**SOLAR COOKER USING PARABOLIC**

**REFLECTOR**

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**INTRODUCTION**

Let's face it, energy is expensive gas, electricity, whatever. So why pay to cook your food? The challenge we gave was to cook food, without spending any money at all. No electricity, no gas, nothing. And, there are no negative side effects on the environment, resulting from our hot dog. What we came up with was...the parabola. So by using the properties of parabolas, we're going to cook a hot dog. Essentially, we're using math to cook hot dogs

The sun sustains life on earth; it is available to everyone daily. There is no cost for solar radiation. Using parabolic, box, or panel cookers means no gas or electricity costs. They are easy to maintain and just as easy to build. With a little planning and some basic mathematical calculations, anyone can own their own solar cooker.  
But what are the advantages to using a solar cooker? Besides the economic savings, solar cooking helps in the fight against global warming and deforestation. By using the sun's rays to cook meals, firewood is saved and in many remote areas time is used more usefully than for gathering the necessary firewood needed for wood burning stoves.   
In the remote areas of the world a solar cooker can be used to distill drinking water and feed villages. Many people in the world must survive on polluted surface water that is difficult for them to decontaminate. Solar cookers offer an easy solution to this problem.   
Often times, it is necessary to collect wood to build large fires in order to purify water. Solar cookers distill water cheaply by using the sun's rays to heat a pot of water. They can be a cost effective solution for those that may otherwise have no resource to purify their drinking water. Solar cookers are also easily transported to remote locations. In many parts of the world they can be easily built using local materials. There are several organizations and programs worldwide that promote the construction of these solar cookers.  
Many ask, how effective are solar cookers? The effectiveness of a solar cooker can vary depending on what materials are used, how well they are crafted, and what type of climate you live in. Cooking time with a parabolic cooker is similar to a conventional stove, and a box oven is similar to a conventional oven. Cooking may take longer is there are fog, clouds or shadow.  
Using a solar oven to slow cook a meal means the food is cooked uniformly and doesn't burn no matter how long it is allowed to cook. Since dishes are allowed to blend and cook in their own juices, the food retains its nutrients. No vitamins or minerals are lost in the process. The only necessity is sunlight; even snowy climates can enjoy the advantages of solar cooking. Parabolic cookers require closer attention because they can reach much higher temperatures.

**HISTORY OF SOLAR ENERGY USE:**

The harnessing of solar energy began with the ancients. They were the first to begin using passive solar design in their homes and to use glass to trap solar heat. The use of curved mirrors to concentrate the sun's rays was developed by the Aztecs, Greeks, Romans, and Chinese. The concept of "burning mirrors," for weapons, has been considered for millennia. It was through the Greeks geometric development that they discovered a parabolic surface held the ideal shape for these burning devices.  
Awareness of the ability for glass to trap solar heat became increasingly important in the eighteenth century. It was during this century that

the first "hot box" was invented by Horace de Saussure. With the advances in science and technology during the Industrial Revolution, came the development of various devices designed to harness solar energy. Solar pumps, solar cookers, solar heat engines, and solar stills are just some of the inventions of this time.   
Augustin Mouchot, a professor of mathematics at the Lyceé de Tours, was an important figure in this revolution. He was the first to develop a solar cooker; he was successful in finding a benefactor to fund his research. This led him to Africa where he invented a portable solar oven for the French troops.

Although these various solar inventions were never very successful on a large scale, they did aide in the advancement of a practical development of this revolutionary technology.  
It was in the 1950's that solar cookers began to evolve into the products we see today. The United Nations and other agencies began solar cooker design studies. These studies found that when properly constructed, solar cookers not only cooked food thoroughly and nutritiously, but also were easy to build and use. Programs were created to introduce these designs to remote locations in the hope of aiding those in need.

**CONSTRUCTION & FABRICATION PROCEDURE:**

For the solar cooker the materials used are:

1. Two pieces of plywood, 1/2 inch thick, 2 feet wide and 4 feet long.
2. Two pieces of lumber, (2x4) 1 1/2 inch thick, 3 1/2 inch wide, and 8 feet long.
3. 16 wood screws, 2 inches long.
4. One stiff steel wire, 3 feet long.
5. 92 small nails or wooden pegs, about an inch long.
6. One plastic mirror, 1/8 inch thick, 2 feet wide, 6 feet long (although 5 1/2 feet long might work better).
7. A drill and a bit that matches the diameter of the 92 small nails or pegs. A larger bit (over 1 inch wide) is needed for the food hole.

