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A simple device to reduce the wastage of cooking gas

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We have invented a simple device to reduce the wastage of cooking gas. The main objective is to reduce the energy loss to the surroundings due to convection, radiation and conduction from pans with spherical bottoms like thachchiya used in cooking traditional food such as hoppers. In particular, the heat loss to the surroundings between the burner and the surface of the cooking pan is considered here. The efficiency of the device is compared with that of the bare pan by measuring the time taken to boil a fixed amount of water while keeping other conditions the same. The result indicates that the device reduces the gas consumption by about 23%. The device can be easily manufactured locally at low cost for practical applications.

Key words: Energy Technology, Cooking Gas Savings

1. Introduction

Any energy resource, whether available in abundance or in limited quantity, is to be managed effectively to get the maximum and sustained benefit. Traditional sources of energy have to be supported with alternate supply in order to overcome the power crisis. In addition to finding alternate sources of energy, simple techniques have to be invented for efficient use of available resources. Most of the developed countries mainly use electricity or gas for cooking purposes whereas a majority of households in some of the developing countries still depend on firewood. In order to successfully introduce energy saving techniques, one has to understand the daily routines of the people such as cooking, eating and working habits as well as their culture. Without such knowledge, many organizations and individuals attempt to introduce novel technologies to the society and are often perplexed at lack of acceptance by people. Hay Stack (Cleovoulou 1997) and Straw Stove (Cleovoulou 1998) are two simple, low-cost and easy to understand devices built from locally available materials to introduce in Tamil Nadu and Ghana, respectively. These devices are made to suit needs of the people and their traditional cooking practices in the respective countries rather than introducing unfamiliar new technology. These devices are proven to be successful in reducing use of firewood by 50%. Hay Box (Arnold 1980) is another such example that reduces 58% of cooking time and 44% of the cost.

The use of gas and electricity for cooking purposes has been increased significantly in developing countries such as Sri Lanka. Devices such as rice cookers, pressure cookers and microwave ovens have also been introduced for efficient cooking. Such technologically improved devices also have to be used properly in order to save energy (Cureton 1995). These devices are getting popular very slowly in Sri Lanka because majority of people are either unable to purchase these equipment or have no interest in such devices due to their traditional methods of cooking. Therefore, in countries like Sri Lanka, new devices at low cost have to be invented to suit the needs and the interests of the people, in particular, for cooking traditional food.

The use of liquid petroleum gas for cooking purposes in middle class households is becoming more popular in Sri Lanka, rapidly replacing the traditional use of firewood. However, with frequent increase of fuel prices, use of gas is becoming an additional burden, increasing cost of living by a rather significant amount. Therefore, a gas saving device, which can still be used in traditional cooking would be a very useful introduction to our society. We examined several different types of pots and pans used in normal household cooking in Sri Lanka. In comparing them, it is clear that the traditional pan with a spherical shaped bottom, "thachchiya", is less efficient in absorbing the heat generated from the flame. Flat bottom pans, on the other hand, absorb more effectively, especially, when the size of the flame is smaller than the size of the bottom of the pan. However, the spherical bottom prying pans, thachchiya (it is used to make hoppers as well), are used in every household for traditional cooking and frying which is not replaceable by any pots or pans of other shapes. Therefore, we have studied the possibility of reducing energy loss while cooking in this particular shape of pans.

We have attempted to design a simple device to minimize the loss of heat when cooking using standard gas cookers. In cookers, the gap between the flame and the bottom of the pan is open, and hence some of the heat is lost to the surroundings. We have studied the possibility of reducing the heat loss through the gap, using proper insulating and reflecting materials in specific shapes and sizes to cover the gap. Here we report the results of a study that indicates the possibility of saving at least 23% of gas with a very simple and low cost device that can be manufactured locally and marketable easily. Some preliminary results have been submitted for publication elsewhere (Ranatunga and Dharmaratna 2006) in abstract form.

2. Materials and Methods

In using standard gas cookers, especially with thachchiya, the heat is lost to the surroundings from the region between the burner and the pan as mentioned earlier. It is certain that all three processes, convection, radiation and conduction contribute with different orders of magnitudes to the heat loss in this region. Therefore, the amount of gas used in cooking can be reduced by minimizing the heat loss to the surroundings in this region and directing the heat generated towards the pan.

