Quadrant II – Transcript and Related Materials

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Notes

Introduction:

A device which consist of two electrodes in contact with an electrolyte which

convert chemical energy to electrical energy and vice-versa is called a cell.

In electrochemical cell chemical energy is converted to electrical energy when the reaction occurs at the respective anode and cathode by either gain of electrons or by loss of electrons.

Galvanic Cell

- A Galvanic cell is an electrochemical cell that can produce electricity with help of a chemical reaction.
- Galvanic cell converts chemical energy into electrical energy
- Galvanic cells may be either reversible or irreversible in the thermodynamic sense.
- The reactions in a galvanic cell are spontaneous
- In the galvanic cell the anode is negative charge and the cathode is positively charged.

Electrolytic Cell

- An electrolytic cell is a cell that uses an electric current for the progression of chemical reaction.
- Electrolytic cell converts electrical energy into chemical energy.
- Electrolytic cell is a type of irreversible cell.
- The reactions in the electrolytic cell are non-spontaneous.
- In the electrolytic cell the anode is positive charge and the cathode is negatively charged.

Reversible Cell

A reversible cell is a cell in which the driving and opposing force differs in extremely small amount from each other and the chemical change taking place in it can be reversed by applying an external force greater than the emf of the cell.

• In reversible cells the reaction does not occur until the electrodes are joined by a conductor and current is drawn from it.

A reversible cell should satisfy the following conditions:

- i. When the external emf of the cell is extremely greater than the emf of the cell, then current should flow through the cell and the cell reaction of the cell should get reversed.
- ii. When the external emf of the cell is very less than the emf of the cell, then current should flow from the cell.
- iii. When the external emf of the cell is exactly equal to the emf of the cell, then no current should flow through the cell.

Example: Daniel Cell

The reaction of the Daniel cell is

Anode: $Zn_{(s)} \longrightarrow Zn_{(aq)}^{2+} + 2e^{-1}$ Cathode: $Cu_{(aq)}^{2+} + 2e^{-1} \longrightarrow Cu_{(s)}$ $Zn_{(s)}^{2+} + Cu_{(aq)}^{2+} \longrightarrow Zn_{(aq)}^{2+} + Cu_{(s)}$ The cell reaction can be adjusted to forward or reverse direction by adjusting the external emf of the cell.

- In the Daniel cell if the external EMF is slightly more than 1.09 Volt is used than it changes the direction of current in opposite direction as well as reverse the reaction.
- When the external EMF is equal to 1.09 Volt the cell reaction stops and remains in equilibrium.
- When the external EMF of the cell is slightly less than 1.09 Volt is used than the reaction $Zn_{(s)} + Cu^{2+} + Cu^{2+} + Cu_{(aq)} + Cu_{(s)}$

takes place and small amount of current is given out.

Irreversible Cell

In an irreversible cell the driving and opposing forces do not differ in extremely small amounts and the chemical change taking place in it cannot be reversed by applying an external force

When in a cell reaction gas is evoked or a precipitate is formed the cell is irreversible because the cell cannot be brought back to its original condition by reversing the current.

Irreversible cells are those which necessitate alternate of chemicals when they give out electricity these cannot be recharged.

Example

Zinc and Copper electrodes dipped in the solution of sulphuric acid. When the cell is producing current the cell reaction is

$$Zn_{(s)} + 2H^{+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + H_{2(g)}$$
 (a)

The zinc electrode dissolves to form zinc ions and hydrogen is liberated at the copper electrode.

When the current is reversed than reaction (a) is not reversed. Instead the following reaction (b) will take place

 $Cu_{(s)} + 2H_{(aq)}^{+} \rightarrow Cu_{(aq)}^{2+} + H_{2(g)}^{-}$

Copper goes into the solution and hydrogen gas is liberated.

Difference Between Reversible cell and Irreversible Cell <u>Reversible Cell</u>

- Cell reaction is reversible
- EMF is generated by the cell reaction of its own

- Cell reaction occurs only when the two electrodes are connected externally
- It is a Galvanic cell
- For these cells thermodynamic principles may be applied
- Work done is maximum and maximum work is related to other thermodynamic quantities
- Both the electrodes are reversible with respect to one or other of the ions in solution

Irreversible Cell

- Cell reaction is irreversible
- An external potential greater than the cell emf is required for the cell reaction to occur
- Cell reaction may occur even if the two electrodes are not connected externally
- It is an Electrolytic cell
- Cells are not amenable to exact theoretical treatment
- Work done is minimum
- The electrodes are not reversible