

Intensive Design of Solar Picnic Products

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Abstract

As an ideal clean energy, solar energy has been used widely in cooking applications. The shape designing and color analysis of Solar Picnic Products are carried out in the light of the heating principle of the box-type solar cookers. The problem of the inconvenience in bringing the spices, water, and mess kit in a picnic is solved by the intensive design concept., which also help to achieve the rational allocation and use of the cabinet space of solar cookers and the purpose "intensive" and "portable".

Keywords: Industrial design, Picnic products, Solar, Intensive

1. Introduction

With the improvement of living standards of people, entertainment has changed accordingly. People pursue gradually more natural and pure forms of entertainment and picnic is a good choice. Experiencing the fun of life in the nature is an unchanging fashion. However, there are many problems in the picnic: cooking utensils, spices, food and other essential goods are inconvenient to bring; the whole process of picnic can not be separated from the use of "fire", which brings great security risks; picnic will cause a certain degree of fuel consumption and environmental pollution. In the light of these problems, it is essential to design picnic tools that are portable, safe and environmentally friendly^[1]. As an ideal renewable energy, solar is eco environmentally friendly, full of radiation power, and inexhaustible, which is suitable to use in picnic.

2. Background

Solar cooker uses solar radiation energy to cook food, which obtain heat through condensation, heat transmission, heat accumulation, etc. At present, solar cookers have three types: focused, foldable, and box-type.

Focused solar cookers focus sunshine on the bottom of the pan through a bowl-shaped reflector panel so that the temperature rise to a higher degree in order to meet the requirements of cooking. The key component of this kind of solar cooker is the optical collector, in which there exist not the problem of the choice of mirror material but also the problem of the design of geometrical shape. The prevailing choice is the silvering or aluminized glass mirror, and people

also choose polished aluminum mirror and aluminized polyester film material, etc. The advantage of such a solar cooker is fast cooking, but it is not easy to control, and may burn the food. For example, the BCK solar cooker(Fig. 1 (a)), designed according to the principle of focused solar cookers, can heat food and water in the open using solar energy. It is portable, convenient and environmental friendly.

Foldable solar cookers usually needs a plastic bag or glass pot for heat preservation because of its limitation in heat. The advantages of such cookers are simple producing, low cost, and disadvantage is that it is necessary to frequently adjust the direction of solar cookers on the sun at any time because its reflective panels will overshadow. Solar picnic products designed according to the principle of foldable solar cookers(Fig.1 (b)), is constituted by three reflective panels, which can gather the sunshine on the pan, making the products collapsible and easy to carry.

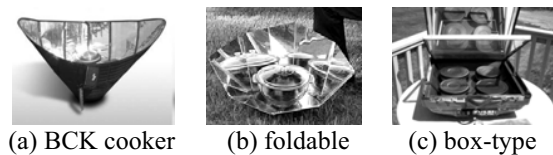


Figure 1. solar picnic products

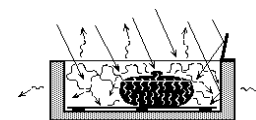


Figure 2. principle diagram of the greenhouse effect

Box-type solar cooker have a light transmittance of the top closure panels, wall inside sticks the aluminum foil (or metal heat-absorbing plate), and at the bottom of it a dark heat-absorbing metal plate is placed. One or more reflector plates can be added to the top, so that more sunlight comes into box. The principle of heating is the greenhouse effect (Fig. 2), that is, in a sealed box, the sunlight enters incubator through light board. And then encounters the absorption of black body which transfers into longer wavelength heat energy. Finally it will be released by the absorption plate. In physics, thermal radiation is also a form of physical movement, mainly infrared radiation whose wavelength is longer. Light board is designed into the double glazing structure, just to prevent the traverse of long wave. It has the effects on allowing sunlight of short wave into it instead of long wave one, so the heat can stay in the confined space^[2].

