

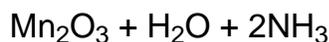
Chem12 Common Electrochemical Cells and Storage Batteries : Notes - 40

Leclanché cell

This cell is called a "dry" cell as the electrolyte is a paste instead of a liquid. The paste consists of MnO_2 , NH_4Cl and ZnCl_2 . The cell consists of a zinc cylindrical container (anode) and a graphite (carbon) rod (cathode).

The anode reaction is : $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$

The cathode reaction is : $2\text{MnO}_2 + 2\text{NH}_4^+ + 2\text{e}^- \rightarrow$



The voltage of this cell is 1.5 V. Unfortunately, this cell has a poor "shelf-life". This means that it will not keep its charge for long while in storage.

Alkaline cell

The alkaline battery (it is really a cell) is an improvement over the Leclanché cell. It has a more consistent voltage, increased capacity, larger current and a longer shelf life. Because of the long shelf-life, alkaline batteries can be kept in flashlights for several years without losing their charge. They look similar to the Leclanché cell.

The Anode reaction is : $\text{Zn} + 2\text{OH}^- \rightarrow \text{ZnO} + \text{H}_2\text{O} + 2\text{e}^-$

The Cathode reaction is : $2\text{MnO}_2 + \text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{Mn}_2\text{O}_3 + 2\text{OH}^-$

In this dry cell, KOH, an alkaline substance, is used as the electrolyte. The cell operates under basic conditions. The voltage is also about 1.5 volts.

Mercury cell

This 1.35 volt cell is used in watches and calculators. It is often smaller than a dime. The anode is zinc and the cathode is mercury (II) oxide. The electrolyte is a moist paste of HgO and potassium hydroxide.

The anode reaction is : $\text{Zn} + 2\text{OH}^- \rightarrow \text{ZnO} + \text{H}_2\text{O} + 2\text{e}^-$

The cathode reaction is : $\text{HgO} + \text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{Hg} + 2\text{OH}^-$

These cells are commonly used but there could be environmental problems when they are disposed of as the mercury is toxic. These cells should be recycled.

Nickel-cadmium cell

This popular 1.3 volt cell is rechargeable. Several of these cells can be connected in series. The voltage will be the sum of the cell voltages. (Note : Rechargeable batteries are also called storage batteries. A battery consists of several cells connected in series)

The anode reaction is : $\text{Cd} + 2\text{OH}^- \rightarrow \text{CdO} + \text{H}_2\text{O} + 2\text{e}^-$

The cathode reaction is : $\text{NiO}_2 + \text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{NiO} + 2\text{OH}^-$

These cells should be recycled as the cadmium is toxic.

Lead-acid storage battery

This battery usually consists of six cells connected in series. In one cell, the anode consists of a plate of (spongy) lead. The spongy lead has numerous small holes increasing the surface area. The cathode consists of a plate of PbO_2 . The electrolyte is sulfuric acid.

The anode reaction is : $\text{Pb} + \text{SO}_4^{2-} \rightarrow \text{PbSO}_4 + 2\text{e}^-$

The cathode reaction is : $\text{PbO}_2 + 4\text{H}^+ + \text{SO}_4^{2-} + 2\text{e}^- \rightarrow \text{PbSO}_4 + 2\text{H}_2\text{O}$

A film of lead (II) sulfate is formed on both electrodes during discharge, consuming the sulfuric acid. The battery is rechargeable. On recharge the lead (II) sulfate is converted back to metallic lead and lead (IV) oxide at their respective electrodes.

The cell voltage is 2.04 volts. A lead-acid battery usually consists of six cells connected in series. The voltage of the battery is about 12 volts. The advantages of this battery are that it is very dependable, operates at low temperatures, can produce a high current and is

rechargeable. This battery is used in automobiles. These batteries should be recycled as the lead is toxic.

Hydrogen-oxygen fuel cell

In this cell hydrogen (or methane or propane) reacts with oxygen. The electrolyte is a potassium hydroxide solution.

The anode reaction is : $2\text{H}_2 + 4\text{OH}^- \rightarrow 4\text{H}_2\text{O} + 4\text{e}^-$

The cathode reaction is : $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-$

This cell is used to produce electrical energy during space missions. The astronauts drink the water that is produced by the cell. It is a very efficient cell but it is still expensive to produce.

Questions : 1) Which species is reduced in the Leclanché cell ?

2) Give the overall reaction for the Alkaline cell.

3) Give four advantages of the alkaline cell over the Leclanché cell ?

4) Which cell is used in watches ? Give the overall reaction.

5) What is the main advantage of the Ni-Cad cell ?
What is a disadvantage ?

6) What is a battery ?

7) Which battery is found in cars ? What is the electrolyte in this battery ?

8) Give four advantages of the lead-acid storage battery.

9) Which cell is used on the shuttle ? Give the overall reaction.

Answers : 1) MnO_2 , 2) $\text{Zn} + 2\text{MnO}_2 \rightarrow \text{ZnO} + \text{Mn}_2\text{O}_3$, 3) consistent voltage, larger current, increased capacity, and longer shelf-life. 4) Mercury cell, $\text{Zn} + \text{HgO} \rightarrow \text{ZnO} + \text{Hg}$, 5) rechargeable, cadmium is toxic,

6) several cells connected in series, 7) lead-acid storage battery, sulfuric acid, 8) dependable, large current, operates at low temperatures, rechargeable, 9) Hydrogen-oxygen fuel cell, $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$.