SOLAR PICNIC

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ABSTRACT

In this paper a new kind of **panel solar cooker** (**Solar Picnic**) is introduced which has two more advantages compared to other conventional models. First, it can be use in **any latitude**. Second, besides **indoor cooking**, it has a special pot which one can make a cup of **solar tea** in 10-20 minutes (dry season) and these advantages can expand the application of panel solar cookers to the parks, picnics and for sports like mounting, etc.

Keywords: Panel solar cooker, solar tea, Solar Picnic

1. INTRODUCTION

As is well known, the various kinds of solar cookers are available, like: box cookers, panel cookers, and concentrating cookers. Panel cookers, the newest kind of solar cookers, have the advantages of being simple, light-weight, and inexpensive. Nowadays, many Africans use panel cookers to cook their food.

The main purposes of the innovative new panel solar cooker which is described in this paper are:

1.1 Changing the structure for its ability to use in any latitude.

1.2 Testing the physical parameters and choosing the best materials due to economical-technical conditions.

1.3 Designing a special tea pot for expanding the applications of panel solar cookers and increasing its popular interest (at home, park, picnic, at the mountain, bicycling, etc).

2. BACKGROUND

Because of my previous experiments with reflector telescopes and because of interests of attaining high temperatures, I began with concentrators in solar cooking. I built some of them and had a paper about a new design (semi parabolic solar oven) which has been reported in SCI newsletters. The result for me was understanding that because of long pay-back time of concentrator solar cookers in Iran, they can be used only for educational purposes and haven't much hope to be popular, even solving their other problems like tracking and so on. After that I saw a guide "how to make a panel cooker" in Daneshmand magazine. I built it but after testing, I understood that the back plate angle of it is not suitable for Tehran (35.5°N Latitude). Although I found some other interesting kinds of panel solar cookers in SCI archive, for example DSPC for equator areas (unlike CooKit which is special for near equator), and "Suntastic cooker" which is not only adjustable for different sun's altitude but also it is really a kind of concentrator. However, I decided to design a kind of panel solar cooker which should be easy to build, use, adjustable, and having more base area for putting various dishes on it.

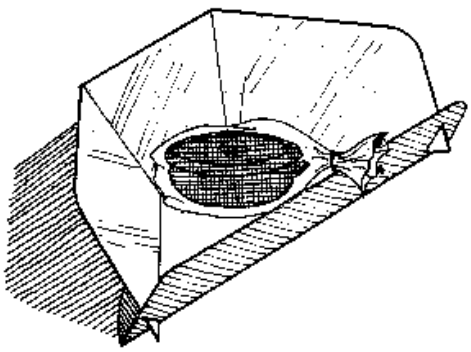

Figure 1: CooKit

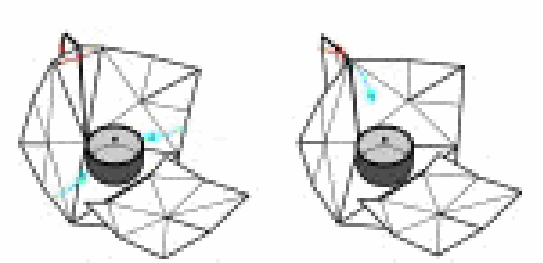

Figure 2. Suntastic Cooker

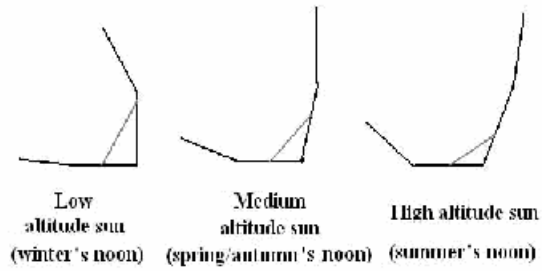

Figure 4. The position of the back and front sheets in the various altitudes of the sun.

