BATTERY : Types, Cases of Fires/ Accidents, Precautions/Maintenance etc.

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Electricity has now become an integral part of our Day-To-Day life. Major portion of Rural India and part of Semi-Rural areas and smaller cities are still reeling under acute power shortage. To mitigate the problem the Commercial & Industrial areas use Stand-By Diesel Generators and the residential population use the Inverters with batteries having back-up as per individuals need. All the electronic gadgets, scooters, cars, DG.sets etc use batteries. We often read in Newspapers a report about accidents/fires involving a battery and there is therefore a need to know about different types of batteries and various issues associated with their use and precautions to be taken to prevent accidents/fire etc. Out of 5 incidences mentioned below four are experienced by the author during a period of last 40 years in which member of technical staff known /friends etc were involved.

A. Various instances of Accidents/Fires caused by Batteries

While dealing with different cases of accidents an attempt has been made to first give the details of accidents and then discuss about the causes and precautions/preventive actions to be taken by giving brief information about the components and use of different batteries.

1. Fire Due to Explosion of S.M. F. Battery of U.P.S.

Due to cloud burst followed by incessant rains caused flooding of most of the areas of Mumbai & New Mumbai in July 2005. India's Largest financial institution has it's World Data Centre and all the associated I.T. departments in New Mumbai. It's L.T. Distribution Panels and S.M.F. batteries of some of UPS were housed in the basement which got fully submerged under water and remained under water for almost a week. Battery Bank's were disconnected from the U.P.S. Subsequently, after removal of water, -ve terminals of all the battery bank's were disconnected to prevent the completion of circuit till the battery conditions are checked. All the batteries were cleaned and their voltages were checked. As batteries being S.M.F. type and no physical damage was found they were put in to service one by one. As the power supply was still erratic the U.P.S. was taking care of critical loads and batteries were getting charged and discharged. However, after 4-5 days there was sudden fire in one of the battery bank. Further investigation about probable cause was carried out.

2. Eye & Face Injury due to Flooded Type Lead Acid Automotive Battery

A young helper in a battery dealer's work-shop was charging the automotive battery of a truck

belonging to his friend. He used to assist the qualified technician in the work-shop. On that fateful day his senior was on leave and the helper took over the battery charging & testing. Out of the two batteries one battery was found charged and other was not during the normal period of charging. He continued charging for few more hours but found no improvement. He remembered that his senior was adding electrolyte and distilled water in the batteries they used to manufacture locally. Hence, by opening the knob of a battery cells he poured Acid in the battery which was charging. Instantly the electrolyte in the battery cell flashed over his eyes and face and he got injured.

3. Flash Over of a Mobile Battery

A young college girl had kept her Mobile phone for charging with a newly procured charger. Due to incoming call the mobile was ringing. When the girl responded to the call she experienced that the mobile is hotter than it used to be but as the call being from the best friend she ignored it & continued with the talk and within a few seconds the mobile battery exploded causing facial injury to the girl.

4. Fire in a Car Battery

Depending upon the Engine capacity, each motor car is equipped with the battery & connecting leads of designed AH & current rating which is adequate to start the engine. Sometimes due to lubrication related problems the car engine tend to draw more starting current and a weak battery fails to start the engine. In one of the cases the Taxi driver finding that the car engine is not starting went to the battery charging shop and got much higher AH battery which was the only available battery at that juncture installed in the car as a stop-gap replacement. As the size was bigger it was tied with a rope. After running for 7-8 hours and with 2-3 stop overs the driver noticed smoke from car bonnet while driving and stopped the car.

5. Fire in a 787 Dreamliner Aeroplane

Boeing Co. had introduced its giant Dreamliner Aero planes with much fanfare. After few successful commercial flights there was an incidence of a Fire at Narita Airport in Japan when a 787 Dreamliner Aero plane's take-off was aborted due to a battery fire signal.

Before going in to the details of finding out the causes, it is necessary to know the different types of batteries and their working principles.

Different Types of Batteries

Batteries are basically classified as "Primary"(Not re-chargeable) and "Secondary" type which can be re-charged and can be re-used. Alkaline batteries used in Wrist Watches, Remote controls, Electric keys, Children Toys, Pacemaker for heart patients etc are of primary type. Secondary batteries are of following types:

1. Lead Acid Batteries

They are basically of following types :

A. Starting or Cranking type.

B. Deep Cycle Batteries. They are further classified as Tubular/ S.M.F.(V.R.L.A.)/ Wet Cell OR Gel Cell/A.G.M. (Absorbed Glass Mat).

