The ParaPanel Solar Cooker

Introduction:

There are many people all over the world who cook solar. It is possible to cook in the UK just using the power of the sun even in midwinter. On a clear Spring/Summer/Autumn day we receive about 1Kw of energy per square metre of the earth's surface. It's less in Winter, but still usable. We know how hot a car gets if it's parked in the sun. If we use a lens or mirrors we can focus this on a smaller area and increase the heating effect. These can melt steel if well designed! I don't suggest you try that, but a home-made cooker is a safe thing to build, providing you remember that THE POT GETS HOT. The cooker itself does not. So use gloves or a thick cloth when handling the pot.

I designed and built the cooker described here in 2017. It produces about 500 watts; compare that to an electric slow cooker that uses under 200 or an electric oven that uses 1Kw. It is built using cardboard, duck tape, glue, string and a shiny material – mylar(emergency/space blanket) or aluminium foil(you can even use foil that has been used to wrap a roast if you wash it and flatten out the crinkles). The pot can be a used food tin painted black on the outside and the 'oven' can be an upturned pyrex or clear plastic bowl.

It can be placed on the ground or on a table as it doesn't get hot. Some people even put then on a table indoors next to a window: I haven't tried that as our home doesn't have south-facing windows with table-space under them. I made a very simple lightweight trestle table.

Cooking times are longer than electric or gas but this can be better for the flavour and texture of the food.

I have used metric and Imperial measurements due to my age!

Components:

Cardboard baseplate 48x18 inches. I used 3-ply board to make it reasonably rigid. It can fold in half for transport forming an 18x24" briefcase format. Handholds are cut in each half.

18" high cardboard reflector. This is the 'parapanel'. Made in 2 halves with 3" straight sections to approximate to a parabola with focus in centre and 7.5" from back of it. Each half is 30" long and when curved just fits in the 24" width. One half has a flap that overlaps the other. This is clipped at the top to hold the surfaces in line. The parabola is hinged to the base at its vertex using duck tape. It is also hinged so each half folds to a 15"width that lies flat on the base for transport. The back surfaces are scored vertically along the grain of the corrugations to form the panel sections; this helps it follow a curve.

The parabola is supported in use by some buttresses; these are glued to the back of it and can fold flat for transport. Two tensioning strings are tied to clips on the base. They have a square of cardboard tied to one end; the string slips through a small slot at the joint between two These pull against the buttresses to keep them in place on the base. It is further aligned by small cardboard blocks glued to the base; these will marginally reduce efficiency by creating a small shadowed area behind them.(overcome by facing them with reflective material.) Glue one in front and one behind where you want them to position the panels.

(The original design had a folding cardboard web glued to the back of the parabola; this slots over its corresponding buttress that were glued to the base. The glue-line on the base was not long enough to take the forces created.)

Vertical reflective surfaces are Mylar survival blanket glued to the cardboard using diluted pva(craft or wood glue or similar). Horizontal reflectors are aluminium foil to withstand the heat in the cooking area. The Mylar is cut in pieces that are small enough to be glued without too many wrinkles. The edges are bound with reflective aluminium tape. The pva is spread on the cardboard in 6”swathes and the Mylar stretched over it using a flat plastic item(old 12v alarm battery) in an ironing fashion. (equal results were obtained by wiping over with a wet cloth.) The swathe is allowed to dry before attaching the next 6”.

The area of the base that is behind the parabola provides storage space when in use. It can also be used to place stones or other heavy objects to stabilise it. Alternatively it can be clipped to a table using market stall clips or paper spring clips.

Pot Surround:

A pot surround is used to stop heat being convected from the cooking pot.

The pot surround is 4 pieces of rigid clear plastic sheet. These protect it from the wind and are joined using double-sided transparent tape and a hinge made of cooking bag material.

A square piece of plastic sits on top to keep the heat in.

