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A Review on Various Parameters and Aspects of Solar Water Heater

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Abstract

Solar water heaters are the heaters which uses the incident solar photon radiation for generating heat and then it converts it into heat energy. The heat which is generated through this thermal energy source can be used for various industrial and household applications. There is a rapid growth seen in the market of Solar water heater by 15% annually. Also, the government of India has a target of 20 million unit's production by the end of the 2020s for the Solar Water Heater collectors. As this is one of the non-conventional sources of energy, it also decreases our dependability on the fossil fuels as solar energy is in abundance. It is also eco-friendly and will contribute on that aspect also.

Keywords: Solar Water Heater, Solar energy, Absorber

Introduction

Solar water heating (SWH) system has the following components. These are

1. solar thermal collectors
2. connecting pipelines
3. water storage tanks
4. the circulating water system

The radiations that are comes from the sun's energy is converted into heat, and this heat is then transferred to the collectors. The sun rays that are falling directly on the collector tube results in the heating of tubes. The water present inside the tubes is allowed to pass through heated tubes which leads in the change of temperature of the fluid. This liquid inside tubes get heated up, and the temperature starts to increase. The Solar water heater is a plan that does not have any fuel consumption, so that makes the annual cost for the operation a lower side, so we can say that due to saving the cost of operation of the same is one-third as compared to the fossil fuel. The reimbursement period of Solar water heater is around 5-6 years.

India is considered as a tropical country having abundant sunlight that is solar energy which offers the most real-world solution for reducing growing energy demand. India is the individual country in the world which has an independent Ministry for Renewable Energy which is known as Ministry of New and Renewable Energy (MNRE). The cost of electricity per unit will double shortly, and it cannot be met only by thermal, wind, hydropower plants because they are not reliable. Solar Energy is entirely reliable. India guarantees many sunny days, plus the system used is very efficient. Solar power energy

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can be used in different ways. Its main advantage is that it can be incorporated with any device that runs on electricity. It can provide us with hot water, can run refrigerators, televisions and any other appliances. Not only at home, but solar power also has application even outside the house like street lights, solar powered boats, vehicles, and many other things. Also, the government has taken steps to help people by providing financial support. This is done to reduce the effect of pollution. Many researchers have done a lot of work in this area. Some of the contribution done by various researchers are given below.

Research done on Solar water heater by various researchers:

Bhargava [1], examined the solar water heater (SWH) which is based on Phase Changing material. The main objective of this was to deliver the hot water throughout the day by introducing such kind of material which changes phase for storing solar energy. Due to the addition of the Phase-changing material, the water temperature during the day hours rises which is done due to the increased thermal conductivity of the solid-liquid phases of the materials. The calculations are taken out for three different materials: P116 Wax, $Na_2SO_4.10H_2O$ and $Na_2HPO_4.12H_2O$.

Khan et al. [2], made the water heating system coupled with glazed and unglazed collectors at Bangladesh. The key goal of the study was to find out how the glazed collector gives high performance than the unglazed collector. During the testing stage, the effectiveness of the glazed collector got improved by around 70% than the unglazed collector.

Zeghib & Chaker [3], had studied the outcome of experiments done regularly for a domestic solar water heating system fitted in Constantine. The collector was having a surface area of $2m^2$ and a storage tank of 200 litres capacity. February was taken for the testing purpose since it considered as the best time. The unique simulation program was used for interpretation of results which is written in a programming language named as Fortran.

Runqing et al. [4], gives a summary of the growth of the solar water heater industry in China by the market information collected from the year 1998-2009. Some policies were introduced to accelerate the development of the SWH industry. The first policy was implemented in 2007 which includes the compulsory fitting of the solar water heater, and the other policy was made in 2009 which involves the subsidy schemes on solar water heaters.

Sampathkumar & Senthilkumar [5], had done an experimental study based on the operation of the solar water heater placed in single basin solar still. They found that solar distillation method is best for supplying fresh water to rural societies. The chief objective of this investigation was to efficiently employ the solar energy used for a water heater for solar still production enrichment. At last experimental study was finished by comparing solar radiation with collector efficiency on a solar still. The modification improved the yield by 77%.

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Mustafa et al. [6], has done the innovation on collectors to raise the overall performance of the solar water heater. They have used the sum of three layers of glass cover instead of two and one layers. The chief objective was to find or develop new-fangled models that might increase the efficiency of the SWH. They directed the investigation using the experimental methods in which they test the amount of cover glass, flow rate and preheating of water. They found that if the flow rate of water increases and initial heating on the received water, causing the water departure temperature to be higher which leads to the upsurge in the effectiveness of the solar water heater. The schematic view of solar water heater as described by him is given in the below figure.

