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Experimental Study of Solar Water Heater

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Abstract: In recent years solar energy has been strongly promoted as a viable energy source. One of the simplest and most direct applications of this energy is the conversion of solar radiation into heat. The domestic sector can lessen its impact on the environment by the installation of solar flat plate collectors for heating water. Renewable energy is also important for replacing the use of electrical energy generated by petroleum. Energy consumption from petroleum must be reduced because of the limited petroleum resources and their contribution to pollution in the earth. Solar power has become a source of renewable energy and solar energy applications should be enhanced. Solar water heating system is a practical application to replace the use of electrical water heater. Now a days, plenty of hot water is used for domestic, commercial and industrial purposes. Various resources i.e. coal, diesel, gas etc., are used to heat water and sometimes for steam production. Solar energy is the main alternative to replace the conventional energy sources. The solar thermal water heating system is the technology to harness the plenty amount of free available solar thermal energy. The solar thermal system is designed to meet the energy demands. More research is needed to increase capability and reduce production costs of solar water heating system and make the solar water heating system more efficient and practical. The size of the systems depends on availability of solar radiation, temperature requirement of customer, geographical condition and arrangement of the solar system, etc. Therefore, it is necessary to design the solar water heating system as per above parameters. The presented work focuses on the construction, arrangement, testing and evaluation of the performance of a solar water heater system.

Keywords: Solar Energy, Daily Temperature, Radiation, Solar Collectors, Collector Efficiency.

Introduction: The need for renewable energy has been recognized globally as population and the demand for fossil fuels increase. The depleting resources of fossil fuels and increased costs have led to the development of new and technologically advanced renewable energy sources. With the government committed to increase the use of renewable sources of energy, they will slowly replace the use of some fossil fuels. The country as a whole is over reliant on imported gas, coal and oil. Solar water heating production has become more appealing in recent years on a global level; however it has been less popular in India to date on commercial projects. With the over reliance on fossil fuels for energy production, the Indian Government have realized the need to research and develop this area further. With India's dependency on fossil fuel in mind, solar water heating, where water is heated directly from the energy of the sun is becoming an increasingly attractive option.

Research Objectives: In this research we have built a flat plate collector solar water heater and did some experiments to evaluate its performance. To evaluate the performance of designed solar water heating system, the following objectives have been established:

1. Calculate the outflow temperature of the system and its suitability to the end use.

2. Study the pattern of daily average temperature and solar radiation.

3. Evaluate the effect of number of riser tubes in solar water heater.

4. Calculate the mass flow rate of the system.

5. Calculate the efficiency of the system and the effect of various parameters on the

efficiency.

Overview of Solar Water Heating:

In Japan a simple solar water heater was created consisting of a basin with its top covered by glass; by the 1960's more than 100,000 collectors of this type were in use. In Australia the number of sales grew as a consequence of the two increases in oil prices. In the late 1980's, the Australian solar water heater market began to drop as the discovery of natural gas to previously fuel-short regions, such as the Northern Territory and Western Australia, affected the market for solar water heaters. However exports still account for more than 50% of the sales made by Sol- Hart, Australias leading manufacturer of solar water heaters. In the mid 50's Israeli engineer, Levi Yissar, suggested the use of solar energy for heating up domestic water with Israeli's responding by the mass purchasing of solar water heaters. By 1983, 60% of the population heated their water from the sun. When the price of oil dropped in the mid 1980's, the Israeli government required its inhabitants to heat their water with the sun. Today, more than 90% of Israeli households own solar water heaters .

The history of solar water collectors in Greece started when the first collectors were imported from Israel in the mid 70's. The Greek Solar Industry Association was established in 1978 and the promotion of solar systems started around the same period. The technology of the Solar Water Heaters was largely accepted by the market and small units of 2m 2 were installed in order to cover the needs of a household. In 2001 Greece held the first place in Europe for m 2 installed per capita and the second place in the world . Solar Water Heating systems are generally very simple using only sunlight to heat water. A working fluid is brought into contact with a dark surface exposed to sunlight which causes the temperature of the fluid to rise. This fluid may be the water being heated directly, also called a direct system, or it may be a heat transfer fluid such as a glycol/water mixture that is passed through some form of heat exchanger called an indirect system.

Literature Survey:

P. Sivakumar et al presents heating water for domestic purpose is a simple and effective way of utilizing solar energy. Initial cost of solar water heating system is high. But we get zero green energy cost. This paper discuss improving the performance of a flat plate solar energy collector by changing the design parameters of the number of riser tubes and the arrangement of riser tubes in zig-zag pattern from the existing flat plat collector system. Experiments were conducted using copper tube in header and riser with different dimensions. The performance shows that the efficiency is 59.09% when increasing the number of riser tubes

and its 62.90% in the zig-zag arrangement (Z- Configuration) of the riser tube. Now-a-days this system produces higher efficiency than the existing conventional flat plate collector.

N.M. Nahar performed testing of solar water heater extensively. It has been found that the heater can provide 100 l of hot water at an average temperature of 60.6ºC at 16:00 h when tap water temperature was 23.6ºC, it can retain hot water till next day morning at an average temperature of 51.6 ºC. The overall efficiency of the heater is 57%. Based on performance at Jodhpur, a model has been developed by using ambient temperature and solar radiation for the prediction of its performance at various Indian stations. The predicted performance at various Indian stations revealed that hot water is required at most places for domestic use only during winter season and it can provide 100 l of hot water at an average temperature of 50–70ºC that can be retained to 40–60ºC till next day morning use.

Bukola O. Bolaji presented the design and experimental analysis of flow inside the collector of a natural circulation solar water heater. The water heater was constructed and tested at Ado- Ekiti, Nigeria on latitude 7.5ºN. The results show that the system performance depends very much on both the flow rate through the collector and the incident solar radiation. A typical day analysis of the system shows that collector efficiency is high especially around mid-day when the solar collector receives the highest energy. The results showed that the system exhibited optimum flow rate of 0.1 kg sec m 2 at a maximum collector efficiency of 68.5 %. Also the average daily efficiency of the system was 57.7% and the maximum water temperature obtained was 83.5ºC, while the maximum ambient temperature obtained was 34.5ºC.

V.R.Bhore.et.al describes method for testing a flat plate collector operating under natural circulation mode of heat transfer. The present procedure for the system performance characterization as per the code IS 13929 is complex in nature and is difficult to use. This paper propose a simple method for testing of a solar flat plate collector operating under natural circulation mode in general and that of a domestic water heating system in particular. The method can be used for indoor as well as outdoor testing of the collectors. The method suggested in this paper is simple and can be used with minimum instrumentation and provides absolute performance index with a greater accuracy for direct comparison of the different collectors.

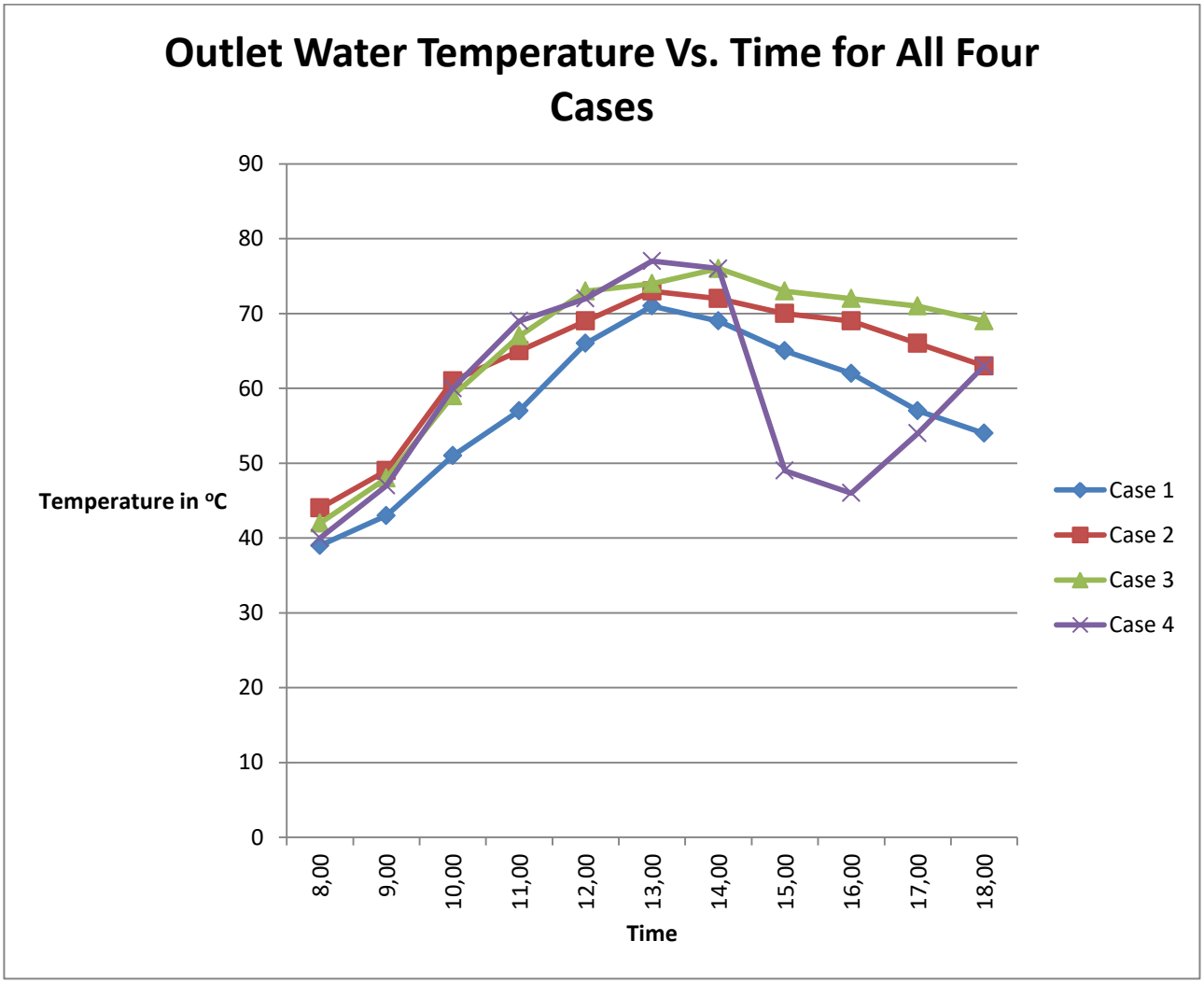
Experimental Setup:

The experimental setup consists of a flat plate solar collector made up of aluminum riser tubes and black absorber surface covered with glass sheet for trapping solar radiation. The aluminum riser tubes are connected to an outer rectangular frame of PVC pipes for circulation of supply water. There is inlet and outlet provided for supply of cold and hot water respectively. There is also a stand provided for providing inclination to the whole setup.

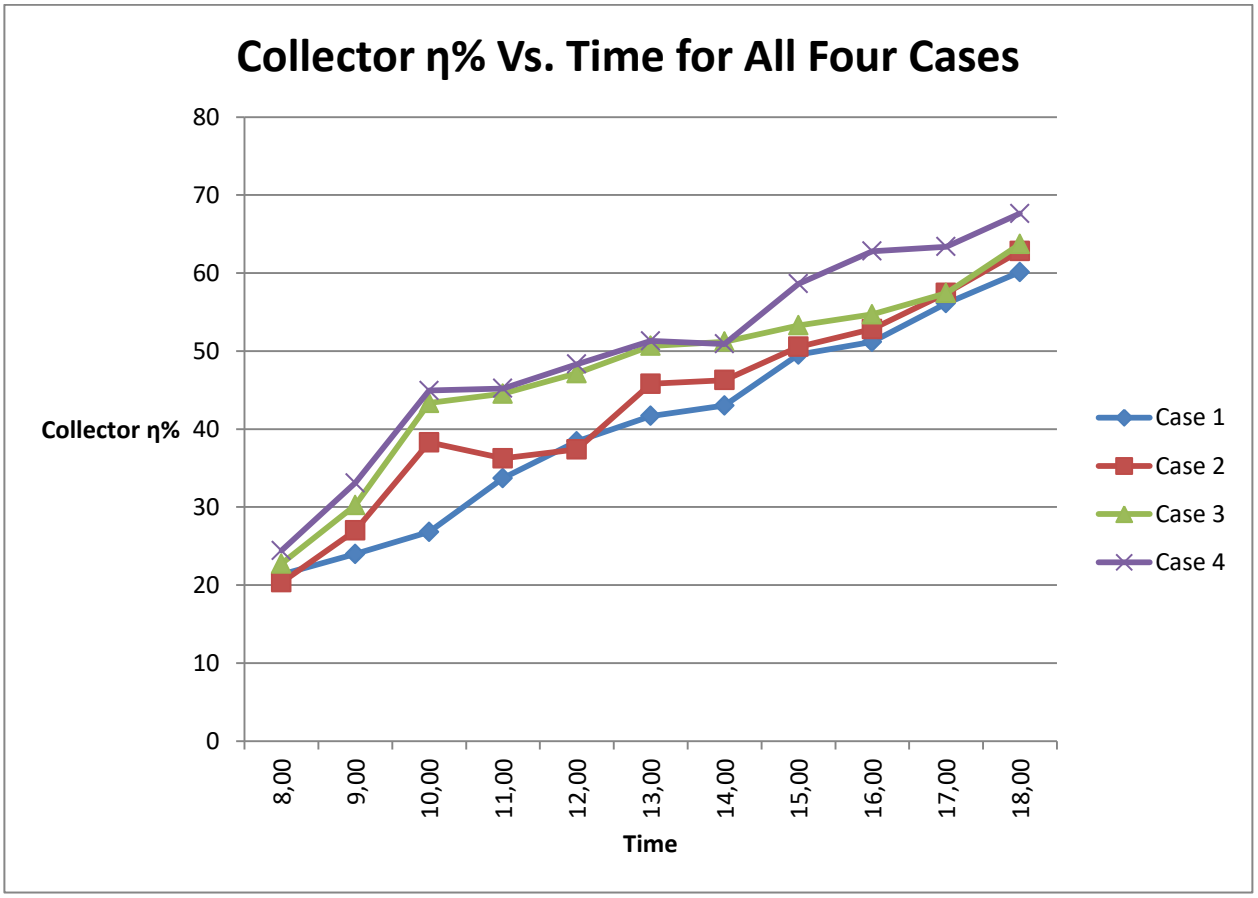
Results and Conclusions:

As we have seen from theoretical and practical investigations that the performance of solar water heater very much depends upon the solar radiation incident on the collector surface. Therefore it is very important to monitor the nature of variation of solar intensity throughout the day. Also it is important to study the variation of average temperatures daily throughout a month, so that we can predict the practical usefulness of a solar water heating system in the Indian scenario.

Variation of Outlet Water Temperature for all four Cases:



Variation of Solar Collector Efficiency for all four cases:



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