Alkaline batteries

It is the improved form of dry cell. It consists of a zinc cylinder which acts as anode and a graphite rod (carbon rod) at the center of the container which acts as the cathode. The zinc cylinder is filled with an electrolyte consisting of powered zinc, KOH and MnO_2 in the form of paste. The zinc cylinder has an outer insulation of card board case (Fig. 3.15). The cell reaction is as follows:

Anode : $Zn_{(s)} + 2OH^-_{(l)} \longrightarrow Zn(OH)_{2(s)} + 2e^-$

Cathode: $2MnO_{2(s)} + H_2O_{(l)} + 2e^- \longrightarrow Mn_2O_{3(s)} + 2OH^-_{(l)}$

Net Reaction:

$Zn_{(s)} + 2MnO_{2(s)} + H_2O_{(l)} \longrightarrow Zn(OH)_{2(s)} + Mn_2O_{3(s)}$

Advantages of alkaline battery over dry battery

Zinc does not dissolve in a basic medium.
The life time of alkaline battery is longer than the dry battery because zinc cylinder is not involved in cell reaction. Zinc powder present in the electrolyte is only involved in reaction. So, there is no corrosion of zinc cylinder.
It gives constant voltage when the current is drawn from it.
Even in hot weather, it performs better than other type of batteries.

Uses

It is used in cameras, calculators, radios and watches.

Lead acid battery (or) Lead storage cell (or) Lead accumulator (or) Acid storage cell

Lead acid battery can be operated both as a voltaic and electrolytic cell. When it acts as a voltaic cell, it supplies electrical energy and run down. When it is recharged, it acts as an electrolytic cell. Thus, it is rechargeable.

Construction

A lead storage battery consists of 3 to 6 voltaic cells connected in series. In each cell, lead acts as anode and lead dioxide (PbO_2) acts as cathode .

Various plates are separated from the adjacent one by insulator like rubber. Anodes and cathodes are immersed in 20 to 21 % dil. H_2SO_4 having a density of 1.3 gm/ml. The cell representation is given below.

$$Pb \mid PbSO_4 \parallel H_2SO_{4(l)} \mid PbO_2 \mid Pb$$

Working (Discharging)

When the storage cell is supplying electricity, lead is oxidized to Pb^{2+} ions and $PbSO_4$ is formed at anode. At cathode, PbO_2 gains the liberated electrons and gets reduced to Pb^{2+} and $PbSO_4$ is formed.

At anode:

$$Pb_{(s)} \longrightarrow Pb^{2+}_{(l)} + 2e^-$$

$$Pb^{2+}_{(l)} + SO_4^{2-} \longrightarrow PbSO_{4(S)}$$

$$Pb_{(s)} + SO^{2-}_{4\,(l)} \longrightarrow PbSO_{4(s)} + 2e^- \quad ....(1)$$

At cathode:

$$PbO_{2(s)} + 2e^- + 4H^+_{(l)} \longrightarrow Pb^{2+}_{(l)} + 2H_2O$$

$$Pb_{(l)} + SO^{2-}_{4\,(l)} \longrightarrow PbSO_{4(s)}$$

$$PbO_{2(s)} + 4H^+_{(l)} + SO^{2-}_{4\,(l)} + 2e^- \longrightarrow PbSO_{4(s)} + 2H_2O_{(s)} \quad ......(2)$$

Overall cell reaction during (discharging) use (1) + (2)

$$Pb + PbO_2 + 4H_2SO_4 \longrightarrow 2PbSO_{4(S)} + 2H_2O + \text{Energy}$$

At the time of discharging process, $PbSO_4$ is deposited at both the electrodes and H_2SO_4 is consumed. As a result, the concentration of H_2SO_4 decreases gradually.

Recharging

The cell is recha rged when the density of H_2SO_4 becomes below 1.2 gm/ml. It can be done by applying an external electricity across the electrodes. The following reaction will take place during recharging process :

At anode : $PbSO_{4(s)} + 2e^- \longrightarrow Pb_{(s)} + SO^{2-}_{4\,(l)}$

At cathode: $2PbSO_{4(S)} + 2H_2O \longrightarrow PbO_{2(s)} + 4H^+_{(l)} + SO^{2-}_{4\,(l)} + 2e^-$

Overall Reaction