Construction and working of Lead acid battery

Secondary batteries

Secondary batteries store energy for use in a variety of applications, from consumer electronics to large-scale energy storage systems (from mobile phones to electric vehicles).Unlike primary (non-rechargeable) batteries, secondary batteries can be recharged many times, making them more cost-effective and sustainable.

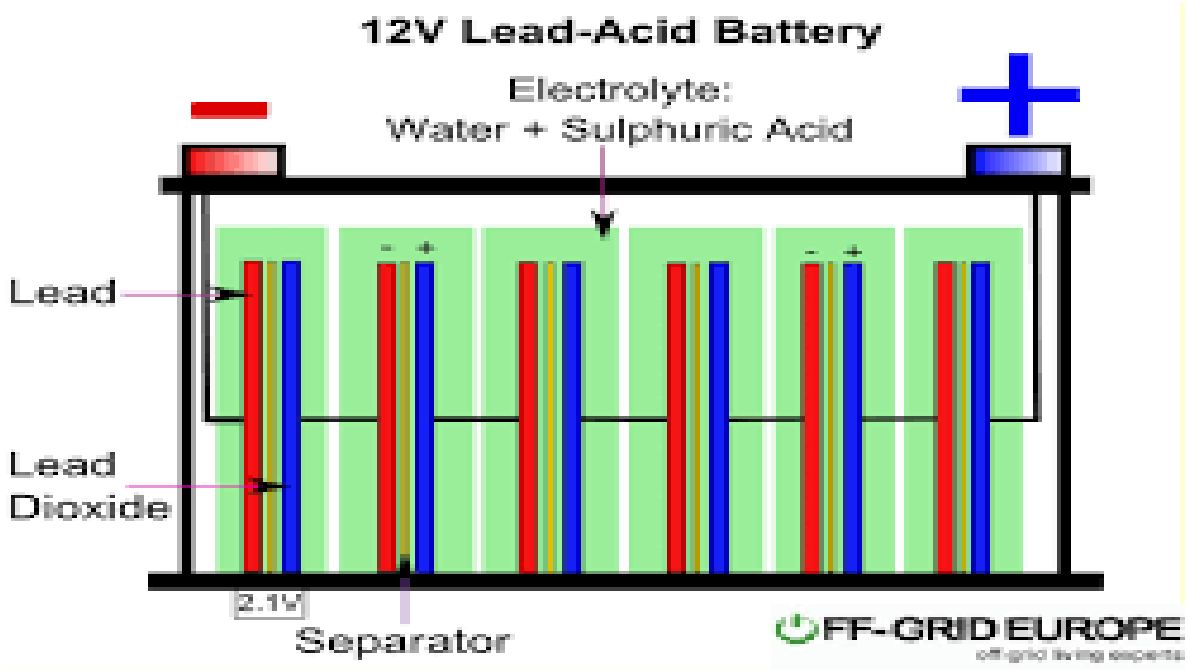
In these cells, the electrode reaction can be reversed by passing an external electrical energy. Hence, they can be recharged by passing electric current through them and can be used again and again. They are also called as storage cells or accumulators.

Examples

Lead Acid Battery and Lithium ion Battery

Lead Acid Battery

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.

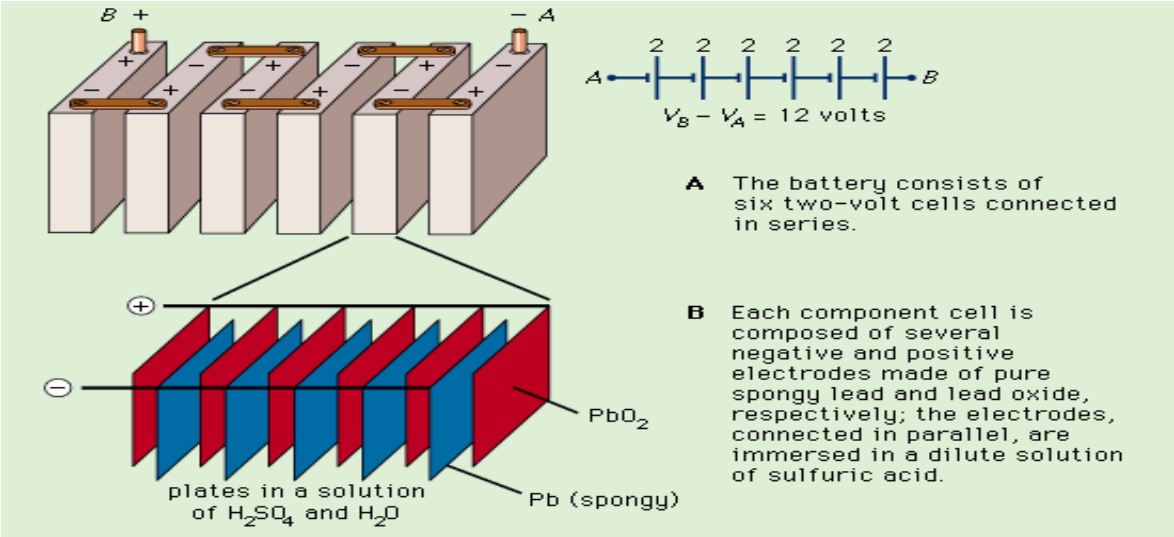


Construction

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 |$PbSO_4$ || H_2SO_4 (L) |PbO_2 |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:

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

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

$$Pb\ (s) + SO^{2-}{}_{4\ (l)} \longrightarrow PbSO_4(s) + 2e^- \ldots\ldots (1)$$

At cathode:

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

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

$$PbO_{2\,(s)} + 4H^+_{(l)} + SO^{2-}_{(l)} + 2e^- \longrightarrow PbSO_{4\,(s)} + 2H_2O(s) \quad .....(2)$$

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

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

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

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

Hence, the recharging involves exactly the reverse process of the normal cell reaction.

Note:

Decrease in density Decrease in density of dil. H_2SO_4 can be measured with the help of hydrometer.

Uses

It is used in automobiles such as cars, buses, etc.

It is also used in gas engine ignition, telephone exchanger, hospitals, power stations, etc.

Advantages of lead acid battery

It can be constructed easily.

It produces high voltage.

It acts as effectively even at low temperature.

Self-discharge is very low when compared to all other batteries.

Disadvantages

Recycling of this battery causes environmental pollution.

Mechanical strain and normal pumping reduces battery capacity.

Fill in the Blanks

Type of battery which can be only used once_____

Type of battery which can be recharged_____

On charging secondary batteries, the reaction is _____

Thermal plants have more efficiency than fuel cell (True/False_____

Most commonly used battery in automobiles & inverters_____

Secondary cells are charged by passing current through it in the _____direction

Grid of lead packed with _____ as cathode in lead storage battery

Electrolyte used in lead storage batteries_____

Another name of dry cell_____

(LEAD OXIDE, REVERSED, LEAD ACID BATTERY, LECLANCHE, OPPOSITE, PRIMARY, SULPHURIC ACID, FALSE, SECONDARY)