### **Assembly the parts**

The two sheets of plywood are placed together, one on top of the other. Using a tape measure and a carpenter's square, the points are mark off where the holes will be drilled for supporting the aluminium foil (the 92 small nails or pegs).

All holes are drilled completely through both sheets of plywood. The holes are to be drilled according to the following table:

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| **Inches from left** | **Inches from bottom** |
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Next we drill a set of holes above the first set, about a third of an inch above the first set of holes. The first set of holes will eventually have 23 of the small nails placed in each side, to hold the mirror up. The second row will also have 23 small nails pushed in, this time to hold the mirror in place from above. The exact spacing is not critical, but we don't want them too close together, or the top nails will hit the mirror instead of resting on top of the mirror.

Next we drill eight holes for the screws that will hold the 2x4 lumber in place. The holes are 3/4 inch from the edges of the plywood. On the left and right, a pair is drilled 15 inches from the bottom and 13 inches from the bottom. At the bottom, a pair is drilled 10 and 12 inches from the left, and the last pair is 36 and 38 inches from the left.

The focus of the parabola is 9.14 inches from the bottom, and 24 inches from the left. Drill a hole that is the same diameter as the spit wire, or a little bit larger. This hole should go through both sheets of plywood.

Just above one of the focus holes a large hole is drilled in one plywood sheet, just touching the hole for the spit. This large hole will accommodate the food (hotdogs or kebabs), so it should be at least an inch in diameter, but three or four inches would be better. The spit with the food on it will be inserted into this hole, and the spit will then drop into the much smaller hole at the focus, to keep the spit in exactly the right place.

Cut four pieces from the 2x4 lumber. Each piece should be exactly 2 feet long.

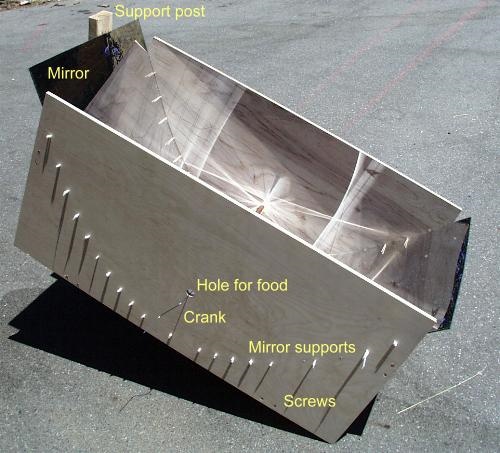
Using the 2 inch long screws, screw the 2x4 pieces to one of the plywood sheets, centering each pair of screws in the end of each piece of 2x4. The result should look something like the legs of a small table.

Attach the second plywood sheet to the other end of the 2x4 pieces.

Next push 46 of the small nails into the bottom row of holes.

Now we set the aluminium foil with cardboard onto the top of the cooker, and gently push it down to rest on the nails. Put a pair of nails in the center pair of holes on top of the mirror, and then work your way outwards, placing pairs of nails to hold the mirror down. The last step is to place a few screws in the remaining long piece of 2x4, leaving the head of the screws sticking an inch or two out of the wood. These will act as supports to hold the cooker so it is tilted toward the sun.

The spit is formed from the 3 foot piece of wire. A coat hanger can be used, but wires that thin tend to sag in the middle when burdened. A thicker, stiffer wire is better.



**COOKING IN THE SUN:**

The solar cooker is aligned with the sun. We start with the cooker flat on the ground, then turn it until it is parallel with our shadow. The sun will just barely graze both of the plywood sheets when the cooker is aligned properly.

Next we tip one end of the cooker up until the shadow of the spit falls directly on the center nail at the bottom of the parabola.

We hold the remaining scrap of 2x4 up against the back side of the cooker, and mark where a screw should be placed to hold the cooker at the right elevation. We screw the screw into the 2x4, leaving an inch or two sticking out to hold the top 2x4 spreader. According to our convenience, the screw can be placed a little higher up, and the cooker can be adjusted to the exact angle by tilting the support backwards.

When the cooker is adjusted properly, the sun will be focused on the food, making bright lines across it (sunglasses are recommended at this phase).We can see the shadows of the nails on the walls of the cooker. These shadows should all cross at the focus, where the hotdogs are.

