UTILIZING SOLAR THERMAL ENERGY FOR HOT WATER AND INTERIOR SPACE IRRADIATION BY USING INTELLIGENT SYSTEM CONSIST OF POLYMERIC LENS ARRAYS

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Abstract

This article is designed for a two purpose intelligent system consisting of a Solar Water Heater (SWH) and interior space irradiation at night. This is done by using a pair of magnifiers during the day to concentrate sunlight on an absorber plate which has been set up at the interior space of the building. The absorbed solar energy by the water inside the aquarium raises its temperature. When the sunlight intensity decreases at the sunset or cloudy weather, the array of the magnifiers are guided to the inside of the building. We can scatter sunrays in the inside of the building by locating the ceiling luminous sources above these arrays. This makes the interior more beautiful and fascinating during night.

Keywords: Thermal Energy, Light Lenses, Solar Water Heater, Light Irradiating.

1. Introduction

The cheapest available energy is the solar energy which reaches us during the day. Using the sun's energy to heat water is not a new idea. More than one hundred years ago, black painted water tanks were used as simple solar water heaters in a number of countries. SWH technology has greatly improved during the past century. Today there are more than $30 \times 10^6\ m^2$ solar collectors installed around the world [1]. The concentration of solar radiation or other diffuse light sources in a single lateral direction is required for many applications. Such applications include the concentration of solar radiation into narrow water pipes for water-heating systems and the excitation of photochemical reactions [2, 3]. The other uses of optical elements is the ideal artificial irradiating to provide nice optical environments [4].

2. Design

In each area, the amount of radiated solar energy, depends on the summit direction angle, the climatic conditions and geographical state. To evaluate the amount of the received power reaching the earth, the following cases should be considered:

1- The practical measurements of this received amount in a year period.

2- Modeling and calculations based on available formula and scientific sources.

Therefore we can do the calculations by using powerful software and then simulate the model. After doing the primary evaluation, intensity of incidence ray calculation is done for two different cases of radiometric calculations on the optical system based on range change 'Fig. 1 and 2'. Optical waves are involved in absorption, scattering, reflection and diffusion while

passing through atmosphere. The atmosphere consists of gases and aerosols which are the main factors in ray absorption, scattering from the source to the detector. The amount of radiated energy received from the sun decreases due to passing the optical rays through the atmosphere. Some factors like climate conditions, aerosols in the atmosphere, pressure, altitude and temperature decrease this amount. In fact, the vision range resembles atmosphere passing condition.

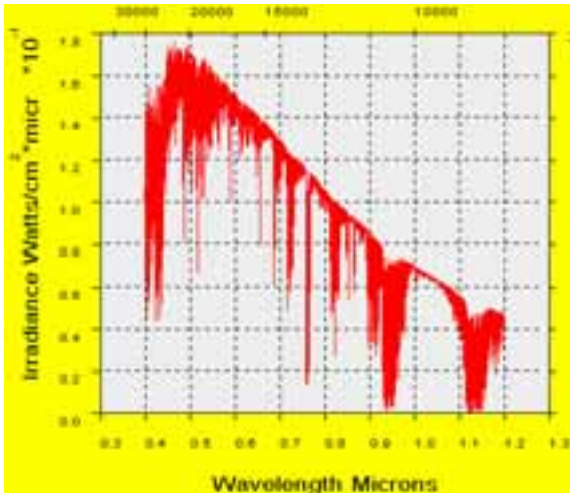

Fig. 1. The best conditions for passing the rays through atmosphere is as follow: the top summit angle of the sun is zero, the vision range 23 km, the leaning orbit of the sun is zero.

