

A first approach to a self made, low budget (hopefully) solar cooker.

This article is my attempt at documenting my experience making a parabolic solar cooker. I have been reading a lot about solar technologies on the internet and have had the great chance of working with someone who owns a company that sells and designs solar thermal and photovoltaic solutions. I wanted to get into a hands-on DIY project for a long time and the moment came when my father moved to a new house. The old owners left their directv dish mounted on the roof, and since it was no longer useful I decided it would be the perfect opportunity to take my first steps into the world of solar heating, with a simple technology: solar cooking.

Before I start to describe my progress so far, I'd like to introduce myself and make a few comments on the objective of this article. My name is Juan Sebastián Estrada, I'm a 27 year old environmental engineer from Medellín, Colombia, where I currently live. Although I have a bachelor's degree in engineering and some understanding of mathematics and physics, I don't have much experience in mechanical engineering or anything of that sort, so for this kind of project I prefer to think of myself as a simple amateur who is just starting his first solar project. Having said this, I hope that this article will provide at least some useful information and encouragement for **anyone** who wants to try and make their own solar cooker. There are lots of articles and information out there, a small part of which I have read, and which are very useful, but I believe that every attempt should be documented and discussed so we can learn from each other. Also, since I live in a Latin American country, I will write the article in Spanish because I have found that there is a great lack of information in my native language.

I also hope to receive as many comments as possible and a lot of ideas on how to improve my project, because there is still a very long way to go to what I want the cooker to be.

So on with the cooker: I've taken some pictures to document the progress and have already recorded a small video of the cooker in action; however I have not taken many pictures of the process, which I hope to be able to describe fairly easily. Any new action taken on comments and ideas received will hopefully be much better documented.

First I took down the dish from the roof and removed the base so I could easily transport it. It is necessary to say that while you see many of these dishes all around and you think they are round, they are not, so it is not really a paraboloid but more of an ellipsoid, this allows the focus to be off center and that way it is easier to point the dish at the sun without making a shadow with the pot most of the time (but not always as you will see in the first pictures). This one is approximately 65 cm in one axis, 61 cm in the other axis and 5 cm deep, and has a total surface area of approximately 0.28 m². The focal length is about 55 cm.

Then came the problem of the reflective surface. I tried two different alternatives at the same time:

I tried to get small square mirrors but shockingly they are not easily available (I live in a very big city so you think this kind of stuff would be easier to find and buy), so I bought some scrape mirrors from a local glass shop (about 0.5 m² for US\$3) and tried cutting them in 5x5 cm pieces with very poor results. Since this is supposed to be a low budget project it didn't seem right to buy a professional glass cutter that costs US\$30 or more (so I bought a cheap one for about US\$4). Even so, I tried positioning and aiming the mirrors that I was able to cut fairly well, and the result

disappointed me even more. Lining up these small mirrors on a parabolic surface is not easy and it would be even more difficult to glue them in place and aim each and one of them to the same spot, so to me this didn't seem like the right choice. The other alternative were aluminized polyethylene bags (I believe this is called mylar in some places or at least it is something similar) used all around town to bag fast food. They come in all kinds of sizes and are ridiculously cheap. I bought a package of 100 15x20 cm bags for about US\$1. Then I cut them into 5 cm stripes and proceeded to glue them to the dish.

This had better results than the mirrors because it will naturally follow the curve of the plate, but the cornerstone here is the adhesive. I went to the local home improvement store with the intention of buying some spray adhesive, but at US\$26 a can (they only had a very large size one, I don't know if it comes in smaller sizes) I decided it was against my objectives. So I applied some regular paper glue (a little diluted in water) to the bag stripes with a brush and put them on the dish. Although I didn't sand the dish to remove the paint (which I believe is somewhat non-sticking) the bag stripes adhered fairly well (you can easily peel them off but they won't come off on their own), but given that the thickness of the adhesive forced me to dilute it in water, it was impossible to avoid bubbles and wrinkles from forming. Still, I was happy with the first result and wanted to give it a try (first pictures ahead!).



Figure 1. This was the first finished result.



Figure 2. These were taken at about 9 a.m. The second picture captured more light than was intended, so you can't really appreciate the area of the beam, and though much of the light is still not reflected directly to the focus because of the wrinkles and bubbles in the plastic, it still makes a good tight beam

at a spot which was able to burn the wood (pine wood, don't know if it makes any difference) and set it on fire after about a minute.

The next step was to test it at an open location (my apartment only receives direct sunlight until 10 a.m. or so), so I took it to the *summer house* (we don't really have seasons here, only rain and dry seasons, so for lack of a better word I will call it the summer house or weekend house) (Medellín is located at an altitude of approximately 1,500 m above sea level, 6°14' above equator, and has an average temperature of approximately 24°C, I took the dish to the summer house which is about one hour from Medellín but has a hotter climate –over 30°C- and usually much more direct sun).

