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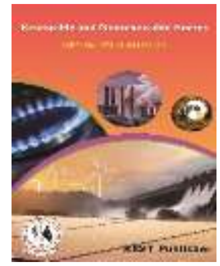

Comparative Performance Study of Front Access Terminal Battery Designs

***K. Kalyani Radha, B. Omprakash**

JNTUACEA, Ananthapuramu, Andhra Pradesh, India.

*Corresponding Author Email: radha.mech@jntua.ac.in

Abstract: *The ongoing development and maturation of battery technology as applied in the telecom field continue to present new pathways to innovation. Recent advances in cell safety, refinements in energy density, and developments in intelligent on-board battery management systems are driving the growing interest in new technologies. All telecom power systems encounter similar challenges in three key areas: power management, power storage, and the loads placed on the system. In any given scenario, these variables must be considered and the most appropriate technologies employed. While there is a growing selection of equipment to choose from in the efficient power management, storage, and distribution of this energy in a lightweight package remain a formidable challenge. Utilizing a battery in any electrical circuit ensures operation at the highest level of efficiency. Our project aim is design and development and manufacturing analysis of Front Terminal Access battery, to enhance the battery life and deliver more power output by reduce the sulphation effect and implementing AGM batteries.*

Keywords*: FTA battery is designed to enhance the life of the battery for float duty applications.*

1. INTRODUCTION

The battery is, quite simply, an electrical storage device that uses a chemical reaction to convert “electrical energy” into “potential chemical energy” and back again. This project aims at design, development and performance analysis of FTA battery. In this project, we are responsible for designing the FTA battery, selecting its materials, integrating the components of the FTA battery, preparing for testing and analyzing data of the battery. By analyzing the data recorded by the FTA battery, we will investigate the reasons of its success and/or failures. Every Telecom Exchange has 2 sets of battery banks connected through power plant. Batteries provide 48V DC supply during the power interruptions to the exchange equipment preventing shutdown of the telecom services. Thus the batteries play a critical role in telecom services. The flooded type of lead acid (open type) batteries had given way to VRLA (valve regulated lead acid) batteries which work on Oxygen recombination principle which has ensured no water loss. The cumbersome routine of engaging people and topping the cells with a dose of water before every charge is done away with; besides savings in floor space. VRLA Batteries mainly use lead dioxide and lead as positive. and negative electrodes, dilute sulfuric acid as electrolyte. Each cell give a nominal voltage of 2.0 V and a string of 24cells connected in series gives 48 V required for the operation of the BTS & MSC communication systems. The battery is the primary "source" of electrical energy. It stores chemical energy, not electricity. Two different types of lead in an acid mixture react to produce an electrical pressure. This electrochemical reaction changes chemical energy to electrical energy. In the modern era, electrical energy is normally converted from mechanical energy, solar energy, and chemical energy etc. A battery is a device that converts chemical energy to electrical energy. The first battery was developed by Alessandro Volta in the year of 1800. In the year 1836, John Frederic Daniel, a British chemist developed the Daniel cell as an improved version of the cell. From that time until today, the battery has been the most popular source of electricity in many daily life applications. In our daily life, we generally use two types of battery , one of them is which can be used once before it gets totally discharged. Another type of battery is rechargeable which means it can be used multiple times byA Front Access Battery is 12V @ 150Ah Industrial lead acid Battery. Our project aim is to design, development and

performance analysis of a FTA battery for Float and Cyclic duty applications for cellular application of Base Transceiver Station (BTS) and Mobile Switching Centre (MSC) sites in “AMARA RAJA BATTERIES” Ltd.

1. OBJECTIVES OF THE PROJECT

The major challenge of this project is to ensure the lowest environmental impact, to enhance 2X storage life, 10% more power and 30% longer life in harsh conditions. Our unique expertise can protect battery from 85% of battery failure risks, cut their costs by 80% in harsh environments and reduce fuel usage by 70% in off grid sites. The aim of this project is to fit all 4 modules with-in 19” and 23” width relay racks only, and to provide the most reliable energy backup solutions globally with a short payback time. Front Access Battery offers a unique opportunity to have a first battery for Float as well ascyclic application project. They are responsible for all aspects: designing the Front Access Battery, selecting its mission, integrating the components, testing, preparing for launch and then analyzing the data. Paper is intended for a conference; please observe the conference page limits.

