

## **Greenhouse Enclosures Comparison Tests**

### **Introduction**

Several types of greenhouse enclosures are being used for cooking with the Solar Cookers International's 'CooKit'. The two most popular ones are the use of a heat-resistant plastic bag and the use of the Solar Household Energy's 'HotPot'. The 'HotPot' consists of a clear glass lid and a clear glass bowl that form an enclosed greenhouse for a black metal bowl. Many people have also successfully used only a clear glass lid with their pot to solar cook.

I used a pot with a clear glass lid for most of my solar cooking because it was difficult for me to obtain heat-resistant oven bags. Oven bags also require regular replacement due to wear and tear, and it is therefore not as cost efficient in the long term. On the other hand, the 'HotPot' is very effective and durable, but they are expensive and also not available for sale in most part of the world. I was lucky to find a clear glass bowl, which fits the lower portion of my three-quart size Graniteware enamel pot perfectly. Hence, I have my own little 'HotPot' after adding a clear glass lid to it. Recently, I decided to find out, through a simple test method, how the use of heat-resistant plastic bags, the 'HotPot', the metal lid and the clear glass lid would faired when compared with each other.

### **Test Method**

For the comparison tests, I used a homemade 'CooKit', which is capable of accommodating two 3-quart size Graniteware enamel pots at the same time. The other items required for the tests were two oven thermometers, two identical 3-quart size Graniteware enamel pots with a metal lid, one Reynolds oven bag, two clear glass lids, and one large glass bowl for making the 'HotPot'. The Graniteware enamel pots that I used were black both on the inside and outside. Since most solar cooking pots are black only on the outside, I decided to line the inside of both pots with white color paper for the tests.

Four test runs, with no load, were performed. Each test run consisted of two different pot configurations, placed side by side, in the same 'CooKit' solar cooker. The followings were the four pot configurations used for the tests:

1. A Graniteware enamel pot with a metal lid.
2. A Graniteware enamel pot with a clear glass lid.
3. A Graniteware enamel pot with a metal lid and enclosed in an oven bag.
4. A 'HotPot', which consisted of a Graniteware enamel pot with a clear glass lid and a clear glass bowl.

An oven thermometer was placed inside each of the pots for temperature measurement during the tests.

Each test run started off with both pots at room temperature of about 30 degrees C. Temperatures of both pots were recorded after they had reached the stagnation point, which took about 30 minutes or more depending on the sunshine. The 'CooKit' and the pots were then moved into the shade where the pots temperatures were recorded again after five minutes in the shade.

## **Test Results**

The results of the four test runs are shown in the tables below:

Date: 10 Feb 08 Test Run 1	Stagnation Temperature	After 5 minutes in the shade
'HotPot' (1)	137° C	109° C
Pot with oven bag (1)	109° C	92° C

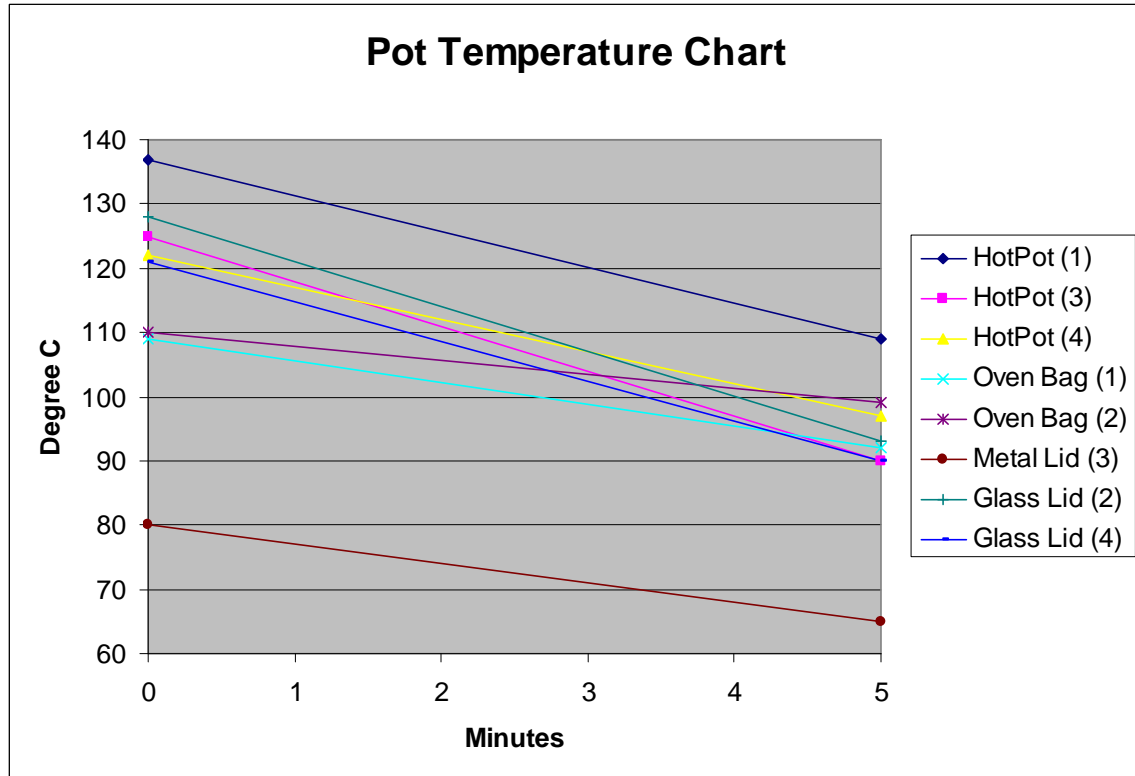
Date: 10 Feb 08 Test Run 2	Stagnation Temperature	After 5 minutes in the shade
Pot with glass lid (2)	128° C	93° C
Pot with oven bag (2)	110° C	99° C

