

## Design and Fabrication of Solar Water Heating System with Green House Effect

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**Abstract:** A sun beam is transparent but it is having full of energy responsible for circulation of air, weather and all life is possible only under the sun. The total sun radiation reaches the earth may goes back to universe, if not absorbed and retained by the atmosphere due to green house effect. Solar water heating systems are now being used widely for domestic and commercial applications. Because of geographically tropical and also eco friendly, solar energy has to be developed further technically, solar energy is the best choice over the other unconventional energy sources. Solar energy absorption and retention requires technical skills for the development of the equipment. Black body radiation, green house effect by double glass system with recirculation of air is being planned to develop the equipment.

The present work is aimed to develop the solar water heating system for multiple domestic applications. The bore water is being used for the water source for evolving the hot water for bath and cooking, warm and pure water for drinking purposes. Hot air is also worked out for warming the rooms during winter.

**Key Words:** Solar radiation, Green house effect, black body radiation, pure water, hot water

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### I. Introduction

The light spectrum of solar energy in the form of electromagnetic waves first filtered at ozone layer, partly absorbed by the atmosphere and reaches to earth. The solar electromagnetic radiation reaches the earth is subdivided into five ranges namely ultra violet (UVC, UVB, UVA), Visible and Infra red. The solar spectrum of light having different effects on the living organisms, based on its frequency. The solar energy consists of nearly 50% visible light range, 40% infra red range and only 10% of UV range. Infra red range is not visible but is sensed by temperature. All materials and organisms emit infra red light in the form of radiation. Infrared can be blocked by the glass and water vapor. Generally glass is considered as semi insulator for heat transfer. Infrared radiation spans a wide region of wavelengths. At the shorter wavelength end, near visible red, the behavior of infrared light is not that different from visible light. This radiation, called near infrared, does pass through glass. it is not absorbed by the glass. It's energy is too large to excite atoms in molecules to higher vibrational states. It is also the radiation absorbed by CO<sub>2</sub> and causes the green house effect. Infrared radiation is a form of light, not heat. Heat is transferred by molecular collisions and is relatively slow. Infrared radiation moves at the speed of light and is fast. We associate infrared light with heat only when it interacts with matter and excites vibrational modes of motion of atoms in molecules. In order for that to happen, a vibration mode must set up an oscillating electric field in the molecule that can couple with the electric field component of the infrared wave. While the nitrogen atoms in N<sub>2</sub> vibrate, they are unable to create an oscillating electric field. Consequently, N<sub>2</sub> is not infrared active. Carbon monoxide, CO, is a polar molecule and therefore will set up an oscillating electric field when the carbon-oxygen bond stretches. It is infrared active

With the raise in temperature of the metals the colour of the heated material gradually changes from a dull red to bright white. This is the phenomena of radiation and light is a form of radiation and heat also a form it. All kinds of radiation heat, light, radio waves, and x rays etc. are manifestations of the same electromagnetic radiation in wave form. The schematic wave has four properties amplitude "A", wave length " $\lambda$ " frequency " $\nu$ ", velocity " $v$ " cm/sec. frequency  $\nu = v / \lambda$  The important properties of waves is their capacity for interference making dark and bright bands. Another property is the diffraction and capacity to bend around an obstacle and in the process the wave also divide into two.

The wave length of radiation varies for different applications. The radio waves are of greatest length, the thermal radiation is of shorter wave length 1cm to 10<sup>-2</sup> cm. waves of visible light are still shorter 4x10<sup>-2</sup> to 8x10<sup>-2</sup> cm The shortest wave length are those of "X" rays from 10<sup>-7</sup> to 10<sup>-9</sup> cm All these kinds of radiation propagates at the same velocity that of light C= 3x10<sup>10</sup> cm/sec. The frequency of each kind of radiation  $V=C/\lambda$

The simple experiment performed by the Newton passing the sun light through a glass prism and

observing the seven colour spectrum. It is also noticed that the spectrum of light depends on the material present at the source of light. It also explains about spectrum of light diffraction of different frequencies of radiation with prism media. The greatest amount of energy carries by UV light and less of infra red light generally called as heat waves. The atoms of the materials, liquids and gases of mass vibrate and collide with the increase of temperature. From the Stefan Boltzman work found that with a rise in temperature the total amount of radiated heat grows very rapidly proportional to the fourth power of absolute temperature of the body. Thermal radiation consists of rays of various wave lengths. If we change the temperature the spectral composition also changes. From the works of Wein at the same temperature different materials radiate differently.

