

The Edison Battery White Paper #2 (Follow Up)

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An extensive supplement to the youtube video at:

<http://www.youtube.com/watch?v=K84PywMwjZg>

This is intended to be a quick follow up to the original Edison Cell White paper I've been sending out for several months.

The main purpose of this second paper is to give the answers to some of the real world questions that builders using the first white paper had, and to further detail the experimental cell's progress.

A few words first...

Before we get into the latest adventures with the cells, I simply wanted to take a moment to THANK YOU ALL for your awesome input, questions and ideas.

I got a little overwhelmed with the amount of email I received, and apologize to the many people I was very slow in replying to or haven't gotten to yet.

I always want to give a detailed response, and that often slows me way down.

I also want to thank those who sent some small donations (before I even had a donation link up!!!) to keep this research going!

I hope that the research I've been putting up for you in these papers is *particularly* useful because I'm NEVER simply regurgitating "internet information" of questionable origin nor recited overly optimistic apocryphal stories.

These white papers are letting you know what's happening with cells that are actually tested and working in my shop!

So everything is first hand, fully tested info unless otherwise specified.

The current home made cells in my shop have a small "test" plate size, but currently have almost the same capacity of a modern NiCad battery.

So the next big tests will be for us to "size it up" and see what happens as I'm able to afford to do that.

Thank you again for your help with that! Your help lets me do the experiments and pass this info on to you MUCH faster!!!

(My 12 year old son burst out laughing when I said "another \$50 in chemicals and I'll have tried all the combinations." He said "Dad, you've been saying that for 2 years now.") ☺

Where To Get Materials

The first question I got from everyone was where to get materials, and I have some GREAT tips for you there!!!

Although texts on these cells go into great detail on the PURITY needed in the oxides, I found that many oxides used in these cells can be gotten from pottery supply houses, and that the purity is quite good!

The cost of these oxides from a pottery supplier are a tiny fraction of what chemical suppliers are asking for their products.

Pottery supply houses sell these oxides as colorants.

I am guessing that in Edison's day, only a laboratory would be able to make oxides to the purity needed, but today it appears that modern methods allow even an oxide used as a pottery colorant to be more than 99.7% pure.

Because I'm a meticulous fellow, I did purchase both lab, and pottery versions of the oxides, and in my own (admittedly very humble and small scale) experiments, I did not find a difference in performance.

Source For Nickel

Another source I've been asked for are sources for nickel metal. Depending on what you're doing, it might be interesting to note that Canadian nickels, pre 1981 were 99.9% nickel.

eBay often sells these by the bag as "Canadian Nickel Coin Bullion."

So, this can be a great inexpensive source for raw nickel.

I would very much like to find, or have a way to make nickel wool. I have found it in small quantities, but only at high costs.

The Nickel II Controversy

Several people wrote to tell me (and to point me to internet articles) that said NiO was the correct oxide, and not Nickel II ($\text{Ni}(\text{OH})_2$) mentioned in the first white paper..

I found conflicting articles on this subject while following the leads given. So, I did what I always do, and built a cell with each!

Again, my results are purely experimental and small scale, but I do want to report that the NiO cells I made performed VERY poorly compared to Nickel II, and Nickel III cells I made.

So, I'm fairly certain that the original white paper claim that Nickel II was used was correct.

More on that in just a bit.

Making Your Own Nickel II

The next stumbling block that a lot of us have hit after the first paper is getting the Nickel II hydroxide $\text{Ni}(\text{OH})_2$.

For some reason this is one of those compounds that they will sell you a boatload of, but not just a few ounces or pounds.

Quite a few people wanted to know how to make it themselves, so I'll go ahead and do what I just said I never do, and regurgitate a method for "tubular" nickel II oxide that I haven't personally tried. (I'll go into why I haven't tried it in just a bit.)

The Nickel II in the original Edison Cell was made by spraying nickel sulfate into hot sodium hydroxide.

The nickel sulfate was prepared by dissolving nickel shot into 20% sulfuric acid at 100 degrees C.

This solution was then brought down to a PH of 3 – 4 by adding nickel hydroxide (other bases are also said to work, but Edison used nickel hydroxide).

The solution was then sprayed into boiling sodium hydroxide, and the precipitate was washed, filtered, screened and used.

A fairly simple recipe fortunately!

Nickel III

The reason I have not used the Nickel II method above is that in experimenting with these cells, I tried MANY oxides of nickel and iron just to see how they would perform.

Much to my amazement. Nickel III oxide from a pottery supplier worked by far the best, beating commercial Nickel II in my home made cells!

So, I believe that's good news all the way around, though it certainly gets the "experimental" designation as we're a little out of the Edison box.

So, I am currently using/experimenting with ordinary black Nickel III as my positive electrode in future cells...

