

Volta's Pile

(As imagined and built by Richard Morton)

The voltaic pile was the first electric battery that could continuously provide electrical current. It was invented by Alessandro Volta, who published his experiments in 1800. This invention enabled a series of discoveries including electrolysis and the discovery or isolation of the chemical elements sodium, potassium, calcium, boron, barium, strontium, and magnesium. Volta's Pile reigned supreme until the 1870's when the dynamo (generator) was invented.

Volta's invention built on Luigi Galvani's 1780s discovery of how two metals and a frog's leg can cause the frog's leg to respond. Volta demonstrated in 1794 that when two metals and brine-soaked cloth or cardboard are appropriately arranged, they produce an electric current. This pile is patterned after those original ideas. It is solidly built with brass, zinc and copper (substituting for silver which Volta originally used) and will last for years and years.

It's safe to operate and it's recommended that you use salt water as the electrolyte—make your own using potable water and dissolving as much table salt (NaCl) as possible. Then place 5-8 drops on each insulator (white cloth disc), re-stack the pile and place it into the stand. It is helpful to first make the individual stacks of copper (Cu), salt water soaked insulator and zinc (Zn), then stack them into two larger piles, and then place the entire stack into the frame securing the top with 3 brass cap nuts and making sure to properly align the brass strip on the top to the front facing right stanchion. Other electrolytes can be experimented with including Coca-Cola or vinegar. **Under no circumstance should you try other acids as they are dangerous - they will ruin the pile and improperly handled they will ruin your day. DON'T USE ACIDS!**

Never fill the clear tube with any substance; its purpose is to keep the pile aligned and is not designed to hold any liquid. Even if you were successful in filling it, the pile would not produce any voltage, as the salt water would just short the individual cells. No worries if you don't heed this warning as no lasting damage can occur – it just makes a mess!

The pile's output can be connected to a voltmeter, LED or other electrical device that draws a very small amount of current. The left brass binding post is negative

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while the right post is positive. This polarity is correct assuming you assembled the pile as described with the bottom disc of copper and the top disc of zinc.

To connect an LED, the LED's longer lead must be connected to the positive post and the shorter lead to the negative post. Now gently lower the top contactor by turning the brass knob until the contact is just touching the top zinc disc. Do not over tighten as it will force the electrolyte out and this will affect performance. Remember this pile is a primitive battery and it generates very little amperage. Therefore, it cannot (even briefly) supply the needs of most modern gadgets. You may notice that after a short while the LED begins to dim. What's happening is the oxygen (O_2) dissolved in the salt water is being depleted and as it is consumed, the voltage begins to drop. To restore, simply provide some new electrolyte and voila, it works anew...

When you are done, it's recommended that you disassemble the pile and thoroughly rinse the metal discs and insulators to remove any salt water and then let the components air dry. Finally reassemble the unit for display.

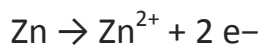
How does it work? Not being an expert the following is what I have cobbled together in an attempt to explain the magic. You may find more complete or even contradictory information. If you do, I salute you for being inquisitive and having curiosity.

The salt bridge is a vital component of any voltaic cell. In this pile, it's the 1-inch cloth discs saturated with an electrolyte solution. The purpose of the salt bridge is to keep the solutions electrically neutral and allow the free flow of ions from one cell to another. Without the salt bridge, positive and negative charges will build up around the electrodes causing the reaction to stop.

The contemporary, atomic understanding of a cell with zinc and copper electrodes separated by an electrolyte is the following. When the cell is providing an electrical current through an external circuit, the metallic zinc at the surface of the zinc electrode is dissolving into the electrolyte as electrically charged ions (Zn^{2+}), leaving 2 negatively charged electrons (e^-) behind in the metal:

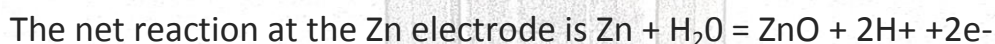
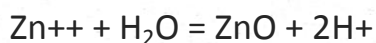
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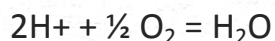


This reaction is called oxidation. While zinc is entering the electrolyte, two positively charged hydrogen ions (H^{+}) from the electrolyte combine with two electrons at the copper electrode's surface and with dissolved oxygen to form water. This reaction is called reduction. The electrons used from the copper to form the molecules of water are made up by an external wire or circuit that connects it to the zinc.

Overall the chemistry might be:



At the Cu electrode:



The H^{+} must get from the Zn electrode to the Cu electrode. This is the function of the electrolyte, (salt bridge) and the NaCl probably serves several purposes. One is to get some of the Zn to dissolve. Another is as the salt bridge. It may also help make the water more reactive.

CERTIFICATION	
Serial Number	#1
Cells (Cu & Zn)	12
Electrolyte	Saltwater (H_2O NaCl)
Voltage	9v (est.)
Current (milliamps)	200 (est.)
Date Assembled	May-05-2014
Hand crafted by Richard Morton	