**Block Body Radiation:**

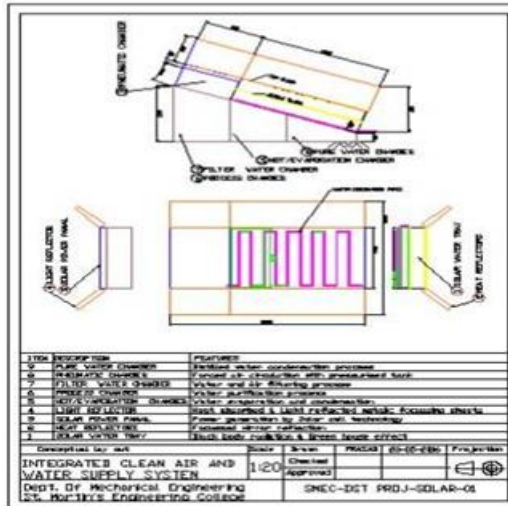
Kirchoff established in 1859 the ratio of the emissive power of bodies to their absorptive power is a universal function  $U=U(V,T)$  independent of the nature of the bodies. As per Max Plank the amount of heat the atoms receive from outside equals the amount of energy  $E_{vib}$  of the atoms is proportional to the absolute temperature  $T$  so  $E_{vib} = kT$  where  $k=1.38 \times 10^{-16}$  ergs /degree is the proportionality factor called Boltzman's constant. Radiant energy increases with frequency  $E_{rad} = hv$  where "h" is the Plank constant,  $h=6.62 \times 10^{-27}$  erg/sec.

**II. Methodology**

It has been proposed to design a solar water heating systems by utilizing the "greenhouse effect" to collect the sun's energy. Sunlight is transmitted through the double glass system and absorbed by the black body collector and transfer the radiation energy to the water media. The evaporated water vapor along with gases due to impurities in the water can act as the green house effect and improves the temperature of the water further. Glazed black and blue steel chips also used to absorb more solar energy in line with black metallic coating of the heating chamber.

The chamber is sloped at  $18^0$  to collect more solar energy. The Dia 12mm blackened GI pipes are used to collect radiated heat transferring to the hot water circulation. The input water is filtered to minimize the particles present in the bore water. Filters are also used for warm drinking water. The distilled water is collected through condensation process. The hot air is collected by the recirculation of air with small fans worked by the solar cells. Some of the critical components have been fabricated in-house employing readily available materials. Proper care has been exercised in the process so that the required effects were met and their assembly results in perfect equipment as proposed.

**Fig-1** Schematic view of the Solar Water Heating System



**2.1 Components And Materials Used**

Major components used in this equipment are fabricated chambers with GI sheets, GI pipes and pipe connections. Copper mesh with charcoal filters to free the bore water from dust particles and some of the bacteria present in the water. Bore water and open air. Solar cells are used to run the fans for the circulation of air and water vapor. Plain sodium glass is used to trap the solar radiation. Rubber packing's and insulating materials are used appropriately.

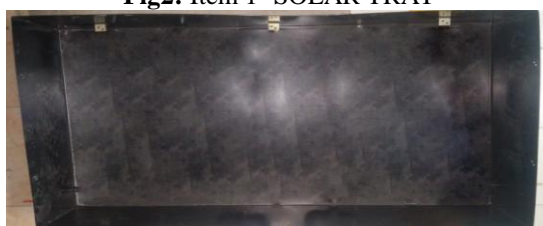
### **Design Philosophy**

The Solar Water Heating System with Green House Effect is designed and fabricated as a prototype model. The assembly drawings followed by part drawings are made considering the locally available standard materials. To increase the effectiveness of absorption of solar energy different techniques are adapted in the design. Namely 1) double glass system to retain the radiation of the black body, 2) The basic chamber and the pipes and pipe connections all black metallic coated for black body radiation effect. Dark blue and black steel chips are used to improve the black body mass for higher radiation effect. In the basic design heat reflectors are planned to concentrate the solar energy for extracting the higher temperatures. After analyzing the basic equipment the reflectors are going to be attached for further analysis. The important green house is developed with evaporation of water vapor and also evaporation of water impurities makes as gaseous atmosphere to retain the radiation energy. The outcome of all these techniques results in extracting hot water, warm water, purified water and hot water.