Date: 10 Feb 08 Test Run 3	Stagnation Temperature	After 5 minutes in the shade
'HotPot' (3)	125° C	90° C
Pot with metal Lid (3)	80° C	65° C

Date: 17 Feb 08 Test Run 4	Stagnation Temperature	After 5 minutes in the shade
Pot with glass lid (4)	121° C	90° C
'HotPot' (4)	122° C	97° C

It should be noted that the sunshine, wind and cloud conditions varied for all the four test runs. In addition, a small amount of heat was lost during the brief periods when the pot with the oven bag was opened to obtain the thermometer readings. We would expect the heat lost to have a slight impact on the subsequent temperature readings taken while in the shade.

The chart below shows how the temperature readings from all the four test runs would look when presented together. The starting points at the y-axis are the stagnation temperatures for the various pot configurations. The ending points, on the right, are the pots' temperatures after five minutes in the shade.



## Result Analysis and Conclusions

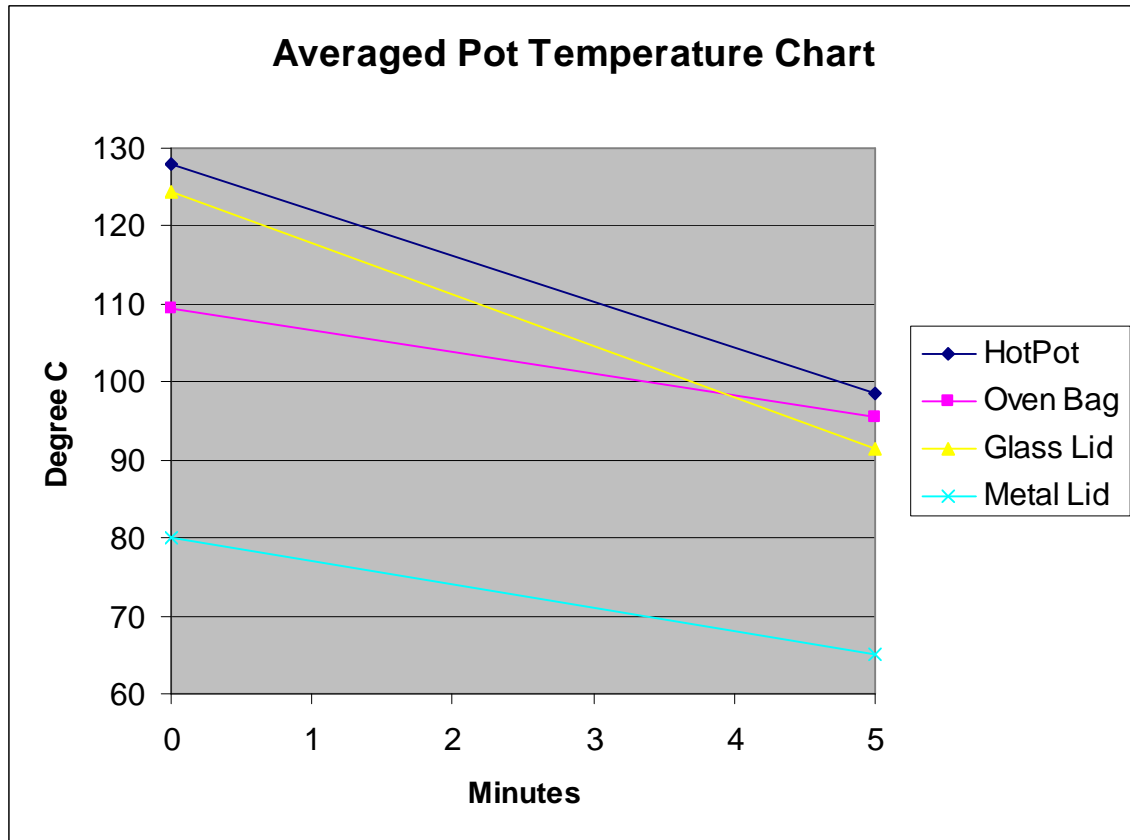
The above test data are meaningful only for the intended relative performance comparison purposes, and they are by no means indicative of the absolute heating and cooling rates for the various pot configurations.