In all studies discussed below, a standard burner and a gas cylinder with a standard controller available in the market are used to provide the heat for cooking. Aluminum pan with approximately spherical bottom (a thachchiya, diameter 18 cm) filled to about 3/4 of the volume with a known amount of water is used for all tests. A temperature sensor connected to a computer through a data acquisition

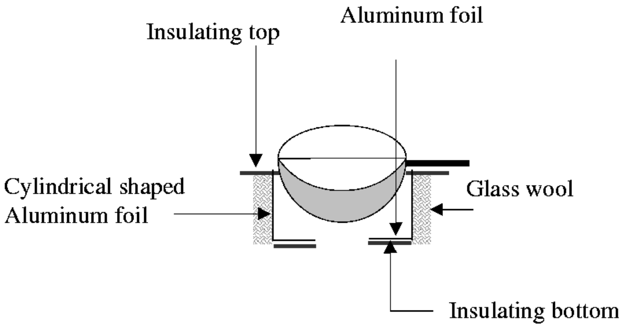


Figure 1 A sketch of the device

unit is used to measure the variation of the temperature of water with time. The time taken to heat the fixed amount of water from room temperature up to the boiling point is used as a measure of useful heat absorbed by water.

The fraction of the heat absorbed by the pan depends on the size of the flame, which depends on the rate of gas flow, and the height between the burner and the pan. The first study was to determine the optimal height between the burner and the bottom of the pan. For a reasonably good flame (almost blue flame) the time taken to boil the water sample is measured for various heights of the pan. The rate of flow of gas was kept the same for all measurements. The procedure was repeated to find the optimal height between the burner and the pan. The optimal height was found to be about 5 mm under the conditions used in this experiment (size of the pan, size of the flame, etc.) and it was kept as a constant for the following tests.

In order to reduce the heat loss in the gap between the burner and the bottom of the pan, various devices were tried. Figure 1 shows the device constructed after several experiments. This particular device is a result of five experiments, namely, (a) the pan with no cover, (b) the gap covered with a cylindrical shaped aluminum foil with an insulating top, (c) same as (b) with partially covered bottom with aluminum foil on the top of an insulating sheet, (d) same as (b) with the cylindrical foil covered with glass wool (thickness 2.5cm) and (e) same as (c) with cylindrical foil covered with glass wool as in (d). The setup used in experiment (e) is shown in Figure 1. For each of the above cases the time taken to boil the same amount of water is measured while keeping the other conditions, such as the optimal height to the bottom of the pan, the rate of gas flow and other environmental conditions, the same.

3. Results and Discussion

For the selected rate of gas flow with a good blue color flame, the time taken to boil the water depends on the height between the burner and the bottom of the pan. The optimum value for the height was found to be 5 mm for the rate of gas flow used.