### **2.2 Fabrication Processes**

The equipment is developed with sheet metal fabrication using the GI sheets, pipes and pipe connections. The main chamber Fig 2.695x1100x265 mm is fabricated and placed on the floor at 20° to receive the optimum solar energy for the sun radiation.

**Fig 2: Item 1- SOLAR TRAY**



Filter chamber Fig 3 is made with rust free GI sheet, black powder coated is fixed at the top of the main chamber. The water is filtered and maintained the water level for preparing the warm drinking water and part of it evaporated for maintain the green house effect.

**Fig 3: Item 2- FILTER CHAMBER**



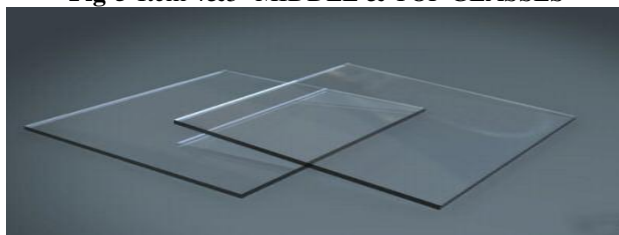
The blackened GI pipe assembly is used to heat the circulated gravity associated water connection. The pipe assembly is fixed on the main chamber with couplings.

**Fig-4-Item 3- PIPES ASSEMBLY**



Double plain glasses are fixed one above the other with rubber packing. The glass chamber is provided a space of 135mm.

**Fig-5-Item 4&5- MIDDLE & TOP GLASSES**



**Fig-6-Item 6- BASE**



Base structure item-6 is developed with angles to fix the main chamber and located inclined at  $20^{\circ}$  to the floor. A pure water chamber item-7 is built with anti corrosion GI sheets fabrication and placed at bottom of the main chamber and the condensed water vapor is collected and supplied by separate pipe connections.

**Fig-7-Item 7- PURE WATER CHAMBER**



**Fig-8-Item 8- BLUE & BLACK STEEL CHIPS**



Two fans are used for recirculation of water vapor and other gases to increase the green house effect.

**Fig-9-Item 9- RECIRCULATION FAN**



**Fig-10-Item 10- SUB ASSEMBLY**



Solar panel is used to develop the required dc input to run the recirculation fans .The solar panel is fixed at the side of the main chamber.

### **2.3 ASSEMBLY**

Figure-11 shows the total equipment assembly with all the parts and sub assemblies of the equipment.

**Fig-11- FINAL ASSEMBLY**



### **III. Experimental Details**

The Input water connection is given from the over head tank to circulate water by gravity. The out let hot water pipe connections are given to kitchen and to the bathing purposes. Pure and drinking water supply connections are given to the kitchen. Hot air pipe connections for room warming are to be developed further. The green house effect is tested with double glass system and the formation of water vapor is observed during process. The taste of the pure water is similar to distilled water. Whereas the warm water taste is normal. The maximum water temperatures are measured up to 75<sup>0</sup> C during the summer. The double glass system is trapping the radiation much effectively and due to that improvement of water heating system is observed by about 5%.

### **IV. Results And Discussion**

- 1) The basic prototype with double glass assembly tested with input water supply.
- 2) The water temperature 75<sup>0</sup>C is observed consistently in the summer months.
- 3) The distilled water is collected in the bottom chamber and evaporation and condensation process is observed significantly.
- 4) The double glass chamber is with water vapor and is cleared by air circulation with fans and improved the condensation process.
- 6) The steel chips (black& blue) are increasing the capacity of the black body radiation effect
- 6) All the assembled equipment is functioning as per the designed aspects.

### **V. Conclusions**

1. The proto type of solar water heating system is designed and developed and tested for its performance.
2. The hot water temperatures are obtained much above the commercial models available in the open market.

3. The multipurpose utility functions are tested and obtained as per design aspects.
4. The double glass system is effectively working to trap the radiation with green house effect.
5. The black and blue chips are absorbing and dissipating the heat to the water effectively.

#### **VI. Future scope:**

- 1) The preliminary functioning of the equipment is only tested and further experimental work has to be conducted for the optimization of the proto type
2. To improve the capacity of the equipment all the functions of solar heat absorption techniques are to be optimized by vigorous experimentation and research work.
- 3) The size and shape of the prototype can be made more effectively..
- 4) The reflectors can be tried out to increase the temperature of the water further

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