How To Remove Rust Using Electrolysis

Presentation by Terry James for the Alabama Woodworkers Guild

For an excellent summary of the details and chemistry behind the Electrolysis process I recommend an article by Andrew Westcott at https://www.qsl.net/2e0waw/rust.htm

If you have an old tool that is rusted and you want to remove that rust, there are many products that will help dissolve the rust. Commercial products like Evap-o-rust or household product like white vinegar will loosen rust quite effectively. You may also use mechanical means such as sandpaper or wire wheels to physically remove rust. The down-side of most of these methods is that they can potentially remove or etch the underlying base metal. If used carefully, that may not be a big factor and in simple cases like cleaning rusty screws or flat surfaces these methods may be the best choice.

However, Electrolysis is a method that is fast, safe, effective, and does not affect the base metal once the rust is gone. Be aware that if the rust is bad enough and the base metal is deeply pitted, no method will restore the metal lost to rust in those pits. However, electrolysis will remove rust within the pits without affecting the surrounding metal.

Rust happens in a couple of layers. The outer layer we see is a flakey layer composed of Ferric Oxide (Fe_2O_3). This substance occupies a significantly larger volume than the base metal and, therefore, the Ferric Oxide (Red Rust) tends to flake away from the base metal.

Under the Red Rust layer is a layer of what is commonly called Black Rust (Fe_3O_4) which is the same chemical composition as Magnetite. This substance does not occupy a larger volume than the base metal, so it usually remains tightly bonded to the base metal. If you sand away the Red Rust layer, you have probably seen this dark shiny black layer. Continued sanding will reveal the shiny silver metal under the Black Rust.

Since the rust formation process is an electro-chemical process, we can use electricity to physically dislodge both layers of Rust. This process is called Electrolysis. It involves submerging the object to be de-rusted in an electrolyte solution and inducing an electric current through the object. It also requires a second electrode ideally composed of piece of iron (or other ferrous metal). This electrode is considered sacrificial and will become heavily corroded in the Electrolysis process.

What you will need is

1. A non-conductive tank. A plastic Tub large enough to hold your object and the sacrificial electrode. It should be deep enough to submerge your object completely.
2. An Electrolyte solution. An effective and inexpensive choice is to dissolve about a tablespoon of Washing Soda for each gallon of water. Washing Soda can be purchased at most Grocery Stores near the Laundry Detergent. It produces a mildly alkaline solution that is generally safe but be sure to follow common sense safety and read the cautions on the package.

3. A DC power supply. This can be a battery charger or a car/boat battery or an old computer power supply. Voltage is not critical but since 12 volts is a common battery voltage is reasonably safe to handle, it is a good choice.

4. Wire to connect the Electrodes. You can clip a battery charger lead directly to the object you are de-rusting and the sacrificial electrode, but do not submerge the sacrificial electrode clips in the electrolyte solution as they will get very corroded if you do.
5. A sacrificial electrode. I like to use rebar since I have access to it, but any steel or iron bracket or sheet metal can be used. I have read of people using stainless steel as the sacrificial electrode, I do not recommend it. Stainless contains Chromium which can leach into the electrolyte solution during the Electrolysis process as hexavalent chromium. This compound can be highly toxic to even touch which makes the resulting disposal of the used electrolyte problematic and dangerous. There are those who say its production is not likely and favor using stainless steel electrodes, but I choose to keep this process as benign as I can. In short, avoid using stainless steel.

This section of rebar was bent to fit the tub I am using and the middle section will remain above the electrolyte. I soldered a short section of copper wire to the rebar to assure a good electrical connection, but that is probably overkill.

6. A rusty object to clean. In this example I am taking the rust off of an old Stanley #5 hand plane.


The base of the plane is very rusty. I will need to assure a solid electrical connection to the metal, however. In this case I can use one of the handle screw posts to wrap a section of copper wire around for that purpose.

Make sure the object being de-rusted and the sacrificial electrode can remain in a position where they do not touch since that will short-circuit the voltage source.

Note how deep the electrolyte solution will need to be to fully submerge the object. Fill the container to at least that depth with warm water and note how many gallons that takes. Warm water helps the Washing Soda dissolve, but if you can only get cold water that is fine; it will just take a bit more stirring to dissolve the Washing Soda. Add about 1 Tablespoon of Washing Soda to the water and stir until it dissolves. The exact amount is not critical. Too little will slow the electrolysis process. Too much just makes a mess. The process will still work as long as there is a reasonable amount.

