INCREASE THE PERFORMANCE OF A USED IN SOLAR COLLECTOR A REFRIGERATOR SOLAR BY CHANGE OF GEOMETRY SUPERFICIAL

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Abstract. *The paper presents a study concerning the performance of a solar collector used in the cooling system by adsorption using solar energy as an energy source. The objective of this study was to assess the influence of change in surface area of solar collector, the amount of energy, absorbed by the collector / reactor with the aim to increase system performance. Thus can the attainment of a better cooling system of the COP.*
Keywords: *Energy, adsorption, Refrigeration, Form factor.*

1. INTRODUCTION

Solar energy is essentially a source of clean energy, available throughout planet and can be used in many applications such as, in a heating system of industrial water in a cooling system by adsorption, among others. Solar energy, produces no pollution, in addition to being available on a large scale, it is a renewable and virtually inexhaustible. The technology involved in the exploitation of solar energy is simple and is accessible to all countries including underdeveloped. The countries of the southern hemisphere, next to the line of the equator, are the countries which has increased availability of solar energy in particular Brazil, with its territory located mostly in latitudes between the Equator and the Tropic of Capricorn, presents an incidence of solar energy quite favourable. The instantaneous power incident on the earth's surface can reach in excess of 1000 W/m^2. The average annual energy incident in most of Brazil varies between 4 kWh/m^2.day and 5 kWh/m^2.day.

The principle of operation of a solar collector is the same that exists when we leave, under the action of the sun, closed and a vehicle parked for a few hours on public roads. The action of solar radiation is increasingly present as the interior of the vehicle approached the black. In a system of cooling by adsorption this concentration of energy is intended to promote the process of desorption adsorbato contained in the bed of porous, initiating the cycle of cooling.

The amount of energy that is absorbed by a solar collector depends on various factors, such as weather, geographical position, tilt the collector, shape, dimensions. Another parameter that should be considered in the analysis of collectors is the temperature of stagnation, because there is a limit of the physical transfer of heat to the fluid of work, and there may be a moment that ended the transfer of heat depending on the temperature of the fluid and the surface of the collector, that become equal. At this moment, as there is exchange of heat, all power is lost for the incident neighbourhood and efficiency of the collector falls to zero.

2. RATIONALE THEORY AND PROCEDURES

2.1. COLLECTORS SOLARES

A solar collector is a special type of heat changer, which transfers the radiant energy, from the sun, a fluid. The amount of energy required for the operation of a system of supply solar, and cost are some of the factors that determine the type of solar collector to be used. The sophistication of solar collectors tends to make them more efficient and thus seek a greater degree of convertibility. Such collectors can be divided into several categories, depending on the temperature they reach. So you can classify them as follows:

- Collectors of low-temperature → Hit less than 50 ° C, and uses absorbers metallic or non-metallic, in applications such as heating water in pools.
- Collectors of medium-temperature → Hit temperatures between 50 and 100 ° C. Generally flat-plate collectors are (covered with glass) or concentrators (low power of concentration), who use air or liquid as the means of heat transfer. In this category, are also included collectors of the evacuated tube, which are ordinarily used for residential heating water.
- Collectors of high-temperature → Hit high temperatures, and in general are collectors with parabolic reflectors or circular ramp type collectors, which are used mainly on the generation of electricity and detoxification of water.

2.1.1 COLLECTORS EVALUATED

In this work were compared two types of solar collectors, both featuring Geometric different, but with the same dimensions and different surface areas, made with same material (copper) and on the influence of solar radiation. Figure 1 shows a collector with triangular area, while Figure 2 shows a collector with tubular surface. The change of geometric formats of tubular for triangular aims to increase the area exposed to sunlight, promoting greater temperature of the collector and consequently more adsorbato away from sorbent that is in the collector / desorption reactor in the period, thereby contributing to greater efficiency of the system. The dimensions of the collectors were considered equal to 1 m long by 1 m wide, as shown in Figures 1 and 2. The areas of exposure to sunlight of collectors were calculated as follows:

$$A_{CT} = \left(\sqrt{\frac{B^2}{2} + H^2} \right) \cdot C \cdot N_f \tag{1}$$

$$A_{CTu} = \pi \cdot R \cdot C \cdot N_t \tag{2}$$

Since:

A_{CT} - Area of the collector triangle (m^2)
B - half the base of the triangle (m)
H - half the basis of triangular (m)
C - Length of collector (m)
Nf - Number of stages of the triangle

