SOLAR PARABOLIC CYLINDRICAL HEATER WITH FILM OF POLYETHYLENE FOR HEATING OF WATER AND DRYING OF GRAINS

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Abstract. It was developed in the Energies Renewable Center of Unesp-Guaratinguetá a parabolic cylinder solar heater with a polyethylene film. The equipment is used to the water heat and also by a substitution component system makes it able to dry grains, like rice, coffee, flour, bean, corn and soy. It has three meters of length, 0,8 meters of width and 0,8 meters of height. The water heating system is composed by 5 blackish copper pipes (9 mm of diameter) connected in series, located at the parabola focus in the length direction. The system has capacity to make the outflow water temperature reaches around 200 centigrade. The daily 5 hours of sun cans produce 200 liters of hot water. The same parabolic cylinder heater can be used to dry grains by a variable components system. This variable component system is a square copper pipe with 3 meters of length; 0,1m of width; 0,06m of height and it is in the parabolas focus located. It is possible to use his own inclination to the grains descent. The daily production depends on the size and on the temperature that each kind of grain can resist without burn.

1. INTRODUCTION:

The alternative energy source research grows up in the 70 decade with the oil crisis; up to that time, there were barely new sources experiences. Its brings, the need of been researching and investing in new others energy sources. At present, the environmental impact is the conventional sources problem. In a near future the heat liberated by the energy consumption will be the cause of the deep world climate modifications. In the environmental backups and fuel questions exists the technology domain. The third world and in development countries are the biggest alternative energy sources holders. The first world countries are years and years dedicated for take advantages of those development technologies; it is a new economic domain form. Brazil receives around 2.000 kWh/m in a year, what represents 685 W/hour/day and considering on average eight hours of the sun

daily lighting the land. For calculations effects, must be taken the most intense four hours of sun (10:00am to the 2:00pm) and without clouds days. Brazil is the second biggest energy country quantity receiver of the world; around 29 quintillions of kWh resulted by his territorial extension and tropical situation. By the researches datum obtained in 1999, the electric energy consumption in Brazil is 42% directed for the buildings sector, being 84,1% corresponding to companies and residences and 15,9% for the administration and achieving public, being 13,8% of the Internal Brute Product of the country. In agreement with the Brazil energy company manual the residential sector takes 25% of responsibility for the national energy consumption. The electric shower is the second biggest residence consumer, corresponding to 25%, barely losing for the 30% of the refrigerator. His utilization reaches a peak on 6:00pm to 7:00pm, corresponding to 8,5% of the national energy demand in this schedule. These facts aim the electric thermal source importance of the hot water obtaining, mainly in an energy rationing time being that Brazilian electric hydraulic energy generation is practically exhausted. The solar energy collectors utilized for the hot water output can be divided in two groups: the flat and the alternatives with deferments forms, being the flat more utilized. The residential heater water system are generally composed by flat collectors that produces hot water varying of 60ºC to 100ºC temperatures, and basically consists in a copper or aluminum pipes streamer fixed to a blackened plate and covered with a transparent glass that, heats all the system when exposed to the solar light, being the heat transferred to the water by conduction. The cylindrical parabolic collectors resemble to a middle cut drum, internally cover by a mirrored stuff, concentrating the solar rays about a straight line in the focus, in which is a pipe installed for the water passes, reaching 250ºC medium temperatures. The project has as main objective: the optimized profile obtaining of a reflector parabola that is composed by a continues mirrored sector, by a metallic structure supported, equipped with a automatic complex system that accompany the sun, so this way the collector is always perpendicularly positioned to the solar rays. The efficiency peak will be the in the schedule between 9:00am and 3:00pm, in decrease or no cloud regions. They will be focused innovations about the following parameters: the parabola profile obtaining form, the constructive optimization procedure, the peculiar stuff utilization, the radiant energy capture and reflection optimization. This work presents economic, thermal and stuff feasibilities. The developed collector has as main innovation: his parabolic format that concentrates all the received radiation in copper pipes that are fixed in the parabola focus. The water after been heated goes for a conventional boiler. The reached temperatures in focus of the parabola are relative high when compared with a conventional collector, becoming him more competitive. The agricultural product drying is an old civilization practice, when there was not grains storage worry and the naturally grains humidity diminutions occurs in the own field. The drying was deed in natural environment conditions, mainly dictated by the solar energy incision and by the air movement. Lately, the drying conditions it tried to be partially controlled, and this passed to be deed in special stoves or heated rooms. In Brazil, a significant output part of grains still being dry by a primitive form, or deed during a long period of natural procedure in fields. The utilized drying grains methods are enough diverse. They can be classified by the following topics: the natural drying, that is deed in the field; and the artificial drying, that can be deed in low temperatures (natural or lightly heated air) or in high temperatures (provoked by air streams of artificial heating). The main objective of the alternative collectors studied is the making cost reduction, seeking to his industrial and domestic water heating use socialization, since