2. LITERATURE SURVEY

A ready and affordable supply of energy is essential for maintaining the standards of living in the developed world. Coal, mineral oil, and natural gas (fossil fuels) together with uranium (Nuclear power) have been exploited as major source of primary energy. But their supply chain can be extremely intermittent and unreliable. It is therefore, Irrespective of the source, an effective storage system is critical for the efficient use of the energy and for the good stewardship of its supply. The development of the effective and affordable means to store energy for ever increasing number of application and great demand continues a major challenge to the Scientists, Technologists and Engineers. Batteries (Lead Acid) are employed in a wide verity of different applications. Each application having its own distinctive duty cycles, applications are like Automobiles, Electric vehicles, Telecommunications and Hybrid electrical vehicles (HEV) and Remote area power supply (RAPS). For Automobiles, battery provided a quick pulse of high current for starting and lower sustained current for the other purposes the battery remains high state of charge for the most time. Electrical batteries on the other hand are expected to undergo deep discharges and recharges over a period of few hours repeatedly (so called deep cycle discharge duty). The same is true of batteries used for backup power in telecommunications, broadband network and in other uninterruptible power supply (so called Float Duty) although in such services the battery should seldom be called up discharge. In-between the extreme cases of float duty and deep discharges the batteries in hybrid electrical (HEVs)and in storage units for remote area power supply (RAPs) systems, spend most of the time for cycling about an intermediate state of charge after near 50% (So called Partial State of Discharge Duty). In many regions of the world the n grid power is unreliable, suffering frequent power outages every day. This means frequent recharging hence shortening the battery life. In some other regions of the world on-grid power supply is continuous with a very rare interrupt. This means frequent recharging is not required hence most of the battery will be at fully charged state in standby mode. To minimize the impact of outages or use of generators and at the same time the credibility of the battery needs to be exceptional, as the number of cycles will be increased when the grid goes down. Our project aim is to design and development of Front Terminal Access (FTA) batteries for both Float and Cyclic duty applications for cellular applications of BTS (Base Transceiver Station) and MSC (Main Switching Center) sites. FTA batteries having terminals front side for easy handling and installation in cellular application for 48V banks. We can easily add on modular to increase the lower capacity. The new FTA battery took the proven performance of the Amara Raja Batteries technology and modified electro chemistry to deliver more power high cycling and fast recharge. This makes FTA batteries ideal for unstable and standby applications.

3. LEAD ACID BATTERIES FOR TELECOM APPLICATIONS

Lead-acid battery is often the weakest link in telecom installations. At CSIR-CECRI a study was conducted on the various versions of lead-acid batteries namely gelled-electrolyte Valve Regulated Lead-Acid Battery [VRLAB], Absorbent-Glass-Mat [AGM] VRLAB and hybrid VRLAB and flooded- electrolyte versions of lead-acid batteries. These batteries were fabricated and their performances were tested in stand-alone-lighting application during the period 2014- 2015. The details of the study were reported in ref [1]. The results of the studies are given below.

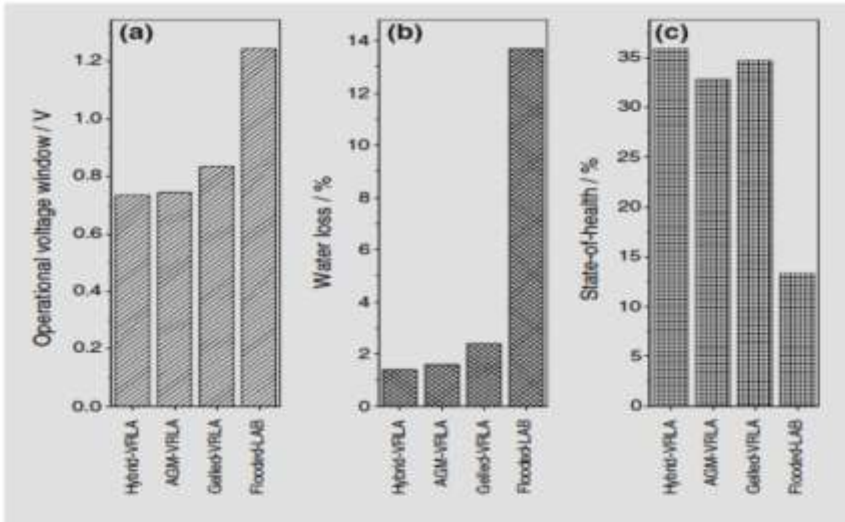

FIGURE 1. showing a. operational window b. water loss c. state- of- health for hybrid VRLA, AGM VRLA Gelled VRLA and flooded lead-acid batteries