In certain applications the Lead Acid batteries are now getting replaced by other types like :

C. Nickel Cadmium. (Ni-Cl.)

D. Nickel Metal Hydried.(NiMH.).

Latest developments in batteries include

E. Lithium Phosphate

F. Lithium Polymer &

G. Lithium Ion etc.

Working Principle & Infrastructure of Lead Acid batteries

A Flooded Lead Acid battery has basic components namely lead plates, Lead oxide and Sulphuric Acid. Various other elements are used to alter porosity, hardness, density etc. Normally, a Lead Acid battery contains 35% Sulphuric Acid & 65% water which is called as an Electrolyte. When we test the battery with Hydrometer, we basically measure the amount of Sulphuric Acid. When the reading is low the quantity

of Sulphur in the electrolyte is LOW as it is resting on battery plates. When the battery is re-charged the Sulphur on the plates returns to the Electrolyte. **The starting battery** is designed to deliver high initial energy to start an engine and therefore have more no. of plates. Plates are normally thinner and have a different material composition. **Deep Cycle battery** delivers lower initial energy/current but a greater OR Long term energy delivery. They have thicker plates and can survive larger no. of discharge cycles. **Starting batteries** should not be used for Deep Cycle application as thinner plates have a tendency to warping & pitting due to larger no. of discharge cycles needed in Deep Cycle batteries. Vice-Versa is true in case of **Deep Cycle batteries** used for starting as they will not be able to deliver higher starting energy/current . However, there are some makes of batteries which can be used for dual purpose. Other versions of Lead Acid batteries are Wet Cell (Flooded), Gell Cell & A.G.M. Wet Cell batteries are also of 2 types namely serviceable & Maintenance free. Both are having the electrolyte in different forms.

Gell Cell & A.G.M. batteries are of special category which are almost double in cost as compared to earlier types. These batteries do not Sulphate OR degrade easily. They **have electrolyte in a paste form**. They are safer to handle as there are less chances of explosions due to generation of Hydrogen. Corrosion is also very low. These batteries need a special charging rate. A.G.M. batteries are popularly used in **Solar, Marine, Power Sports, RV and Stand-By applications**. Even in idle condition the A.G.M. batteries have a capability to hold charge for a longer period. **A.G.M. batteries are also called V.R.L.A. Dry Cell batteries** etc. They have a greater life span. They give best performance when recharged before being allowed to drop below 50% discharge rate.

Gell Cell batteries are similar to A.G.M. type as the Electrolyte is in suspended state. They contain Silica Additive to stiffen as against Antimony used in Flooded Lead Acid batteries. They need lower voltage for recharge. They are popularly used in Hot Weather & for very Deep Discharge cycle application. The output & capacity of battery is rated in terms of AH, RC, CA CAA etc. Most batteries have date of manufacture in coded form. Month is normally indicated in letters A,B,--L & year by letters 11,12,----. i.e. D13 indicates April 2013 as its manufacturing date.

Causes of Sulphation & Lead Acid Battery Failures:

80% battery failures are due to built up of Sulphation. This occurs when Sulphur molecules in Electrolyte becomes so deeply discharged that they begin to deposit on battery Lead plates. When the plates are thickly coated the chemical reaction stops & battery dies.

Common causes of Sulphation are :

(a) If battery remains idle for long period. A period as little as 24 hours in hot weather and several days in cold weather lead to Sulphation.

(b) Deep Cycling of an Engine starting battery.

(c) Undercharging of batteries to only 90% .

(d) High temperature of 100+ deg. F increases internal discharge rate.

(e) Low electrolyte level in flooded type causes battery plates to expose to air which causes Sulphation.

(f) Parasitic load which is a load put on a battery with vehicle engine in OFF condition (Computer/ Digital Clock etc.in a car OR Due to short circuit in wiring of the equipment which causes drain of batteries.

Battery life is shortened the more deeply it is discharged in each cycle. Lead Acid batteries loose capacity in low temperature. At 32 degree F a battery will deliver 75% of it's rated capacity at 80 degree F. Battery charging voltage changes with temperature.

In high temperature the battery chemistry becomes more active. & measurably decreases battery life. A battery may last for 5 years in 60 to 80 deg. F environment but may last for only 2 years in very hot weather like in Desert. For every 8.3 deg. C.(OR 15 deg.F) above recommended 25 deg. C (77 deg.F) the life of battery will reduce by 50%.

