# The Edison Battery White Paper



An extensive supplement to the youtube video at:
http://www.youtube.com/watch?v=K84PywMwjZg

After more than a year of experimenting with different Edison cell designs, it is a GREAT pleasure to be able to pass along to you everything I've found out about these cells in just a few short pages.
(It all looks so simple now, but believe me, many wrong roads lead to the right ones!)
Two things about these cells really slowed me down!
First of all, when you're trying to recreate a "hobbyist" version of a cell that was famous for it LONG LIFE, how do you know you've succeeded unless you wait for a long period of time to see if a design holds up?
Next, there are such a VAST number of possible combinations of materials, that every success and every failure with this battery only encourages you to try 10 variations on every variation you've tried!
I certainly see why Edison famously tried thousands of combinations before settling on those he liked best.
My little shop has been full of jar after jar filling my shelves with battery experiments in progress since starting this; even with the advantage of following Edison's design.
I read all 43 patents, and did my best not to reinvent the wheel, but I still found that using modern materials made many experiments unavoidable.
In the end, I have some great, accurate, straight forward info for you on recreating the cell as Edison made it, and I have a lot of shortcut information on constructing a hobbyist cell.
My current hobbyist cell has had about 6 months of testing and APPEARS to be holding up fine, and it has a capacity of perhaps 1.5 amp hours even with a small plate size.
So, I think that's a reasonable amount of testing, and a reasonable capacity to pass it Along to you.
The cell should be entirely expandable, but I limited it's size as a test cell since I was trying so many designs.
Thanks for your interest in the cell, and I hope what follows is interesting and useful to you in recreating your own versions of the cell!

## Parts Available

I'm going to make available many battery parts on my web page if you'd like to get a quick start and decide if these cells are for you.
http://www.noonco.com/edison/parts.htm
It's always nice to be able to experiment more rapidly, and save a little time.
I wish they'd been available when I started.
I'm also writing a more formal article for Nut & Volts Magazine that you can get for a few dollars should you choose.

Note: This article is out, and Nuts & Volts has been sending out free issues to those who ask.
I hope we can all support Nut & Volts because they're one of the best, and last magazines supporting our interests!

## The Original Edison Cell

In the "Edison Battery Video" I placed on youtube, I showed a cell constructed with a simple nickel and iron plate which were separated by a piece of perfboard.
This cell would probably be fine for a science fair, but as I studied these cells, I found that that design was deeply flawed, and not even really accurate to the elements in an actual Nickel Iron cell.
The fact that it worked was actually an accident!

It is an oxide of nickel (Nickel II hydroxide Ni (OH)2 ) that is used as the positive electrode of an Edison cell (not nickel plate as shown in the video).
It is an oxide of iron (Fe3 O4) that formed the negative plate of an Edison cell, and not simply a piece of iron as shown.

The cell in the video probably worked because there was undoubtedly a variety of oxides on the metals I used just by coincidence (and built up after many chargings). The metals themselves may have traded a few ions to get that process started.

A traditional Edison cell worked as follows…

## The Positive Electrode

Nickel II Hydroxide is used for the positive electrode of the battery.
Nickel II has very poor conductive qualities, so, Edison needed to find a way to pick up charges from the Nickel II, and deliver charges to the Nickel II in the battery.
To accomplish this, he took a length of ½" steel pipe, and perforated it with 88 holes per square centimeter. Each hole is .25mm X .40mm.
He then gave this tube a heavy plating of Nickel.

Important note:
Edison cells owe much of their long life to the fact that the materials that make them are insoluble in the electrolyte. It is therefore extremely important to use no metals or other materials that might corrupt the electrolyte over time.
Virtually any metal will corrode in an alkaline solution when voltages are present.
I had copper alligator clips corrode and BREAK inside a cell in just a matter of days!
Brass, stainless steel, copper and many other seemingly robust metals will also be destroyed by the cell over time.
The only inexpensive metal that seems to resist corrosion entirely is nickel.

The nickel tube is then filled with alternating layers of nickel flake and nickel II hydroxide. There are 32 layers per centimeter.

Each layer is tamped firmly in place with a ram rod.