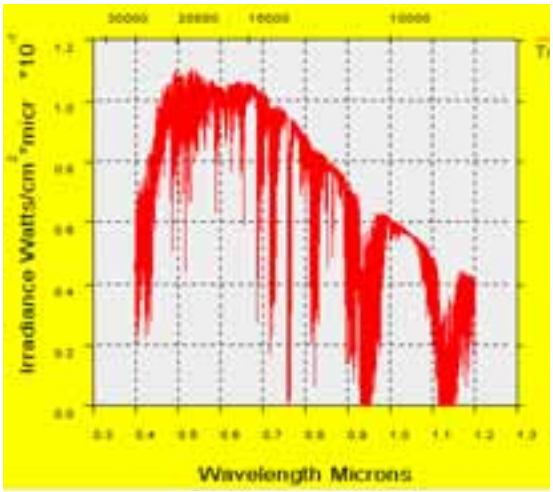

Fig. 2. The worst conditions for passing the rays through atmosphere are as follow: the summit angle of the sun is 50, the vision range is 5 km, and the leaning orbit of the sun is 23.

2.1. Optical modeling

Different kinds of optical collectors, such as parabolic mirrors and Fresnel lenses have been used in new water heaters. The proposed design has two purpose functions, one as solar light collector and the other as interior irradiating. So considering architectural remarks, one cylindrical lens has been used 'Fig.3'.

In order to decrease the weight, increase the tolerance against solar light for a longer time, lower expenses and conserving the architectural conditions, lenses made of PMMA are used. In this model, ceiling light source and lens arrays are used for contrasting at night. Suitable coverings are used for increasing absorption coefficient and decreasing heating for absorber and a window is set up between the lens and

the plate to isolate the absorber plate from outside. Furthermore, in order to prevent the unwanted reflection from two surfaces of the window which wastes energy, irradiated covering is used. Considering suitable absorber covering on the absorber plate made of copper with anodized unclear and the related figures to incidence energy on the lens mouth, we calculate that how much the temperature of this plate increases after one hour.

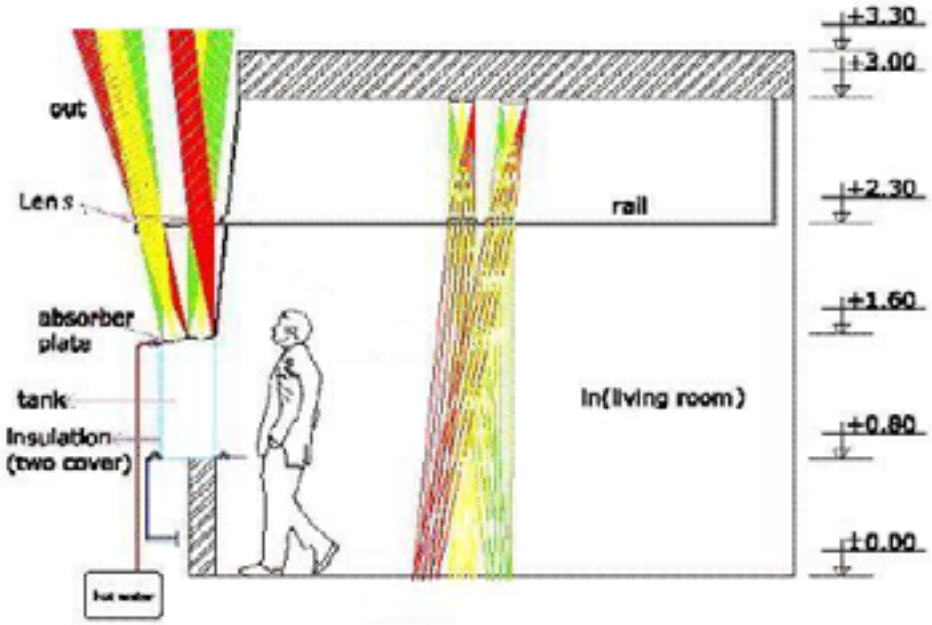

Fig. 3. The design of longitudinal section of solar heater system with irradiating attachments.

2.2. Electric modeling

This system is managed by a microcontroller and a few sensors. We use ATmega16 which meets our all needs. A panel and an LCD monitor has been added to the control system to announce the situation and some warnings or change some of the presupposed amount.

