OPTIMIZATION PROJECT OF THE CONSTRUCTION AND EFFICIENCE ANALYSIS OF A SOLAR COOK FOR FOOD COOKING

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Abstract. *A model of solar cook with reflective surface composed of four mirror segments is presented, constituting a parabolic surface gotten through the fiber glass use, applied on a ceramic mold. The reflective surface of the parabolic was gotten through the use of multiple plain segments of mirror of 2 mm of thickness. The parabolic structure is composed for four modules, and has mobility of movements for the correction in relation to the sun apparent movement. The parabola composed of four segments also it is divided in four modules, making it easy to transport and storage it. Manufacture processes and assembly technician details will be presented with an analysis of the thermal, economic and materials viability's of such archetype, that has an important social connotation and a primordial aspect, that is the combat of ecological damages caused by the use, in wide scale, of the firewood to cook foods. It was found* that the levels of focus temperature obtained with the built cook are superior to the mentioned in the specialized literature and that the times to cook food are very close to the obtained with the gas conventional cook.

Keywords: solar cook, foods cooking, solar energy, low cost

1. Introduction

According to the Manual it is Solar Box Cooker's, published by Technology it goes Life, of Finland, about a third of the world population (2 billion people), depend on firewood for satisfaction of their energy needs addressed for cooking foods and heating and that this represents in the current days an annual deforestation of the tropical forests in the order from 20.000 to 25.000 Km^2 Bezerra (2001).

In agreement with IBGE, version of 1996, the annual extraction of firewood in the Brazilian Northeast is of 18.000.000 cubic meters and that the Northeastern population of the rural zone is in the order of 17.000.000 inhabitants. If the solar cook was used by only 30% of this population the firewood extraction for cooking food would suffer an annual reduction of 5.370.000 cubic meters Souza (2004).

Those data point for the need of increasing the use of the solar cook for cooking food, as a form of nature preservation, and contribution to soften the ecological unbalance for the indiscriminate use of the firewood, besides the fact of reducing the emission of pollutant gases in the atmosphere. As one can see studies that make possible the use of solar cooking, through the optimization of its construction process and of the generated temperature levels, as well as the improvement of the comfort of the user, should have priority and are indispensable for a political combat to the ecological unbalance, that soften the energy head office, contribute to the man's fixation in the field and it can give an option of generation of income, through the domain of the construction of solar cooks, for your future commercialization.

The main objective is to project a reflective cook that can work in the period between 8 and 15 hours, in areas of drop or any cloudiness, and the northeast area is the most viable of our country for the use of such cook type, once it presents an average of hours of sun in the order of 3000/year Censolar (2001).

This paper presents a cook, handmade, that has as the main objectives: the obtaining of a parable reflector optimized profile; the parable is segmented, composed of four parts, with each one put upon the other to make easier its transport; the parable has a easy control manual accompaniment system; the use of a composite based in gypsum and expanded polystyrene (EPS) for the pot thermal isolation and a easy construction type of pot support Silveira (2004).

More deepened innovations will be focused on the following parameters: form of obtaining the profile of the parable, optimization of the reception and reflection of the radiant energy constructive processes, the modulation of the parable in several segments bent, the weight of the structure, the thermal isolation of the pot, among others.

Such optimization processes will provide a larger power of competitiveness of the cook conventionally in relation to the fuels used, and it will provide larger viability use for such prototype, that has social and ecological reaches priceless. Such studies have as priority to contribute for the decrease of the social inequalities, to avoid the migration of the interior people, as well as, to propitiate until a form of generation of income, through teaching this kind of such equipment production technology to the rural communities.

Once our region is privileged in what concerns the incidence of direct solar radiation, presenting in vary cities, even levels of hours of sun superior to 10 hours/day, this study is shown extremely pertinent and viable, accomplishing the larger objective of a Public University, that is to address your studies for the resolution of population problems.

The built cook will be tested for the determination of the time of cook for some food, being diagnosed its thermal efficiency in order to compare it to the other developed cook.

2. Bibliographical revision

Today the solar cook is a reality having already been studied for several researchers in international ambit. The more used three types of solar cook for cooking food are: box type solar cook, concentrative cook and solar cook that use plain collectors, being the two first used types more.

The box type cook work for effect greenhouse or concentration and effect greenhouse agreed. They can have external reflectors distinct numbers (0 the 4), lightly concaves or plans. They are characterized for allowing the attainment of maximum temperatures of 150°C, it takes a long time to heat and its operation, generally, is difficult. On the other hand they have the advantage of being able to function practically without the user intervention, keeping the food warm during a drawn out time, they do not produce harmful effect to the user nor for contemplation nor for reflection, are steady and they do not present risks for the production of flames, not generating, therefore, susceptibility to the burnings Passamai et al. (2000).

They are constructed with low cost materials, however its use is not viable for every day of the year. Easy transport models can be constructed. They are light and folding. Possible to be connected to an auxiliary system that uses gas as combustible. The food can be removed to complete its baking in a conventional way in cloudy case of the sky. Some experiences have demonstrated that many processes of firing can become fulfilled in 75°C, during more than two hours. This type of cook finds ample application in the whole world, mainly in Asia and Africa, being distinguished in India and China, as being the countries that have more invested in social programs that make possible the construction of low cost solar cooks, for a significant use by its people Das et al. (1994).

In the LMHES of the UFRN already being constructed versions of type box cook. The main innovation of this type of cook was the use of a composite material for the absorber-reflecting box manufacture.

The concentrative systems are usually constituted of reflective surfaces in parabolic, semi-spherical, cylinder-parabolic, conical and log-conical form. These systems present a satisfactory performance to good levels of direct solar radiation in clear sky, without cloudiness Duffie&Beckman (1991).

The concentrators are circular reflectors that concentrate the solar light in the absorbing surface. Its disadvantages are the necessity of direct solar radiation, mechanism of accompaniment to follow the solar movement in each 30 minutes, food fast heat loss in case of focus deviation or accented cloudiness; lack of stability in relation to the winds; risk or burnings and damages to the users for reflected rays. On the other hand they have the possibility to reach high temperatures, what it allows to cook or to fry Souza (2004).

The surfaces reflectors are obtained with polished aluminum leaf coating, plastic aluminized, anodized aluminum, nickel-plated bronze foil etc.

Some great port installations in the whole world that use concentrative cook, being distinguished an installation for food baking using eighty four Scheffler reflectors of ten square meters that exists in the Indian that cooks for eighteen thousand people and also in Indian a solar cook with 15 meters of parabolic diameter Scheffler electronic page (2004).

In the solar stoves that use plain collectors, the warm foods are cooked in a indirect way using hot oil. There are models that have two or three plain reflectors and can operate with oil or air as fluid of work and can have up to two pans each one. Its disadvantages are its great structure, great weight, difficulty of transport, advanced technology and high cost. Its advantages are: easiness of use, cooking in the shade, does not need orientation, they function without the intervention of the user, keeps the food hot during all the time, does not produce sparks, are stable and they do not offer risk of burnings. They can be made of all sizes Silva (2003).

It is foreseeing that the rural populations are the largest users of this type of solar equipment, mainly those populations that inhabit the sunny areas. For the middle class, the cook certainly will find application in practice of the “camping site ", picnics and in correlating activities. For this application it becomes necessary to develop a type of solar cook that offers easiness of transport, occupying the least possible volume since the similar ones to the existent concentration, are in your majority models that occupy a reasonable volume relatively for the fact that they are partially dismountable.

For some types of concentrative cooks shown by literature it was observed that the ebullition necessary time of a liter of water with initial temperature of 20 Celsius degrees located around 15/30 minutes, for good levels of solar radiation and low cloudiness.

In the ambit of LES/UFRN they were already built and rehearsed 04 versions of cook concentration and four versions of type box cook. This work represents an optimization and innovation in relation to the solar cook prototypes history in UFRN.

3. Description of the projected solar cook

For the construction of the proposed solar cook, that has as main characteristic a new overlapping mechanism of the parable reflector parts; small and mobile pieces to facilitate its transport; simpler mechanism of following the sun apparent movement; low weight and utilization of a new type of thermal isolation for the pan, it was followed the following procedures:

1. Project of the parabolic surface dimensions - the dimensions of the cook were defined starting from the pretension of obtaining a parable reflection area around 1,0 m^2;
2. Draw of the parable reflector in AutoCAD - it was drawn the profile of the parable, printing it in the real size;
3. Production of the standard profile for the construction of the mold - the profile of the parable was reproduced in a steel plate for the construction of the form mold to optimize it obtaining process;
4. Making of the structure of fixation of the standard profile - a structure was built for the fixation of the standard profile built through the obtained profile, that allowed it turn in 360°;
5. Manufacturing of the fixation structure for each part of the surface parabolic - the fixation structure for the four parts of the parable was built being used iron of building site of diameter of 6mm;
6. Construction of the Mold - the mold was made in concrete and it received covering of mass and ink waterproof. The structure of the standard profile it was fixed in the mold through a located hole in the center of the same;
7. Use of glass fiber and polymeric resin for the parable construction - being placed a layer of fiber fabric in the mold, being positioned the structure of the parable, being placed other fiber layer covering again the structure and soon after being applied resin on the fiber fabric, it was obtained a piece in fiber with a quite advanced perfection degree, after the necessary time for a perfect dry of the resin. Before the making of the parable the mold was covered with wax to guarantee an optimized unmold of the structure of built fiber;
8. The cuts of the mirrors - The mirror pieces were obtained through the cut of a glass sheet of 2.0mm of thickness. The pieces were cut in way the if they adapt perfectly to the curved profile of the parable. It used mirrors pieces much smaller than introduced them by the literature. To get a better reflector parable a form was used, corresponding to 1/12 of the area of the same, composed by 38 segments of mirrors;
9. Fixation of the mirrors - it was used it glues for wood in the fixation of the mirror pieces in the parable;
10. Painting of the structure - the whole structure of the solar cook was painted to protect it of the bad weather, reducing the effects of the degradation of it exhibition to natural phenomena.

4. Theoretical Development

Is presented to follow it the necessary equations for the determination of parameters that translate the thermal efficiency of the solar cook in study Bezerra (2001), Funk and Larson (1998), Souza, (2004), Incropera, (2003).

The Equation (1) shows the thermal balance for the solar cook in study and by its use it can be calculated the maximum power absorbed by the pan can.

$$\boxed{I \,.\, A_C \,.\, r \,.\, \kappa \,.\, \alpha_p = \mathrm{P}_{ABS}} \tag{1}$$

Where:

I - incident direct solar radiation (KW/m^2)

A_C - concentrator useful area (m^2)

r - concentrator reflectivity (%)

k - reflected radiation fraction that is absorbed by the pot (%)

α_p - pot absortivity o (%)

P_{ABS} - pot absorber power (W)

The useful power is calculated for the Eq. (2), showed follow:

$$P_{USEFUL} = P_{ABS} - P_{LOST} \tag{2}$$

The lost power it can be calculated for the Eq. (3), showed follow.

$$P_{LOST} = U \,.A_{ISO}\ (T_{ip} - T_{ep}) \tag{3}$$

Where
U - loss global coefficient (W/m^2. °C)
A_{ISO} - isolate area (m^2)
T_{ip} - pot internal temperature (°C)
T_{ep} - pot external temperature (°C)

The loss global coefficient is determined for the Eq. (4) show follow.

$$U = \frac{1}{\frac{r_e \,.\ln(r_e / r_i)}{k_{ISO}} + \frac{1}{h_{ce}}} \tag{4}$$

Where
r_e - pot external radio (m)
r_i - pot internal radio *(m)*
k_{ISO} - isolate thermal conductivity (W/m^2.°C)
h_{ce} - convective coefficient between pot external surface and ambient air (W/m^2. °C)

The convective coefficient can be determinated for the Eq. (5) shown follow*:*

$$h_{ce} = \frac{k_{air}}{L} .c.R_a{}^n \tag{5}$$

Where
K_{air} - air thermal conductivity (W/m^2.°C)
L –pot height

An another parameter of basic importance for the study of systems that work with reflection is the concentration factor that is defined by the Eq. (6), case of the systems formed by parabolic surfaces.

$$C = \frac{A_c}{A_{foco}} \tag{6}$$

Where:
A_c = concentrator area (m^2)
A_{foco} = focal area (m^2)

It is possible to establish a relationship among the concentration, the temperature and the dissipated energy by the radiation in the focus of a concentrator, for values of C varying of 1: n.

The temperature of a located body in the focus of a concentrator depends on the flow density in the image of Gauss and it is governed by the Stefan-Boltzman law.

If C represents the concentration, the energy in function of C it comes given for Eq. (7).

$$E = C.P_{useful} = \sigma.T^4 \tag{7}$$

Where
σ = Stefan-Boltzman constant = 5,67 x 10^{-8}W/m^2.°K^{-4}
T = focus temperature (°K)

The theoretical value of the temperature can be determined through the Eq. (8).

$$T = (\frac{C.P_{USEFUL}}{\sigma})^{1/4} \tag{8}$$

5. Experimental procedure

Tests were made with the prototype for the determination of the temperature in the focus, after the perfect positioning of the prototype in relation to the movement of the sun. The temperature data were measured with a digital thermometer and a cromel-alumel electrical thermocouple, in six days of tests, with low levels of cloudiness, in intervals of 15 minutes Souza (2004)

Evaluating the efficiency of the thermal insulating also used to involve the absorber, as well as if the relationship among the area of the absorber and focal area it provided an optimization in relation to the final objective of a less time of cooking.

It was determined the cooking times of several foods, comparing in relation to the time obtained with the conventional cook. The results obtained with the test cook were compared with the ones tested in several parts of the world. The Figure (1) shows the projected solar cook built in test for cooking foods.

Were also made tests with the cook heating up water and oil, in a natural convective process, that circulated from a thermal reservoir to a thermal absorber that was positioned in the focus of the cook. That type of cooking procedure, in an indirect way, allows it to happen without the human exhibition to the sun because it was obtained through the use of the warm oil in a heat exchanger.

The temperatures of the two fluids were measured, proving the viability of the heating system operation for cooking. For the storage of the warm fluid a thermal reservoir was used, in cylindrical form, of steel plate, covered with a composite based of gypsum and expanded polystyrene (EPS). The built thermal absorber, also thermally isolated with the same composite used in the reservoir, was built using plates and copper tubes. The system of indirect heating is shown in the Fig. (2).

The data of global solar radiation were measured with a radiometer built in LMHES of UFRN, coupled to a digital multimeter.

Figure 1. Solar cook proposed in test.

Figure 2. Indirect cooking system in test.

6. Results analysis

Through the use of Eq. (1) that shows the thermal balance proposed for the cook in study, the maximum absorbed power by the pan can be calculated.

Considering the values I = 680 W/m^2, A_c = 1.0 m^2, r = 0.95, k = 0.95 e α_p=0.9, it has pot absorber is calculated:

P_{ABS} = 552.33 W

As $P_{abs} = P_u + P_{lost}$ = 552.33 Watts and P_{lost} calculated for the Eq. (3) corresponds to 25.25 Watts , the useful power one becomes equal:

P_{useful} = 526.75Watts

Using equation 6 the concentration factor can be determined, wants corresponds C = 158.73.

The theoretical value of the focus temperature determined through the Eq. (8), correspond to 1102°K or 829°C.

The Table (1) displays the values of temperature of the pan bottom in the first test, which consisted of the determination of the time ebullition of 1 liter of water. They were lifted up data of temperature of the insulating thermal also used to minimize the thermal losses for the pan and of the water inside it. The test was realized in 07.02, beginning the 11h40min.

Table 1. Levels of pot temperature of the solar cook in test.