The back sheet should be adjusted by a pair of strings and the front sheet by putting a stone under or above it.

3. THIS PROJECT

3.1 Designing

For making Solar Picnic I used transparent plastic sheets and aluminum coated adhesive tape on it. This cooker contains two strings for adjusting back side panels and for fastening the cooker after usage. The flexible plastic sheet with special design of cooker can be used for summer season. Then for changing it for other seasons (lower sun altitudes) the strings must bend to upper holes of back wall.

Mounting aperture of this cooker is 0.18 m^2 which seems to be about half of CooKit, so we must use smaller dishes for it. The power of Solar Picnic calculated from useful thermal energy (calculated in next part) is about 40 Watts.

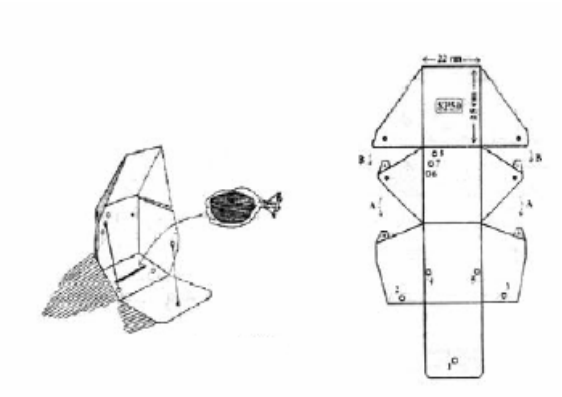

Figure 3. SolarPicnic
Left: the dark colored pot placed inside the transparent nylon bag.
Right: The solar picnic in the opened form.

Figure 5: (SP40- 150 ml glass)

Figure 6. Temperature rise of water in triangular glass bottle.

Figure 7. The compact solar picnic in closed form.

3.2 Primary heat efficiency measuring

After designing and building the Solar Picnic, I searched for a proper container for making tea in a short time. The best dish I found was the sanestole syrup bottle with volume of 150 ml (equal to a small cup of tea). But it could not reach to boiling point of water.

The heat efficiency of Solar Picnic is obtained by (equation 1) :

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$$\eta = \frac{mc\Delta\theta}{IAt}$$

Equation 1: heat efficiency

m = mass of water (kg)

c = heat capacity of water (kJ/kg C)

$\Delta\theta$ **= temperature difference (C)**

I = Intensity of solar radiation (W/m2)

A = aperture area (m2)

t = time interval of temperature change (s)

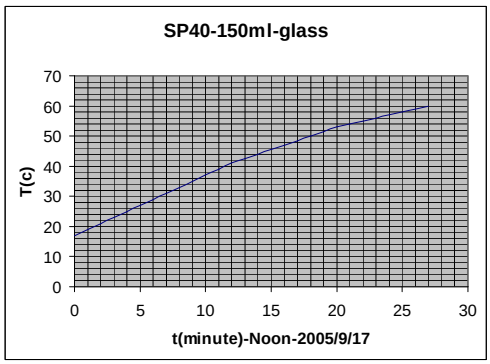

Figure 8: Temperature ratio for triangle glass bottle.

From the curve obtained, it can be seen that temperature ratio is falling down near to the boiling point of water. This is due to the emissivity of container (dark bottle) which increases by increasing the temperature. The solution for avoiding this part, we must use selective colors (for example the black chrome metal plating) which has high absorption and low emission. And this has its own economic and environmental problems. However with these conditions the thermal efficiency for three intervals (at the first part of the curve: η_1 , middle part : η_2 , and last part : η_3) of the above curve is calculated as follow:

$$\eta_1 = \frac{0.15 * 4200 * 2}{700 * 0.18 * 60} = 16\%$$

$$\eta_2 = 11.5\%$$

$$\eta_3 = 8.5\%$$

3.3 Different Studies

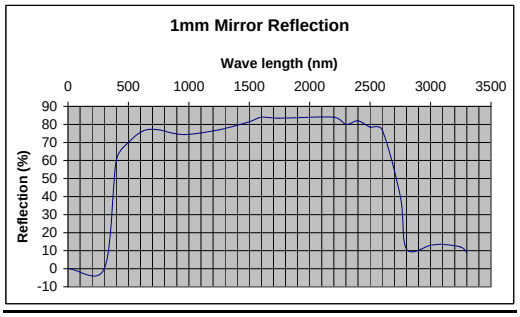

Figure 9 Reflecting spectrum for 1 mm thick glass mirror.

