A DEMONSTRATION OF ELECTROLYSIS BY A COLORIMETRIC METHOD

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Although electrolytic chemistry plays a major role in general chemistry, the student's idea of electrolysis is usually dependent on what he observes during a demonstration of the electrolysis of water. Since pure water is a non-conductor of electricity and sulfuric acid or some other conductor must be added to catalyze the reaction, the average student is pretty well be fuddled when he attempts to explain just what happens. The instructor tries to make the subject less abstract by going into an explanation of the electrolysis of aqueous or fused NaCl. These are simpler, but if the student has not grasped the fundamental idea, they are not very meaningful. By introducing color changes in the experiment, the student's interest and attention are greatly stimulated.

The apparatus consists of a standard H-shaped electrolyzer with two refinements: (1) The electrodes have been pulled down about even with the cross-bar and (2) the one-hole stoppers have been replaced by two-hole ones and glass tubes equipped with screw clamps inserted in the second hole. The tubes reach to the bottom of the electrodes thus allowing the solution immediately surrounding the electrode to be withdrawn, resulting in a more rapid color change.

In demonstrating the electrolysis of aqueous NaCl (commercial salt should not be used as it is often basic enough to color phenolphthalein before the electrolysis is begun), a beaker containing a weak solution of starch and KI is placed under the anode. Water containing a few drops of phenolphthalein is placed under the cathode. The screw clamps are opened slightly and the electrolyte is allowed to drip into the beakers. No change is noted in the solutions until the current is turned on; then the starch-KI solution turns blue due to the chlorine generated and retained in solution and the phenolphthalein-water solution turns red due to the NaOH.

$$\text{Cathode reaction: } 2Na^+ + 2e + 2H_2O \longrightarrow 2NaOH + H_2$$
$$\text{Anode reaction: } 2Cl^- \longrightarrow Cl_2 + 2e$$

The student will attempt to explain these phenomena even though he has had no previous study of electrolysis.

A variation of the above can be carried out by the electrolysis of a solution of Na_2SO_4. In this case a solution made alkaline with a drop of NaOH and colored with phenolphthalein is placed under the anode. Water, with a drop of phenolphthalein, is placed under the cathode. The outlets are allowed to drip for some time to show that no change takes place until the current is turned on. When the current is turned on, the colored beaker turns clear, and the clear beaker turns red.

$$\text{Cathode reaction: } 2Na^+ + 2e + H_2O \longrightarrow 2NaOH + H_2$$
$$\text{Anode reaction: } 2SO_4 + 2H_2O \longrightarrow 2H_2SO_4 + O_2 + 2e$$

If the student understands these changes, he will have a fundamental understanding of electrolysis.