Time(min)	Tpot(°C)	T_{water}(°C)	T_{iso}(°C)
0	720	28	40
5	505	59	41
10	580	85	41
15	600	100	42

The data contained in the table shows the thermal viability of the proposed cook, for the obtaining of excellent levels of focus temperature and for the ebullition of a liter of water in only 15 minutes. It is standed out that the measured temperatures in the pan bottom for a volume of 1 liter of water in cooking process. In spite of the literature to show in some cases times for ebullition of 1.0liter of water in 15 minutes, we believe that those data are unreal once the solar cook in study reaches higher temperature levels than the pointed ones by the literature.

In what concerns to the thermal isolation proposed for the pan, other innovation type for the process of solar cooking, once the pans are always used without isolation, it is noticed that the same was shown quite efficient once the thermal gradient obtained in the pan was of 60°C, with the composite external temperature around 42°C, only 12°C above the ambient temperature.

The data contained in the Tab. (2) corresponds to every test day and the behavior assumed by the same, presented by the graphs of Fig. (3).

Table 2. Medium data obtained to everyday of test hour the hour.

Days of test	hours of the day							
	08-10	09 -10	10 – 11	11 – 12	12 – 13	13 –14	14 –15	**Media**
Day 1	380	612	711	720	720	650	410	**600.5**
Day 2	400	550	650	700	700	550	400	**564.29**
Day 3	400	565	680	700	700	610	550	**600.71**
Day 4	450	620	680	750	700	650	550	**628.57**
Day 5	440	600	650	690	680	585	500	**592.14**
Day 6	480	680	680	750	800	615	550	**650.71**
AVERAGE	**425**	**604.58**	**675.16**	**718.33**	**716.66**	**593.33**	**493.33**	**606,15**

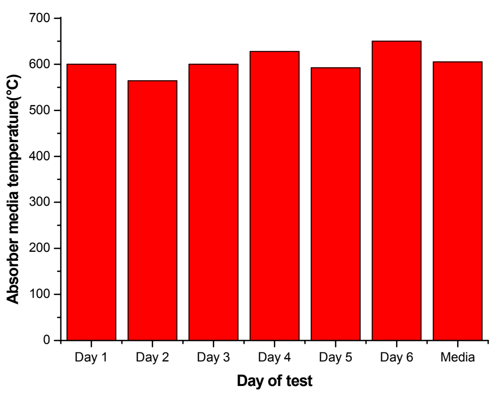

Figure 3. Average behavior of the focus temperature in function of the time for every test day.

The Table presented display that the global solar radiation varied between 720 and 770 W/m^2, with an average for every test day of 740 W/m^2. The standard deviation in relation to the obtained medium measures was of 0.019 KW/m^2, demonstrating that the days of rehearsal happened for intense global solar radiation and with low cloudiness days.

Considering that for intense global solar radiation days, the diffuse radiation corresponds to 20%, it can be concluded that the direct solar radiation is between 576 and 616 W/m^2, with an average of 592 W/m^2. Those data demonstrate the solar cook viability of use in our area, because they are potential of great magnitude, found in few areas of the world.

The average temperature data of the measured absorber varied from 564.3°C to 650.7°C, with average of 606.1°C. The standard deviation for these temperature data corresponds to 30°C. It is noticed that even for the minimum value the temperature level reached it is highly significant, being considered that the flame of a gas conventional cook reaches levels around 800°C. Therefore, the cook presents average levels of temperature close to the reached by the conventional cook.

The obtaining of such levels was due the perfection of the obtained parable and use of mirrors of small area. In relation to the pointed cooks for the literature the temperatures obtained by the cook in study, they were always superior Solar Manual Cooker (1982), Bezerra (2001).

To conclude the tests with the cook in study, it was realized tests of cooking of bean and rice. The bean, brown type, in the amount of half kilo, was placed in the pan directly from the package. The amount of rice corresponded to 250g. Such amount were chosen following orientations contained in Bezerra (2001). The test was made in a day of low cloudiness.

The beginning of the test happened at 10am, and after two hours the bean was ready. The time of cooking of the rice was of 26 minutes. Those times are compatible with the ones shown by the literature, although it is not mentioned the way the food was prepared for cooking, nor the type of each one of them.

