Rough Plans for Parabolic Trough Solar Cooker

Introduction

The parabolic trough cooker (or "cylindro-parabolic solar cooker") has several advantages over other solar cookers. It provides the instant frying/grilling power of a pure parabolic cooker, and yet easier to construct because the reflective surface is only bent along one dimension.

The following rough "plans" are meant more to provide inspiration than to provide a clear step-by-step plan. In other words, these "plans" bear little resemblance to assembly instructions for a piece of Ikea furniture.

The following directions will make more sense if you first watch this two minute video in which the solar grill is explained by a three year-old (literally): http://www.youtube.com/watch?v=MGq1XOXg1G0.

The initial question any solar cooker asks is how much heat is produced. Unfortunately, I don't have a precise answer. Taking the temperature of a cooking surface is more difficult than taking the temperature of a cooking area. However, the grill produced enough heat during the late summer in Los Angeles to brown meat in about 10 minutes, to cook corn on the cob in about 15 minutes, to burn green beans in about 15 minutes, and to burn eggplant in about 20 minutes. In short, it produced levels of heat comparable to a kitchen stovetop.

Another question a serious solar cook might ask is how frequently it needs to be adjusted. The bad news is that the long focal length means that slight movements by the sun cause the light to quickly miss the target. The grill had to be adjusted about every 10 minutes before the cooking power dropped off noticeably. In addition the finished solar grill is somewhat cumbersome to move around, and is perhaps its greatest design flaw. The good news is that, it cooks quickly enough that it only has to be adjusted once or twice during a cooking.

Wooden Frame

Step 1: The wooden curves

The wooden frame is 240cm long and 40 cm deep with a focus at 90 cm. The curve is generated by the equation y = 1/360*x^2.

Do yourself a favor in drawing the curve and use metric. Millimeters are much easier to mark off on a ruler than fractional pieces of inches.

As you can see from the picture below, each side of the wooden frame is made of two pieces of plywood, one set slightly below the other. This allows the reflective sheet of plastic to rest on the lower piece of plywood.

From a single sheet (8' X 4') of ½ inch plywood cut out 4 curves. All four curves follow the equation set forth above. The two "shorter" curves are about 6 inches tall. The two taller curves are about 8 inches tall. Only the top edge of the shorter curve needs to be cut out exactly. This is a miserable painstaking project, but precision here is necessary as a slight distortion can cause the light to entirely miss the cooking surface three feet above.

Once the four curves are cut, glue or nail together a tall curve with a short curve. This will produce two matching pairs of curves. The picture below gives the basic idea.

Step 2: Cutting the wooden struts

The two curve pairs are connected by eight 2" X 1" pieces of wood. My wooden struts were cut to be three feet long. It is important to remember that the reflective surface must be about ¾ inch (2 times the actual width of ½ inch plywood) wider than the struts because it will extend over the struts onto the groove created by the two curves. Refer to the illustration above if this is not clear.

Step 3: Attaching the brackets

The next step is to attach 16 four inch metal brackets that will support the wooden struts which will connect the two curves. The tricky part is correct placement.

The brackets must be placed about ¾ inch below the lower curve. That way when the wooden strut is placed on the bracket, the reflective surface can rest flushly on both the groove between the curves and the wooden struts.

The brackets are attached with nuts, bolts and washers as shown in the picture below. Holes had to first be drilled in the wood.

<u>Step 4: Attach the wooden struts</u>

The wooden struts are attached to the brackets in the same way the brackets are attached to the wooden curve; with nuts, bolts and washers. The head of the bolt was sunken into the wooden strut enough so that it would not rub against the reflective surface.

Reflective Surface
The reflective sheet of plastic was originally 8 feet by 4 feet and about 1/8 inch thick. It was purchased at a plastic store near Los Angeles.

The plastic sheet was cut to be about a foot narrower (3’ ¾” by 8 feet) so as to be a fraction larger than the wooden struts (3 feet).

The plastic mirror rested snugly on top of the wooden struts and on the groove between the plywood curves.

Metal Frame
The original metal frame (shown in the opening picture) was an elaborate stand alone system that unfortunately did not work very well. It relied on adjustable pipe fittings that were unable to hold the substantial torque that was placed upon them. The modified metal frame abandoned the initial goal of supporting the entire solar grill and focused successfully on the more modest goal of supporting the cooking surface.

Rather than describe the design, I'll let the pictures do the talking. First, however, a few notes. The pipes are 1 inch in diameter and schedule 40 in thickness (a metal shop will know what this means). The pipe fittings were purchased from: http://www.easyfit.com/maincatalog.html but I have since learned they can be purchased locally. The two side supports were cut so that they would place the focus where it needed to be, at 90 centimeters from the vertex of the parabola.

This weld connecting these two pipe fittings is essential, as there is a tremendous amount of torque at this joint and an exact 90 degree angle is essential.

In order to use the solar grill, it had to be braced up on something so that it would be at the correct angle to the sun. A picnic table worked quite well, and was quite stable. However, adjustments required at least two people. This makeshift system surprisingly worked better than the elaborate metal frame seen in the first picture of these plans which suffered from dangerous wobbly-ness.

Cooking Surface

The cooking surface was the most costly component of the solar grill. I had originally planned on using an old sewer pipe I had found, but this idea was vetoed emphatically by my spouse. With this idea vetoed, I felt entitled to spend lots of money. I purchased a stainless steel tube about 4 inches in diameter. This cost $100. I had it cut lengthwise. This required special machining (not every band saw can cut a 3 foot stainless steel tube lengthwise). The cutting cost another $100. At both ends of the cutting tube are stainless steel circles. I did the machining on those myself and had a friend weld them to the cut tube.

To finish it off, I painted the outside of the tube with heat resistant paint (used to paint BBQ grills).

In retrospect, I realize that all this expense was probably not necessary, and that a simpler setup would probably have been fine.

Finally, the metal circles were bolted to a pipe fitting and voila, the metal frame was complete.

Here is the solar grill cooking zucchini, green beans, eggplant, and mushrooms.

I would love to hear about your adventures building a parabolic-trough solar cooker. Please let me know about your results, and don’t forget to send pictures.

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