In 'Fig.4' shows different parts of electronic system and the place of sensors as follow:
1- Optical sensor: we use a changeable resistance with light . When the light increases then the discharge voltage increases and it stimulates micro controller. A potentiometer is used for changing sensitiveness.
2- Lens location sensors: Each one of them is a micro switch they have been used to specify the start and finish route inside the room.
3- Motor: We use a left /right round universal motor.
4- Sensors of water surface: They have been used in a glass box to specify the water level and they include micro switches which are stimulated by a floating.
5- Temperature sensor: To specify temperature and prevent to cause high and critical temperature in the box.
6- Magnetic tap: Controllable tap with electrical current which is controlled by micro controller and temperature output sensor.
7- Water level sensor for announcing of filling output tank.
8- Decorative lamps.
9- Thermostatic tap.

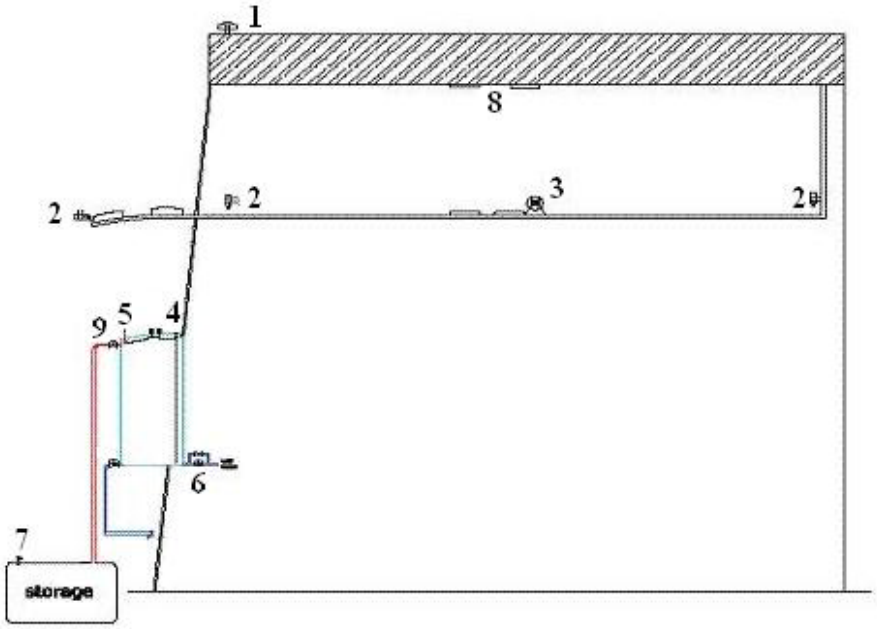

Fig. 4. The details of electronically system.

3. Conclusion

In our design, the lens quality is used for two purposes:

1- To concentrate the sunlight in order to heat water

2- Irradiating at night to make the interior space more beautiful

This system can be used separately in each unit in different floors in a building. We can increase the number of them in the southern part of the building considering the width of the system so the produced warm water will be more and the interior space will be more beautiful at night as well. Since the main tank is transparent, so the person will not have difficulty in vision to the inside or outside of the building. According to the done calculations and experiments, the best conditions for using the solar water heater are as follow:

The amount of incidence energy will be 523KJ on the sensitive plate this amount of energy can increase the temperature of the sensitive plate to 141 $^{\circ}C$ after one hour.

References

[1] Minister of Natural Resources Canada, (2004), Clean Energy Project Analysis: Rescreen Engineering & Cases Textbook, Canada.

[2] R. Winston, I. M. Bassett, W. T. Welford, and R. Winston, “Nonimaging optics for flux concentration,” Progress in Optics, E. Wolf ed., North-Holland, Amsterdam, 27 (1989), 161–226.

[3] R. Winston and W. T. Weldford, (1989), High Collection Nonimaging Optics, Academic Press, NY.

[4] Shilpa Nandi and Susheela Sawkar "Intensity of Artificial Lighting in Living Room and Study Area of Urban Residential Homes in Dharwad City", J. Hum. Ecol. , 21(2007) No.1, 63-64.