In my demo, it took 3 gallons of water to completely submerge the plane. I added Washing Soda just measuring in the palm of my hand about 3 tablespoons. Feel free to be more precise, but the exact measure is not critical at all.

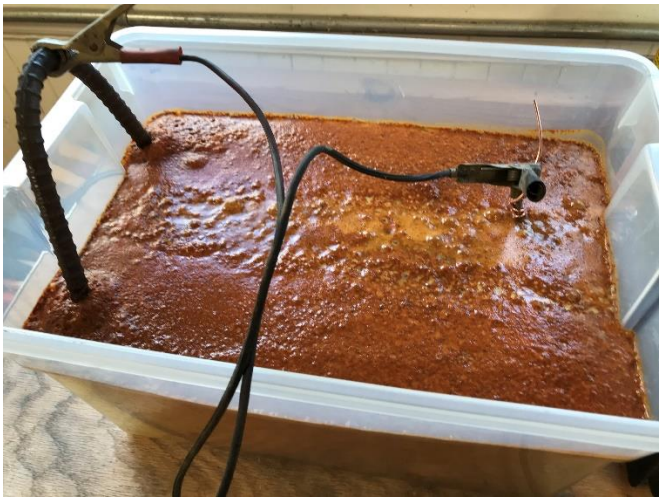
IMPORTANT!!! Connect the Negative Lead (usually black) from the voltage source to the object you are de-rusting. Connect the Positive lead (usually red) to the sacrificial electrode. This is the only critical thing about this process since if you get it backwards, you will de-rust the sacrificial electrode and corrode the object you are trying to clean even worse.

Plug in the charger or turn on the voltage source.

After a few minutes you will see bubbles forming on the object being de-rusted as well as the sacrificial electrode. Since the electrolyte solution is basically a soapy mixture, these bubble will create a foam over the top of the solution. After a while, this layer will become thick and stained with a rusty color.

The time required to compete the process can vary a lot depending on how rusty your object is, the concentration of the electrolyte, and the amount of current you can generate through the solution. You can de-rust an object if a few hours with a powerful charger but going too fast can be harder on the object as it causes the black rust to be dislodged fast. Since it is tightly bonded to the base metal this may affect the base metal more. I prefer to use an old battery charger I have that is incapable of supplying more than a few amps of current. As a result, it might take several days for the process to complete. That is fine with me.

Keep in mind that the process produces both Oxygen and Hydrogen gas as a by-product (the bubbles you see). Neither is harmful, but Hydrogen is flammable and creates an explosion hazard if allowed to accumulate. The good news is that Hydrogen dissipates rapidly and easily in a well-ventilated space so a reasonably ventilated space should prevent any hazard. Do not put your electrolysis tank in a cabinet or enclosed space.



As the process progresses, you will see the rusty brown foam accumulate on the surface of the electrolyte. This is normal. Once the bubbles stop forming, the process is complete. Turn off the voltage

source, and disconnect the electrodes. Be sure to turn it off before removing connections as this eliminates any spark potential which makes safety sense when Hydrogen gas may be present.

When you remove the object, it will likely be very black. That is normal and the desired result. The black residue can usually be removed in clean water with a scotch-brite pad or a stiff brush. You will likely see the silver color of the base metal under the black layer. When the object is clean dry it thoroughly. You can use compresses air, or an alcohol product the remove the water. This needs to be done right away since the base metal is newly exposed and will start to rust again quickly if it is still wet. I recommend applying oil or wax as a protective coat as soon as possible to help prevent rust in the future.

Feel free to stop the Electrolysis process and any point to check the progress. It can be started and stopped without affecting the result. It is not a good idea to leave the electricity off for an extended period, though.

When you are done, there is nothing wrong with using the same setup for another object. Eventually the solution with get gross enough that you'll want to make a new batch of electrolyte. The old solution can be poured down a drain or dumped in the yard. There is nothing environmentally harmful in the solution and it can be handled without danger. The rusty color may stain, but it is easily washed off your hands.

After two days in the electrolysis tank, the planes base was removed and rinsed off. A light scrub with the sponge removed all the black residue. The result looked like this: