International Journal of scientific research and management (IJSRM)
||Volume||1||Issue|| 2 ||Pages|| 90-93||2013||
ISSN (e): 2321-3418

An Analytical Review On Solar Water Heater

P.Vijay[1] K.Raja Sekhar[2] E.Srikanth Reddy[3]

Mechanical Department K.L. University

ABSTRACT

Solar water heater has comprehensive variety of functions in homely as well as industrial category requirements of hot water. According to Renewable Energy Policy Network data (2011), more than 90 million people feel necessity for daily use of hot water. Solar water heater is not only eco-friendly but desires minor maintenance and operation cost compared with any other solar operating devices. It also consists of very low energy payback of 2 years to 3 years time. Generallysolar water heater is consists of two types so called active solar water heater and passive solar water heater. This review explains about researches conducted on solar water heater by various researchers of the world.

Introduction

Solar water heater is a device which mainly used for heating the water. In is operated by sun, hence it is called as solar water heater. It is consists of various components like absorber plate, casing, pipes, storage tank etc. It is widely used in industrial as well as domestic. There are various industries, which require water temperatures of more than 50 degree or up to 70 degree Celsius, at that time; solar water heater is a feasible solution. Because it increase water temperatureup to 70 degree Celsius. There are various researchers have made on solar water heater to increase efficiency or effectiveness of solar water heater. In all researches more than 90 percent researches have made on absorber plate, because it is very useful part of solar water heater. Fig.1 shows actual figure of solar water heater.

Fig.1. Solar water Heater

2 Solar Water heater Systems

Solar water heater system possess many advantages includes it does not require any cost of electricity. It has also very low running cost as well as maintenance cost. All the solar water heater systems are broadly classified as Active solar water heater and passive solar water heater. In passive solar water heater, only solar energy is used to increase temperature of water but in Active solar water heater, not only solar energy but also some mechanical force is required to increase temperature of water. Fig.2 shows simple line diagram of passive solar water heater.

2.1. Passive solar water Heater

Passive solar water heating systems depend on heat driven convection to circulate water or heating fluid in the system. These passive systems can be divided into the two main categories, the integrated collector storage and the thermosyphon SWH systems. Integrated collector storage solar water heaters (ICSSWH) use a tank that acts as both a Storage and solar collector apparatus. This system is also popularly known as a batch SWH system. One of the

Simplest designs of ICSSWH system is in which a simple tank is enclosed with a glass cover such that it performs as a collector as well. However, one of the main drawbacks of this design is the heat loss, which is more pronounced at night

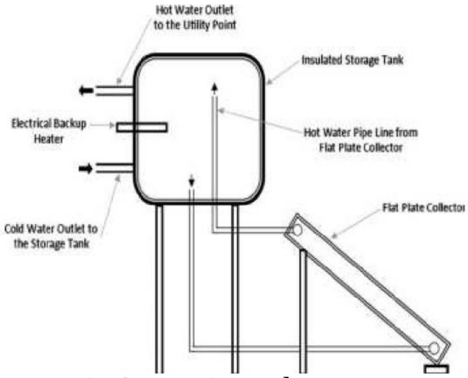

Fig.2. Passive solar water Heater

The first detailed study on closed and exposed single tank systems was carried out by Brooks at the University of California Agricultural Experimental station in the US in 1936 .While the investigations showed promising potential, further research was eclipsed by the increased use of natural gas and oil in the US, but the research in solar water heating gained momentum in Japan

Prime requirement of every solar water collector is to increase efficiency of solar collector, which is also a part of solar water heater. To increase efficiency of solar water heater, researchers have introduced reflectors in order to maximize the solar radiation incident on the absorber surface. Reflecting concentrator designs can be either flat or curved, line axis, symmetrical or asymmetrical depending on the main concentrations. Davis et al. developed a symmetric cusp reflector ICSSWH system particularly to suit Colorado’s cold weather conditions, and found that the collector efficiency can reach as high as 72%. Stickney and Nagy designed an inverted ICSSWH system which consisted of a glass lined tank enclosed in insulation with a double glazed aperture facing downward to collect the reflected solar radiation from the parabolic reflector. This accomplished increased heat retention during night and affected the increased daytime temperatures. Yet another design focusing on insulation was introduced by Schmidt et al., comprising of a pressure-resistant single tube absorber which was integrated to an involute reflector that enclosed a transparent insulation material. This type of ICS system could achieve an overall annual efficiency of 28% and an annual solar saving facto

Numerous analytical and experimental studies have been intensively carried out on the thermosyphon SWH system to analyze its performance. Fundamental models to estimate the thermal performance of the natural circulation for SWH systems were developed to predict the heat gain in the thermosyphon-driven SWH, when subjected to no drain-off conditions. The models were validated with experimental data. Yet another mathematical approach utilizing ‘‘finite-difference method’’ (FDM) was carried out by on to evaluate the thermal performance of a natural- recirculation SWH system. However, the measured experimental data were contradictory to the theoretical predictions. Hence, the model was modified by taking into account the experimental conditions and used the FDM to predict the gain in the temperature at a given time step. Similarly, Sodha and Tiwari used explicit expression to analyze the performance of a SWH system with natural thermosyphon circulation between the storage tank and the collector. The results confirmed that the SWH system’s performance can be predicted accurately by using simple explicit equations.

2.2. Active solar water Heater

Unlike passive systems, active systems use one or more pumps to circulate the working fluid in the system. Active systems can be categorized into direct circulation and indirect water heating systems. In the direct or open-loop systems, water from the storage tank is directly circulated to the collector to be heated by solar energy, whereas in the indirect active system the heat transfer fluid is circulated through the collector and rejects heat through a heat exchanger to the water in the storage tank.

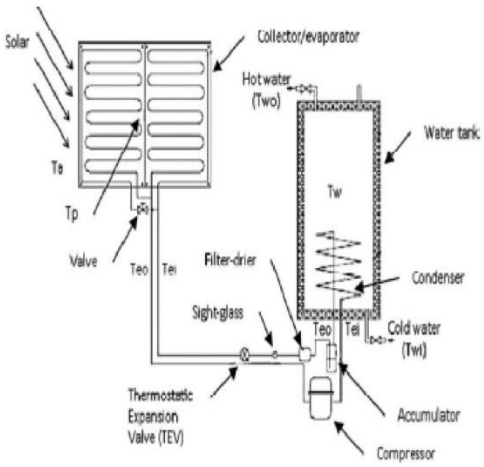

Fig.3. Active solar water Heater

In general, direct heating systems are commonly employed in regions with ample sunshine and experience moderate ambient conditions. For regions with less sunshine hours and low ambient conditions, indirect water heating systems are employed. These systems are reliable in operation and ensure effective freezing protection. Heat transfer fluid (HTF), such as ethylene glycol and other refrigerants is circulated between the collector and the storage tank through the heat exchanger. Indirect SWH systems operate on a heat pumps (HP) mode, to supplement the solar energy gain in the collector. These HP based SWH systems have shown several design improvements during last 20 years. The hot water is generated utilizing waste heat or other low temperature sources, in which an exclusive working fluid is circulated in the collector and the heat gain isrejected through a heat exchanger to the storage-water. The solar assisted heat pump is a commonly used type; however one of the challenges is that its performance is very low when the ambient temperature is low. There exists numerous studies related to the indirect mode of SWH systems to improve its performance, and some of the recent research is discussed.

Alonefrom heat pumps, heat pipes are also imported to reinforce the system's performance. A heat-pipe water heater is formed and tested by Huang et al. The performance of the combined solar heat pipe collector and conventional HP were examined to calculate the overall COP of the system. When solar radiation was low, the system operated in HP mode. However, during clear sunny days, the heat-pipe mode operated independently of electrical energy input, for higher thermal efficiency. The results showed that the COP of the hybrid-mode of operation could attain as high as 3.32, and as such its performance was higher by about 28.7% compared to the HP mode of operation.

3 Collector Types

Design of the collector is also a very important point in designing of solar water heater. Because, if collector temperature is low then difference between inlet and outlet temperature is also less hence efficiency is also less. Because efficiency of solar water heater is directly proportional to the temperature difference between inlet and outlet temperature. Generally flat plate collector and evacuated glass tube collectors are mainly used.

Flat Plate Collector

Solar collector concepts instantly being refined, to almost some extent simple flat plate solar collector was found the minor applications still due to its lower temperature difference. Its characteristics are noted, and compared with other collector types, it is the simplest and least expensive to assemble, install, and maintain. It is capable of using both the widespread and the direct beam solar radiation. For homely and industrial use, flat plate collectors can produce heat adequately at high temperatures to heat water in swimming pools and buildings; they also can produce a cooling unit, exceptionally if the incident sunlight is enlarged by the use of a reflector. Flat plate collectors freely attain temperatures of 50 to 70ºC. With accurate engineering using majorsurfaces, reflectors to enlarge the incident radiation, and heat-resistant materials, over operating temperatures are feasible.

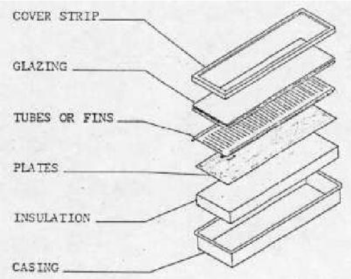

Fig. 4 Components of flat plate collector

Evacuated glass tube collector

A solar collector which is capable of achieving a high temperature range between 77 to 177 degrees Celsius will work efficiently under these circumstances. However, flat plate collectors are almost half less in price than the evacuated tube collector. They are well suited for many kinds of applications such as industrial cooling and heating applications.

They can be an efficient backup to flat-plate collectors for homely space heating, especially in regions where it is cloudy. For home purpose hot water heating, flat-plate collectors look to offer a cheaper and more reliable option.

4. CONCLUSION

After signing the Kyoto Protocol, the research on renewable energy has become progressively important. To convert solar energy into thermal energy SWH (solar water heating) is one of the best compelling technologies. This technology can be commercialized and developed across the world. Despite this there is a large scope of developing the system to increase the performance and the efficiency of the system. We have already presented the primary design feature and some technical advancement regarding the energy efficiency and cost effectiveness of SWH system. Numerous designs of solar water heaters have been introduced into the market and these are being utilized in tropical regions of developing countries. The developments in heat pump based solar collector technology illustrate an assuring design for utilizing the solar energy as a dependable source for heating water in some solar adverse regions. This technology is influenced by many sustaining factors like nature of the refrigerant.

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