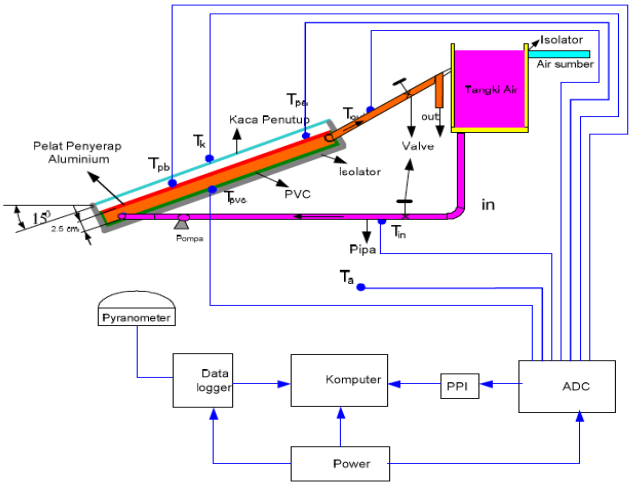

Fig.1. Schematic view of Solar water heater as shown by Mustafa et al. [6]

Sun, Xu & Ding [7], a companion study is being performed in the different methods for the prediction of the values of the solar water heater plant which works on the seasonal water tank. The methods used are temperature stratification method, numerical method and the uniform temperature method. For the comparison, we can see that the numerical method has a very long time which is approx. Four to five weeks whereas the temperature stratification method shows the results similar to the numerical method in the duration of two to three hours. However, the variation in the uniform temperature method is very high which makes it unsuited for the predication propose.

Kulkarni & Deshmukh [8], the energy cannot be stored directly that is coming from the sun, and the solar water heater can only work at a perfect at the day time but not at night. This problem could be resolved with the help of a phase change material (PCM). In the phase change material (PCM) the heat that is coming in the form of radiation from the sun is being stored in the PCM which is done due to the phase change. When the heat is supplied, they change their phase and this phase change store an amount of heat in it.

Li et al. [9], the studies are being performed based on the position of how the immersed coil is present on the in the heat exchanger. The efficiency of the discharging and charging is also compared. The

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charging efficiency is how much water is being entered through the inlet whereas the discharging efficiency is the amount of water that comes out from the collector. The positions are being kept the bottom, top and the centre at the water tank.

Ling et al. [10], in China there is an application of the system in which the collector that is a flat plate is kept in the balcony at around 65 degrees. The experiment is being performed in the sunny condition so that the maximum amount of the heat can be absorbed. The radiation that is coming from the sun is having a sweet absorption when kept at the inclination. The inclination helps in the heat gain factor and a lot of increased factor with the inclination when the atmospheric temperature increases this led to the decrease in the temperature drop in the water tank.

Khan et al. [11], developed the prototype of a new solar water heating system that can be used for small-scale household purposes. This system converts the incident solar radiation into heat and then diffused it into the water. They examined the thermal efficiency in different seasons. Thermal efficiency was around 29% in summer, 14% in winter, and 15% in the rainy season.

Hossain et al. [12], examined the low-cost, flat plate (SWH) for financial analysis and thermal efficiency. The device they used has two side snake flow which is parallel. This system is having improved overall thermal efficiency when compared to other systems, and it has low-cost creation, and its fabricated is also not a bit complex. They have used copper elbows which are 68 in total and they all inclined at a right angle.

Yoo [13], examined the operation of SWH for three years that is installed in the housing complex. This collector was installed on the rooftops of the buildings. This study also provides feedback for the conventional design baseline. The accumulated heat gain from the three-year operation was 52%.

Oliy & Ramayya [14], has done experimental testing of a Serpentine Flat Plate Solar Water Heater. The primary goal was to improve the thermal performance of collectors using a striped technique. The striped mechanism was applied on the absorber plate to diminish thermal fusion in the plate and to enhance the practice of energy conversion from the collector to water.

Urban et al. [15], in this study the different solar technology is being evaluated which can be namely defined as the photovoltaic and solar water heater. This all makes a low carbon emission which led to greater use in the country. This type if constructions are being mainly followed in the smaller based town or the village due to the space requirement that is a lack in the urban city.

Zhao et al. [16], The solar water which is having a phase change material have a broader set up to be installed since it is having a combination of two tanks one for the water and one for the phase change material. Also, the problem can be seen in the specific heat loss that causes an unstable system of performance.

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Conclusion:

So many researchers have contributed in the area of solar water heater. From the review done by various researchers on solar water heater, it can be concluded that the heat transfer capacity changes and get enhanced by taking different type of collectors and also by changing its orientation. The effectiveness and efficiency can further be enhanced by taking phase change material (PCM) for its operation. Also, by tilting at some well-defined angle, the properties can further be enhanced.

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