# Retained Heat Cooker Reduce Cooking Energy, Cooking Time and Reduce Indoor Air Pollution

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***Abstract*— Cooking is necessary need for human race irrespective of locality. Various types of fuels are used for cooking food items in cooking stoves which are responsible for greenhouse gas emission. Retained Heat cooker (RHC) is a promising solution for reducing cooking energy which employs the retained heat for cooking in an urban or rural kitchen. Different kinds of food items may be cooked using RHC including rice, potato, chicken, beef, and vegetables etc. which require water for their cooking. When the food is heated to its boiling temperature on the cooking stove, the food can be continued to be cooked using this cooker by retaining the heat. This option offers several benefits including reduction of fuel usage, greenhouse gas emission, increase shelf life of food, energy savings for cooking leading to monetary savings, reduction indoor air pollution etc. RHCs can save cooking energy up to 48% for different food items as compared to cooking using conventional cooking stove and save stove time by two- third. Also, $CO_2$ reduction as well as reduce indoor air pollution using RHC ranges from 45-111 grams per kg of food items for different food items.**

***Index Terms*— Cooking; Energy efficiency; Energy saving; Green house gas emission. Retained Heat cooker; Shelf life of food;**

## I. INTRODUCTION

In Bangladesh only 6 percent of the population has access to natural gas supplied by the Government of the People's Republic of Bangladesh. The rest of the population, mainly people in rural areas, use biomass for cooking. In developing countries, household energy use has 10 percent share in world's primary energy consumption, a total of 1,090 Mtoe. The main use of energy in the households in developing countries is for cooking followed by lighting and heating. And household use of biomass in these countries accounts for almost 7% of world primary energy demand [1].

Cooking of food items involves heating at certain temperature range for a specific duration. This heating can be obtained by various ways, e.g. burning firewood, kerosene, natural gas, LP gas, electricity etc. A significant amount of energy is consumed during the cooking process. Even a small percentage of reduction in energy in cooking will contribute to an enormous energy savings since cooking is carried out in every single house. The temperature range and heating duration varies for each food item. In order for the food to be properly cooked, the food item has to be kept at the certain temperature range for a certain time period. Many of the food items in our country contain starch. This starch has highly organized structures, known as starch granules. When starch is heated with water, it undergoes a transition process in which the starch granules break down the inter-molecular bond in presence of water and heat, this phenomenon is called gelatinization. Gelatinization temperature is regarded as the temperature at which the phase transition of starch granules from an ordered state to a disordered state occurs2. The gelatinization temperature for rice and potato are 66°C-82°C and 55°C-66°C, respectively3. RHC have been used to reduce the energy consumption during cooking in many countries as a tradition.

The RHC must retain this temperature for slow cooking for a longer duration for slow cooking. Using the RHC will lead to a significant amount of energy savings. However, till date, no report has quantified the amount of energy that can be saved by using such a Cooker. Also, the energy savings will be varied for different food items as well as the cooking methods used. Shelf life stability of the food items is much higher in RHC cooked foods as compared to that in traditional cooking technique In this paper, the energy consumption, possible energy savings and CO2 emission reduction potential by using RHC have been quantified.

A N M Zobayer describing RHC to State Minister

*Fig 1. Retained Heat Cooker*

*Fig 2. Recycle Polystyrene*

## II. RETAINED HEAT COOKER:

RHC provides the possibility of slow cooking by retaining the heat within the enclosed space using thermal insulation. It also reduces the energy consumption for conventional cooking, thus minimizing the fuel consumption in areas with fuel shortage. In many areas, in Bangladesh or elsewhere in underdeveloped or developing countries, women have to walk a long distance for collecting fuel for their cooking purpose. Insulating material has to be used for retaining heat within the RHC. Recycling polystyrene materials have been used as thermal insulating material having a thermal conductivity of 0.03 W/m-K. These insulator materials are placed within compartments and then sewed with the cooker.

## III. HEAT RETENSION TEST

Heat retention test was carried out to evaluate the heat retention potential of the RHC. A specific amount of water in a pan is placed in the RHC after heating it to around 100℃ and the RHC is closed. The temperature readings are taken at equal intervals to evaluate the heat retention capacity. The same amount of water in the same pan is kept without the RHC after heating it to the same temperature and the temperature readings are taken. Two results are then compared.

