Electrochemical Chameleon Lab: Water splitting comes alive

Overview:

Normal tap water (H_2O) is electrolyzed using a common 9-volt battery Epsom salt. The H_2 and O_2 gases that are produced are isolated and collected safety in separate containers. A natural anthocyanin pH indicator extracted from red cabbage is used to show vividly color changes at the positive and negative terminals of the battery during the water splitting process.

Hazards:

Vinegar (an acid) and ammonia (a base) can irritate the skin and eyes. Avoid direct contact with skin and eyes. In the event of direct contact flush with water for 15 minutes. Natural anthocyanin dyes can stain clothing and skin. Avoid spilling anthocyanin dyes on clothing and skin.

Protocol for *Acid Bath* pH indicator lab:

- Pair up with a partner and obtain eight vials from the stock station for your group
- Number your vials 1 – 8 with a permanent marker
- Halfway fill each of your vials with the stock pH indicator solution
- To vial 1 add a few drops of vinegar (an acid) and record your observations
- To vial 2 add a few drops of lemon juice and record your observations
- To vial 3 add a few drops of Sprite and record your observations
- To vial 4 add a few drops of tap water and record your observations
- To vial 5 add a few granules of antacid and record your observations
- To vial 6 add a few granules of baking soda and record your observations
- To vial 7 add a few granules of baking powder and record your observations
- To vial 8 add a few drops of Ammonia (a base) and record your observations

Protocol for Electrolysis Lab:

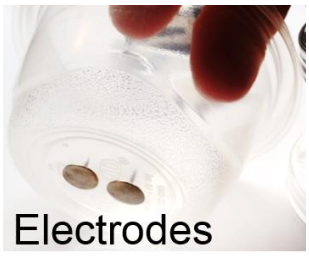

Fig. 1. Electrode Position

- Make two marks on the bottom of your plastic storage that are the same distance apart as the terminals of your 9-volt battery
- Insert one thumbtack into the bottom of the container at each of the marks that you have made as shown in Fig. 1 to form an electrolysis cell
- Pour purple pH indicator solution into your new electrolysis cell until the container is 3/4 of the way full
- Return to your work station and insert two plastic pipettes into the purple pH indicator solution
- Squeeze the bulb of each pipette one time and release it to fill each pipette with the same amount of solution
- Without removing the tips of the pipettes from the solution, place each pipette tip over one of the electrodes in your electrolysis cell
- With the help of your partner to stabilize the pipettes so that they don't disconnect from the electrodes, place your electrolysis cell on top of your 9-volt battery so that each battery terminal is connected to only one of the thumbtacks that is inserted into the bottom of your cell
- ***Do you observe any bubbles or color changes?***

- Remove the pipettes from the cell terminals and dispense their contents back into the electrolysis cell
- Add one teaspoon of Epsom Salt (magnesium sulfate, $MgSO_4$) to your electrolysis cell and stir the resulting solution until it is almost entirely dissolved
- Insert the two plastic pipettes into the purple pH indicator solution again
- Squeeze the bulb of each pipette one time and release it to fill each pipette with the same amount of solution
- Without removing the tips of the pipettes from the solution, place each pipette tip back over one of the electrodes in your electrolysis cell again
- This time switch roles with your partner to stabilize the pipettes so that they don't disconnect from the electrodes while your partner places the electrolysis cell on top of your 9-volt battery so that each battery terminal is connected to only one of the thumbtacks that is inserted into the bottom of your cell
- ***Record your observations***
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- ***Dispose of your solutions down the drain.***
- ***Rinse out and return your glassware***

1. **What happened at the positive battery terminal?**

2. **What happened at the negative battery terminal?**

3. **How much solution was left in each of your pipettes when your experiment was finished? What does this mean about the volume of gas that was produced at each terminal?**

4. **From Question #3, explain how we know that water has the molecular formula H_2O?**

5. **Do you think that the solution at the positive terminal was acidic, basic, or neutral?**

6. **Do you think that the solution at the negative terminal was acidic, basic, or neutral?**

Instructor's Guide:

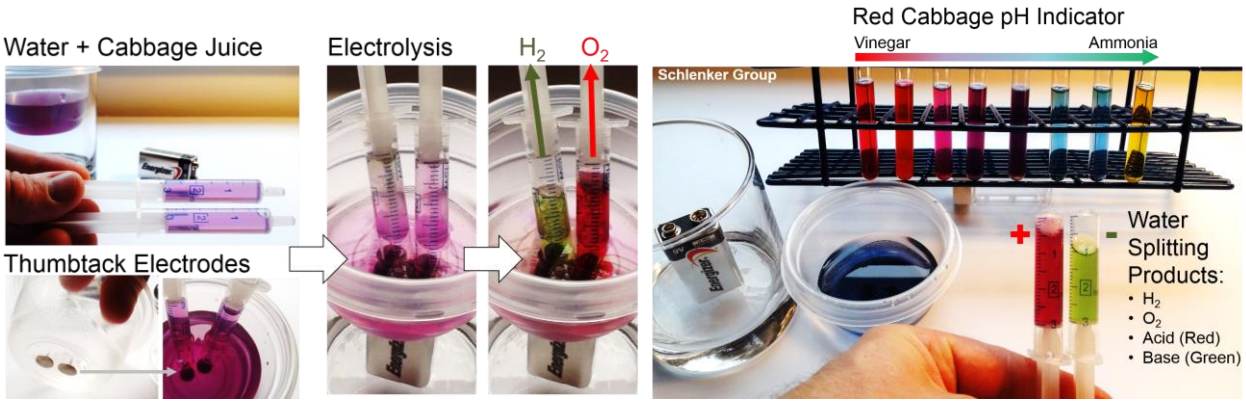

Fig. 1. We have extracted a natural anthocyanin dye from red cabbage. We use this dye as a universal pH indicator. The color change from purple to green or red allows us to show that splitting water into 2 moles of H_2 (larger volume of gas) and 1 mole of O_2 (smaller volume) using a common 9-volt battery and two thumbtacks also generates acid (red) at the anode and base (green) at the cathode.