Manual for the manufacturing of a baking oven for 8 m² or 10 m² Scheffler Reflector

This manual for the construction of a baking oven for Scheffler Reflectors is based on a design Christoph Mueller developed in Argentina in 2003. You find a documentation of his work at www.hc-solar.de. He describes the basic concept of the oven as follows:

“The baking chamber measures 60 x 60 x 60 cm³. The whole system is built completely out of materials which are available in Argentina. The oven operates without active ventilation. A convective airflow is accomplished by a 1 meter long chimney, which lets the air flow in at the top of the baking chamber. From there the air flows through the baking product and leaves the chamber at the bottom. There the air partially transfers its heat to a pebble bed storage to store some thermal energy for one to two hours of independent baking. This is mainly to insure that the baking product isn’t spoiled when the sun is hidden by clouds. In this case the airflow would reverse and enter at the bottom and leave at the top. When the air passes through the pebble bed it re-enters the receiver of the Scheffler reflector. This receiver is constructed from iron sheet which is bent in a zic-zac profile. This improves efficiency since the radiation losses are minimized.”

We want to share our own experience using and constructing this well tested oven, following the copyleft philosophy. Therefore we prepared this construction manual. The main specifications have been kept. We added a few parts, clarifications and drawings to help in proper understanding.

List of Materials

- 3 lengths of angle iron 25x25x3 mm
- 3 galvanized iron sheets 0.8 mm thick
- 4 iron sheets (mild steel, black) 0.8 mm thick
- 10x10 mild steel square bar, 1.3 m long
- 10x10 aluminium square bar, 1.3 m long
- Borofloat® glass pane 400 mm diameter
- 5 m glass fibre string (oven seal), 10 mm diameter
- Welding electrodes, 2.5 mm
- Pop rivets, 4x10 mm
- 485 ltrs insulation material (best: rockwool mats, 8m² of 10 cm thick insulation mats)
- silicon
**Comments**

In this manual the original specification of using **galvanized steel** sheets of 0.8mm thickness for the outer cover and **mild steel** sheets of 0.8mm for the inner oven chamber is maintained.

The inner chamber (baking chamber) is **welded**. This prevents food items from getting in contact with insulation material and avoids humidity entering into the insulation.

The outer cover from galvanized sheets is joined with **rivets**. Make sure you join the parts in such a way that water from cleaning the oven will always run off (instead from running into the insulation).

If you are looking for a nicer finish that is more conform to kitchen standard requirements you can use **stainless steel** sheets of 0.7 or 0.8mm thickness for all the parts. This will result more expensive. For the heat exchanger (parts M) we recommend to maintain **mild steel** because of the higher conductivity.

As **insulation material** we recommend rockwool mats: they are comfortable to handle and imply less health hazards. If rockwool is unavailable go for glass wool mats. Organic substances (cotton, wool, etc) are inadequate as insulation because they would burn.

The **volume** of insulation is around 485 litres. This corresponds to 5 to 6 kg of insulation (\(\delta = 10 \text{ kg/m}^3\)). In case you have to use loose glass fibre make sure to de-compact it properly; you might need a bit more weight of loose glass fibre than in case of mats. In any case: protect yourself very well against breathing in the fibres. Use a proper protective mask (for fine particles!) the most hazardous are loose glass fibres - so please try to use mats.
For the glass pane at the opening where the concentrated light enters into the oven we recommend you to use a heat resistant glass. We got good results with a 400mm diameter piece of 3.8mm thick Borofloat® 33 from SCHOTT. Borofloat 33 has a high transmission (lets a lot of light through) and is heat resistant up to 450°C. One pane costs about 40 € (you can order by internet). This manual is specifying an opening of 380mm diameter for a glass pane of 400mm diameter. If you cannot get hold of this special glass you have two options:

- you use a Pyrex glass lid of a cooking pot or frying pan (then you might have to adapt the size of the hole in part D. Don’t choose an opening smaller than 350mm diameter). Pyrex is heat resistant and has high transmission.

- use ordinary (window) glass and cut it into strips to reduce breakage from heat expansion. In that case you need to change the hole in piece D to a square shape. You can refer to Christoph Muellers original design.

Our experience is that pyrex glass lids work very well and are durable. The difficulty is rather to find a lid that is big enough (or to built such an accurate primary reflector that the size of focus is small enough to use the standard sizes lids of 280mm diameter). The strips of normal glass perform well, but occasionally a strip breaks. Therefore this set-up requires more maintenance. Facility to exchange a broken strip should be taken into account for the design of the window-frame.

In any case: keep the glass clean! Dirt on the glass causes uneven heating that leads to tensions which can provoke breakage. The same effect occurs with splashes of water. Make sure never to sprinkle water on it when it is hot! Only clean the glass pane when it is cold.