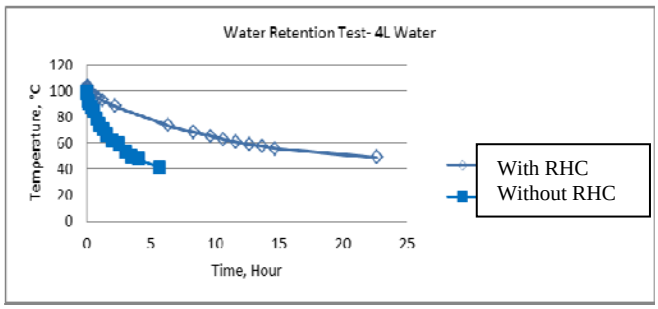


*Fig. 3. Heat retention test for 4 liter water with and without RHC*

The graphs show that the heat loss rate is higher when RHC is not used. Considering a temperature of 65℃, a temperature many food items are cooked, water reaches to this temperature in around 2.5 hours without RHC where it takes for water to reach the same temperature for around 9 hours with RHC from the same temperature of 100℃.

## IV. COOKINHG RICE WITH LPG STOVE

The room temperature and the water temperature were 320C and 270C respectively during the test. 2.5 liters of water was mixed with 1 kg rice and put on the pan. The LPG Stove was switched on after the LPG supply from the cylinder is ensured. A thermocouple has been inserted into the rice-water mixture to measure the temperature throughout the process. The gas knob was kept full open from 0 to15 minutes, half open from 15 to 25 minutes and quarter open from 25 to 35 minutes. The temperature reached the boiling temperature 100℃ after 10 minutes. The cooking is completed at 35 minutes, and the LPG stove is switched off. 55 grams of LPG have been consumed during cooking. Fig 6 shows the temperature profile during the cooking.

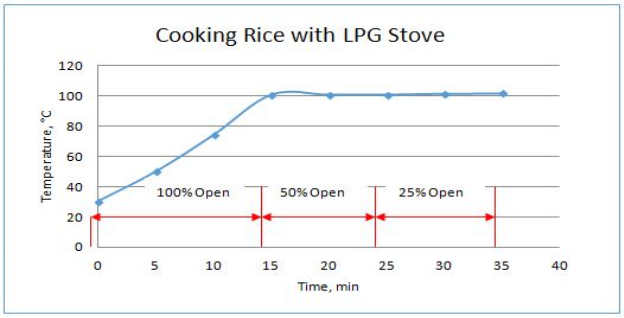


*Fig.4. Temperature profile during the cooking.*

## V. COOKINHG RICE WITH LPG STOVE USING RHC

The room temperature and the water temperature were 30.80C and 27.50C respectively during the test. 2.5 liters of water was mixed with 1 kg rice and put on the pan. The LPG Stove was switched on with gas knob 100% open. A thermocouple has been inserted into the rice-water mixture to measure the temperature throughout the process. The temperature reached the boiling temperature 100℃ at 15 minutes. Instantly, the pan is put inside the RHC and kept there for 30 minutes. The temperature of the rice drops down to 94.40C during the period.35 grams of LPG have been consumed during cooking.

*Fig 5: Rice Cooking with RHC*

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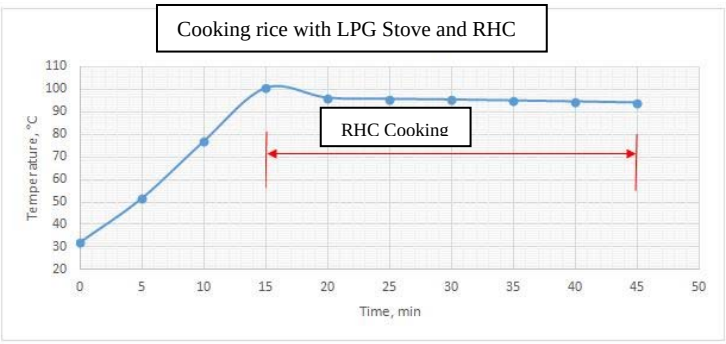


*Figure 6: Temperature profile for cooking rice with RHC*

## VI. DIFFERENT FOOD ITEM COOKINHG TIME USING RHC

| Type of food | Stove using time at boiling temp (Minutes) | RHC using time (minutes) | Total Cooking time (minutes) |
|---|---|---|---|
| Rice | 10-12 | 20-25 | 30-35 |
| Potato | 10-12 | 20-25 | 30-35 |
| Chicken | 10-15 | 20-25 | 30-35 |
| Vegetables | 10-12 | 20-25 | 30-35 |

*Table 1: shows the summery of the cooking time of different item of food using RHC*

