



**German-Afghan Bilateral Cooperation
Promotion of Renewable Energy**



**MANUAL FOR CONSTRUCTION OF A
SOLAR-COOKER MADE OF CEMENT**



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1. Introduction

One of the most urgent problems humanity will face in the near future is the lack of energy. Traditional energy sources like mineral oil will one day be as good as depleted.

Because of this, the importance of renewable energy will increase.

Solar energy is one of the most basic renewable energy sources currently known to mankind.

One of the cheapest ways to use solar energy especially in rural areas is a solar cooker.

The following pages provide an overview of how to build a cement solar cooker.

2. Preparation

A. Building materials needed

To build a cement solar cooker the following materials are needed:

1. **425 # Cement**
2. **Coarse-grained sand**
3. **Fine-grained sand**
4. **Gravel**
5. **6", 8", 10", 14", 16" steel rod**
6. **12" iron wire**
7. **3.3 cm, 2.5 cm and 2cm diameter iron pipes**
8. **4cm and 2cm wide flat iron**
9. **6mm*20cm screws**
10. **Mirror or reflective foil**
11. **Tar**
12. **Used machine oil**

B. Required Tools

To ensure that poor families can afford a cement solar-cooker the costs should be kept as low as possible. To achieve this only the minimum tools necessary are listed:

1. **Shaper**
(required only once)
2. **wheel-barrow**
3. **shovel**
4. **coarse and fine sand sieve**
5. **bucket**
6. **tape measure**
7. **pincer**
8. **hammer**
9. **metal saw**
10. **drill**
11. **grinding machine**
12. **thread cutter**
13. **bolt cutter**
14. **spatula**
15. **plaster float**



C. Preparation of the basic form

The first step to build a cement solar cooker is to construct a **Basic Form**. This basic form is needed to build the master form of the solar cooker's transportable form. Later on a solar cooker can either be built from the master form or from the transportable form. The master form will be stationary while the transportable one, as the name implies, can be moved around. To save space the solar cooker is normally built with the transportable form.

The construction of a basic form comprises of the following steps:

1. Bank up soil in a hemispherical pile



2. Fix shaper in the centre of the pile



3. Stamp the pile of soil and sprinkle with small amount of water



4. Mix cement (Coarse-grained sand with cement in a 4:1 ratio and fine-grained sand with cement in a 1:3 ratio)



5. First apply a layer (3.5 – 4 cm thick) of the coarse-grained sand-cement mixture on the pile of soil

Then apply a layer (0.5 – 1 cm thick) of the fine-grained sand-cement mixture



6. Then rotate the shaper cautiously to create the ideal fit (attention should be paid not to apply too much pressure from above while rotating the shaper, instead the shaper has to be rotated steadily).



7. After the basic form has the desired shape, remove the shaper and let the form dry for some time until its surface is fine-grained and smooth. Mix fine-grained cement with water and use a spatula to repair and smoothen the form.



8. Let the basic form dry for two or three days.



D Preparation of the master form

After the basic form has dried, one can produce the master form, which serves as basis for the transportable form.

This process involves the following steps:

1. Grease the basic form with machine oil.



2. Attach sheets of newsprint to it.



3. Mix cement (Coarse-grained sand with cement in a 4:1 ratio and fine-grained sand with cement in a 1:3 ratio). First apply a 1 cm thick layer of fine-grained cement on the basic form and then a 4 cm thick one of coarse-grained cement. Try to achieve an oval shape with a width of 1.6 m and a length of 2.1 metres.



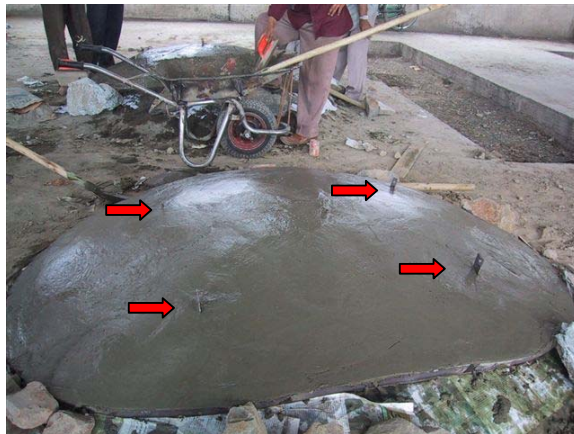
4. Press a 14" steel rod into the wet cement at a distance of 5 cm to the edge.