Tulsi solar cooker (Fig. 1 (c)), which has been designed from the principles of box-type solar cooker, can use solar energy during the day and at night it may have access to electricity for cooking. Regardless of winter or cloudy weather in summer, it can be easy to use, and its portable box-type structure can be used for picnic and some other outdoor usage.

The direction of picnic product development is for the research and development of portable, the use of lightweight picnic products, also as a high-grade environmentally-friendly product to market. Analysis of the three kinds of solar cookers picnic products, focusing solar cooker and folding solar cooker are portable to meet this requirement. However, there is no capacity for cooking, food, water bottles. Taking into account the carry of a variety of picnic supplies is also a problem to be solved, choose choice box-type solar cooker for the design of picnic products. The physical size of box-type solar cooker is square and straight, and it's easy to carry. What's more, the rule of the internal space is convenient for the distribution of the design to incorporate various types of picnic equipments, and then facilitate the purpose of simplicity.

Box-type solar cooker using the principle of the greenhouse effect to heat food, being safe, producing non-fuel consumption, pollution-free, in line with the design objectives, is suitable for picnic utensils. A major factor which determines its thermal efficiency is the thermal insulation material around the box and at the bottom of it. The effect of it is to stop the thermal radiation go outside. Although the box always has a part of heat dissipation, the temperature inside will gradually heat up by the solarization time, until it reaches a balance. Therefore, the maximum temperature inside box-type solar cooker depends on the stand or fall of the thermal insulation material. Generally, the thermal insulation materials are cotton, which reaches to around 120°C-150°C. The temperature used for cooking has been sufficient. If choose the better insulation materials, the cost of solar cooker will increase, it is uneconomical. To increase wall light area of aluminum foil inside the box can also increase the efficiency of box-type solar cooker, as well as shorten the solarization time, or prevent the cooker temperature decrease when it is cloudy. Also in the bottom install a thin metal box, with the role of oil heat to maintain the temperature inside the box stable when the sun has intermittent exposure. Conditions permitting, the surface glass can be covered with a coating whose component is spectral selective materials such as a transparent coating-silicon dioxide. As a result, it changes the absorption and the launch of sunlight, and also improves the efficiency of solar cooker.

3. Product intensification design concept

Intensification is originally used as an economic term which define a form as based on use all resources completely, strongly reasonably utilizes the modern management and the technology, displays the human resources fully the positive effect in order to raises the work benefit and the efficiency. The intensified design's essence is the induction and the

overall plan. The actual product, has the possibility is a certain or some products' combination, also possibly is a series of products straightening up with the information clerk. No matter which form it is, its point is through the intensified design, causes the multiplicity to become unific and order^[3]. product intensification design has three form below.

(1) Intensification design of identical product. When identical product are massive used, will meet the problems of straighten up, motion, adjust and deposite. Public chairs is a typical example. Nowadays, public chairs could be piled up one to another massively, both saving the space and being advantageous for depositing.

(2) Intensification design of series products. The goal of intensification design of series products, especially complete set serial products is for convenience use, information clerk, easy to demonstrate or to carry. There are two main ways: First, through designing, make series products has intensification function. Second, through mediation, intensify products. For example, Using the structure or the packing form causes product intensification, makes scattered product induce in together and simple.

(3) Intensification design of non-series products. This kind of design take facilitation, easy info clerk, and to demonstrate, through the intermedium design, and non-correlated products will be collected.

The intensified design induction and coordinate function have facilitated our life enormously. At present, common combined sound, ensemble of furniture and multi-purpose handsets and so on, are typical intensification design method products.

4. The intensive design of solar-energy picnic product





The purpose is to design a kind of product used in picnic by the theory of box-type solar collector. That product can be used as storing box, chopping block, pan and other cooking utensils. It has high thermal efficiency and can satisfy the demand of cooking in picnic. Meanwhile, it is easy to carry since it can be taken by no matter bicycle or car^[4]. That product can be applied to young people, middle-agers or families.