## VII. PHYSICAL CHARACTERISTIC OF COOKED FOOD AT DIFFERENT TIME LAPS WITH TEMPERATURE.

*Table 2: shows that summery of Physical characteristics of cooked foods at different time laps (hour) with temperature [7]*

| ***Type of food*** | ***°C at 0 h*** | ***°C after 5h*** | ***Characteristics after 5 h*** | ***°C after 8 h*** | ***Characteristics after 8 h*** | ***°C after 10 h*** | ***Characteristics after 10 h*** | ***°C after 12 h*** | ***Characteristics after 12 h*** |
|---|---|---|---|---|---|---|---|---|---|
| Rice with RHC | 99 | 65 | warm, fresh, edible | 55 | warm, fresh, edible | 41 | warm, fresh, edible | 40 | warm, slightly smelly, start spoilage, hardly edible |
| Rice Without RHC | 99 | 37 | cool, fresh, edible | 35 | cool, slightly smelly, edible | 33 | cool, smelly, spoiling, hardly edible | 33 | cool, badly smelly, spoiled, not edible |
| Chicken with RHC | 94 | 64 | warm, fresh, edible | 54 | warm, fresh, edible | 42 | warm, fresh, edible | 40 | warm, fresh, edible |
| Chicken Without RHC | 100 | 36 | cool, fresh, edible | 33 | cool, fresh, edible | 33 | cool, fresh, edible | 32 | cool, fresh, edible |
| Vegetable with RHC | 97 | 63 | warm, fresh, edible | 52 | warm, fresh, edible | 45 | warm, fresh, edible | 34 | Cool, fresh, edible |
| Vegetable Without RHC | 98 | 39 | cool, fresh, edible | 35 | cool, fresh, edible | 33 | cool, fresh, edible | 33 | cool, fresh, edible |

## VIII. ENERGY SANIVG AND CO2 SAVING

| Type of food | Fuel Type | Weight of food item | Energy Needed (Traditional Cooking) kJ* | Energy Needed (Using RHC) (kJ*) | Energy Savings (kJ*) | Energy Savings (%) | $CO_2$ savings, (gm) |
|---|---|---|---|---|---|---|---|
| Rice | LPG gas | 1 kg Rice 2.5L water | 2563 | 1631 | 932 | 36% | 56 |
| Potato | LPG gas | 1 kg Potato 1.5L water | 3915 | 2051 | 1864 | 48% | 111 |
| Chicken | LPG gas | 1 kg Chicken 0.25L water | 2873 | 2115 | 758 | 26% | 45 |
| Vegetable | LPG gas | 1 kg vegetable 0.20L water | 3167 | 1745 | 1422 | 45% | 85 |

*Table 3: shows the summery of the energy consumption for different tests, energy savings and $CO_2$ saving[8].*

## IX. CASE STUDY 1: RHC USER AT SATKHIRA DISTRICT

Bithi Karmaker is a young home maker from Satkhira. Her family consists of her husband, her 4 year old son and her mother in law. Every morning Bithi takes her son to school and her mother in law cooks for the family. After returning from her son's school, it is Bithi's turn to prepare lunch for the family. Both Bithi and her mother in law are using RHC for the last 6 months. They use it regularly for cooking rice and also for keeping rice warm. They use it during both summer and winter season. They find it very useful and the family members are also pleased with it. The stove used in their home is a Bondhu Chula and they use wood as fuel.

When asked about fuel savings, Bithi mentioned that both fuel cost and total cooking time has been reduced by at least 50% after they started using Retained Heat Cooker. This means that the family's monthly expenses have been reduced. Moreover, Bithi now has more leisure time for herself and her son. She uses the extra time to help her son with his studies and also for her own personal development. Bithi has completed her HSC and she is interested in learning computer skills to stay updated and to be able to explore job opportunities in the future. She is very confident and motivated young lady and using RHC has helped her to start pursuing her ambitions.

*Fig 6: Retained Heat Cooker User*

## X. CASE STUDY 2: RHC BUSINESS AT BAGERHAT DISTRICT

Moyna Begum is the owner of Pranto Sanitary, a small sanitary shop located in a village in Bagerhat. She is very well known in her community as a successful female entrepreneur. She became actively involved with this business since 2012 as a service provider of Improved cook stove (ICS). As a successful service provider, she is still involved with ICS and her long standing experience has made her more confident to manage her business successfully. She has two sons who also support her and inspire her to move ahead with her business.