It is standed out, therefore, that such cook presented thermal results too satisfactory, and that the mechanism of solar following was shown with good functionality, just needing a larger reinforcement in the structure to avoid undesirable movements that can cart the spill of the food of the pot. The focus was contained in an area around 63 cm^2, and it can be observed that the opaque black ink, applied in the bottom of the pan didn't resist the great temperature levels.

Seeking to correct the current problems of movement of the cook structure in study, it was made a modification in its structure, making possible the fixed focus. Such modification that can be noticed in the illustrations gave very more versatility and easiness of movement to the cook, not carting in additional costs.

Another fact that was diagnosed was an erosion beginning in the pieces of mirrors, it was concluded that it had used inadequate glue for the operation of fixation of the mirrors to the parable, in the case it glues for wood. Once it would promote the structural modification it was left then for the retreat of all the pieces of mirrors, and consequent substitution of the same ones. To optimize the cut of the mirrors and your adaptation to the parabolic profile it was used a form corresponding to 1/12 of the parabolic surface.

After the implemented modifications it was noticed an improvement in the acting of the cook, in function, mainly, of the optimization in the obtaining of the parable absorber, resulting of a closer of the real surface and it was left for the accomplishment of other tests that demonstrated that verification. The Figure (4) shows the optimized solar cook.

Figure 4 - Solar cook modified structure.

The test first that she accomplished was as the verification of the time for the ebullition of one and a half liter of water, breaking of the ambient temperature, around 28°C. The results of that test are shown in the Tab. (3). The test had beginning 10:25am. The temperature in the focus was around 700°C, for the period of accomplishment of the test. It is standed out that that day presented a level of superior cloudiness to the chosen great days for the accomplishment of the tests previously accomplished.

Table 3. Time of ebullition of 1.5 liters of water.

Time (min)	**T_{water} (°C)**
0	28
5	60
10	85
15	100

It is noticed that the levels of temperature of the water in function of the time are practically identical to the previous test, however for a volume of water 50% larger.

It was accomplished, in the same day, other tests for cooking of food, whose results are shown, together with the other two foods of the previous test, bean and rice, in the table below. In this Table there are the relative data the other types of cook already studied and shown in the literature.

Table 4. Comparison of cooking time

Foods	Weight (g)	Gás Cook	Solar Cook (mylar)	Solar Cook (polishing aluminum)	Solar Cook In study
Bean	500g	90 min	95 min	100 min	120 min
Potato	500g	27	30	35	30
Sweet Potato	450 g	26	30	35	30
Rice	250 g	31	35	38	25
Yam	1000g	30	34	37	32
Macaroni	500 g	20	-	-	25
Manioc	500 g	30	-	-	30 min

One perceives that the results obtained with the studied solar cook are extremely competitive with the ones obtained with the gas cook and with other types of solar cooks already developed. it is standed out that the bean was cooked in the test worst possible condition. We also understood that the cooking times with the solar cook were overestimated, therefore the cook in study obtained much higher temperature levels, for reasons already appeared previously Bezerra, (2001), Souza (2004).

It is standed out that in the period of 9:00am up to the 03:00pm the cook was in operation, what guarantees that it can cook two meals a day for each family. The last food to be cooked was the manioc, placed in a pan at 02:30pm with focus temperature around 640°C.

With relation to the cooking indirect the data contained in the Tab. (5) show the evolution of the temperature of the mamona oil placed in a pan situated in the focus of the parable.

Table 5. Indirect heating of two liters of mamona oil in the solar cook.

Time (minutes)	**Oil temperature(°C)**
0	28.0
5	65.0
10	87.0
15	95.0
20	101.7
25	112.0
30	121.5
35	140.0
40	154.0
45	163.5
50	170.2
55	178.0
60	185.0
65	190.0

The test was interrupted in function of an intense release of vapors and emanation of a sufficiently characteristic and strong odor. It can be perceived that such oil is viable for the application in study, once that presents boiling temperature around 200 °C, proper temperature for cooking, however was opted to the choice of one another fluid in function of its high viscosity, that makes it difficult the thermosiphon process, as evidence after that through one has tested definitive of indirect cooking.