5. Weld four fastening hooks from one flat piece of iron and two iron rods. These hooks will be used later for the suspension of the master form.



6. Press the fastening hooks into the master form as shown in the picture.



7. Cover the form with plastic foil.

Remove the foil from the master form after two days, sprinkle with water and then let it dry for seven days.



8. After the master form has dried out, remove it from the basic form.



9. Repair and smoothen the concave curved surface of the master form.



After the form has dried the master form can be used for the production of the transportable form.

E Construction of the transportable form

The transportable form can be used for

- a) the construction of a cement solar cooker or
- b) for the production of other transportable rigs.

The advantages of the use of a transportable rig in comparison to the master form are:

- The form can be used at different locations
- The transportable form requires less space during construction of a cement solar cooker than the master form

The production of a transportable form comprises the following steps:

1. Apply machine oil to the inner surface of the master form and then stick sheets of newsprint to it.



2. Mix cement (coarse-grained sand with cement in a 4:1 ratio and fine-grained sand with cement in a 1:3 ratio). Add a 1 cm thick layer of fine-grain sand-cement mixture to the inner surface.

3. Press 14" steel rod into the wet cement at a distance of 5 cm to the edge.



4. Add a 4 cm thick layer of coarse-grained cement. Weld four fastening hooks from one flat piece of iron and two iron rods. Press the fastening hooks into the wet cement as shown in the picture and cover it with plastic foil. Let it dry for two days, then remove the plastic foil and sprinkle it with water. Then let it dry for an additional five days.



5. After it has dried out, the transportable form is removed from the master form. Put the transportable form onto three bricks, repair and smoothen it in the same way as the master form.
The transportable form is now ready to be used in the production of cement solar cookers.

3. Construction of a cement solar-cooker

A. Construction of the body of the cement solar cooker

The cement solar cooker can be built using the master form as well as the transportable form. No matter which form is used, the steps of the process are always the same.

Construction steps:

1. Draw the required outline of the solar cooker on the form (transportable form or master form)

To draw the outline a metal cross is needed. To create this cross, weld a 1.30m long piece of flat iron and a 1.90m long piece together. To draw, lay both flat irons on the exact centre of the form. With the help of the ends of the cross arms', draw an ellipse as evenly as possible.



2. Cut one a flat iron (about 3 cm x 0.2 cm) into 20 cm long pieces. Hammer these pieces into a triangular form, adjust them to the outlines of the solar cooker and hold together. Weld the pieces of the flat iron together.





3. On the outside of the flat iron ring additional 14" iron rods are welded to prevent the flat iron ring from losing its form.
4. Drill holes into 4 small pieces of flat iron (Size?). Two of these flat iron pieces with holes are welded to each of the longer sides of the flat iron ring.



5. Then the ring will be cut in half on each side between these flat iron pieces. Because of this, the ring can be disassembled into equally sized parts.



6. Apply used machine oil to the form and stick sheets of newsprint to it. If the form is used a lot of times for the construction of solar cookers, the sheets of newsprint are no longer needed, and you only need to grease the form with machine oil.



7. Assemble the two parts of the flat iron ring and lay on the form. Then make a mesh from the iron wire and adjust it to the form (see picture).



8. Riddle the coarse-grained sand and mix it with cement in a 2:1 ration. (One sack of cement should last for two solar cookers.) Put the flat iron ring and the iron wire mesh onto the newsprint.



9. Place a 17-18cm long piece of wood in the middle of the mesh wire.



10. Place two welded fastening hooks on the longer sides in the middle between the centre of the form and the flat iron ring.



11. Apply a 1.5 cm thick layer of cement on the form.



12. Wooden frame: As shown in the picture, place a pattern of pieces of wood on the cement.



13. The fastening hooks have to be embedded as shown in the pictures to prevent deformation later on.



14. Cover the cement with plastic foil and let dry for two days. Remove the plastic foil on the second day and let the cement dry for an additional 3-4 days. During this time, pour water over it several times. After 3-4 days the solar cooker is taken from the form and turned upside down. The solar cooker has to dry for an additional three weeks.



B. Construction of the stand for the cement solar cooker

The stand can be built either as a stationary or a mobile stand.

