



Indicating Electrolysis

by Eric Muller

Acid, base, colors!

Introduction:

A classic activity with a new device. Decompose water with a simple electrolysis apparatus. See that acid and base is created by using an indicating solution.

Materials:

- Stainless steel screws at least 1.5" in length – these can be purchased at most hardware stores
- A shallow clear glass or plastic container such as a Petri dish
- Epsom Salt – can be purchased at a drugstore
- 9-volt battery
- Rubber bands
- Acid – base indicator such as: phenol red, phenolphthalein, bromothymol blue, cabbage juice, etc. Make sure you are aware of any safety issues with your indicator. Also, with your chosen indicator, make sure you know what colors indicates acid and/or base.
- Spoon



Assembly:

1. Place the stainless steel screws on top of each 9-volt battery terminal and perpendicular to the main battery. Both screws should be positioned so that their treads are in contact with the terminals. The heads of each screw should be pointing in the same direction. These screws will be conducting electricity through your device and will also be referred to as the electrodes.
2. Make sure the screws are not touching each other anywhere along their length. Wrap rubber bands around the screws and battery so that they stay in place. You may want to wrap several rubber bands around your device and in different directions. This is your electrolysis device.
3. Fill your shallow container with luke warm water.
4. Pour Epsom salt crystals into the water. About a 1/3 a teaspoon worth for a Petri dish will do. Stir your solution to help dissolve the salt.



5. Place a few drops of acid-base indicator into the salt solution (you might need to add more if using cabbage juice)

To do and notice:

1. Submerge the exposed ends of the stainless steel screws in the solution. Make sure the battery itself does not get wet. You should be able to rest your electrolysis device on the edge of the container.
2. Your screws should begin emitting bubbles of gas and different colors should develop at each electrode (In the picture to the left, the dark chunks are pieces of cabbage.)



What's going on?:

Did you see bubbles forming at the stainless steel screw tips? Did one screw emit more bubbles than the other? Look and see which battery terminal is associated with which volume of bubbles. Look and see which terminal is associated with which indicator color.

The molecular formula for water is H_2O , where H stands for the element Hydrogen and O stands for the element Oxygen. In a water molecule, the Oxygen atom has a tendency to be negatively charged and the Hydrogen atoms have a tendency to be positively charged. Your device pulled apart water into these two components.

Since opposite charges attract, the Hydrogen migrated towards and bubbled from the negative electrode or stainless steel screw and the oxygen migrated towards and bubbled from the positive electrode or stainless steel screw. However, you also create a change in pH or the amount of acid and base in the water.

When Oxygen is pulled from water molecules, an abundance of freed Hydrogen ions (hydronium ions) are created, forming more acid at the positive terminal. Your indicator should show an increase of acid at the positive terminal. Likewise, when Hydrogen is plucked off water molecules at the negative terminal, an abundance of freed OH ions (Hydroxide ions) are produced near the negative terminal. Therefore, your indicator should show the production of a basic solution at the negative terminal.

(The Epsom salt, also known as magnesium sulfate or $MgSO_4 \cdot 7H_2O$ was dissolved in the water to help your battery break up the water more efficiently. Epsom salt breaks up into ions, these charged particles help carry the electric current around the solution more easily.)