The most important safety tip for cooking with the sun is NOT TO STARE INTO THE REFLECTED RAYS. WE SHOULD WEAR DARK SUNGLASSES WITH UV PROTECTION AT ALL TIMES

The sun's rays can burn your eyes and cause blindness if the proper precautions are not taken. Special attention should be given to fire safety as well. Parabolic solar cookers should be covered when not in use.

The spit should be turned every couple minutes to prevent black lines from being burned into the food (unless you like your hotdogs with black stripes). The food will be quite hot in about 10 minutes, or burned black all over in about 20 minutes.



**PRINCIPLE OF WORKING:**

A parabola is a shape with some interesting properties that make it perfect for cooking.

The sun is bigger than the earth, and very far away. This means that the sunlight that hits the earth appears to be in parallel rays.

If we had thousands of tiny mirrors, connected by hinges in a line, and we tilted each mirror so it would reflect these parallel rays onto one spot, the mirrors would line up in a parabola

Mathematically, a parabola is defined as a set of points that are the same distance from both a point (called the focus) and a straight line (called the directrix).

The formula for the parabola used in the solar cooker is

y = 0.035x2+2

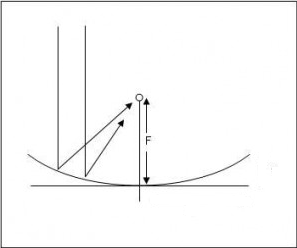
We chose this formula so the parabola would be deeply curved, and would fit into the 2 foot by 4 foot plywood sheets. We want the focus to be close to the mirror, so that as the sun moves, the focus does not move very much.

Having the focus close to the mirror is like having the fulcrum of a lever close to one end. The sun end of our lever can move a lot, while the hotdog end of our lever hardly moves at all. This means that we don't have to raise or lower the cooker very often as the sun moves.

The +2 part of the equation says that the bottom of the parabola will be 2 inches from the bottom of the plywood. This gives us room for the 2x4 spreaders, and room to drill the bottom hole for the support nails.

The bottom of the parabola is called the vertex. The vertex is always halfway between the focus and the directrix. The distance from the vertex to the focus is or about 7.14 inches.

A square meter of the earth's surface gets about 1000 watts of power from sunlight. Our mirror intercepts about 8 square feet of sunlight, or about three quarters of a square meter. This means that our cooker is the rough equivalent of a 750 watt electric stove



**POWER CALCULATIONS:**

**Temperature measurements:-**

Minimum temperature recorded: 400C

Maximum temperature recorded: 950C

Time intervals between two readings of temperature: 20mins

**Observation of period of sunshine at NIT Calicut**

Latitude of Calicut: 11.15 °N

Longitude of Calicut: 75.49 °E

Average sunshine at NIT Calicut: 11hrs/day

Potential sunshine at NIT Calicut: 8hrs/day

**Calculation of area of parabolic reflector exposed to sun:-**

Area = Length \* Breadth

= (4ft)\*(2ft)

= 8ft2

**=**0.72m2

Average power received by earth from sun:1000W/m2

Total power received by the cooker = 720W

**CONCLUSION & INFERENCE:**

Thus we see that the parabolic reflector is equivalent to a 720W electric stove .The total cost involved was about Rs.250/- which is quite affordable.

There is no cost involved in its assembly and can be done manually. It is also environment friendly.

The model is based on a very simple principle of a parabola and has no moving part hence is easy to maintain and repair requiring no special technical skills. It thus entails no running cost.

The solar cooker can be used both in the rural and urban areas. In the rural sector it will save village women from having to trudge for miles in search of scraps of firewood and spending their lifetime in smoke-filled kitchens. In the urban sector it saves energy on kerosene and LPG and makes cooking easy also making our country self dependent in terms of its energy resources and also saving large amount of foreign currency.

It can also replace the traditional stoves burnt on firewood in remote parts of our country thus retaining our forests and ecological biodiversity

Foraging for fuel wood is a demanding task that reduces the time women and children have for school and profitable work too.

The fossil fuels damage the environment and we are dangerously close to exhausting them completely .The solar energy options are therefore becoming more attractive.

Kitchens remain cool while food solar cooks outdoors. This reduces the load on air conditioners and refrigerators in summer months, saving fossil fuels (and lowering utility bills). Also moderate cooking temperatures in simple solar cookers help preserve nutrients also food doesn't need to be stirred and won't burn — food can simply be placed in a solar cooker and left to cook, unattended, for several hours while other activities are pursued.

Electric companies that have trouble meeting peak hour demand because of heavy use of stoves and air conditioners can reduce that demand by promoting use of solar cookers

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