Construction of the stationary stand:

1. Weld a ring of flat iron into circle with a diameter of 50 cm.



2. Cut a pipe with a diameter of 2.5 cm to a length of 25 cm. Weld a 5 cm long piece of 14" iron rod at a height of 2 cm and after another 2 cm a ring of 14" iron rod.



3. Put the piece of pipe in the middle of the flat iron ring and fill it with cement. After several hours, remove the flat iron ring and let the stand dry.



Construction of the mobile stand:

1. Cut two pieces of 90 cm and 80 cm length from a pipe with a diameter of 2.5 cm and weld them together to a T-form. Weld a roller to every end of the T-form.



2. On the T-form, find a spot with equal distance to every roller and weld a 24 pipe with a diameter of 2.5 cm. Weld a ring of 14" steel rod at one third height of this pipe and weld a length of 14" steel rod to one roller each.



Construction of the solar cooker rig

1. Prepare four 6 cm long pieces of pipe with a diameter of 2.5 cm. Cut two holes each with the thread cutter into them.



2. Weld 30cm of a pipe with a diameter of 3.3 cm, 65cm of pipe with a diameter of 2 cm (or 20" concrete reinforcement iron), and one 6 cm piece of pipe with a diameter of 2.5 cm as shown in the picture.



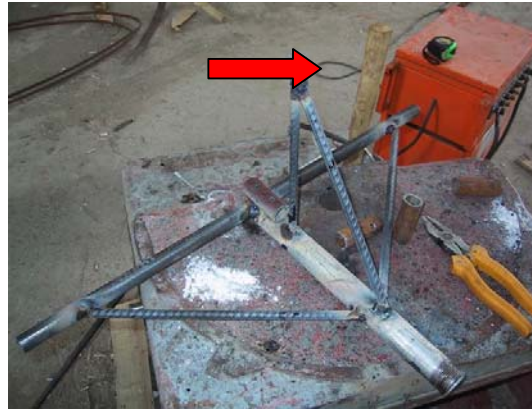
3. Weld two 6 cm long pieces of a pipe with a diameter of 2.5 cm to the other end. Place 6" screws into the holes of the 6 cm long pieces of pipe. To strengthen the rig further, weld concrete reinforcement iron to the T-form as shown in the pictures below.



4. Weld a U-form made from 2 cm flat iron with a hole in it to the rig.



5. Fix the U-form as shown in the picture.



6. The adjusting rod for the solar cooker will be constructed from a U-form made from 2 cm flat iron, a 6cm long piece of pipe with a diameter of 2 cm, 20" iron rod, 8" iron rod and 10" screws as shown in the pictures.





7. The last step in the production of the rig is the construction of a pot holder. The pot holder is made of 20" concrete reinforcement iron, 10" iron rod and 8" iron rod. First cut a piece of 10" iron rod to a length of 80 cm and bend it into a ring. Weld three pieces of 8" iron rod with a length of 5 cm each into the ring.





8. Cut a piece of 20" concrete reinforcement iron to a length of 1.05 m, make a shallow cut at a height of 20 cm, bend the piece of iron at 90 degrees and weld together.



9. Weld the ring to the bent piece of iron.



10. Place the pot holder into the rig as shown in the picture. Take care that the distance between the centre of the pot holder ring (which is the focal point) to the point where the pot holder comes through the solar cooker panel is not larger than 80 cm.



C. Gluing glass or reflective aluminium foil to the solar cooker

1. The gluing of aluminium foil to the solar cooker is easy. Remove the paper from the aluminium foil and stick the foil to the solar cooker one piece after the other.



Gluing the glass

1. To glue the glass, you first have to melt tar and mix diesel fuel to the molten tar. Test the stickiness of the mixture with a cold stone. Apply the mixture with a plaster float to the solar cooker.



2. Cut the glass into long pieces and cut those pieces into small squares with a length and width of 1.5 cm each. Break one square at a time from the glass to glue it to the solar cooker.



3. Draw a line in the middle of the solar cooker. Glue the first squares of glass onto the line and then work from the line to the edges.





4. After glass or aluminium foil has been glued to the solar cooker, fasten it to the rig.



D. Construction of the concrete solar cookers based on the transportable form

The steps for building a concrete solar cooker on basis of the transportable form are identical to those for the construction of solar cookers based on the master form.

