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Health and Capacity Testing of DC Battery Bank

[1]Krishna Kumar, [2]Rekha Dangwal & [3]Rachna Shah

[1]Assistant Engineer (R&D), UJVN Ltd., Ganga Bhawan, Dehradun, Uttarakhand, India
[2] Executive Engineer (R&D), UJVN Ltd., Ganga Bhawan, Dehradun, Uttarakhand, India
[3]Scientist-B, NIC State Unit, Dehradun, Uttarakhand, India
[*]*Corresponding Author: krishnanitald@gmail.com.*

ABSTRACT: DC system is backbone of any power plant. Electrical protection and emergency lighting of the power house depends on the DC supply, and also DC supply is required for monitoring and data logger devices. If the DC supply fails, it may possible to occur uncontrolled situation which may harm to man and machine. Due to this a dedicated team is required round the clock to maintain uninterrupted DC supply.

KEYWARDS: DC System, Battery Bank, Capacity Testing, Impedance Testing, etc.

1. INTRODUCTION:

There are several types of battery technologies available:

(i) Plante.
(ii) Flooded Lead Acid Battery.
(iii) Valve Regulated Lead-acid (VRLA).
(iv) Tubular.
(v) Nickel Cadmium.

Plante Battery has a long life and it has a proven track record of 20 plus years service life. It is the most reliable for standby float application. The positive plates are made of 99.99% ultra pure lead, which forms the basic strength. The cells are assembled in transparent containers, which make the cells very user-friendly. Antimony-free ultra-pure lead and large pool of electrolyte make it a very low maintenance battery. It has excellent high discharge characteristics and is capable of rapid recharging. 100% capacity is retained throughout its life span and therefore no aging factor has to be considered.

2. AFFECT OF TEMPERATURE ON BATTERY PERFORMANCE:

At room temperature batteries function best, operating a battery at higher than room temperature improves performance but will shorten life, where as lower temperature increases the internal resistance and lowers the capacity. A battery which provides 100 % capacity at room temparature will typically deliver only 50 % at –18°C.

3. SPECIFIC GRAVITY OF BATTERY:

Specific gravity indicate whether the battery is charged or not. During discharging of battery, the specific gravity decreases linearly. The specific gravity during discharge can be expressed as:

"Specific gravity = Cell open-circuit voltage - 0.845"

The battery is considered fully charged when specific gravity reaches it's highest possible value.
There are may ways to check the health of DC battery bank, it can be categorized mainly two types:

a) Discharging/Charging test of battery bank (i.e. capacity test of the battery bank).
b) Impedance test.

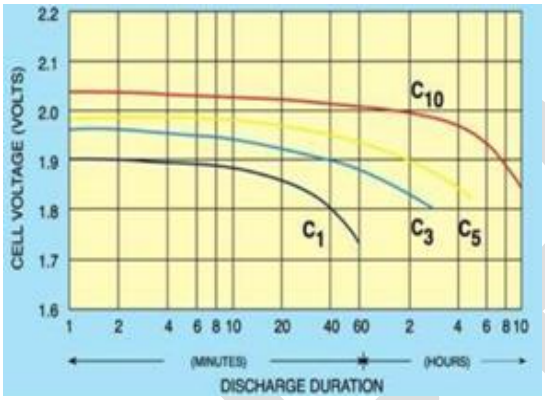
4. DISCHARGING/CHARGING TEST OF BATTERY BANK:

It is a destructive test, means if we discharge the old batteries (more than 05 years) completely, then it is possible that most of the batteries may not be charged again and can harm the complete battery bank, due to this discharge battery at a certain voltage level where all the batteries of the bank discharges at same voltage, but if some battery voltage goes down drastically then

we have to stop the discharging cycle and identify those batteries and replace them with the spare battery. Capacity test is the only way to identify the actual capacity of the battery.

4.1 PROCEDURE FOR PERFORMING A CAPACITY TEST OF A BATTERY BANK:

a) Based on the test type, identify the test discharge values; refer to manufacturers published brochure for all discharge information.
b) Disconnect the Battery from the Charger. Disconnect the Positive (+) Terminal/Pole of the battery Bank, followed by the Negative (-) Terminal/Pole of the battery Bank from the DC Distribution or Battery Charger to isolate the battery.
c) Measure the battery/cell voltage, overall battery bank voltage, current flowing through the bank and the temperature of the drum in every half an hour.
d) Record specific gravity of every cell
e) Discharge current
f) Discharge period (i.e. 5 Hours for a capacity, or < 1 hour for a performance test)
g) End of discharge parameter per bank (i.e. Bank Voltage = 1.75V x No. of Cells)
h) Individual cell end voltage parameter (i.e. 1.75V)
i) Record the following information, i.e. Time, Date, Location, Bank Number, Individual cell voltage, Specific gravity, charging & discharging current.