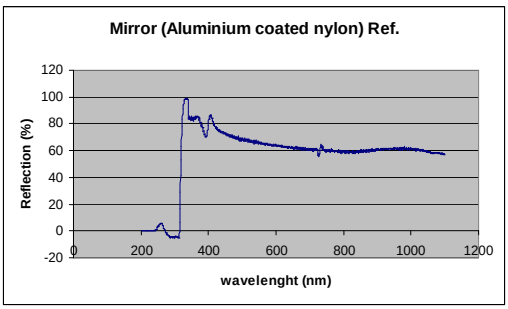

Figure 10: Reflection curve for aluminum coated nylon (silver adhesive tap

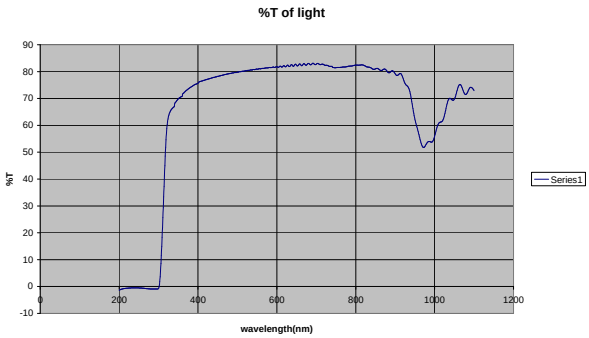

Figure 11 Transmission spectrum of heat resistant nylon bag (Turkish)

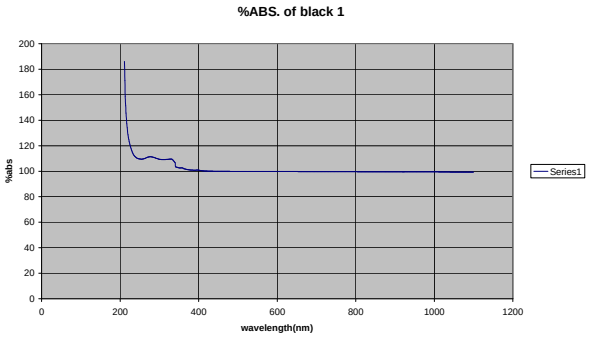

Figure 12 Absorption spectrum of black tape (if used for food dishes).

3.4 Designing a special tea pot

The reason of using this flat shape is that radiation is absorbed better in normal position as compared to inclined position of the container. And more important is that because of low concentrating factor of Solar Picnic (about 2.5). The triangular bottle couldn't get all the lights reflected toward it and some of them pass beside it. But this flat pot can collect all reflected radiations.

For joining the bottom and top parts of the pot, we use clear tin (without lead) for maintain the good taste of tea (or pasteurized water). We used dark black spray paint for better absorption by the pot. The ellipsoidal opening on the top of pot is for putting a small tea bag inside. The only thing one need is to put this pot with cold water and tea bag inside a transparent heat resistance nylon bag and after fastening the opening of bag, one can put inside the solar cooker.

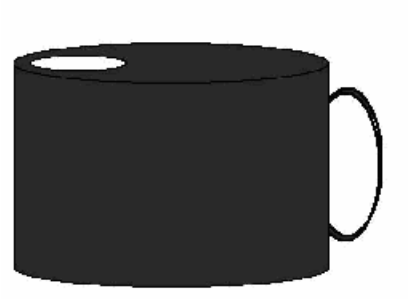

Figure 13 Shows a special tea pot for Solar Picnic, which is built from 500 ml tomato juice can. Once given the proper shape of long ellipsoidal cross section, its capacity is reduced to 300 ml.

