Class XII

SOME COMMERCIAL CELLS (BATTERIES)

CONCEPT MAP

Batteries are cleverly engineered devices that are based on the same fundamental laws as galvanic cells. A storage cell is a galvanic cell that contains all the reactants needed to produce electricity whereas fuel cell is a galvanic cell that requires a constant external supply of one or more reactants to generate electricity.

PRIMARY CELLS

Cells once exhausted cannot be used again therefore, they are not chargeable.

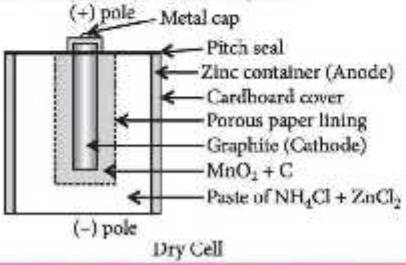
DRY CELL

Anode : $Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^-$

Cathode : $2NH^+_{4(aq)} + 2MnO_{2(s)} + 2e^- \rightarrow 2MnO(OH) + 2NH_3$

Net reaction : $Zn_{(s)} + 2NH^+_{4(aq)} + 2MnO_{2(s)} \rightarrow Zn^{2+}_{(aq)} + 2MnO(OH) + 2NH_3$

Uses : In transistors and clocks, etc.



Dry Cell

MERCURY CELL (Ruben-Mallory Cell)

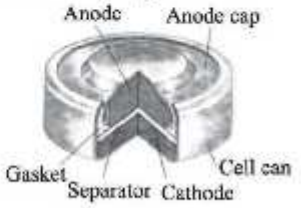
Anode : $Zn(Hg) + 2OH^-_{(aq)} \rightarrow ZnO_{(s)} + H_2O_{(l)} + 2e^-$

Cathode : $HgO_{(s)} + H_2O_{(l)} + 2e^- \rightarrow Hg_{(l)} + 2OH^-_{(aq)}$

Net reaction : $Zn(Hg) + HgO_{(s)} \rightarrow ZnO_{(s)} + Hg_{(l)}$

The cell potential is approximately 1.35 V and remains constant during its life.

Uses : In watches, hearing aids, etc.



Mercury cell

(The reducing agent is zinc and the oxidising agent is mercury (II) oxide.)

SECONDARY CELLS

Cells which can be used again and again therefore, they are chargeable.

LEAD STORAGE CELL

Cell reactions during use of battery :

Anode : $Pb_{(s)} + SO^{2-}_{4(aq)} \rightarrow PbSO_{4(s)} + 2e^-$

Cathode : $PbO_{2(s)} + SO^{2-}_{4(aq)} + 4H^+_{(aq)} + 2e^- \rightarrow PbSO_{4(s)} + 2H_2O_{(l)}$

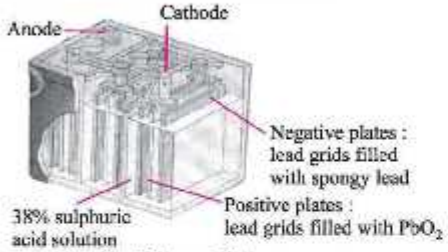
Net reaction :

$Pb_{(s)} + PbO_{2(s)} + 2H_2SO_{4(aq)} \rightarrow 2PbSO_{4(s)} + 2H_2O_{(l)}$

The reverse reaction takes place during recharging :

$2PbSO_{4(s)} + 2H_2O_{(l)} \rightarrow Pb_{(s)} + PbO_{2(s)} + 2H_2SO_{4(aq)}$

Uses : In automobiles and inverters.



Lead Storage Battery

NICKEL - CADMIUM CELL (or NICAD cell)

Cell reactions during use of battery :

Cathode : $2Ni(OH)_{3(s)} + 2e^- \rightarrow 2Ni(OH)_{2(s)} + 2OH^-_{(aq)}$

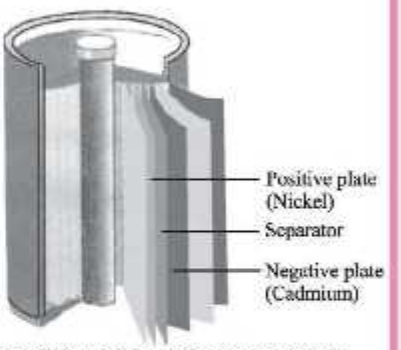
Anode : $Cd_{(s)} + 2OH^-_{(aq)} \rightarrow CdO_{(s)} + H_2O_{(l)} + 2e^-$

Net reaction : $Cd_{(s)} + 2Ni(OH)_{3(s)} \rightarrow CdO_{(s)} + 2Ni(OH)_{2(s)} + H_2O_{(l)}$

The reverse reaction takes place during recharging :

$CdO_{(s)} + 2Ni(OH)_{2(s)} + H_2O_{(l)} \rightarrow Cd_{(s)} + 2Ni(OH)_{3(s)}$

Uses : In portable electronic devices, emergency lighting, photography equipments, etc.



A rechargeable nickel-cadmium cell in a jelly roll arrangement and separated by a layer soaked in moist sodium or potassium hydroxide.

FUEL CELLS

Cells which can convert the energy of combustion of fuels such as H_2, CO, CH_4 etc. into electrical energy.

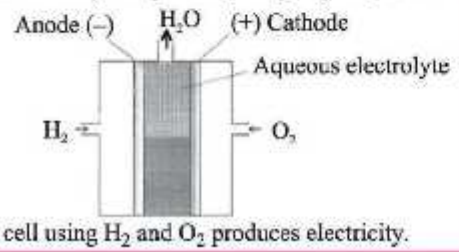
$H_2 - O_2$ FUEL CELL

Anode : $2H_{2(g)} + 4OH^-_{(aq)} \rightarrow 4H_2O_{(l)} + 4e^-$

Cathode : $O_{2(g)} + 2H_2O_{(l)} + 4e^- \rightarrow 4OH^-_{(aq)}$

Net reaction : $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$

Uses : In automobiles on experimental basis, for producing electricity in Apollo Space program, etc.



Fuel cell using H_2 and O_2 produces electricity.

CLASSIFICATION OF FUEL CELLS

(i) Alkali fuel cells [electrolyte is $KOH_{(aq)}$] (ii) Phosphoric acid fuel cells [electrolyte is $H_3PO_{4(aq)}$]. (iii) Molten carbonate fuel cells [electrolyte is $K_2CO_{3(l)}/Li_2CO_{3(l)}$] here, methane is used as a fuel. Recently, a zinc-air fuel cell (ZAFC) is developed in USA as a source of power in automobiles in which zinc metal is used in place of hydrogen gas.