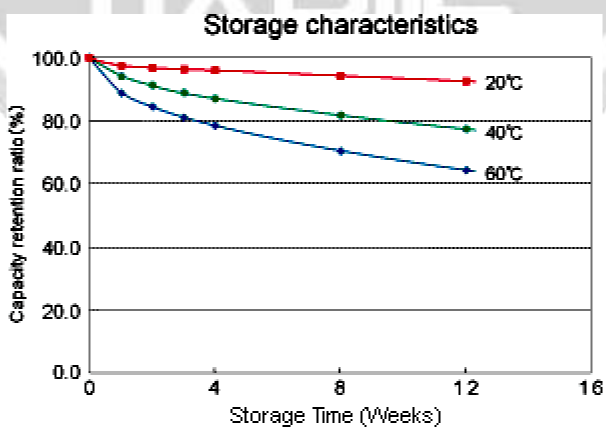

Fig. 6: Typical self discharge rates for a Lithium Ion battery.

II D: Self Discharge Characteristics of PKL Cell

Like other cells PKL cell also lose its power with time. Though it is not quantify yet and at this stage it is not needed so much therefore it is not done. But it shows a very interesting characteristic with time. If we keep it unused for some time its capacity regains. Therefore, it shows better result on intermittent use with some time gap. And in this way it can be used for longer time than continuous use.

II.C Energy Efficiency of BPL/PKL Cell:

PKL cell is a renewable source which produces electricity through chemical process. This cell needs not to be charged. So, the conventional method of calculating energy efficiency is not applicable for this cell [71-90]. Conventional method of calculating energy efficiency is discussed. In next two sections, experimental data are tabulated in Table-1 and calculation of energy efficiency for one unit cell; experimental data of energy efficiency and % of PKL juice concentration are tabulated in Table-1 respectively [91-100].

II. Equivalent Circuit of the PKL Cell

Equivalent circuit of a cell is the equivalent electrical circuit of a cell. Since cell produce electricity therefore to understand the electrical characteristic of a cell it is very much important to know the equivalent circuit of a cell. This circuit is composed with some electrical parameters like resistor, capacitor, voltage source etc. Voltage source is the most important part of the cell. This is the actual current driving force that produces in the cell. There are some actor plays in the cell on the way of current flowing path. We need to identify these actors first. To draw an equivalent circuit of a cell let us consider: R_m = Resistance of the metallic path through the cell including the terminals, electrodes and inter-connections. R_e = Resistance of the electrochemical path including the electrolyte and the separator. C_p = Capacitance of the parallel plates which form by the electrodes of the cell. R_c = Non-linear contact resistance between the plate or electrode and the electrolyte. E = e.m.f. produced by the cell. Among the above components R_c and C_p remain in parallel between the plates and R_e and R_m remain in series with the parallel combination of R_c and C_p on the current flowing path of the cell.

Combining all the components the equivalent circuit of a cell is shown in fig. 7.

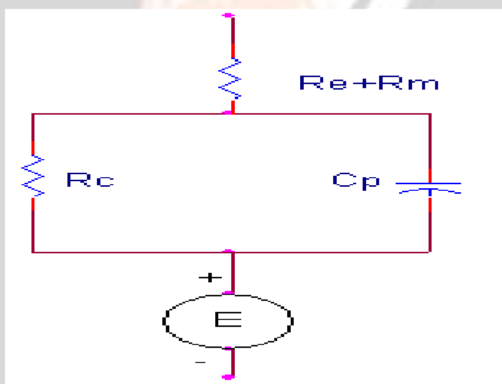

Fig. 7: Equivalent circuit of a cell.

We know the capacitive reactance of the capacitor can be given as $X_c = \frac{1}{2\pi fC}$. So the smaller value of C gives a higher value of capacitive reactance. We also know the capacitor act as an open circuit in DC voltage. Therefore, by ignoring the capacitive part of the equivalent circuit we can simplify the circuit as below:

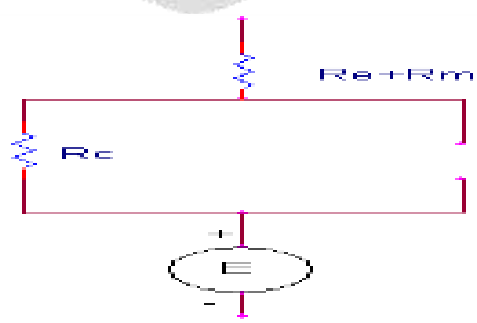

Fig. 8: Simplified form of equivalent circuit.

To make the circuit simple we can redraw the circuit as below:

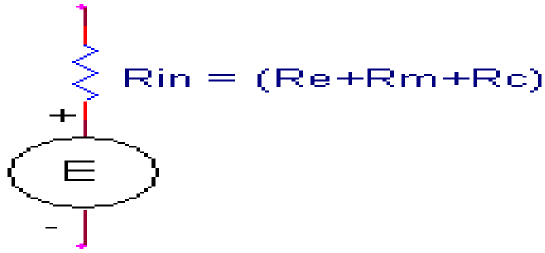

Fig. 9: More simplified form of cell equivalent circuit.

Where, R_{in} is the cell internal resistance which is the equivalent resistance of R_e, R_m and R_c.
In the case of a cell R_m depends on the nature of electrodes used, R_e depends on the nature of electrolytes, R_c depends on the area of contact between parallel plates, age of the cell, the temperature etc. Typical internal resistance of a cell is in the order of milliohms.

IV. Conclusions

Since the internal resistance of a cell or battery represents the health of the battery or cell. So that internal resistance value indicates the battery health. It is shown that the excellent ranking of the internal resistance range of the battery is (0.075 to 0.150)ohm, for good ranking it is (0.15 to 0.250)ohm for marginal ranking it is (0.25 to 0.350)ohm and for poor ranking it is (0.350 to 0.500)ohm. If the internal resistance shows above 0.500 ohm, then that battery or cell becomes fail. According to these results, It is possible to manufacture a good and excellent ranking PKL cell or module.

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