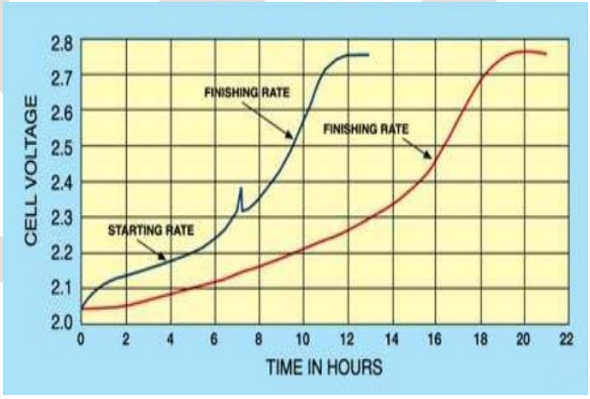


Fig 1.0: Characteristic curve of Plante Cells [1] **Fig 2.0:** Complete Discharge Characteristic curve of Plante Cells [1]

4.2 ARRANGEMENT FOR BATTERY CAPACITY TEST:

For testing of capacity, use normal water in a metal container, because the temperature of the container may increase upto 60^0-80^0C and temperature monitoring of the container is required. For the control of load current i.e. current flowing from anode terminal to cathode terminal in the container is controlled by adding salt (NaCl). If we add salt then current flowing through load get increases and if we want to decrease the load current, then we have to add fresh water or anode & cathode may uplift slightly from drum.

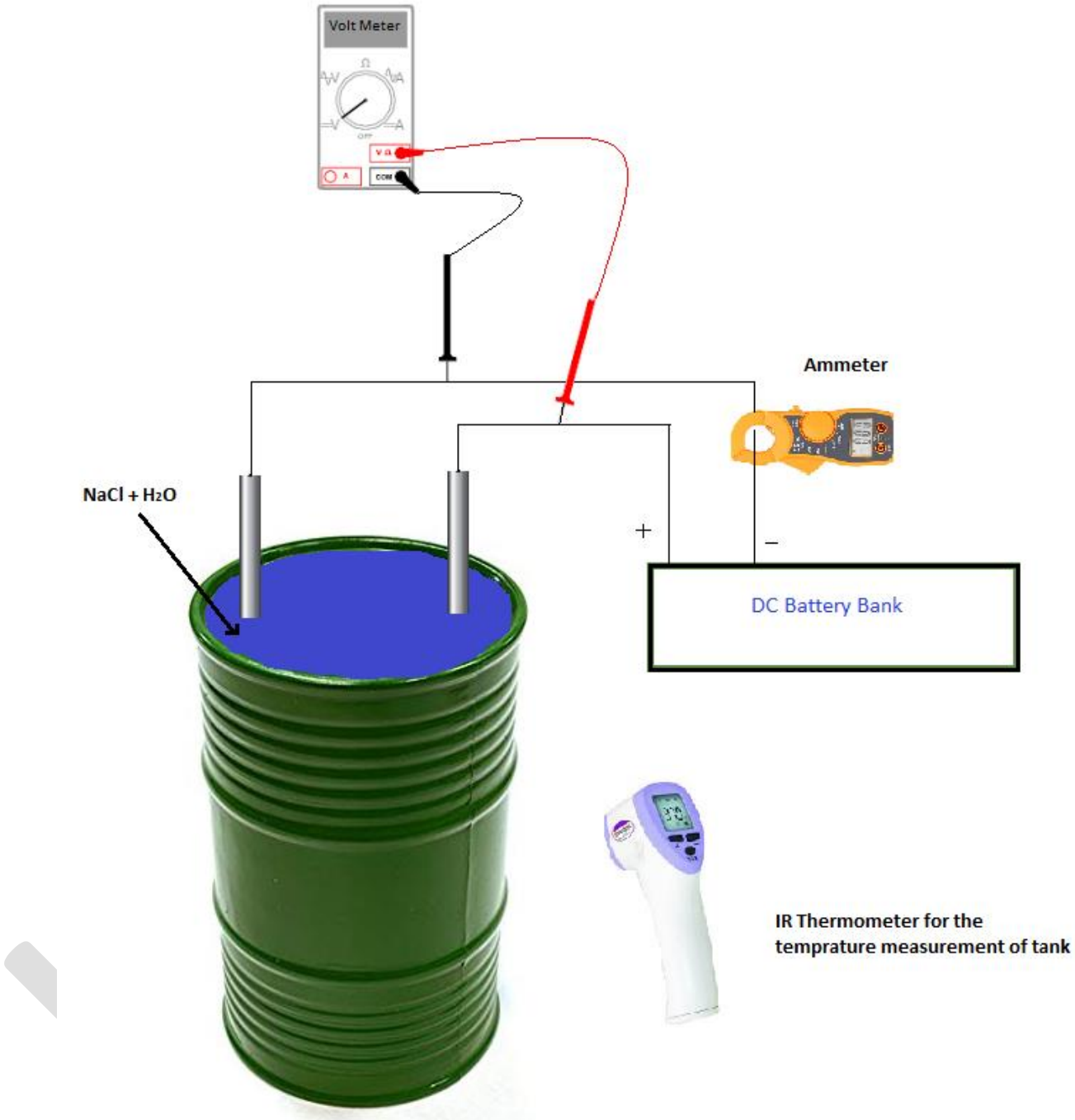
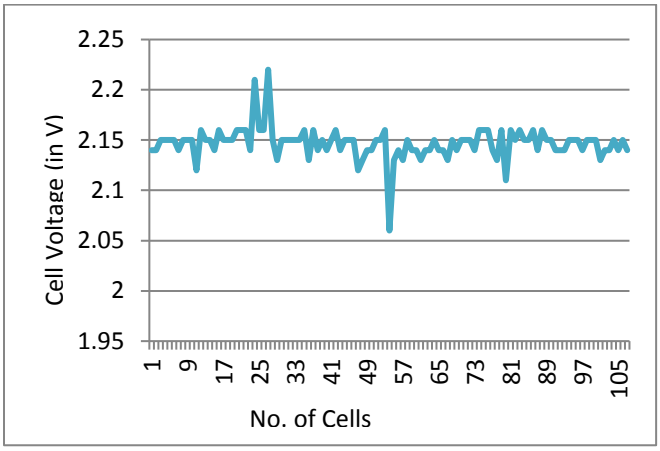


