Concept QuickStart – Electrolytic Cells and Electrolysis

Unit: Unit 2: Electrochemistry

Subject: For CBSE Class 12 Chemistry

Section 2: WHAT THE TEXTBOOK SAYS (NCERT)

The NCERT textbook introduces the concept of an electrolytic cell in a very effective way. Instead of presenting it as an isolated topic, the text first solidifies your understanding of a galvanic cell, specifically the Daniell cell, which generates electricity from a spontaneous chemical reaction. It then thoughtfully explores what happens when this spontaneous process is opposed by an external electrical potential. This comparative approach is the key to grasping the fundamental difference between a cell that produces energy (galvanic) and one that consumes it to drive a non-spontaneous reaction (electrolytic).

2.1 NCERT Key Statements

From the textbook's explanation, we can distill the core principles that define an electrolytic cell and its function. These foundational ideas are crucial for building a clear understanding.

1. **Core Function:** An electrolytic cell is a device that utilizes external electrical energy to force a non-spontaneous chemical reaction to occur.
2. **Formation Condition:** A galvanic cell, such as the Daniell cell with a potential of 1.1 V, can be converted into an electrolytic cell. This transformation happens when an opposing external voltage (E_ext) is applied that is greater than the galvanic cell's own potential (i.e., E_ext > 1.1 V).
3. **Resulting Change:** When the external potential overcomes the cell's natural potential, the original chemical reaction is forced to stop and then proceed in the exact opposite direction.

2.2 NCERT Examples and Distinctions

The textbook uses the familiar Daniell cell as its primary example to illustrate the transition from a galvanic to an electrolytic cell. The cell's standard potential is 1.1 V, which is generated by the spontaneous reaction: $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$. The text explains that if we apply an external, opposing potential (E_ext) that is greater than 1.1 V, the cell's natural function is overpowered, and it begins to operate as an electrolytic cell.

This transformation has several direct and important consequences. The flow of electrons reverses, now moving from the copper electrode to the zinc electrode. Consequently, the flow of conventional current also reverses, moving from the zinc to the copper electrode. Most

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importantly, the chemical processes at each electrode are inverted. Instead of copper depositing and zinc dissolving, the text states that now **zinc is deposited at the zinc electrode** and **copper dissolves at the copper electrode**. This means the fundamental roles of the electrodes have been reversed: the copper electrode, where oxidation now occurs, has become the anode, and the zinc electrode, where reduction now occurs, is the new cathode.

To summarize the textbook's explanation, the key operational differences between the Daniell cell functioning in its galvanic versus its electrolytic mode are as follows:

- **Nature of the Chemical Reaction**
  - **Galvanic Cell:** The redox reaction is spontaneous, releasing chemical energy as electrical energy.
  - **Electrolytic Cell:** The redox reaction is non-spontaneous and is driven by an external supply of electrical energy.
- **Direction of Electron Flow**
  - **Galvanic Cell:** Electrons flow from the zinc rod to the copper rod.
  - **Electrolytic Cell:** Electrons flow from the copper rod to the zinc rod.
- **Processes at the Electrodes**
  - **Galvanic Cell:**
    - *Zinc Electrode (Anode):* Zinc metal dissolves (oxidation).
    - *Copper Electrode (Cathode):* Copper ions are deposited as copper metal (reduction).
  - **Electrolytic Cell:**
    - *Zinc Electrode (Cathode):* Zinc is deposited from zinc ions (reduction).
    - *Copper Electrode (Anode):* Copper metal dissolves to form copper ions (oxidation).

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