Note: Edison used nickel flake in the layers because earlier cells he had made failed over time. The earlier cells he had manufactured used graphite instead of nickel flake for each layer, which was Jungner's original design for the cell; which Edison sought to improve. Edison felt after inspecting his failed cells that it was expansion and contraction of the graphite during charge cycles that had caused them to fail.
However, since graphite construction is simpler and less expensive, I think it's worth noting that Jungner's cells went on to compete with Edison's cells for a number of years, and that Jungner continued to use graphite and packets in his model.

When the tube is filled, the top is sealed by pinching it closed.
This completes the positive electrode.
If multiple tubes are made, they are often mounted together to a nickel grid by bending the pinched ends of the tubes into slots.

So, the positive electrode works by allowing electrolyte in through the holes when submerged, and the nickel tubing and nickel flake make contact with the nickel II hydroxide to pass the charges back and forth.

When charged, nickel II hydroxide becomes nickel III. And on discharge, it returns to nickel II. Knowing this can save an incredible amount of confusion when reading descriptions of Edison cells on the internet, many/most of which list the wrong oxides.

In determining the capacity of your cell, and the number of tubes you'd like, keep in mind that each10cm of tubin8g typically produces 1.25 Ah capacity.

## The Negative Electrode

Forming the negative cell requires only filling tubes (or any other nickel plated metal packets) with the pure iron oxide ($Fe_3O_4$) under pressure.
Most texts state that the purity of this oxide is absolutely critical, so a laboratory grade oxide is recommended.

Note: An important aspect of the negative electrode is that most battery designs allow for an over sized negative electrode. (This electrode can have a larger surface area than your positive electrode by as much as 30%.)
Gassing usually increases when the negative electrode has reached a full charge, so by creating a cell that is fully charged before the negative electrode takes on a full charge, gassing is greatly reduced.

## The Electrolyte

A lot of mythology surrounds the electrolyte, and it's mixture is fairly critical. The video was fairly good at showing a great mixture. However higher and lower concentrations of KOH can have interesting effects.

For example 1.25 g/ml of KOH to distilled water gives the longest life, while 1.34 g/ml gives the highest output (and greatly helps the cells resist freezing in cold climates). This could be very useful for those going "off the grid."
Another popular item floating around the internet is the addition of lithium hydroxide to the electrolyte.
The popular misconception is that this adds to the cells capacity. In actuality, lithium hydroxide decreases the cell's capacity somewhat, however it has a protective effect on the cell during conditions of high temperature cycling.
If you choose to use KOH and lithium, the mixture I've been most pleased with has been: Potassium hydroxide 1.3 g/ml, lithium hydroxide 15 g/l

## The Homemade Cell II

With all the above in mind, I set out to make a greatly improved "hobbyist cell" for all of us that was just as easy to make, but of real practical use.
This cell could be both used for a project, or as the basis for creating your own larger cells; all with MUCH simpler manufacturing.
I have two cells produced by the following method that produce about 1 Ah of output per plate…
In researching small battery electrodes, I found that many manufacturers created flat plates (like those in the video) containing oxide particles with a high surface area.
This was accomplished by HEATING the nickel plate until it was slightly molten, and then pressing the oxide particles against it.. As the plate cooled, the oxide particles were slightly melted into the surface. This gave the metal a sandpaper like surface with very high surface area and great conduction to the oxide.
I tried this method, and found what it created for me in all instances was what we call in scientific terms "a big mess."
But, I mention it in case you want to give it a whirl as it's a good manufacturing idea.
In trying to think of ways to get the same effect without heating and pressing, I began to think of conductive paints and epoxies.

I first nickel plated two steel plates to be my electrodes. I have a youtube video up that shows the nickel plating process at:
http://www.youtube.com/watch?v=Q8Xo43sfLgY
I then used some simple silver bearing epoxy (nickel epoxy might be even better, and is cheaper) and coated the electrodes with this conductive glue.

Note: I strongly recommend getting an industrial quality silver bearing epoxy that is no more than 3 months old. An excellent company for "fresh" industrial epoxy is Ellsworth Adhesives.

I then coated one electrode with nickel II hydroxide, and the other with iron oxide (Fe3 O4).
I allowed the electrodes to dry over night.

Using these two metal parts as my electrodes, I assembled the cell as shown in the video, with two small changes,

First, all internal electrical parts (including wires) should be nickel, or nickel plated. Nickel wire is fairly easy to find, and the screw terminals on top are fairly easy to plate or abandon.
And second, I added 2mm of mineral oil to the top of the cell.