Results For float duty, telecom application conducted on hybrid VRLAB, AGM-VRLAB, gelled electrolyte VRLAB and flooded electrolyte lead-acid batteries suggests that VRLA batteries exhibit both low operational window, minimal water loss and good state of health compared with flooded lead-acid batteries. This is shown in fig.2. The field study for PV stand-alone solar-lighting application conducted on hybrid VRLA, AGM VRLA, gelled-electrolyte VRLA and flooded-electrolyte lead acid batteries suggest that VRLA batteries exhibit both lower internal

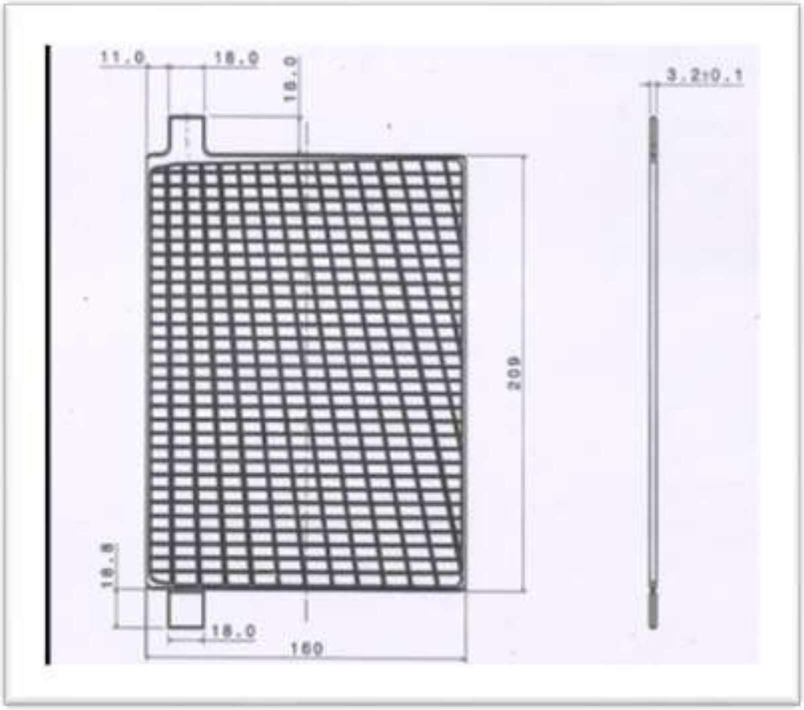

FIGURE 2. POSITIVE ELECTRODE

4. DESIGNING OF FTA BATTERY PARTS

All parts of the FTA battery are drawn by using CAD software. All parts are shown are in exact dimensions all the parts of the FT battery are not manufactured by using same materials. Different parts are manufactured by using different alloys

Positive Terminal: In the lead-acid cell, the positive electrode contains lead dioxide (PbO2) and lead sulfate (PbSO4) as the active materials. Grids act as a skeleton to hold the paste. Radial type Grid is used in FTA batteries. Radial type of grids are used in the FTA battery, this makes electron flow fast and allow the electrons to flow in a shortest possible distance from end of the grid to the lug.

While designing the grids we should have to consider the corrosion rate in acid while in charging mode an in-discharging mode. Corrosion of the external metal parts of the lead–acid battery results from a chemical reaction of the battery terminals, lugs and connectors. Corrosion on the positive terminal is caused by electrolysis, due to a mismatch of metal alloys used in the manufacture of the battery terminal and cable connector.

Negative Electrode: The electrode from which electrons flow when the battery is discharging into an external circuit Reactants are electrochemically oxidized at the negative electrode. In the lead-acid cell, the negative electrode contains spongy lead and lead sulfate (PbSO4) as the active materials.