Fig 3.0: Arrangement for Battery Capacity Test

4.3 BATTERY DISCHARGE TEST REPORT OF 220V PLANTE BATTERY BANK:

Capacity of battery bank: 1395 Ah, Number of Cells: 107, Discharge Current:110A/hr, Specific Gravity 1.205±0.005 at room temperature.



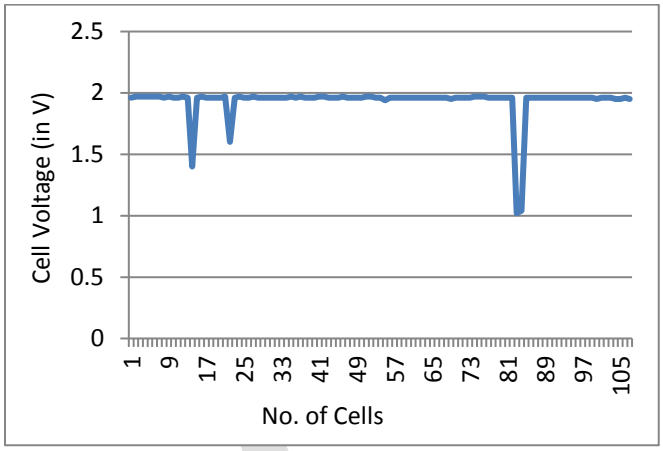


Fig 4.0: Cell voltage during the discharging (after 1 hrs)

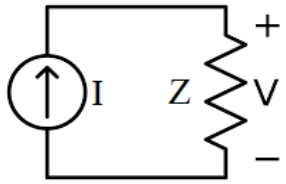
Fig 5.0: Cell voltage during the discharging (after 8 hrs)

From figure 5.0, it can be observed that voltages of Cell no. 14 & 22 is less than average voltage of the bank, means cell no. 14 & 22 has become weak. Also cell voltage of battery cell no. 83 & 84 goes very low and they are require to be replaced from the bank.

After completion of discharging process and recording of results, charging process should be initiated with boost charger. Maintaining charging current as per battery data sheet (80 A in our case) to complete the capacity test.

5. IMPEDANCE TESTING OF BATTERY BANK:

It is a non destructive test and require 1/2 hrs to test the health condition of individual battery cell. This test is safe, fast and easy test and will increase reliability for your critical loads. It also test your inter-cell connections. The AC impedance measurement has a distinct advantage over the DC resistive measurement. Batteries are not resistors, they have capacitance due to a double layer effect that occurs when liquids come in contact with solids (plates and electrolyte). This value changes earlier in the battery aging process. DC testing ignores this parameter. Plante batteries are typically large batteries with low impedance. You need an adequate current to test these large low impedances batteries. Small hand held testers do not have the current. It require to inject at least 10A of current for impedance testing.