Without the mineral oil, your electrolyte will discolor in a few weeks, and lose some efficiency.

## Wrap Up

I have a variety of additional experiments near completion, and plan to double the size of this "white paper" in the coming weeks with many additional tips and tricks.
As I said, one thing that has slowed me down is waiting to make SURE things hold up before I pass them on to you.
I've tested the epoxy in a cell for over a year, and it is still holding up!
I also have a home made plastic conductor that is a fraction of the price, easy to make yourself, and creates a flexible electrode so you can assemble a home made cell in the easy "jelly roll" fashion that capacitors and commercial batteries use to run by you soon.
Hopefully you'll be creating cells that are lifetime, and we can all get off the grid!
A professor at a junior college I went to had a Volkswagen powered with Edison Cells. These Edison cells were from an old power station and were more than 50 years old! Yet, they still gave the Volkswagen a range of 100 miles and 55 MPH… all with off shelf parts!

At this point I've literally spent many hundreds of dollars and countless hours separating the fact and the fiction on these cells to distill everything down to just a few pages for your research for you.
I hope I save you an immense amount of time should you choose to go "off the grid" and make your own cells for your use or profit.

Here is what I would like to ask of you, and it's completely up to you if you think this is a good idea.
I will further expand this white paper with my ongoing results of the home made cells, tips, sources and make all materials available to you.
I'll include all the data I'm collecting now with my cells on charging your cells for the first time (which is important for perfect formation), and ways to extend cell life, and, I'll include the info that's going into the formal article I'm working on. But, the last thing that's slowing me down is honestly the expense of the next round of laboratory oxides, nickel plates screens etc.
It has added up to a surprising amount over time, and so far is just a hobby we're sharing…
I was thinking that what I might do is put up a donation link and send out the new expanded whitepaper to those who can make a small donation to the cause.

This is not a for profit link, but a for chemicals/metals link. I was thinking of asking maybe $10 or $12 for the whole definitive white paper which is coming soon..
If that sounds uncool, no one is obliged. But if it's possible, it would definitely help a great deal to get this done. I think we're very, very close to having really practical cells we can make ourselves!
Write me if the link sounds like an OK thing to do.

Thanks again for your interest, and I look forward to seeing where all this interesting "rediscovery" leads!!!

Walt

P.S. I'm going to cut and paste below a list of links and comments that were sent to me by other builders that you may find useful. I don't know the quality of these sources, but just wanted to pass them on.

For screens and other parts:

Leybold Didactic GmbH
Leyboldstrasse 1
D-50354 Hürth
Phone +49 02233 604 - 0
Telefax +49 02233 604 - 222
e-mail: info@leybold-didactic.de

Also:

www.newarkwire.com
Here is the quote I got.
Nickel 60 X 60 Mesh / .007 dia wire (12" X 16") QTY = 250 @ $36.45 each
Steel 60 X 60 Mesh / .0075 dia wire (12" X 16") QTY = 250 @ $2.62 each

Glad to hear from you. You got all back into this Edison battery. I did some searches and read some amazing articles in the New York Times archives on Thomas Edison's battery:
http://query.nytimes.com/search/query?query=edison+battery&srchst=p&d=&o=&v=&c=&sort=closest&n=10&dp=0&daterange=period&year1=1851&mon1=09&day1=18&year2=1980&mon2=12&day2=31&frow=0
All the old articles are Free... Some amazing history...
I'm working on converting lead acid battery to alkaline as mentioned here:
http://www.boervolk.com/forums/showthread.php?t=943

I ordered my 12volt radiant charger from here:
http://www.r-charge.com/RC_rc2a122.html
These guys got the best chargers in the world!!!

http://www.partsgeek.com/models/the_ev_resource.html

Have you seen: http://www.zappworks.com/battery_specs.htm
http://www.beutilityfree.com/Electric/Ni-Fe

(Miracle of nickel, mineral oil, magnet positive plate twice as big, lithium, the beach and magnetite, recombining gasses, electroplating, magnet)

Where to get nickel rods.  Welding supply stores.
Forming the oxides on nickel and steel wool directly…

Canadian nickels are being sold on eBay for cheap as “bullion.”
These nickels are 99% pure nickel.