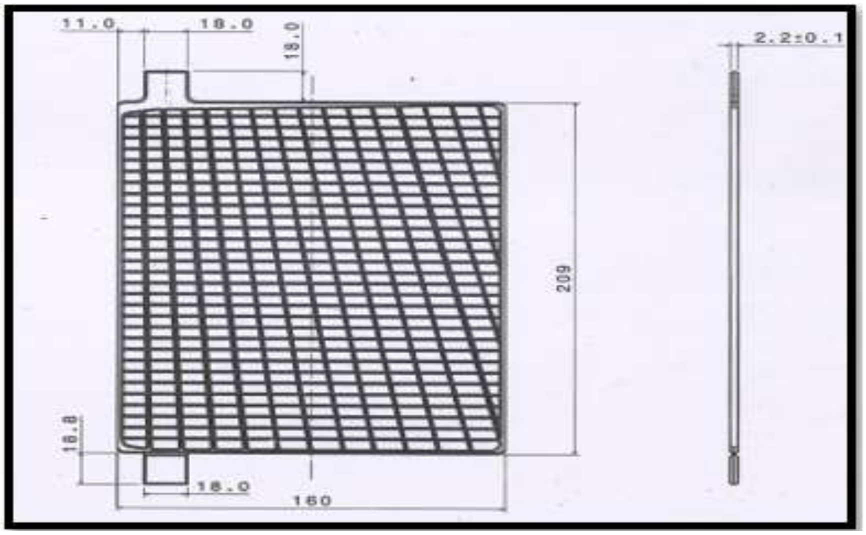

FIGURE 3. Negative terminal

Cover and Container: The container, cover (Lid) and pressure regulated body are made of Fire-Retardant Acrylonitrile Butadiene Styrene (ABS). The container and cover are sealed by the process of heat sealing. In manufacturing of FTA cover and container, ABS is used because of it exhibits aesthetic look and good dimensional stability. Here the main consideration is dimensional tolerance because we have very limited space of 23” only to accommodate four modules in the relay rack.

