

HYDROGEN TORCH REPORT



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Introduction:

First and foremost, I was not able to succeed in getting the hydrogen torch to work although I learned a lot in the process. In the following I will be presenting all that I learned so that a student interested in conducting this project in the future would be able to do so successfully.

The principles behind this project are that you need two electrodes suspended in an electrolyte solution. Then, when a current and voltage is sent through each electrode it begins the electrolysis of water; the oxygen is split from the hydrogen atoms of the water molecule and the hydrogen and oxygen are released in their gaseous states. This mixture of oxygen and hydrogen (oxyhydrogen) is highly flammable and thus can be used to create a torch. To create a torch that is successful in maintaining a flame, the flowrate of oxyhydrogen must be equal to the rate of combustion.

It is important to note that this is a dangerous project. Oxyhydrogen is extremely flammable and in large quantities it's explosive. Also, the electrolyte solution which consists of water and potassium hydroxide should not be in contact with human skin.

Design 1:

In my first design I decided to use a peanut butter jar because it had a tin/aluminum lid that threaded onto the glass jar. The lid was a good material because when I put holes in it, it didn't crack like some of the brittle plastic lids that go on plastic containers. I drilled 3 holes in the lid, one for a tube so the gas could escape and two more for each of the electrodes. The setup can be seen below in Figure 1.



Figure 1. Peanut Butter Jar Setup

I then used Aquaseal to glue the tube and electrodes into the lid, as I found this is a reliable glue that can create an airtight seal, unlike some superglues I tried. For the electrodes in this design, I decided to use concentric rings of 24-gauge stainless steel, thinking that this would maximize surface area, and thus increase the rate of electrolysis. I then used foam, as can be seen in Figure 2,



Figure 2. Concentric ring electrode setup

to locate the electrodes and ensure they would not touch. This design unfortunately did not successfully achieve this. While the inside ring was coiled with a large amount of area only the outermost part of the inside ring is close to the outer ring, meaning that none of the inner coils do anything to help increase the rate of electrolysis. Another difficulty with this design is that 24 gauge steel is too thick to easily make coils with and thus its difficult to wrap them into concentric shapes. This design could be very successful if thinner steel was used and the concentric coils wind intertwined, so that the two electrodes are adjacent to each other in every coil. To achieve this a wooden fixture may be needed to hold the steel coils in a position so that they would not touch each other. Although you would only want to place the fixture on the bottom because on the top it may trap bubbles. Originally, I had two alligator clips that went through the lid and attached to a part of each electrode and then to the power source. The problem with this was that the wires were too thin to provide the necessary power and so they got too hot and melted. That is why in each figure, two metal rods can be seen in the lid, the larger cross-sectional area allowed for the necessary power, which seemed to be about 40 watts. These metal rods were difficult because I found it hard to attach them to the electrodes, especially because I had to screw the lid on. Screwing the lid on means that the electrodes had to rotate with the metal rods in the lid, which just adds another complexity that could lead to error. For this reason it is important to consider how the electrodes are connected to the outside power source so that when the lid is secured on the electrode setup does not get ruined. I was not able to get the torch to light in this first design because I was not able to get the necessary flowrate of the oxyhydrogen. The largest problem was that this jar was not actually airtight, so I had to abandon this design and move to a new one.

Design 2:

In my next design I used a paint can for the pressure vessel as seen in Figure 3.



Figure 3. Steel Paint Can

The steel paint can is great because the can itself can be used as one of the electrodes, and if it is the negative one, you don't have to worry about it corroding. Also, the lid is pressed on so it simplifies the attachment to electrodes, and it is airtight. For the positive electrode I used a metal whisk with steel wool inside, which I then put a sock over. This design ensures the electrodes don't touch and the steel wool has a large amount of surface area which is important for increasing the rate of electrolysis. This setup can be seen in Figure 4 and 5.



Figure 4. Paint Can with positive electrode inside



Figure 5. Positive Electrode Removed

Not pictured is the lid to this design. It was unfortunately blown off in an explosion. The lid had two holes drilled into it, which the whisk and a gas tube were glued, again with Aquaseal. This is better because less holes means a better chance at creating an airtight enclosure. However, the whisk became difficult as it did not have a metal handle, so it became difficult to attach the positive electrode to the whisk, and gas was able to escape through a tiny crack in the whisk handle. The better way to have done this would be to get a hollow metal tube and glue this into the lid. The metal tube should be glued into the lid, so it is electrically isolated from the can. The metal tube would then be able to conduct electricity allowing for easy attachment of the power sources positive wire, and it would also serve as the gas outlet. Thus, by only putting one hole in the can the chance that gas could escape is much lower.

Both designs mentioned above used the same tube to nozzle system. PVC vinyl tubing was used to transport the oxyhydrogen from the can (oxyhydrogen generator) to the nozzle. I used 0.5 inch diameter tubing because it is cheapest. Multiple size tubes will work however it is important that the rest of the system is compatible with your tube size. Meaning it can make the connection between the can and nozzle. I found the 0.5-inch tubing was able to press over the smaller one that was glued into the can. It is important that the tube is long enough so that the nozzle tip can be at least two feet from the can. At the end of this larger tube there was a check valve followed by a syringe (packed with aluminum wool) which could then be fitted with different sized blunt needles, seen in Figure 6. The steel wool and check valve are important to prevent any flashbacks. This is a good design for the nozzle and was not the source of any of my issues.

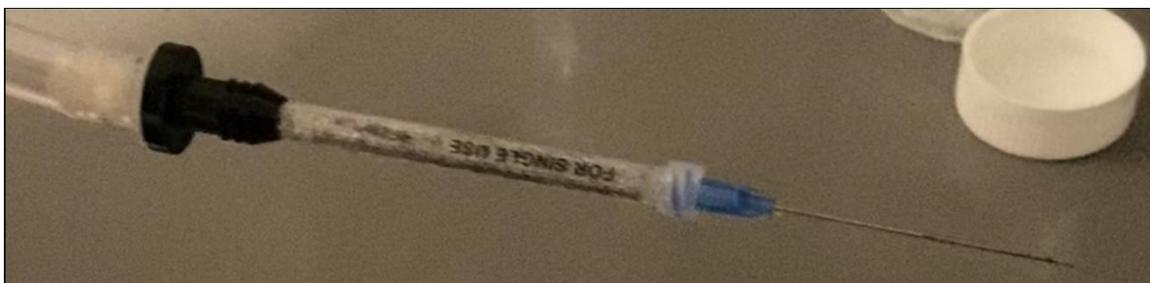


Figure 6. Tube attached to nozzle of torch

Conclusion:

Unfortunately, my apparatus broke before I was able to get it to the point where it was producing a sustained flame. I was able to get interrupted bursts of combustion but not a constant flame. Since there is not a recipe book for this experiment it requires a large amount of trial and error to find the balance that leads to a sustained flame. I would recommend that someone trying this experiment first builds a design they are confident in. Then they can play with the factors that are related to the rate of gas production, such as the concentration of the electrolyte solution, the amount of power, and what size nozzle to use. Ultimately, it will not work if the apparatus does not produce a large enough amount of gas, therefore the most important design parameter is that it is airtight and the rate of electrolysis is sufficient.

