Retained Heat Cooker Development Project with a Pilot Distribution Program in Guatemala

Project Progress Report
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By
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Respectfully submitted,
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Project Background

The goal of this project, being developed under a grant from the Environmental Protection Agency, is the product development, distribution, training and documentation of a retained heat cooker (often called a haybox). The advantages of this technology have been known for 30+ years but there has not been a concerted effort to optimize a design, create a training program and materials, and to execute a wide-spread distribution of the technology.

A retained heat cooker is used to efficiently cook boiled foods such as beans and rice. When foods are boiled, energy (typically from a wood fire) is used to bring the food and water to a boiling temperature. Once boiling temperature has been reached, only enough energy is required to simmer the food (keep it just at the boiling point). Additional energy only serves to convert water to steam without raising the temperature of the contents of the pot. This additional energy wastes wood and water that may have been carried long distances. When the pot simmers (remains just at the boiling point) the amount of energy entering the pot balances the energy lost to the atmosphere through conduction, convection, and radiation. Reduction of the energy lost to the atmosphere, results in a reduction of energy required to maintain a simmering temperature, hence less fuel is required.

If the losses could be completely eliminated, the pot would stay at a simmering temperature with no further fuel required. While there is no perfect insulation, these conditions can be approximated by removing the pot from the stove and placing it into an insulated container. Since practical insulation materials do not completely eliminate losses, the temperature decreases at a rate defined by the quality of the insulation. Fortunately there are many materials with sufficient insulating properties to reduce losses to such a degree that the food will complete cooking without further fuel usage.

Historically, a hole in the ground lined with hay for insulation has been used for a “retained heat cooker”, hence the name “hay box” has been used to describe this type of cooking. The use of the term 'retained heat cooker' is more descriptive of the general process where other insulating materials may be used.

Since the fire may be extinguished once a boiling temperature has been reached, there are many advantages:

- The lady is freed from tending the fire and available for other tasks.
- Cooking is completed without further fuel usage.
- The pot contents cannot boil dry or scorch.
- There are no internal or external emissions due to the simmering phase in the RHC.
- The RHC is portable enabling the man to take it with him to the fields.

The RHC will be constructed such that the pot can be inserted without spilling the hot pot contents and such that it is stable enough that children playing around the unit will not spill the contents on themselves. It is the ultimate in efficiency as additional energy is not required. It is clean since there are no products of combustion.

INTRODUCTION

During the start of this year we have set up a standard for the thermal characteristics of the RHC for Guatemala. Using a staple common to all of Guatemala, we specified a method and a RHC standard for cooking it. A prototype RHC that meets the thermal standard was built of local materials and tested with the method. We expect our production model to reach these minimum standards.

As beans are a main staple of Guatemala and are also a food item that takes a long time to cook, the RHC will be designed with this food in mind. Other foods that can be cooked in the RHC, such as rice or maize, will be able to cook if the design is to cook beans.

The testing and construction of retained heat cookers (RHC) Jan 10-Jan 15 was done with the purpose to determine a minimum standard of heat loss that would be acceptable for cooking in Guatemala, Central America. The tests tuck place in Guatemala City, at an altitude of 1500 m. The boiling temperature was, therefore, 95 º C. Cooking dry black beans was set as a standard because of the expected cooking time in boiling water (2-3 hours).