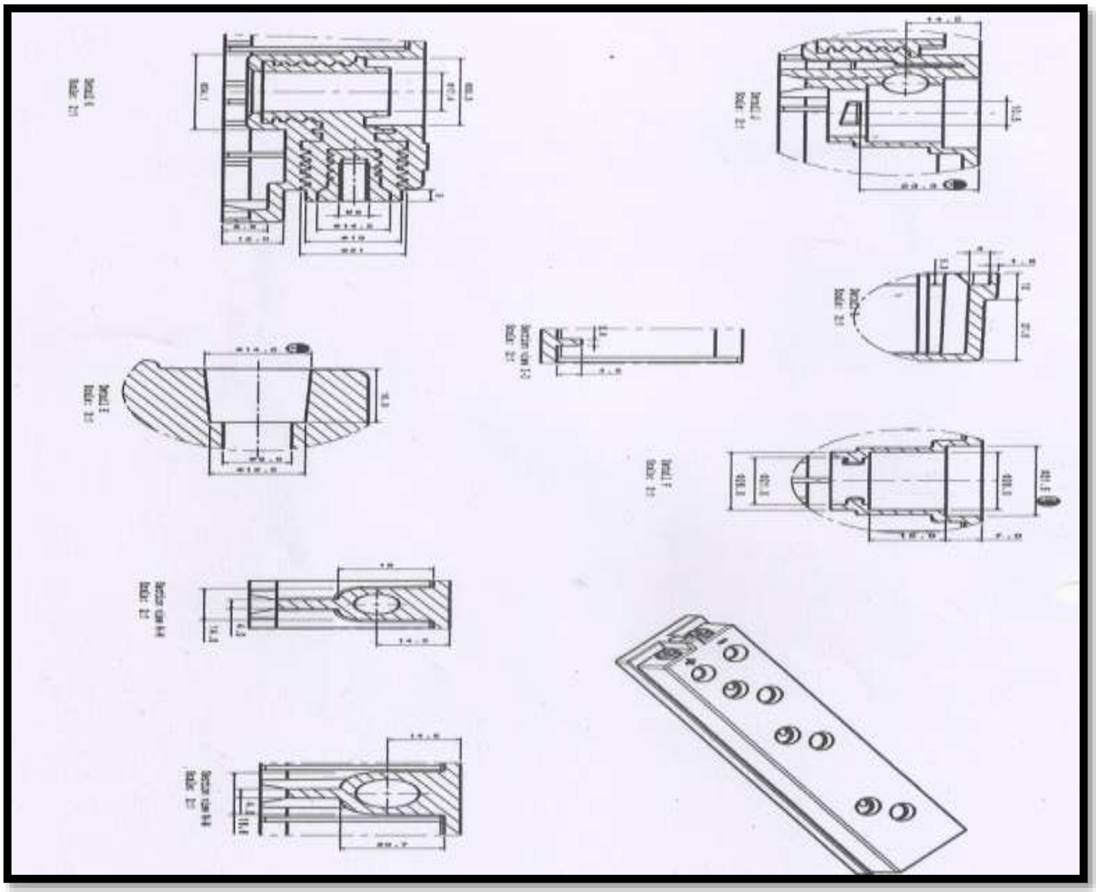

FIGURE 4. FTA Battery Cover

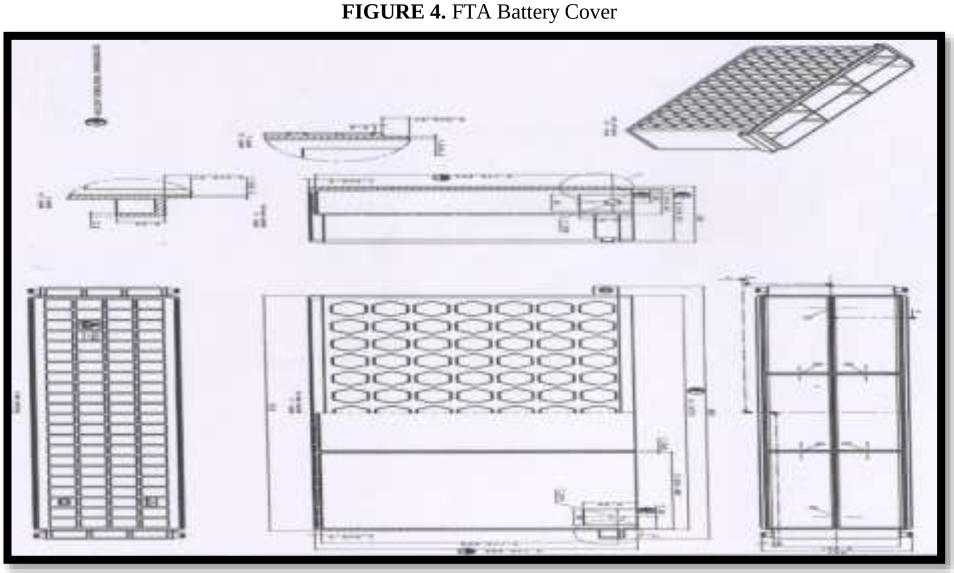

FIGURE 4. FTA Battery Cover

FTA battery Vent Plugs: Types include individual filler plugs, strip-type, or box-type. They allow controlled release of hydrogen gas during charging (vehicle operation). Removed, they permit checking electrolyte and, if necessary, adding water.

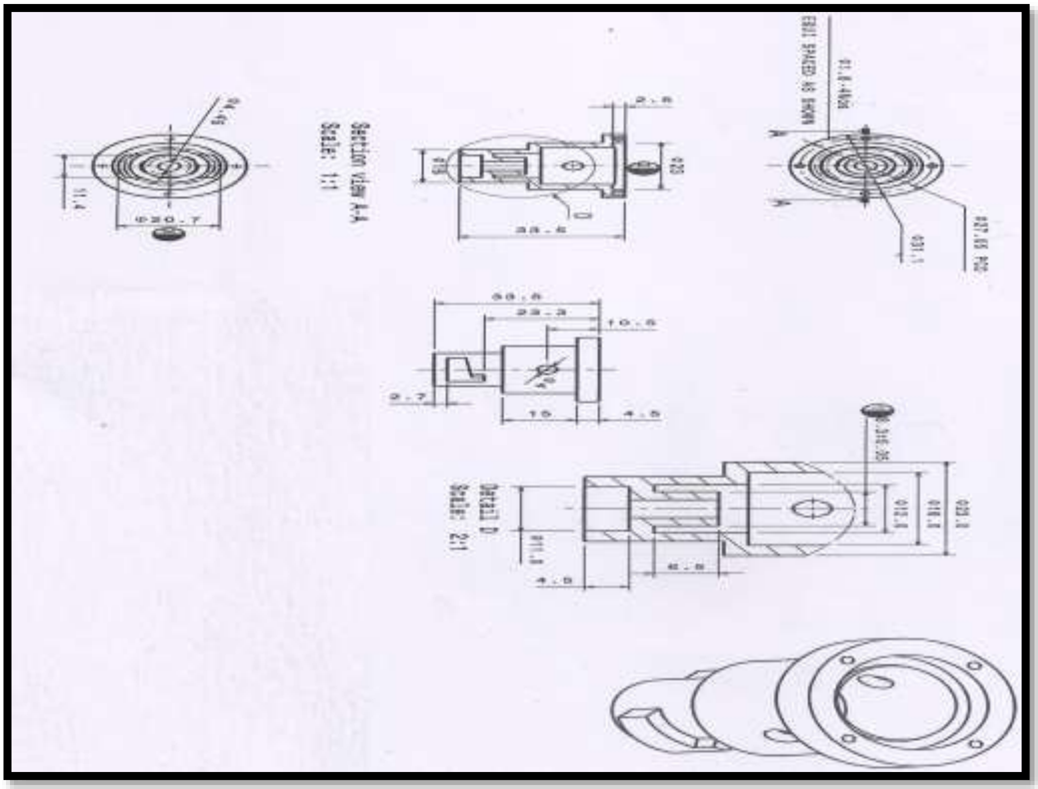

FIGURE 5. FTA Battery Vent Plugs

5. TESTING PROCEDURE

Cyclic Endurance in Telecom Applications: In telecom applications the battery will be exposed to large number of shallow cycles but at different state of charge. The cells or batteries shall therefore comply with the requirements of tested below, which is a simulation of the telecom energy system operation. The cycle endurance test is an accelerated simulation in extreme conditions of the battery operation in a telecom energy system and shall be conducted by submitting the cells or monobloc batteries to a period of 150 cycles.

- Recharge 3hrs with a current 2.35× c_{20} (2.35×7.5×6)
- Discharge the battery with a current 3.4 x c_{20} (A) of during 9 Hrs or until 1.75 V/Cell is reached

TABLE I. UNITS FOR MAGNETIC PROPERTIES

S NO	Discharge h	Charge h	Current A
A	**9**	**-**	2.35× C_{20} (2.35×7.5×6)
B	**-**	**3**	3.4 x C_{20}
Repeat the procedure for 150times			

Capacity check: After the completion of 150 cycles, the battery is cooled down to the temperature defined in the relevant standard as described in JIS spec and stabilized at this value for 16hrs. The capacity test C_{20} is carried out according to the relevant standard as described in JIS spec. End Test Condition: Capacity is checked after each period of 150 cycles. The cycle life shall be expressed in number of 150 cycle sequences completed. Then test is finished. During the 150 cycles when the cell voltage measured in discharge is should not be lower than 1.75V/cell for lead acid batteries, the minimum voltage shall correspond to a safe value for each cell of a battery system and shall be given by the battery manufacturer. After the 150cycles: when the capacity is checked measured rated capacity, then we consider completion of one complete unit. Continue procedure for further 3 units at the end of the end of fourth stage is should not be less than 80% of the rated capacity then only we consider the battery fulfilled the requirement.

Note- Each period of 150 cycles corresponds approximately to 4 years of life expectancy in site condition.

6. RESULTS AND DISCUSSION

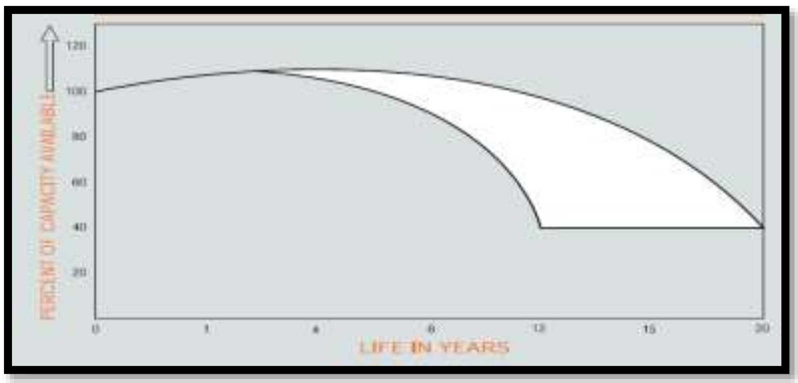

FIGURE 6. Float Life Expectance of FTA Battery

Float Service Life: The float service life, or life expectancy under continuous charge, depends on the frequency and depth of discharge, the charge voltage, and the ambient temperature. At a float voltage of 2.25V to 2.30V/cell and an ambient temperature of 60°F to 77°F (20°C to 27°C) FTA batteries should last eighteen to twenty years before the capacity drops to 80% of its original rating. The graph in Figure shows life characteristics in float (standby) service for ambient temperatures ranging from15°C to 55°C If prevailing ambient temperatures are well above 20- 27°C the life expectancy of this type of battery in float service depends greatly on temperature compensated charging. The typical temperature coefficient is - 2mV/cell/°C. The graph shown alongside is based on temperature compensated charging.

Cyclic life

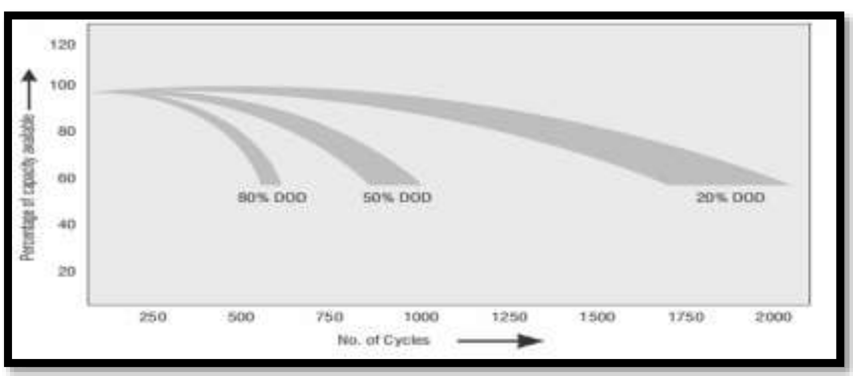

FIGURE 6. Float Life Expectance of FTA Battery

According to my experiments for cyclic application, the FTA battery maintained its voltage for approximately 2000 cycles at 20% (Low Current Drain) Depth of Discharge (DOD). FTA battery maintained its voltage for approximately 1100 cycles at 50% (Medium Current Drain) Depth of Discharge (DOD).). FTA battery maintained its voltage for approximately 600 cycles at 80% (High Current Drain) Depth of Discharge (DOD). Basically, the FTA battery performs with increasing superiority, the Lower the current drain of the module. The float application (Duty) batteries do not maintain their voltage (12years) as long as FTA battery at any level of current drain.

7. CONCLUSION

- The studies reveal that the performance of VRLAB is better than LM flooded LAB for solar street light standalone application. It is also comparable with flooded tubular LAB.
- Sulphation is the major failure in LAB operated under POSC operation such as SPV application
- Water loss in flooded LAB is higher than VRLAB in the said application • at low Sp.Gr.1.28, the growth of lead sulphate crystal initially is in 2-d whereas for higher Sp. Gr the growth is 3-d.
- The performance of PIC based PWM charge controller is better than the conventional series type controller
- The life of lead-acid battery is decided by the number of units completed by the battery according to the JIS spec. This ratio is 1:2.4 for a load of 11W used in telecom stand alone and light application.
- My hypothesis was that FTA would last the longest in all of the devices tested. My results do support my hypothesis. I think the tests I did went smoothly and I had no problems.
- •An interesting future study might involve testing the batteries at different temperatures to simulate actual usage in very cold or very hot conditions. The cyclic application (Duty) batteries do not maintain their voltage as long as FTA battery at any level of current drain in telecom applications.

Scope of future work:

- Use of modified negative electrode with half carbon paste for negative electrode to reduce sulphation
- Use of additives such as carbon, ionic liquids to reduce sulphation in the electrodes

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