3.5 Repeating the thermal efficiency test

Study is made of with flat iron pot. Like before, I calculated the thermal efficiency of the cooker in three parts of the curve obtained. The efficiency obtained is 95% at first part of curve , 25% at middle and only 10% at the last part of it. This time water reached to boiling point in 50 minutes in winter , one can expect that it will reach to boiling point in 25 minutes in summer. Although that made me glad but it's still far from the ideal time for consumer.

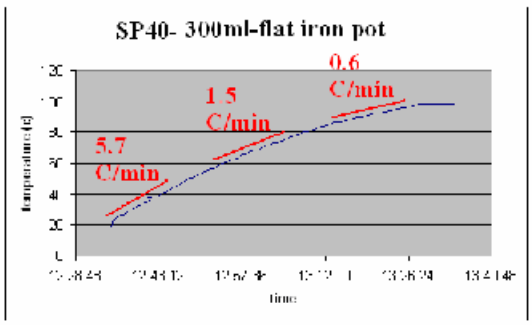

Figure 14: Sp40 -300ml flat iron pot

4. RESULTS

4.1 Technical-economical

4.1.1 Some usual transparent nylon bags are much cheaper in comparison with heat resistance bags (only 0.02 $) and we can use them (in solar radiation conditions) of medium latitude areas, if not used empty in the panel solar cookers.

4.1.2 Aluminum coated nylons are light weight, flexible and much inexpensive, in comparison with 1 mm thick mirror, although it reduce the infrared radiation , but we know that from 55% of infrared solar radiation above the atmosphere only little part of this reach to the earth's surface.

4.1.3 for various kinds of dishes which costumers use themselves, the best thing is to put some black adhesive tape in the cooker bag. Every one could paste it on the outer part of the dishes.

4.1.4 SolarPicnic Cooker with its high back wall could be use with any altitude of the sun. It's because of the modified strings which use also for fastening the cooker at the end of its use.

4.2 INCREASING THE AWARENESS AND ENVIRONMENTAL SAVINGS:

The applications of SolarPicnic Cooker (and other similar cookers) are listed in below. I think it's not important to consider an economic analysis to find a reason for expanding the solar cooking methods in a country like Iran where fuel cost is lower than same amount of potato chips. So we should take it like a sport and fun etc.

4.2.1 We can use SolarPicnic Cooker for slow cooking at home.

4.2.2 We can warm cooked foods in picnic with SolarPicic.

4.2.3 The important result of this project is designing an especial tea pot for using in parks, picnic, or sports like mountain, etc. In addition it can be use for pasteurizing the water.

Finally I suggest that for reaching to the aim of expanding solar cooking methods, we should publicize it in recreational and science parks and so on. Solar cooking has no harmful effects on foods unlike micro wave ovens. People can learn easily how to protect their eyes in work with solar ovens. Of course education of these methods is also useful for critical conditions like earth quake, etc.

Figure 15: Describing how to use SolarPicnic

5. APPRECIATION

Here I would like to express my appreciation for the friendly helps of Mr. Dr. Saremi (SCI), Miss Zahra Reihani (physics teacher), Mr. Ramon Coyle (SCI), Mr. Tom Sponheim (webmaster of solar cookers), Mr. Amir Hosein Mobarra (Iranian Solar Energy Society editor-in-chief), Mr. Ebrahim Jafari (Technician in the Science House of Rey Observatory) and Mrs. Waseghi nia (technician of optic Lab. of Sharif University)

Also I would like to thank Prof. Shyam Nandwani for coming to Iran and gave a lecture about solar energy activities in Costa Rica and inviting me to attend this conference.

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