Input Current, I= 10 Amp

V : Cell Voltage (2.2V)

Z: Internal Impedance of Battery

Fig 6.0: Arrangment for Battery Impedance Testing

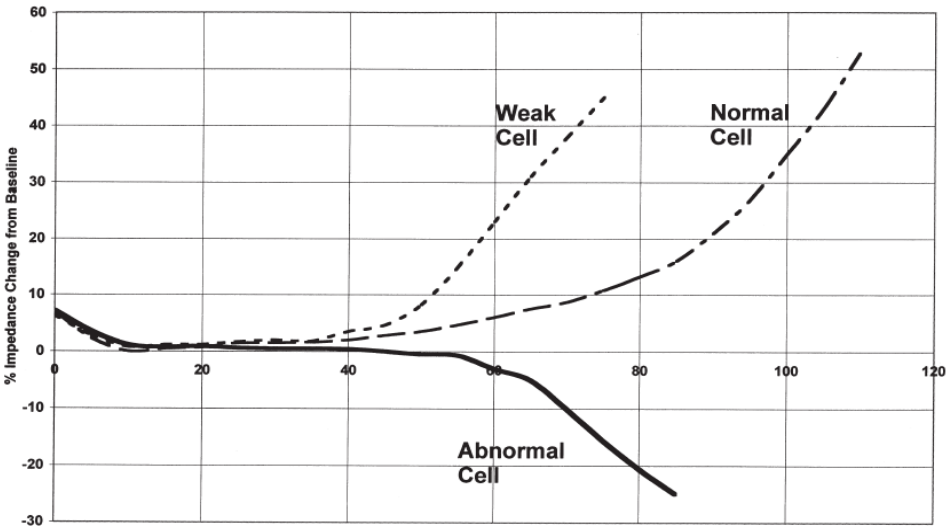


Fig 7.0: Characteristic Table for Impedance Testing [1]

5.1 IMPEDANCE TEST REPORT OF 220V PLANTE BATTERY BANK:

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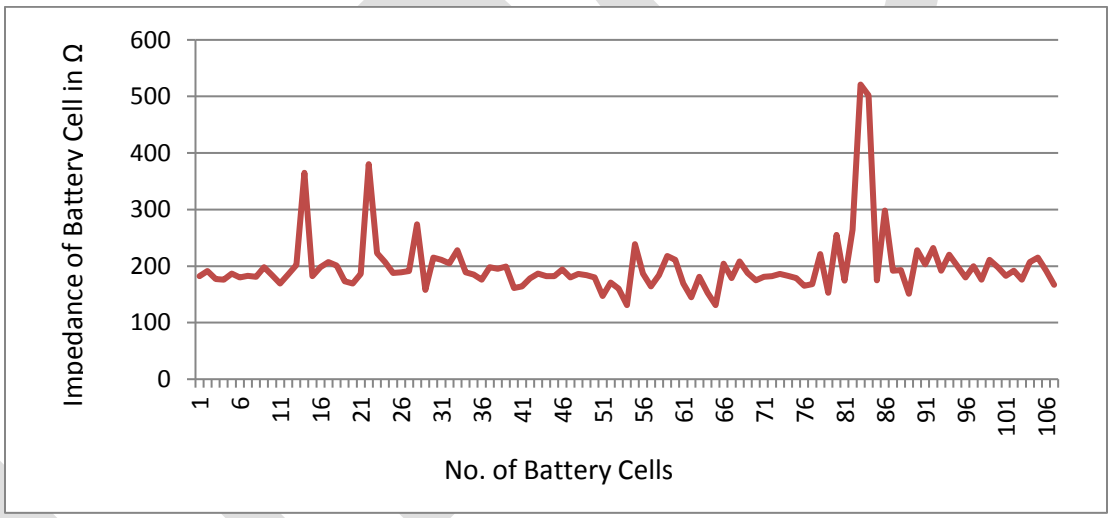

Fig 8.0: Impedance Test Report

From figure 8.0, it can be observed that impedance of Cell no. 14 & 22 are higher than average impedance of the bank, means cell no. 14 & 22 has become weak. Also cell impedance of battery no. 83 & 84 goes very high and they required to be replace from the bank.

CONCLUSION:

To maintain the health of battery bank a maintenance plan should be followed as per the manufacturer guidelines, also to check the health of battery, impedance testing is preferred over destructive discharge test. Impedance testing require less time and manpower than capacity test.

REFERENCES:

[1] Excide Batteries Manuals.
[2] Megger Battery testing guide.