SUMARY

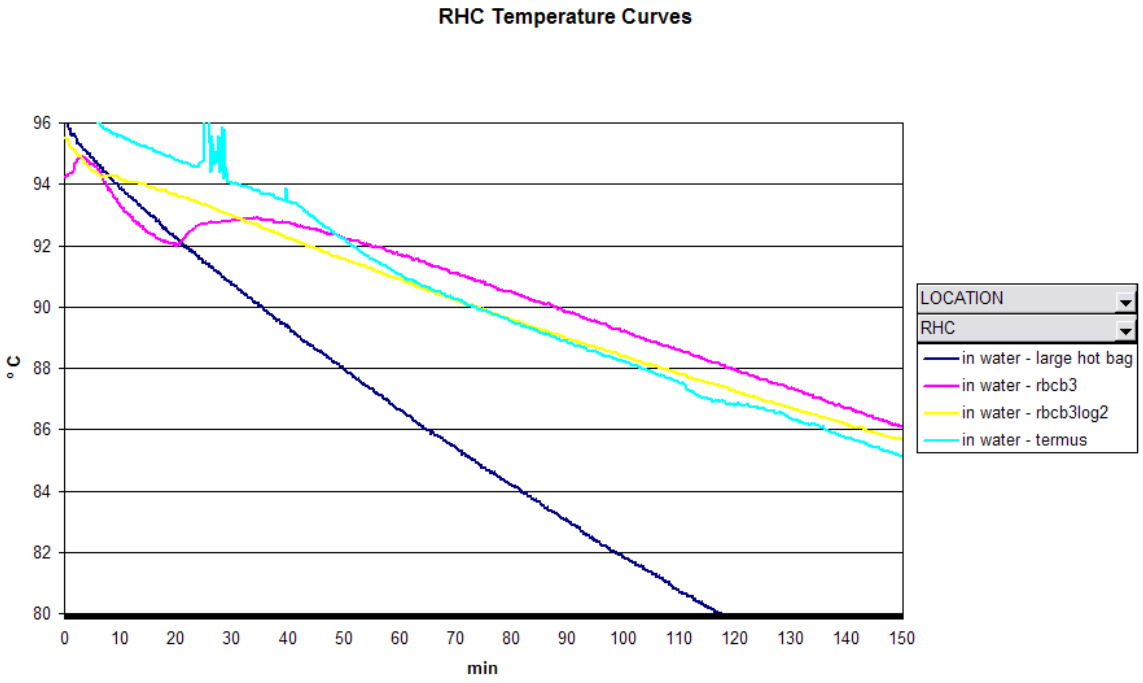
A total of 17 separate tests were performed the week of Jan 11, some with water only and some with black beans. Additional tests were preformed the following week. The testing was done with the use of a PICO data logger to measure temperatures from the initial entry into the RHC until it was removed from the RHC. In some tests, beans were included to determine if the beans cooked after a period of time and in which cookers. Also, while the actual design was not a major priority for the testing, insulation and containers were selected that are available in Guatemala and would be appropriate for construction in Guatemala.

The procedure used is included as an appendix to this report. Also included in the appendix is a description of the RHCs and the tests that were run. The results indicate that a 2 hour test is sufficient to predict performance of an RHC. Note that beans require a longer time to cook.

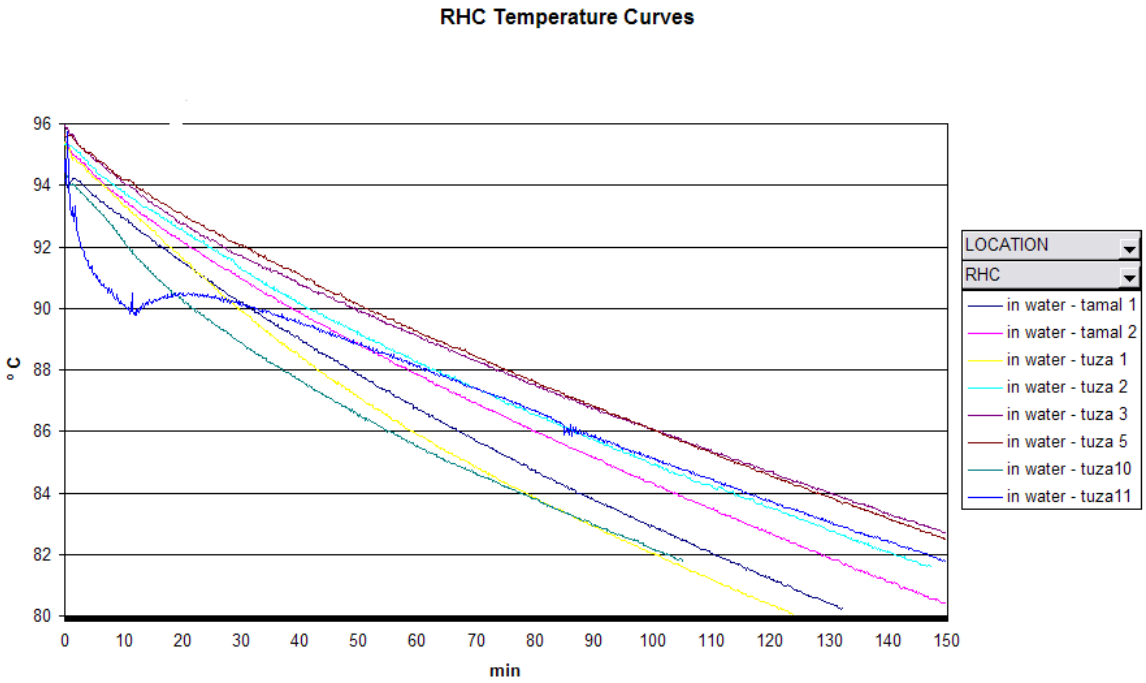
Several types of insulations were used to shield two basic types of inner linings: two metal casings custom built for a pot model found in the local market and a plastic bucket that fits closely around a metal pot for a Thermus brand RHC. The insulations varied from Styrofoam to Tuza (the shell around corn husks).