The frame of the glass window should not press on the glass (because of tensions). Its job is only to keep the glass in place. Make sure that you don’t tighten the bolts of the frame too much. We had better results when we used a frame from aluminium - as described in this manual a 10x10 aluminium square rod serves as a circular frame. The Aluminium has a higher conductivity - therefore there is less uneven stress on the glass from heating of the frame. If aluminium is unavailable you can substitute it by 10x10 iron square rod.
An adequate seal for the door of the oven as well as for the glass pane is a 10mm (diameter) glass fibre string. This kind of string is commonly used for oven doors (e.g. in wood burning ovens). On the door you can stick the string down with a few drops of silicon. For assembling the glass pane with its frame and the string you just have to keep the string in place during assembly. This works best when you lay the oven down with the hole for the glass facing up (so that you can assemble the glass pane in horizontal position). Don’t use silicon here - it would get too hot. The glass fibre string serves as a cushion for the glass. It will allow movement and expansion of the glass due to temperature change. The glass pane needs a string on each face, to prevent the glass from touching the frame. Please don’t use asbestos string as a seal!

The amount of stones you use as thermal mass depends on your requirement. Without stones the oven will need only a short time of pre-heating. The drawback is that it will cool down relatively quickly when it gets cloudy. You add stones into the chamber behind the heat exchanger to help maintain the temperature during spells of cloud cover or to be able to use the oven even in the late afternoon when the sun gets weak. Use fist-size stones and make sure that they are stacked in a way that allows maximum air circulation between the stones, as the heat transfer is by air.

If your location is close to the equator (between 0º to ± 20º latitude) you don’t need any secondary reflector. You can focus the light directly on the glass pane.

For higher latitudes a secondary reflector is essential, otherwise you loose a good portion of the main reflectors power. The shape of the secondary reflector depends on the latitude.

You have to install the oven in such a way that the focal area of the main reflector is located at the opening of the secondary reflector (which is square to the polar axis /rotational axis of the reflector).
The most convenient material for sec. reflectors is highly brilliant, anodized aluminium as used for various solar applications (like SK14 parabolic solar cooker and other reflectors). A good source of solar grade aluminium is ALANOD. If you can’t get hold of this special material you can use ordinary aluminium sheet (around or less then 1mm thick) and cover it with aluminium kitchen foil. The kitchen foil has a high reflectivity but is not very durable. You will have to replace it occasionally. In any case: make sure the secondary reflector is always clean and dust free.

To clean the secondary reflector and the glass pane use clear water with a drop of dishwashing liquid. The dishwashing liquid helps to prevent calcium / lime stains as it makes the water run off easily (it destroys the surface tension). Only clean when the glass is cold!

Make sure that no water enters the insulation of the oven. Wet insulation is useless and fosters corrosion. For the same reason the oven should not be exposed to rain.

More Details

Insulating with roockwool

Fitting G+L
Zanzibar, Tanzania (6.1600S; 39.2830E)

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ASSEMBLY

STEP 1. Cut edges of C. Weld C+D waterproof

STEP 2. Weld A + D waterproof

STEP 3. Support of the inner chamber (angle bar 25x25x3 mm). Weld 4 pieces of 10 x 10 mm square bar, ~25 mm long, at 100 mm on every leg of the support as a stop.
STEP 4. Insert the inner chamber support into the holes in I. Weld 1 piece of 25 mm square bar (10 x 10 mm) to each leg below I to keep piece I in place.

STEP 5. Fill the space between I and the inner chamber support with 100 mm insulation.

STEP 6. Place inner chamber (C+D+A) on support

STEP 7. Rivet G + L (front view / back view)

Flap inside G

Flap outside G  
(to prevent water from entering)
STEP 8. Locate G+L on I. **Attention:** the flap on G goes below I (to prevent water from entering). Fill the space under the lower L with insulation. Note the angle cut of the insulation material around L.

STEP 9. Rivet G+L to I. Then, rivet L + D

STEP 10. Rivet J + I. **Attention:** the flap on G goes below I (to prevent water from entering). Then, fill the gap between J and C with 100 mm insulation.
STEP 11. Rivet P with iron angle of D. Then rivet P with C and with J.

STEP 11. Place E and fill the space with 100 mm insulation material. Then rivet E waterproof. Repeat with F in the other side.

STEP 12. Fill the gap between D and G with 100 mm insulation material.

STEP 13. Rivet K. Fill the top part of the oven with 100 mm insulation material. Rivet H waterproof.
STEP 14. Fill N1 with 100 mm thick insulation material. Rivet N2 on N1. **Attention** with the flaps: prevent water from entering.

STEP 15. Place door (N1+N2) on the oven structure, add hinges and latches at same height. (side views)
STEP 16. FIXING THE GLASS PANES. Remember not to tighten the bolts much, the glass could break when heated.

STEP 17. INSTALLATION OF THE HEAT EXCHANGER / RECEIVER AND STONES. Insert heat receiver and stones, then piece B (supported on angle iron) and piece P. These drawings are sketches to see where to place these elements, actually you have already built the complete oven. Make sure you keep about 30mm space between the glass pane and the heat exchanger. Always transport the oven without stones, heat exchanger and glass pane.

STEP 18. Place the iron rack in the inner chamber of the oven... and start baking!
**PATTERN FOR CUTTING THE METAL SHEETS (4 x 8 feet each)**

**GALVANISED SHEETS:**

**IRON SHEETS:**

(*) Weld M1 and M2 together