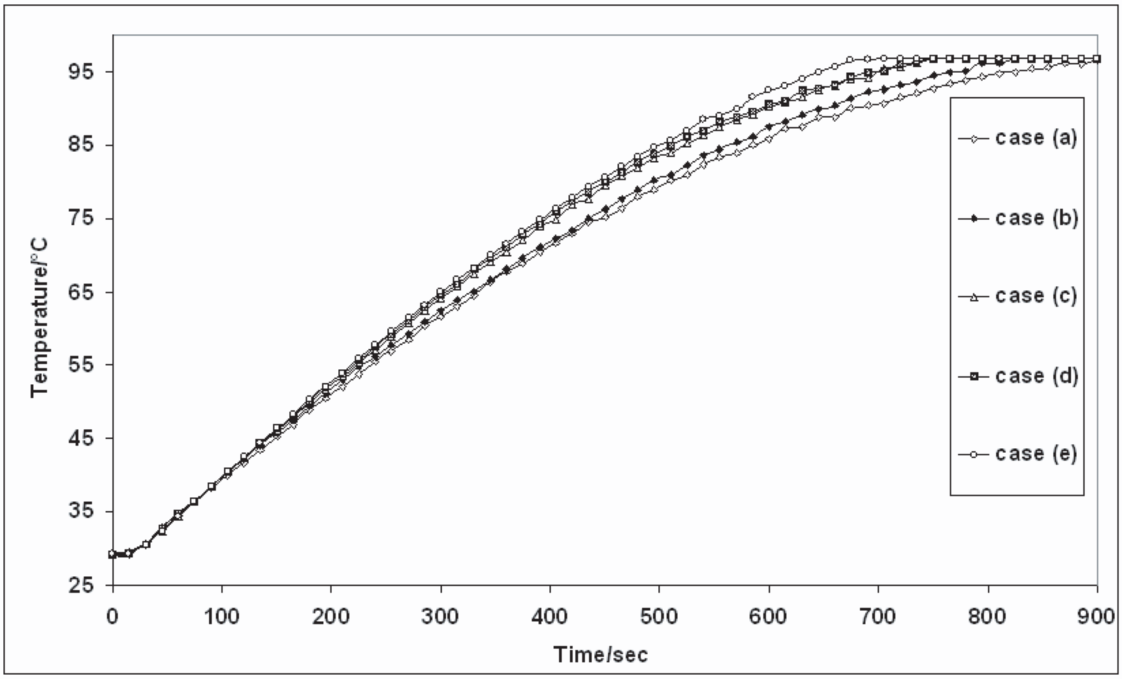


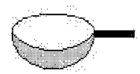
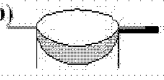
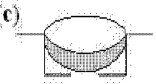
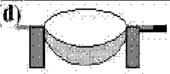
Figure 2 Comparison of the variation of temperature with time

The variation of temperature of water from room temperature to the boiling temperature with time for the above five cases, (a) to (e), are shown in Fig. 2. Reading errors for the points in the plot are smaller than the size of the symbol. As can be seen from the plots, the time taken to boil water decreases from experiment (a) to (e), gradually. The numerical values with percentages of savings are compared in Table 1. This clearly indicates that each component added in each step of experimental setup (from (b) to (e)) contributes a significant factor in energy saving and also in reduction of cooking time. A total saving of 23% has been achieved with the experimental set up (e) in Fig. 1, which is a quite significant fraction of energy saving.

Setup (b) blocks the heat loss due to convection, which is the hot air moving away from the pan. This alone reduces the gas used by 10%. It is interesting to see that the setup (c) with the addition of cover on the bottom of the pan reduces 5% more. Still the aluminum foil gets warm and some energy is lost to the surroundings due to radiation as well as convection. Having the glass wool layer as insulation around the aluminum foil reduces the energy loss by at least another 7%. Having insulating layers at the top and bottom also help to reduce energy loss. Note that the cylindrical aluminum foil cannot be completely sealed to the pan at the top edge, because the burned out gas has to move out of the covered space. From this study it is clear that trapping the hot air around the pan for some time and reducing the energy loss to the surrounding one can reduce the gas usage by at least 23%.

As can be seen here, this is a very simple and less expensive device that can be manufactured by a local company and market very easily for a reasonably low

Table 1 Comparison of experiments (a)-(e)

Experiment	Time heated(s)	Time saved(s)	Saving(%)
(a) 	915	–	–
(b) 	825	90	9.8
(c) 	765	150	16.4
(d) 	750	165	18.0
(e) 	705	210	23.0

price, which can save at least 23% of gas used in cooking. It should be noted that the device constructed here is important for any type of pan with spherical shaped bottom although the study was done specifically for thachchiya. Furthermore, the calculated savings in (e) is in compared with (a), which is with a well-controlled flame with optimal height between the burner and the pan. In normal household cooking the wastage of gas could be much higher than our controlled experiment (a). Therefore, the proper use of this device could save even a higher percentage of energy than shown in the above table when compared with the normal practice of household cooking.

4. Conclusion

We have successfully invented a very simple low cost device that can be used with cooking pans with spherical bottoms, which reduces the use of gas by at least 23%. The device could be manufactured locally with locally available materials. It could be marketable easily, since this type of pans are used in almost every household for cooking traditional food and the gas savings is quite significant when compared with the price of gas. The study is in progress to improve the device, because the optimal dimensions of the device depend on the size of the cooking pan.

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