In Table (6) arte shown the relative data to the temperature evolution of recycled vegetal oil in the interior of the isolated thermal reservoir, resulted of the process of thermal exchange for thermosiphon, for indirect cooking. The average level of radiation for this day corresponded 740W/m^2. It temperature gotten is relative to the point of return of the fluid to the isolated thermal reservoir.

Table 6. Test to determine indirect baking viability, using ten liters of recycled vegetal oil.

Time (minutes)	Oil temperature(°C)
0	28
15	37
30	45
45	56
60	65
75	89
90	105
120	111

The data demonstrate that the system of indirect heating functions in thermosiphon, or either, the oil flowed of the reservoir for the absorber, but the reached levels of temperature do not allow the food cooking. One perceives then that for the attainment of raised temperatures more, for a bigger amount of oil, that can until being stored to be used in hours of low radiation incidence, the use of a reflecting parabola of great dimensions becomes necessary.

It would be for too much important that the Brazilian government, in the combat the exclusions, it implemented a project to contemplate the donation of solar cooks, that could be manufactured by devoid communities members, making possible, therefore, a social project of combat to the unemployment and the poverty. In the use of such prototype, it comes true to the interrelation that should always exist between science and attacks to problems of the population, mainly the more excluded.

7.Conclusions and suggestions

As already he was salient the larger objective of this work it was to build a solar cook that presented compatible acting with the pointed for the literature, that were characterized by its easiness of construction and assembly, that it was modulated to facilitate your transport, that presented low weight and that had an efficient mechanism of following of the direct solar radiation.

To follow, in accord with these goals, it is transferred to discourse it on the conclusions of general character that if infers of the analysis of the data harvested in the assays carried through with the prototype in study.

1. The proposed cook is quite viable for the food cooking, that could bring substantial economy and to avoid ecology attack problems, mainly in what it concerns the firewood use deforestation for;

2. Its functioning is simple, in function of the easy handling of its mechanism of solar following and of your low weight;

3. The optimization of the process of construction of the mold was fundamental for the obtaining of quite significant temperature levels, allowing a decrease accentuated in the time of cooking;

4. The size of the several segments of mirrors that it compose the parable reflectors was fundamental for the obtaining of a more significant focus temperature, for the fact of the same ones they present dimensions well below those shown by the literature;

5. The process of cut of the segments of mirrors was not shown as complicated, for the fact that was obtained a standard segment, corresponding to 1/12 of the reflector parable. Such a standard segment was divided in 38 pieces, which were cut in block, to facilitate that operation. Each part of the parable, in number of four, was composed of three standard segments;

6. The mechanism that allows the dismount of the parable was shown efficient, facilitating its transport;

7. The proposed cook has cooking capacity in the period of 8 the 15 hours, for good levels of direct solar radiation, with capacity of cooking food for all the meals of a family of four people;

8. The proposed prototype is viable mainly for the use in rural zone, for communities of low incoming;

9. The variations of position of the solar cook so that the pot was always in the focus of the system usually occurred at every 1 hour;

10. The proposed solar cook, with some modifications to be made can already become a market product;

11. It is important to have conscience of the risks that the cook can bring for the user, in what concerns concentrations of the solar rays, which can reach the human view. Therefore, it is necessary a previous minimum training for the users of the same;

12. It is also had that to show to the users of such an alternative stove that your efficiency is directly proportional to the intensity of direct solar radiation, and that when the day presents intense hours with cloudiness, the efficiency of the cook is not the same, being therefore adaptable for areas with low indexes of cloudiness, characteristic of the Brazilian northeast.

13. Despite the levels of temperature reached in indirect cooking system was not the ideals for such intention, it proved viability of the proposal, that represents a perspective sufficiently important for cooking food in the interior of the residence, preventing the exposition of the users to the sun. Such idea is innovative once that uses a solar cook that works with concentration instead of solar collectors with reflecting mirrors for the heating of the oil, of sophisticated technology of more cost than the concentrative parabolic.

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