the efficiency of even has a favorable benefit-cost. They demand a high initial investment; this explains the decreases rate of solar systems development for the water heating in the world. The development of smaller cost of a good thermal performance heater is urgently necessary. With this objective, the parabolic solar collectors are being developed to finish with those deficiencies. The parabolic solar collector is today a verified fact, already having been a study object by several researchers in the international scenery. The captor concentration systems forms are normally constituted of parabolic, are-spherical, cylindrical-parabolic, conical and log-conical. To have a satisfactory performance system is necessary to have a direct radiation, clear heaven without clouds (Duffie & Beckman, 1991). The philosophy adopted to do the solar collector project is: simple, with a high benefit-cost, more efficient than the others and more specifically destined to the water heating. For been utilized by the urban population, or even by the rural where they have the electric energy difficult access. Was based on this initially reasoning line that this kind of solar heater collector was developed. It is easy to know that the consumers will give preference to that kind of solar equipment, mainly those that they are economic worried and inhabit sunny regions. With a broadly diffused conception the solar energy is associated with the low output temperature, mainly for domestic purposes. The collector will find application in the domestic heating water, in the hospital sterilization and in the industrial energy generation. For the domestic application is utilized a conventional boiler for the temperature control, for a hospital the system must be adapted for high temperatures utilizations for the water vapor in the equipments sterilization, clothes washes and food making. Increasing the project proportions, can turns possible the use for the electric energy generation, what already is done in countries as German.

In the Table 1 there are some hot water consumption and application data.

Table 1. Hot water consumption estimative.

Application	**Consume liters/day**
Provisional lodging of work	24 by person
Popular house or rural	36 by person
Residence	45 by person
Apartment	60 by person
Hotel (without include kitchen and laundry)	36 by person
Hospital	125 by room
Restaurants and similar	12 by meal
Laundry	15 by kg of dry clothes

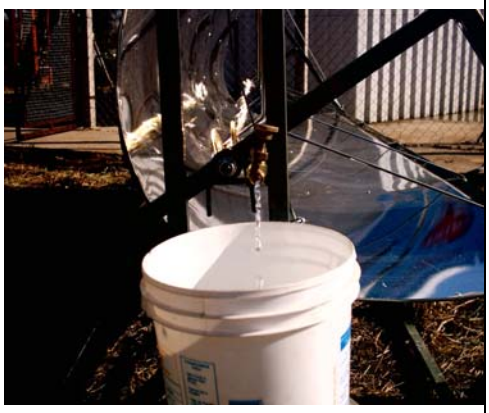
There are solar parabolic collector prototypes that already can be found in the European market prepared for the heat generation. That showed down project consists, at least, in 100m² solar field area utilization. By example: the hotel roof, with his pressurized system supplying hot water to a deaden tank storage. The tank supplies the pressurized water to 180 °C to a vapor generator, which produces the saturated vapor to 4.5 bar of pressure (148 °C). This generator feed the existing vapor distribution. By this arrangement, the excessive solar heat is not wasted, it is supplied to others consumers. With a 116 quilowatts nominal cooling capacity, the generator supplies a significant part of the hotel rooms conditioned air. The existing compression refrigerators will supply this. The laundry is the main vapor consumer that works around 20 hours in the high station. The laundry vapour demand

moves from 300 to 700 kg/hr, approximately on average it is 240 kW. Already with the heater can be obtained an extremely durable grain, but also high perishable seeds. If they were reap in good conditions and subsequently maintained in short humidity contents and low temperature, they can retain their sprout's power and some other qualities by long periods. The objective of adequate storage grain is to maintain his biological, physical and chemical durations qualities, likely immediately after sprout. The dry operation is an important process part that antecedes the storage. The grains dry is deed from the hot air that leaves the solar collector.

3.DESCRIPTION OF THE SOLAR COLLECTOR PROJECT

The solar collector proposed construction, has as main characteristics a high solar radiation search mechanism and a unlike conventional parabolic collector form, followed the following procedures:

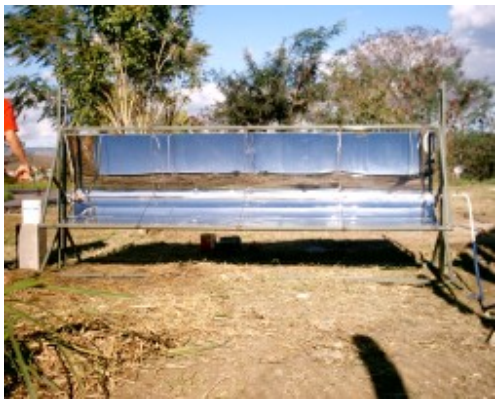
1. The parabola project dimensions- the collector dimensions were defined with the pretension of obtain a 3,0 m² parabolic reflection area.
2. The reflector parabola design – the parabola profile design was did in AutoCAD, printing and extending it for the real size.
3. The parabola profile making- The parabola profile was reproduced in a wood matrix with fixed points with the utilization of nails for give the parabolic form to the steel bars, optimizing his making process.
4. The fixed parabola base construction- was built a metalon 25x25mm metal structure for the reflector parabola fixation. The structure permits its turns in approximately 180°.
5. The mirrored plate fixation in each parabola part– To the mirrored plate fixation in the parabola was deed above the 25x3mm steel bars, rivets fixed, adjusting it to the parabola profile.
6. The coppers pipes fixation- was utilized civil iron to position the copper pipes (5mm of diameter) in the parabola focus.
7. Coppers pipes arrangement- it was deed to a streamer form, aiming at the maximum solar radiation capture.
8. The square copper pipe arrangement in the copper pipes place– The square pipe is located in the parabola focus aiming at the maximum solar rays capture.
9. The parabola fixation on the fixed base – The cylindrical parabolic collector is fixed to his base in a 30º angle approximately, being possible to promote a high solar rays capture.
10. Solar rays accompaniment system- was utilized an electric motor with low energy consumption (3,5volts). The motor turns on when the solar ray enter parallel to a rectangular pipe fixed perpendicularly to the parabola and turn on the photo-sensor located in the bottom of this pipe. There is also a timer that guarantees that the photo-sensor will be deactivated during the night and activated during the day.
11. Structure paint – All the solar collector structure was painted to protect it of the variations climate, minimizing the degradation exposition effects of the nature phenomena.
In Figure 1 and 2 show collector.



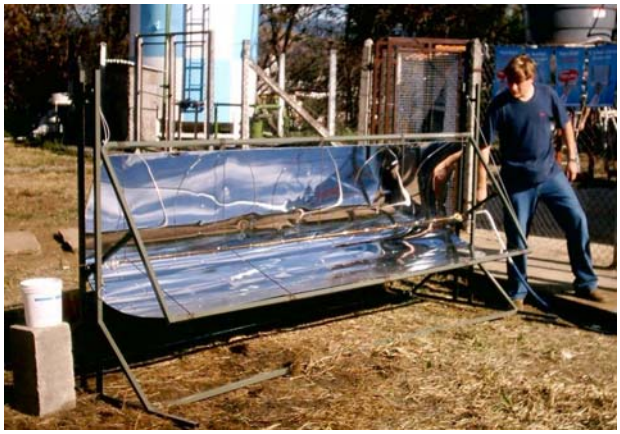
a. Hot collector supplying water

b. Collector supplying vapor

Figure 1. Cylindrical parabolic solar heater in operation.



a.Frontal collector sight



b. Solar collector being adjusted

Figure 2. Parabolic solar collector

4. EXPERIMENTAL PROCEDURE:

They were carried out experiences with the maximum determination temperature prototype in the focus achieved, after a determinate procedure to find the best optimization form and location to position the heater in their perfects coordinates. The temperatures were obtained from a digital thermometer put in the following points: in the focus, in the water exit and another to the environment temperature determination. They will determine the real outflow temperatures. In the grains heater case was deed grains drying time experiences.

5. RESULTS:

The most important measures were of temperature and outflow. An ideal daily outflow in a residence with 5 persons, is approximately 200 l, as can be seen in the Table 1. The outflow obtained in the experiences was limited by the cooper pipes diameter, showed in the Table 2.

Table 2. Results obtained during the experiments

	Experiment 1	**Experiment 2**
Environment temperature (°C)	16	16
Focus temperatura (°C)	117	84
Water temperature (°C)	85	50
Outflow (ml/s)	2,2	7,14
Outflow (l/h)	7,9	25,6
Outflow (l/7h)	55,3	179,2

In the grains drying is not possible to calculate, the exactly drying time, due to many variables that are involved in the procedure. The variable elements includes: the relative environment air humidity temperature variations, of the hot air humidity that leaves the heater, after pass through the grains mass, cleaning the grains and the hot air stream intensity, etc. The problem would be simpler if it will not have hot air and others variations factors, and if those leaves the heater being always saturated. Is sufficient say that; the grains drying is not an exact science and, like this, requires a constant procedure vigilance.

6. CONCLUSIONS AND SUGGESTIONS:

The solar collector developed is enough viable for the water heating and to the grains dry, being able to bring favorable benefit-cost and a high electric energy economy. His operation is very simple; it has an easy handling automatic solar accompaniment mechanism. The automatic procedure of solar accompaniment has a fundamental optimization importance for the solar radiation absorption. However, the reflector stuff utilized does not have a so high efficiency, as mirror, that fact didn't give so expressive experience results. The near step will be testing a new reflector stuff that has a better benefit cost. That will be able to obtain bigger temperatures than the conventional collectors, and heat a bigger water quantity in smaller time, showing his high efficiency. Therefore, the parabolic solar collector developed for heat water and dry grains, has a high efficiency and can becomes a market product.

7. REFERENCES:

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