I didn't take the base of the dish then because of its weight, so I had to improvise a stand for the pot. I made two tests on consecutive days first in the morning then at about 1 p.m. It heated 750 ml of water and brought it to a shy boil in about 30 to 35 minutes, which I think is not that bad considering the size of the dish.





Figure 3. A first boil in approximately half an hour (750 ml water).

So this was the first step. I was really happy it worked well, but I knew the reflective surface needed to be improved for better performance and also better appearance.

Talking to a friend who drives a taxi, he pointed to me that in some shops they make quick repairs of car lights with an auto-adhesive shiny paper, so I decided to give it a try. I had already looked for auto-adhesive (here in Colombia that kind of paper is simply known as contact) paper in home improvement and office supply stores but had failed to find one that had a good mirrored surface. This one turned out to be actually very good. Although the finish is not as smooth as the aluminized bags, on plain sight it seems equally reflective, and it is very much easier to apply, but is also a little more expensive. I got approximately 0.6 m^2 (it comes in 60 cm wide rolls) for about US\$5. Since this was a retailer I think it will probably cost much less if purchased directly from the producer, but I have yet to find it, too bad there are no details about the manufacturer printed on the back of the paper.

So this time I took the new auto-adhesive paper and the dish mount, removed the aluminized bags and applied the new reflective surface. It sticks very well to the surface and almost makes no bubbles or wrinkles. The hard part was trying to make the stripes overlap as less as possible, but even so the finished look is much better and I don't think a little overlapping will make that much of a difference here.



Figure 4. The dish with the new reflective surface and mounted on its original structure.

One advantage of the original base is that it allows you to move the dish and the pot at the same time and also you can adjust the angle so it points directly at the sun. However it is rather heavy (I haven't weighted it but I would say the whole thing is over 5 kg), so this is not going to be a very portable cooker but you can also carry just the dish and a lightweight tripod to hold the pot.

Then came the second test. This configuration does provide a tighter beam although it is still not uniform and some light still gets deflected to other directions. On similar conditions it was able to burn the same piece of wood much faster:

Tests in Medellín (Figure 2) and summer house: About a minute with the aluminized bags surface.

Test in summer house with auto-adhesive surface: About 10 seconds!



Figure 5. Burn marks on a piece of pine wood. Upper three marks correspond to aluminized bags surface. Bottom single mark corresponds to the auto-adhesive surface, which burned much faster.

The comparison when boiling water was also encouraging. I have to admit to a sin when heating water with the new reflective surface: I changed the container. With the aluminized bags surface I used the pot that can be seen in the pictures. With the auto-adhesive surface I used an aluminum can that I painted with a high temperature black spray. But I promise to re do the test with the old pot and update the results.



Figure 6. The main difference with this configuration is that this can is painted black on the bottom whereas the pot is not.

The can is also thinner, but I also want to point out that although there is a beam at the bottom of the can, much of the heat was directed toward the side and since the can is smaller in diameter some (perhaps a considerable amount) of the light probably slipped past the can. Given all this variations it is probably not sound to make a comparison between the tests, but still I do think that it is worth mentioning that this configuration brought the first steam bubbles on the side of the can in just under 10 minutes, and after 25 minutes (I checked every 10 minutes or so, so it might have been less), although it wasn't boiling that much, bigger bubbles had formed which did not in the first test and there was a real boil on the side of the can that received the most heat.



Figure 7. Small bubbles in under 10 minutes with no cap on the can.



Figure 8. A real boil in just over 20 minutes, having put a cap over the can just after the first bubbles appeared.

Conclusions and expectations:

Given the size of the dish it is probably still not powerful enough to cook lunch, maybe some eggs for breakfast or even some stir fried vegetables ;).

I expect to improve the pot mount so that it can stand much heavier loads. Will publish new pictures when updated.

To be able to really cook I think it needs to have at least twice or three times its current power. I would really love to hear some ideas on how to expand the dish following its current shape (I have some very crude ideas) so that it can capture up to 1 m², or perhaps also some ideas on how to use the dish as a mold to make two or three more dishes the same size as this one (I have thought of fiberglass but I've never worked with it and perhaps there is an easier way).

Even though this is not expected to be a high duty cooker (I will leave it at the summer house and use it at the most once or twice every weekend, but probably just once every other week), I know eventually there will be an issue of degradation of the reflective surface due to UV light, so I plan on doing some tests on small pieces of plastic here in Medellín and maybe apply some kind of spray or any other form of UV protection that I can find. Again, suggestions are most welcome.

The cost: So far the cooker has been really cheap, mainly because I got the dish for free, but I think it would not be very hard to find an unused directv dish from a neighbor or friend. So the cost has been mainly the reflective surface: I have already spent about US\$14 on the materials I have bought, but the auto-adhesive paper accounts for just US\$2 to 3 (I still have about half of what I

bought), so it is about US\$10/m² at retail price, which I think is not that cheap but also not that expensive if I manage to protect it from UV light so it lasts for a long time. All the other materials have been recovered-reused, only add a few cents for some nuts and bolts. We'll see how we do for expanding it.



Figure 9. Finally, a picture of me! ;)

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