

## 10.2 Science and Technology of Electrolysis

- The invention of the electric cell and then electrolysis resulted in many discoveries in chemistry. Soda (sodium carbonate) and potash (potassium carbonate) were thought to be elements and through electrolysis the elements of sodium and potassium were discovered.
- Many metals can be produced by electrolysis of their ionic compounds, however, 2 problems occur
  - Most naturally occurring ionic solids have a low solubility.
  - For many, water is a greater oxidizer than the active metal.
  - To overcome these problems it was found that ionic compounds could be melted and act as electrolytes.
  - Usually the metal ions gain electrons at the cathode to form the metal.
- In molten-salt electrolysis, metal cations move to the cathode and are reduced to metals, and nonmetal anions move to the anode and are oxidized to nonmetals.
- E.g. Strontium chloride  
$$\begin{array}{ccccccc} \text{Sr}^{2+}_{(l)} & + & 2\text{e}^{-} & \rightarrow & \text{Sr}_{(s)} & & \text{reduction at the cathode} \\ & & 2\text{Cl}^{-}_{(l)} & \rightarrow & \text{Cl}_{2(g)} & + & 2\text{e}^{-} \quad \text{oxidation at the anode} \end{array}$$

### Production of Sodium

- See figure 3 on page 738.
- Electrolysis is expensive and requires a lot of energy. How do you reduce cost and energy? Add an impurity to lower the melting point (salt and ice melt at a lower temperature turning it to water a few degrees below zero).
- Sodium chloride is contaminated with calcium chloride uses electrolysis to produce sodium metal and chlorine gas.

### Production of Aluminum

- Aluminum is the third most abundant material on Earth. It is found as aluminum oxide ( $\text{Al}_2\text{O}_3$ ) which has a melting point over  $2000^{\circ}\text{C}$  which makes electrolysis impossible (no containers available that would not melt).
- It was found that you could dissolve aluminum oxide in cryolite which acted as an inert solvent and dropped the melting point to  $1000^{\circ}\text{C}$ . Now aluminum could be produced by electrolysis.
- The price of aluminum went from \$45000/kg to \$0.90/kg after the above process was discovered.
- See figure 5 on page 739.

### The Chlor-Alkali Process

- See figure 6 on page 740.
- Sometimes high voltages are needed to overcome the reduction of water.
- The chlor-alkali process relies on high voltages to produce chlorine gas, aqueous sodium hydroxide, and hydrogen gas.

### Refining of Metals

- Electrefining: production of a pure metal at the cathode of an electrolytic cell using impure metal at the anode.
- Used to refine metal from an impure state to a pure state.
- The anode in the process is oxidized and copper goes into solution. The copper is reduced at the cathode and is plated onto it. The process takes copper from 99% to 99.98% pure.
- The impurities, such as gold, silver and platinum can be recovered and sold since they are not reduced at the cathode.
- See figure 7 on page 742.

### Electroplating

- Electroplating: depositing a layer of metal onto another object at the cathode of an electrolytic cell.
- Cheaper metals are plated a precious metal to create the look of the precious.