Those scattered stuff, such as food, water or water can, spice or seasoning bottle, cutleries, pans, etc, is indispensable, yet is also difficult to carry. However, we can design those things that don't belong to one seriation intensively. For example, we can put food in a lunch box and then put the lunch box into box-type solar collector. Thus, these three complementary articles are designed intensively together. In term of water can, seasoning bottle and cutleries which belong to on seriation can be put together by a drawer. A drawer can help to put those three articles in order, and make it more convenient and cleaner. Besides, we can combine the drawer and box-type solar collector together by utilizing space reasonably. That is intensive design for articles not belong to one seriation.

4.1. Shape design

Shape-designing is the core of industrial design. The correct relationship between function and appearance is the primary coverage of shape-designing and important element to decide whether the design succeeds^[5]. The picnic product made by intensive design contents two functional units: solar-energy heater box containing heating lunch box and food and the drawer which includes cutleries, seasoning bottle and water can. The appearance of this product depends on the different combinations of these two units. By assemble these two units reasonably, the product can be quite easy to carry. There are four kinds of combinations of the two units (Table 1).

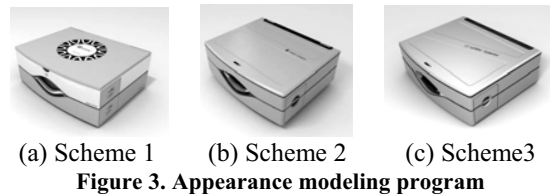
Table 1. Advantages and Disadvantages of the four combinations

	Program 1	Program2
Way		
Instructions	Upper for dishes, lower for heating.	Upper for heating, lower for drawer.
Advantages	Large capacity.	Large capacity; convenient.
Disadvantages	Inconvenient.	Long drawer and high tank.
	Program 3	Program 4
Way		
Instructions	Storage in both sides.	Storage box on front.
Advantages	Right length; large capacity.	Convenient; with operational table.
Disadvantages	Difficult to carry.	Heating capacity is limited.

As can be seen from Table 1, Program I is not appropriate for its lack of convenience. Program II Program III can not meet design objectives because they are large and their proportion is not harmonious. Combination methods of program 4 is much more scientific. Although the heating capacity is smaller, it can satisfy 3 to 4 people at the same time and meet the requirements of picnic use. In the meanwhile, the formation of the operational table greatly facilitates the user to deal with the cutting of food. Therefore, program 4 has been selected for the program design.

The modelling is the product which synthesizes function, material, structure, formation, humanities and other factors, and the cross-correlation dynamic relation of these numerous factors is the most charming place of the modelling. "Force" is the essential factor of dynamic form, for example: body, surface transition, three-dimensional space's rhythmic variation, linear sense of direction, smooth feeling and so on, thus the shape has innervation and sense of life. The box-type solar cooker with the side box-shaped appearance, whose front is designed into a circular shape to avoid the appearance of old-fashioned, and its full of patterns make the whole product have a sense of the force aesthetic feeling dilating to the outside, while a handle is accommodated at the same time among it, having provided location and depth space

to mentioning hand. Fig. 3 (a) and Fig. 3 (b) are two kinds of outward appearance design proposals. The color of the outward appearance modeling scheme 1 is too bright, and the crown graph is somewhat trivial, which make the outward appearance is not unified with the overall style. The external form of the scheme 2 is rigorous, while its upper cover has had the emboss-rization division and reorganized treatment, all make it have a sense of half third dimensions, but the square division appears a bit stiff. Therefore immediately next we have the modification on the basis of scheme 2, and let the division adopt an oblique line to carry out asymmetric handles. At last we get scheme 3 (Fig. 3 (c)), which appears relatively lively. The outward appearance color gives first place to green, which reflecting the green environmental protection and is compatible with nature, and at the same time it gives a overall feeling of steady, atmosphere, so scheme 3 is identified as the ultimate scheme in the end.