There are many variables which will affect the performance of a RHC some of which are out of the control of the RHC design. These include the type of bean being cooked, the preparation of the food, the ambient temperature, and the initial (boiling) temperature (determined by altitude). One of these variables, the preparation of the food, can be influenced with instructions on how to use the cooker. The initial boiling temperature can also be simulated for higher altitudes than the lab were the tests are done by controlling the temperature with the burner's resistance. However in the field boiling temperature is just a constant of altitude. In the design of the RHC we will account for these variables place a margin for errors in following the instructions that will be supplied.

TEST RESULTS



Graph of our best version and those commercially available.



Tests run using tuza, a local material, for insulation.

The table below shortly describes the testing of the week.

DESCRIPTION	NAME	90.0 Minutes	120.0 Minutes	150.0 Minutes
rbcb2 with corners plugged with wool	rbcb3	89.83	87.95	86.08
same as above	rbcb3log2	88.97	87.26	85.67
Thermos Shuttle Chef bought in USA	termus	88.87	86.77	85.14
foam around plastic bucket	foam1	87.7	85.99	84.45
rbcb1 with lid	rbcb2	87.68	85.87	84.29
foam1+polyester	foam2	87.7	86.08	84.05
same as above	foam2log2	87.29	85.48	83.81
10 cm styrofoam	st1	86.61	84.69	82.96
turkey bag added to tuza 1	tuza 3	86.76	84.69	82.7
turkey bag added to tuza 1	tuza 5	86.83	84.57	82.5
tuza and tamal in nixtamal bucket	tuza11	85.82	83.71	81.76
US radiant barrier	Rb1	85.97	83.41	81.02
top is foam	tamal 2	85.14	82.67	80.4
foam top, foil, turkey bag	granza2	84.58	82.34	80.39
pail around grb3	pail1	84.04	81.82	79.8
Guate. rb 3layer	grb3	85.04	82.13	78.92
foam top	Granza1	81.97	79	76.47
St1 with corners filled	st2	87.89	86.18	
Rb1 in cb box	rbcb1	87.67	85.58	
Al foil added to Tuza1	tuza 2	85.72	83.51	
top is small plastic bag	tamal 1	83.78	81.23	
Plastic surrounded by tuza	tuza10	82.97		
Plain	tuza 1	82.91	80.36	

Yellow highlighted tests were done previously.

CONCLUSION

Given the demands on the RHC based on Guatemalan conditions, it is suggested that a RHC be designed to keep the contents to a temperature of no less than 80 C. over a period of 3.0 hours, based on a 30 minutes of pre-boiling time. Boiling time could be increased depending on conditions. However, the above time cooked beans in Guatemala City.

The tests confirmed what has also been determined by other RHC research. The characteristics that are important are an air tight inner to preventing convective losses container and sufficient insulation to prevent conductive losses. The reflective barrier helps contain heat loss but is less important than the other two design parameters, more tests on this will be forthcoming.

What has been learned in the previous month has been used to plan the further testing. In the immediate future a set of tests will be run to find how the available insulations can be used in the construction of the RHC. These tests will compare the insulations and, in the process, help find out about their availability. Additionally, tests on the different individual parameters that define a good RHC will be run. We also continue to define the survey that will determine certain physical characteristics of our commercial RHC. The course for future development is described in the following appendix.