A_{CTu} - Area of the collector tubular (m^2)
R - Lightning of the tube (m)
Nt - Number of tubes

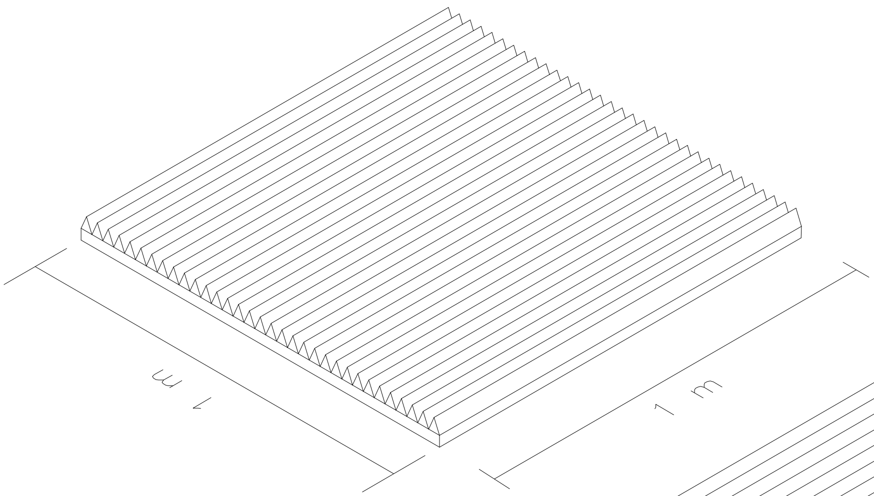

Figure 1- Collector solar triangle

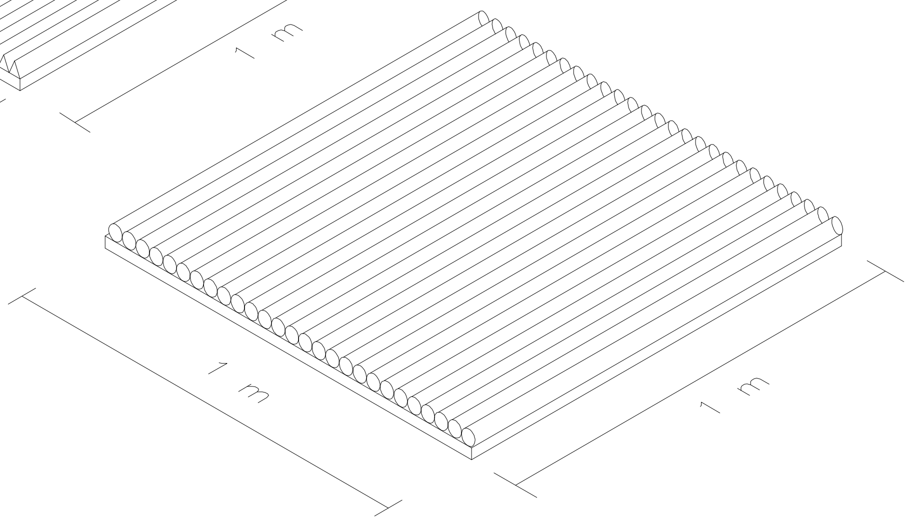

Figure 2 - Collector solar tubular

2.2. SOLAR RADIATION

The solar radiation that reaches the top of the earth's atmosphere comes from the region of the solar photosphere which is a layer tênue with approximately 300 km of thickness and surface temperature of about 5800 K. However, this radiation is not presented as a model of regularity, because there is the influence of external layers of the Sun (chromosphere and crown), with hot spots and cold, cromosféricas eruptions, and so on. Despite this, one can define an average of the level of solar radiation incident on a surface usually located on top of the atmosphere. Recent data from WMO (World Meteorological Organization) indicate an average value of 1367 W/m2 for extraterrestrial radiation. Mathematical formulas allow the calculation from the "solar constant", the alien radiation throughout the year, making the correction by the elliptical orbit. The solar radiation is electromagnetic radiation that is spreading at a speed of 300,000 km / s and can be observed aspects ondulatórios and corpusculares. In terms of wavelengths, the sun is the spectral range of 0.1 m 5 m, with a maximum spectral density by 0.5 m, which is the green light. It is through ondulatória theory, which are set for the various physical facilities, properties in the range of solar absorption and reflection and, in the range of 0.75 to 100 m, corresponding to the infrared, the properties of absorption, reflection and emission. The incident solar energy in the material can be reflected, transmitted and absorbed.
The data on the incidence of sunlight that arrive in the city of Joao Pessoa / Paraiba / Brazil longitude and latitude of 34.87, 7.10 thereof, were obtained through a program that simulates the total solar radiation incident. In general, the radiation can leave a surface due to reflection and to the issue, however the means are simplified to areas that can be approximated as black body. The solar collectors were considered to be a black body, where all the solar energy that reaches the surface of the same is fully absorbed.