2. Nickel Cadmium, Nickel Metal Hydried, Batteries

Nickel Cadmium batteries use Nickel Oxide hydride & metallic Cadmium as electrodes . These are wet cell batteries. They are used in Standby Power as well as Motive Power. They offer good cycle life & performance at low temperatures. They have ability to deliver practically its full power at high discharge rate. Disposal of heavy metal Cadmium batteries was causing environmental problems. Due to latest development the Nickel metal hydride batteries which are cheaper than above batteries are now popular & used in portable electronic devices, photography equipment's, emergency lights etc. in place of Ni-Cd type.

3. Lithium Phosphate, Lithium Cobalt, Lithium Polymer & Lithium Ion batteries.

Lithium batteries are now substituting Lead Acid type. Lithium Manganese Oxide (LMO), Lithium Nickel Cobalt Oxide (LNC), Lithium Polymer etc. batteries offer lower energy density but longer life & inherent safety**. Among Lithium batteries, the Lithium Iron Phosphate(LiFePO4) are considered to be safest as they do not overheat & even when punctured do not catch fire**. Internal components are non-hazardous & pose no environmental hazard. Phosphate & Iron are abundantly available and cheaper. Lithium Ion batteries have now become dominant form of rechargeable battery today. They are lighter, less expensive & more energy dense. They are powering everything from Mobile phones, Laptops to cars, Commercial jets etc**. Lithium Ion batteries pose safety hazards as they contain flammable electrolyte. Short ckt. will cause overheating and rupturing of Lithium Ion batteries.**

B. Probable Causes of Fires in the 5 incidences of Fires described earlier

S.M.F. Battery Fire In July 2005 :

It was found during the investigation that though the external surface of batteries were thoroughly cleaned of mud from the water deluge it is most probable that the small pores/valves in S.M.F. batteries for release of accumulated gas due to overcharging/short-ckt might have been blocked by the mud in some of the battery which might have entered in it and dried up. Accumulated gas pressure during continuous charging of a sulphated battery might have built up & due to blocked escape may have led to explosion in a bid to get released. No other possible cause could be found,

Eye & Face Injury due to splashing of Electrolyte from Automotive Battery & Smoking incidence of a car :

a. Automotive batteries are flooded type which contain an electrolyte a combination of Water & Sulphuric Acid. **Specific Gravity** of water is 1 and that of Sulphric Acid is more . When acid is poured in water due to its high density/Sp. Gr.(1.265) it goes down and water comes on surface. Same happened in the 2nd case of battery involving the helper whose eyes & face was injured. When he poured Acid in the electrolyte the acid went down and hot electrolyte of charging battery splashed out injuring the worker.

b. In the 4th case involving the Car battery, it was found that though the higher capacity battery was used the connecting lead cable were not changed causing overheating & burning of cable insulation which melted and burning insulation pieces falling on the wooden plank on which oversized battery was mounted & tied it started burning.

Mobile Battery bursting & Aeroplane Battery Fire:

a. As stated above, nowadays Lithium Ion Batteries are used in Mobiles, Aeroplanes etc. due to their dense energy charge. In these batteries following safety features are provided.

   Shut Down Separator (For safety against overheating)

   Tear-Away Tab (For Built Up Internal Pressure)

   Vent (For Pressure Relief)

   Thermal Interrupter. (Over-current/Over-voltage protection)

   In case of mobile the newly procured charger was defective causing overheating of the mobile

battery. Failure of one of the above safety feature of Lithium battery resulted in the explosion of battery. In case of the Dreamliner Aeroplane the findings were not reported by the manufacturers as a matter of their policy.

C Precautions /Maintenance of Batteries

Lead Acid flooded type batteries should be cleaned with a baking Soda and water solution. It should be ensured that connecting cables are of correct size to carry the current . The cable connectors should be tightened properly and Petroleum Jelly should be applied on the connectors. Level of Electrolyte in flooded type be checked at regular intervals and only Distilled water be added whenever the water level falls down. It should be ensured that the plates are fully covered with electrolyte. It should be ensured that the electrolyte do not spill over and lie on battery surface. If for any reason the battery is kept on BOOST charge position, it should be put back on floating charge position to prevent OVERCHARGE.

The Lithium Ion batteries used in Mobiles/Laptops and other household equipments should be kept at normal ambient temperatures. Proper rated charger needs to be used.

We should remove wrist watch, hand bracelets and other jewellery at the time of battery checking testing etc to prevent accidentals short-ckts/sparking etc. Safety goggles Or at least wide zero number spectacle be used. When any electrical work is to be done on the vehicle **it is advisable to remove Ground Cable**.

It can be concluded from the above information that use of correctly rated battery with its charger when properly maintained and when the proper safety precautions are followed we can use all the battery operated equipment's quite safely and chances of accidents/fires can be prevented.