Do the internal structure design of scheme 3 about the appearance (Fig. 4 – Fig. 6). Boxes, cutlery, condiment bottles and water bottles in both right and left two drawers use embedded design portfolio, as well as the formal language. Then combine the various elements together to not only make our products better in all parts functions, but also has good the overall sense. Because of the structure of a square box, water bottles, lunch boxes and a bowl will be a square structure. All these can echo the form of a unified whole and look like a series. Also makes full use of the tank interior space. The left side of the drawer that is used to store water bottle, and the right side of the drawer for the upper and lower levels of design can store seasoning bottles and tableware respectively and no messy with easy access.



The overall dimension of it is 360×300×110mm, which makes it easy to be put on the backseat of a bicycle or in the boot and the capacity is big enough for two or three person to use. When you use it, you should open the top head and light panel first, and then take out the meal box from the heating trunk. Open the lid of the box and put the food in. Finally, adjust the box's position and the lid's (glisten's) angle to let more sunlight in. After a while, the dish is ready to eat. There is no need to waste your energy taking care of the food and worrying about whether it's scorched. The product is also convenient for picnic in your own courtyard and porch in the same way listed above.

4.2. Color Design

To make a design for color appearance of products, color of the three elements performs for different characters in sculpt. When brightness is different, high brightness color makes people feel sharp, pleased, low-lightness color with dull, dark, negative character. When purity is different, high purity color has a strong, bright, active, stimulating character, low purity color with the performance of steady, subtle, gentle and rational character. The differences of hue is in the format of different colors, such as red has the function with excitement, excited, alert, warm, etc.^[6]. The cooking utensils are chosen for clean, soft, fresh colors, so to maintain a high color purity and low pureness, adjust hue, and have the aide design for the gold, blue and silver-white all three kinds.

5. The experiment of prototype heating

The prototypes are heated in the experiment. It's divided into potato heating experiment and empty container heating experiment, carried out many times in sunny day and cloudy day separately. Then calculate the average value according to the recorded data. The time of heating potato and the temperature is displayed in Fig. 7. The temperature in container raised to 80℃ after about half an hour. After that, the temperature raised slowly and keep still in about 90℃. The potato became cooked after about 45 minutes.

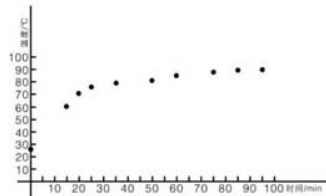


Figure 7. Time and temperature figure in potato heating experiment

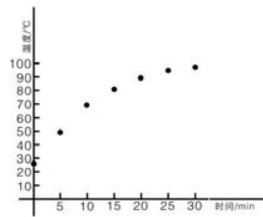


Figure 8. Time and temperature figure in empty heating experiment

Empty container heating experiment and the temperature is displayed in Fig. 8. The temperature in container raised to 98℃ after half an hour in average. The effect is fine.

Through analysis we got the reason for the longer heating time, that the prototype is not equipped with heat-preservation and heat-insulation materials. A box solar cooker with a good heat preservation could raise the temperature to 100℃ in 20 minutes.

Heating other food and the heating time is displayed in Table 2.

Table 2. Heating time of various types of food

Types	Cook-ed	Cereal	Veget-able	Eggs	Meat	Legu-me	Cook-ies
T/h	0.5	1-2	0.5-1	1.5-2	0.5-2	1-2	0.5-1

According to the experiment, cooking raw food needs longer time, and shorter time for cooked food. So it's better to choose cooked food in picnic. At the same time, small food could be cooked fast, such as vegetables, meat slice and so on. So it's good to do appropriate processing before cook. Also easy barbecue can be made. All of these need less time and good for picnic.

6. Conclusion

Using green new-type energy to replace traditional energy, we can solve the problems such as energy waste and environmental pollution, leading to the harmonic development. According to the heating theory of box solar cooker and intensive design idea, we design solar energy picnic product. We want to initiate a green, healthy, environmental protect and safe picnic fashion. At the same time, we want to improve people's environmental consciousness, bring green energy into daily life.

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