$$M_p.c_p.\frac{\partial T_p}{\partial t} = Q + h_{cont.}.A_{cont.}.(T_L - T_p) - U_g.A_{p.}.(T_p - T_{amb}) - \tau.F.A_{col.}.(T_p - T_L) \tag{3}$$

$$Q = I.\alpha.\tau.A_{Col} \tag{4}$$

Since:
Q - Energy is absorbed by the solar collector (W)
I - Energy Radiante (W/m^2)
F - Form factor of collector
A_{Col} - Area of the solar collector(m^2)
A_p - Area of the losses collect solar thermal (m^2)
$A_{cont.}$ - Area of contact between the plate and the porous bed (m^2)
U_g - Overall coefficient of thermal losses (W/m^2.K)
A_p - Area of the plate solar (m^2)
M_p - Mass of the solar plate (Kg)
C_p - Specific Heat of material from the solar collector (W/Kg.K)
α - Absorbance of glass
τ - Transmittance of the glass
T_p - Temperature of the plate (K)
$T_{amb.}$ - Room temperature (K)
T_L - Temperature of the porous bed (K)
$h_{cont.}$ - Coefficient of thermal contact between plate and porous bed (W/m^2.K)

2.3. FATOR FORM OF GEOMETRIC

The form factor describes the fraction of energy that leaves a surface and reaches a second surface. It takes into account the distance between the areas, calculates the distances between the center of each surface, and its orientation in space in relation to another, computed as the angle between each normal vector and vector designed to areas of the centre of a surface to center of another surface. He is a dimensionless measure. The form factor is defined previously characterized as a factor in a point to point. For use with areas that have a positive area, the equation must be integrated over the area of one or both areas on the areas. The form factor of between a point on a surface and another surface area with positive can be used if supusermos that point represents all points of the surface.

He is a purely geometric relationship, regardless of point of view or the attributes of the area. The factors so obtained through analysis of only a triangle and a tube of collectors in a cross-section according to Figures 3 and 4, were calculated using the theorems of reciprocity equation (5) and the sum equation (6).

$$A_i \cdot F_{ij} = A_j \cdot F_{ji} \quad (5)$$

$$\sum_{j=1}^{N} F_{ij} = 1 \quad (6)$$

$$F_{ij} = \frac{1}{A_i} \iint_{AiAj} \frac{\cos\theta_i . \cos\theta_j}{\pi . R^2} dA_i \, dA_j \quad (7)$$

The equation 7 can be used to determine the form factor associated with any two surfaces that are broadcasters and reflecting diffuse and have radiosity uniform. As we can see in Figure below was possible to calculate the form factor of the surface 3, through the adjacent rectangles formed in perpendicular planes. Areas 1 and 2.

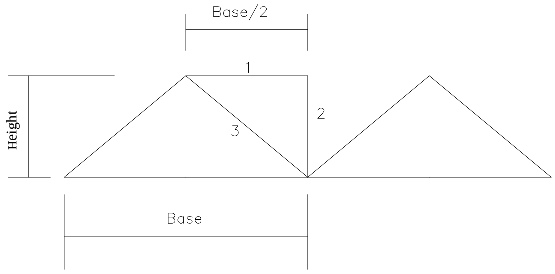

Figure 3 - frontal view of the collector triangular

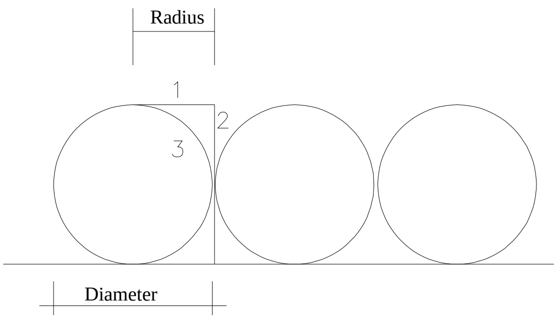

Figure 4 – Front view of the collector tubular

3. RESULTS OF SIMULATION

The form factor of the collector tube is almost constant as many of its radius around 0.71. Already the collector triangular realize that reducing the height and increasing the basis of the form factor was higher, one can reach a size that is a result of higher factor in the way compared with the collector tube, as can be seen in Figure 5.