Comparing the stagnation temperatures obtained from the tests, one can draw the conclusion that the 'HotPot' has the best heating rate, followed by the pot with a clear glass lid, then the pot with a metal lid plus oven bag and lastly the pot with a metal lid. The 'HotPot' came in with the best heating rate was to be expected because it has a clear glass lid and a better greenhouse enclosure. What was not expected was that the pot with a clear glass lid had outperformed the pot with a metal lid plus oven bag. The reasons could be due to:

- The metal lid had prevented sunlight from reaching the inside of the pot, where it mattered the most.
- The downward conduction and convection of heat, from the hot metal lid to the lower part of the pot, were not efficient.
- The amount of sunlight coming in from the top was significant, and this had helped to rapidly raise the temperature of the pot with the clear glass lid.

To determine the relative cooling rate of the pots, we will compare the slope of the temperature curve for the various pot configurations. A steeper slope means a faster cooling rate. In order to eliminate confusion due to too many curves, I have decided to use only the average temperatures to represent each of the four

pot configurations, as shown in the chart below, for the comparison. From the chart, one could deduce that the pot with the oven bag cooled at the slowest rate, the 'HotPot' was next and followed very closely by the pot with a clear glass lid.



The curve for the pot with a metal lid was at a much lower temperature range than the others. As such, it was not possible to make a direct comparison with the others using the slope method. However, the pot with the metal lid was expected to have the fastest cooling rate should its stagnation temperature were to be at a range comparable with the rest. The reason was due to the complete absence of a greenhouse enclosure for the pot with the metal lid.

The pot with the clear glass lid came in third because of the higher amount of convection heat loss through its exposed side walls. We would also expect the amount of heat loss to be higher should a pot with a taller side walls was used.

### **Recommendations**

Based on the test results, the 'HotPot' is the best overall pot configuration to use. However, from an economic standpoint, the followings are recommended for those who are using similar type of cooking pots with their 'CookKit':

- The use of the heat-resistant oven bag and the metal lid can be replaced with a simple clear glass lid when cooking under good sunshine conditions. This

would lead to a better performance as well as long term savings because the glass lid can be reused many times over.

- The heat-resistant oven bag can be saved for use, together with the clear glass lid, on days when the sunshine or wind conditions are not as perfect.

The other advantages of using a clear glass lid are:

- Food content and the cooking process can be observed with the lid on.
- Quick access for stirring of food if required.
- Easy visual confirmation of when the food is cooked.

The above tests were done under the tropical conditions in Singapore with the equipments that I have available. Perhaps similar tests can also be performed at other locations, where 'CooKits' are being used, to see if the local climatic conditions and equipments used would yield the same results and conclusions.

## Photos



'CooKit' containing a pot with a metal lid and enclosed in an oven bag next to a 'HotPot'



'CooKit' containing a pot with a clear glass lid next to a pot with a metal lid and enclosed in an oven bag



Pot with a clear glass lid



'HotPot'



Pot with a metal lid and enclosed in an oven bag