I have also used a transparent plastic mixing bowl (11” diameter and 6”deep); these are 75p in Wilko) but it is possible to buy a slightly bigger one for about £1.50 in some local independent shops; this would be better if using a saucepan for the cookpot. A pyrex bowl or clear casserole can be used. You can also use cook-in bags but they are a bit fiddly if you want to inspect or stir the food. You also have to inflate and tie them so they leave an air gap round the pot.

Here it is in position. The pot shown is made from a baked bean tin. It is raised on a trivet made of interlocking plywood covered in self-adhesive foil. The lid is a tuna tin placed upside down on top; both are painted black on the outside only.

Once folded, it is held in the closed position by a treasury tag, you can see the handholds. The pot surround folds and can be carried inside, But I might make a pocket on the outside so it doesn't scratch the reflective surface.

The black bits at top left are the duck tape that acts as a hinge for the panels

Calculations:

The following are the calculations I used so that the focus is 19cm from the back of the cooker. This allows the pot to be placed far enough from the reflector to receive sunlight from behind. There is no need to plot every point as the cardboard will not curve exactly. I suggest you make the parabolic reflector before you mark the points on the base. You can then place it on the base to show you the best points to mark. I then drew the parabola freehand so it 'looked right'. Then hinge/tape the reflector onto the base. Stand it vertical and glue the blocks to the base so they best position the reflector to follow the curve. Don't let them become glued to the reflector. Maybe just do one at a time on each side. After these have dried, glue the reflective surface on the base and the blocks. It doesn't have to cover behind the reflector.

X (distance from centreline)	Y (height from baseline)	Focal length
0	0.00	19.00
4	0.21	19.00
8	0.84	19.00
12	1.89	19.00
16	3.37	19.00
20	5.26	19.00
24	7.58	19.00
28	10.32	19.00
32	13.47	19.00
36	17.05	19.00
40	21.05	19.00
44	25.47	19.00
48	30.32	19.00
52	35.58	19.00
56	41.26	19.00
60	47.37	19.00
64	53.89	19.00
68	60.84	19.00
70	64.47	19.00
72	68.21	19.00

On reflection:

Sorry about the pun.

The pot is not particularly suited to the task. A wider pot would be better. I have a Snow Peak titanium mug that works quite well as it is wider and a dull grey colour but that is still too narrow. Also It would be better raised higher so more sunlight is reflected upwards to it. The only 9 inch saucepan I have is light yellow and I don't want to paint it as it is in keeping with my caravan. I will try wrapping it in a close-fitting black metal mesh jacket. Some people say that a clear lid works as well as a dark one. Others that it is best to have the sunshine on the bottom of the pot as it transfers the heat better, I found that a trivet helps to lift the pot us so it gets some reflection under it.

It is worth turning the cooker every hour so it faces the sun better to maximise insolation.

Results so far have been quite promising at 50 degrees North in July.

Half a litre of water gets to 95 Centigrade in about an hour. Noodles cook in the same time.

Broccoli and baby potatoes cook in about 90 minutes but tend to be on the firm side. The broccoli scorched a bit. Cut the broccoli into smaller sprigs so it can be completely covered in water without too much space between sprigs. Baked potatoes – just put one in the pot without water – are very successful with the skin not getting hard like it does in a microwave.

In September 2017 water boiled vigorously.

In November 2016 I made a smaller cooker with two flat reflectors 9" wide by 17" tall on a reflective base. It was able to raise 1/2 litre of water to 90C in November in about an hour so there may not be much benefit in complicating the design as the ParaPanel but it looks more sexy or macho depending on your politics. The panels slid into slots in the base set at 90 degrees. I didn't notice any difference in output when I placed them at 60 degrees. The tops of the reflectors were held together by a spring clip, For a 'quick and dirty' cooker just sellotape the foil onto the cardboard.

Possible explanation for the comparative performance are

- the smaller cooker was entirely covered in reflective tape and this gave a better surface.
- I used a cook-in bag as the pot surround with less air around the pot.
- The sun was lower in the sky so benefitted from the reflectors being vertical.

The small cooker would be ideal for young people to attempt.

If this has inspired you to think about the subject, http://solarcooking.org/plans/ and solarcooking.wikia.com are useful starting points.

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