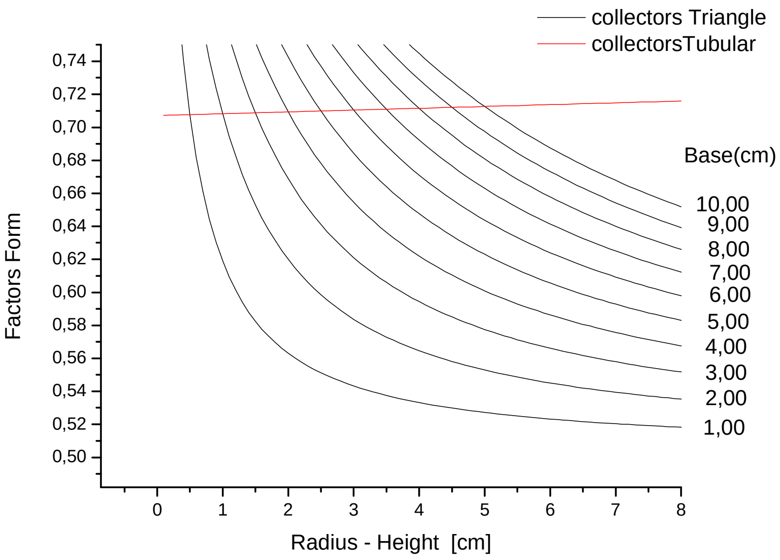

Figure 5 – Factors Form of collectors and tubular triangular

The temperature of the bed is porous tabled in Figure 6, where to obtain these results were considered the following dimensions, based on results shown in Figure 5, to the extent that the collector was triangular: Basic 5.00 cm, height 4.00 cm corresponding to an equal factor in the 0647 area and exposed to sunlight of 1.88 m^2. For the collector tube the diameter chosen was equal to the height of the previous collector 4 cm, corresponding to a collector with an area exposed to sunlight of 1.57 m^2 and form factor of 0.71. During the twelve hours of exposure to the sun, according to the simulation, there was an increase in temperature of the bed porous due to change the geometry of the triangular collector of tubular goods, is perceived in Figure 6 shows that, temperature of the bed Porous obtained in accordance to the equation 3. I noticed that the temperature in the triangular collector is greater than the tubular therefore presents an area of greater exposure to sunlight.

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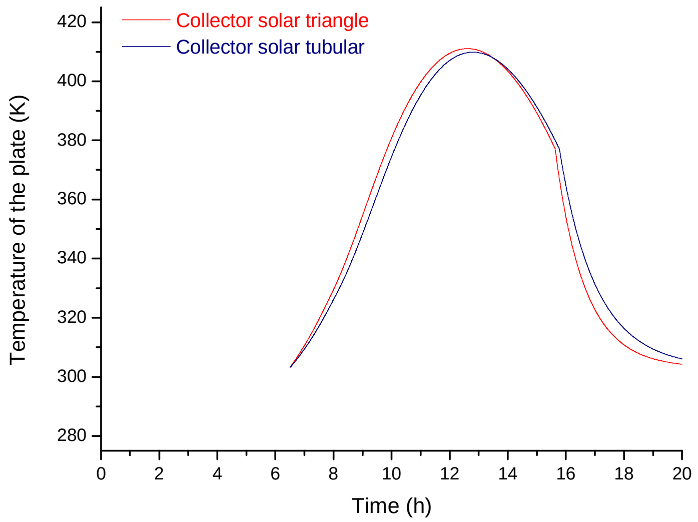

Figure 6 - Temperature of the porous bed by collectors

5. CONCLUSION

The change in geometry of the solar collector of tubular goods triangular, contributed to a small increase in temperature of the plate that was exposed to the same solar radiation, as can be seen in Figure 6, significantly increasing the area of contact between the plate and porous bed, that for the collector with tubular geometry was 1.57 m^2 and the collector with triangular geometry was 1.88 m^2

Despite the change of geometric dimensions chosen for the collector, not contributing to the increase in the form factor, which was around 0.64 to 0.71 and collector triangular tubular, but helped to decrease the time of cooling of the bed by having a porous largest area of heat transfer. The work continues with the main objective of confronting these results of the simulation with the experimental results

3. ACKNOWLEDGEMENTS

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