Forming Charge

The next question I was asked was about what type of charging cycle should be taken on to form the right oxides on the plates and get the battery off to a good start.

Texts on the subject say that forming the plates is critical to cell capacity and life.

What I've personally found is that these batteries are so robust, that even accidental overcharging or flat discharging do not seem to damage them, and this goes for the forming process as well.

In general, in my home made cells, I've switched from a custom charger I built that carefully regulated voltages and amps, to an ordinary NiCad charger just to see what would happen.

As I guessed, the NiCad charger seemed to do just as good a job as the carefully regulated charger for these cells.

I find after about 3 to 5 complete charge/discharge cycles, the cells start performing well. The FORMAL way to charge your cells is also very simple, so it's worth doing on higher capacity cells where you have a real investment.

The literature indicates Edison's preferred method was:

- 1.) Charge your cells for 48 hours at $\frac{1}{2}$ their normal rate of charge.
- 2.) Discharge your cell to .9 volts, and then charge them again for an additional 10 hours at a full rate of charge.
- 3.) Discharge your cell. .9 volts, and charge again for 14 hours at $\frac{1}{2}$ their normal rate of charge.
- 4.) Discharge your cell to .9 volts, and charge at full rate for $5 \frac{3}{4}$ hours.

Determining what your “full rate” of charge should be is a little tricky, and will depend on your design. A “full rate” of charge was a charge sufficient to bring a cell to full capacity in 5 hours.

The Edison manual indicated that he used 1.7 volts to charge the 1.2 volt cells during the forming period. He also recommended flat discharging the cells periodically, and recharging at the 1.7 volt level to keep them healthy.

Regular day to day charging of your battery should be done at approximately 1.45 volts. The only real reason for the lower voltage is to decrease gassing and the frequency with which you might have to add distilled water.

I've been using a simple ½ amp charger on my very small cells.

I have not yet “sized up” to experiment with the capacity needed on the larger cells.

So, still some work to be done.

Oil Tip

As previously mentioned, when your cell is complete, a little mineral oil on top will protect your electrolyte from CO₂ damaging your cell.

I wanted to quickly mention that you should make adding oil to your cell the very very last thing you do in construction.

Only add oil after your cell is all checked out and working exactly how you wanted.

Your cell will not be harmed even if you run it for a month without oil.

The reason I throw in the caution is oil creates a HUGE mess if you decide to alter your cell in any way after it's been added.

It can coat a plate you are pulling in or out and ruin it, and it can coat the cell's casing and become a nuisance.

In addition, gassing in the cell can create a foam in the oil that can climb out of any unsealed part of your cell and make a huge mess.

As long as you add the oil at the very end, and make sure there is a sufficient gap at the top of your cell between the oil level and the top of your container, the oil works GREAT and is no problem at all.

But, I hope to save you from the mess I created of several cells and my shop by not realizing this. ☺

Gassing

One “problem” with Edison cells is that they do gas quite a lot. In fact, I've been so impressed by how much hydrogen and oxygen gas is created at low voltages in the KOH electrolyte that I think that solution (and nickel electrodes) might make a wonderful combination for those wanted to create and capture hydrogen and oxygen gas for other purposes.

This is a much less expensive and more efficient combination than the platinum and sulfuric acid in distilled water which is usually used for electrolysis.

However, for our cells we want to minimize or deal with the gassing as simply as possible.

This means that you need to have one of three different systems if you want your cells to be largely “maintenance free.”

The first system is the easiest, and was common in remote power stations that used Edison cells that were rarely attended.

These cells were simply designed to have a large amount of electrolyte above the top of the plates. Typically, the active plates in the cell were only half the height of the battery casing, and the electrolyte was filled to the top.

It was common to have to add water to these cells only once every 10 years.

Edison recommended changing the electrolyte every 5 – 10 years anyway, so this probably worked out perfectly.

Because this type of cell is heavy, it clearly is only useful for fixed locations or uses like “off grid” power storage. Some off grid setups simply employ an automatic watering system.

The next method described I have not tried, but it sounds intriguing. In one of Edison’s designs, he sealed the cell, and placed a platinum wire in the top of the battery above the electrolyte and plates. When the battery was charged, the wire heated up and I assume combusted the hydrogen and oxygen gasses trapped in the case turning them back into water.

Because of the concept of igniting explosive gasses in a sealed cell, I haven’t given this a try. But, I assume if Edison did this, it can be done safely in a sturdy cell.

The last method is by far the coolest. There are currently regenerative catalytic battery caps which can change oxygen and hydrogen gasses back into water with better than 98% efficiency.

You can find these caps by doing a Google search on “Hydro Cap.”

I do have several research papers that detail construction of these caps, so that’s on the list for future papers and experiments as I can get to it...

Notes to self for next paper: Electroless/steel wool/ developing the oxide
Extra electrode tip.