Since end of 2015, Moyna Begum became involved with the promotion of RHC in her area. She has already sold as many as 100 RHC of 110 within only 3 months' time and is looking forward to sell more. She has been using RHC in her own home too and being a user helps her to clearly explain to her customers about the benefits and procedures of using this technology.

*Fig 7: RHC with ICS*

Moyna Begum has come up with an innovative idea to create awareness about RHC among her customers of ICS. Whenever she visits any household to set up a ICS, she carries her own RHC with some rice, lentils, oil and spices. After setting up the ICS, she asks the permission of her customers to use the new ICS to prepare her own lunch and this is also a part of testing the newly installed stove. This gives her an opportunity to demonstrate the use of RHC. After boiling the rice and lentils, she removes it from the stove and places it in the RHC. At the same time, she explains to the members of the household that the cooking will be completed in the RHC. She also explains the other benefits of using RHC and finally when her khichuri is ready, she offers them to taste it. Moyna Begum has received a good response by using this innovative approach for promoting a new product.


*Fig 8: RHC sale center*

Moyna's future plans include renovating her sales outlet of Pranto Sanitary to allow better display and storage of her products. She also plans to conduct promotional meeting and demonstration at 2 local schools as she feels that the school teachers can be a good target market for the RHC and can also influence others to use it. She believes that with regular promotional activities and awareness campaigns, it is only a matter of time before the RHC becomes popular because the benefits of saving time and fuel cost means a lot for any family.

## XI. RESULT AND DISCUSSION.

The energy consumption has been calculated for cooking different food items with and without RHC. For LPG Stove, the LPG consumption has been measured by employing a weighing scale. The mass of LPG is then converted to kJ (1 gm of LPG is equivalent to 46.607 kJ) 1.

Plain rice has been cooked using LPG Stove both with RHC and without RHC (Traditional method) and then the energy consumption has been compared.
For cooking rice with LPG stove alone, 55 grams of LPG, equivalent to 2563 kJ, has been consumed. The cumulative energy consumption profile can be seen in [Table 3].

Same amount of rice was cooked with LPG Stove and RHC. The pot was put instantly in the RHC after reaching the boiling temperature and kept there for 30 minutes. The total energy consumption was 1631 kJ yielding 36% energy savings. The cumulative energy consumption profile is shown in [Table 3]. The savings of 932 kJ leads to reduction of 56 gram $CO_2$ emission. The cooking with RHC required additional 10 minutes as compared to cooking LPG stove alone.

It is evident that RHC cooking retains nutrient quality and extremely extends shelf life stability of the cooking foods as regards to the traditional or conventional cooking technique. Mass people use of RHC in cooking different food items will definitely reduce the cooking man time.

As a new product, which can be locally manufactured, it will generate employment opportunities for many men and women and reduce poverty. It will also improve the living condition of the households by reducing fuel expenses and less indoor air pollution.

## XI. ACKNOWLEDGMENT

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## XII. REFERENCES

[1]https://www.iea.org/publications/freepublications/publication/cooking.pdf.

[2] Ubwa, S. T., J. Abah, K. Asemave, and T. Shambe. "Studies on the Gelatinization Temperature of Some Cereal Starches." International Journal of Chemistry 4, no. 6 (2012): p22

[3] Morales‐Sanchez, E., J. D. C. Figueroa, and M. Gaytan‐Martínez. "Wet method for measuring starch gelatinization temperature using electrical conductivity." Journal of food science 74, no. 7 (2009): E382-E385.

[4] http://www.climateactionprogramme.org/climate-leaderinterviews/sarah_collins_wonderbags_founder_explains_how_her_invention_is_changing_liv, accessed 20 September 2014

[5] Technical Report, Solar Bottle Light 'BotolBati': Energy Efficiency Improvement of Baonea-badh Slum, http://www.change.org.bd/Solar%20Bottle%20Light_CHANGE_GIZ.pdf, Accessed 27 July, 2014

[6] Food And Agriculture Organization Of The United Nations Website, http://faostat.fao.org/site/339/default.aspx., Accessed 13 June 2014

[7]Nutrient Quality and shelf life stability of Wonder bag food, by Prof. Dr. Sheikh Nazrul Islam, Institute of Nutrition and Food Science University of Dhaka, Dhaka-1000

[8] Retained Heat Cooker Develop and testing by Prof A K M Sadrul Islam , Islamic University of Technology (IUT), Gazipur, Bangladesh.

[9] Welcome to Wonderbag. http://nb-wonderbag.com