iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL
FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 Issue: III Month of publication: March 2018

DOI: http://doi.org/10.22214/ijraset.2018.3174

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

A Review on Modified Solar Water Heaters

Sagar jadhav[1], Anurag Ninawe[2], Abhijeet Dange[3], Akshay Anjikar[4]
[1, 2, 3, 4] *Department of Mechanical Engineering, Priyadarshini Bhagwati College of Engineering, Nagpur, India*

Abstract: In the recent era non-conventional energy is a good gift for a human being. Day to day the use of conventional energy is an adverse effect on nature and hence the use of a non-conventional energy is needed to be advanced. In view of an energy crisis, the application of solar energy in the form of solar water heater is most useful for domestic, commercial and industrial purpose but it was found that due to improper design of panel, the efficiency is reduced and there is a lot of wastage of space during installation. Thus as the whole principle, solar energy could supply all the present and future energy needs of the world on a continuing basis. This makes it one of the most promising technologies of the future among all the unconventional energy sources. One of the most widely known solar thermal applications is a solar water heating in terms of installation expenditures and energy cost over the total life of the system, solar water heating technology has proven to be cost-effective for several domestic and industrial applications. The technological practicability of these systems has long been recognized and it is presently employed in commercial sectors of many countries. This paper presents a review of various types of a solar-assisted water heater and their market potential. Residential solar water heating is a promising age-old technology which has been evolved and developed both in the range and quality of a successful packaged market product .This research mainly focuses on the recent solar water heaters.

***Keywords**: solar water heater, solar energy, non-conventional energy, unconventional energy. etc*

I. INTRODUCTION

In today's climate of growing energy needs and increasing environmental conceal, alternatives to the use of non-renewable and polluting fossil fuels have to be investigated. One such alternative is a solar energy. Solar energy is a clean and abundant energy resource that can be used to supplement many of our energy needs. Solar energy can be utilized as a form of heat such as solar water heating system(SWSH) have been commercialized in many countries of the world including India. Their technical feasibility and economic viability has been established. It is now recognized as a reliable product that saves substantial amongst of electricity or other conventional fuels, leads to peak load reduction and prevents the emission of carbon dioxide as a major greenhouse gas. Thus in the principle solar energy could supply all the present and future energy needs of the world on a continuing basis. This makes it one the most promising or the unconventional energy sources to make the solar energy compatible with the energy sources, research work is going on all over the world. Professionals are trying their level best to make the efficient design of solar collector and apparatus setup. utilize the solar energy in useful form, there are some equipment like a solar water heater, solar cooker, solar dryer, solar photovoltaic cell etc

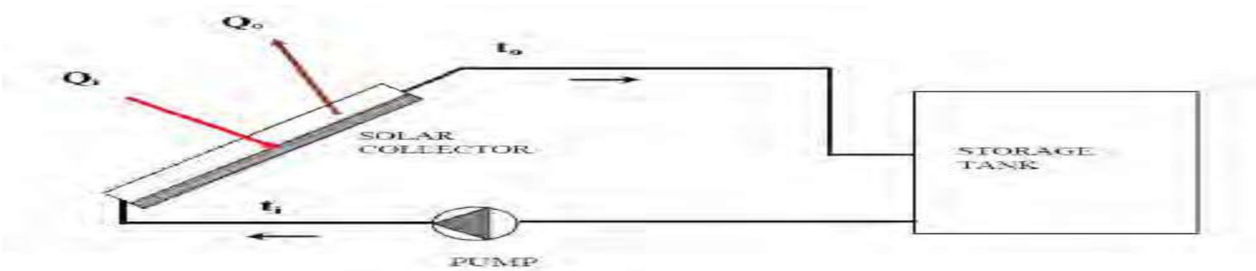


Fig.1 Typical Solar Water Heater

Solar radiation can be widely used for water heating in hot water systems, swimming pools as well as a supporting energy sources for central heating installations. Most solar water heating systems for buildings have two main parts: a solar collector and a storage tank. Solar collectors are the key component of solar-heating systems. They gather the sun's energy, transform its radiation into heat, and then transfer that heat to a fluid. Solar water heating systems can be either active or passive, but the most common are active systems. Active systems rely on pumps to move the liquid between the collector and the storage tank, while passive systems rely on gravity and the tendency for water to naturally circulate as it is heated. A typical solar water system is shown in fig.1 The performance of these solar system is depends on the collector. The collector absorbs maximum amount heat from sun and this energy is used for heating the water. Now a day's many compact design of solar water heater is available. The thermal performance improvement techniques like used of grooved or rough surface absorber is widely used in solar water heater [1][2].

II. A BRIEF HISTORY OF A SOLAR WATER HEATING SYSTEMS

SWH Advanced from hypothesis to a prototype in the year 1767 by Swiss naturalist De Saussure, who built an insulated box painted black at its bottom with two panes of glass covering at the top [3]. He called it' 'Hot Box'',as the invention was capable of aiding in cooking, heating, and producing hot water. the first commercial SWH, named Climax, was patented in the US by Clarence M. Kemp in 1891 [4]. His idea was further implemented as an integral collector storage solar water heater. Kemp placed a metal tank within a wooden box covered by a glass cover at the top part. His system produced hot water(38.8 1C) on sunny days. As an alternative to burning wood or expensive fuel for heating water, the SWH became popular in California and many other states very quickly. A third of all of the homes in Pasadena, California had SWH systems by1897 [5]. In early 1900s,several researchers focused their attention in improving the design of the SWH system to make it durable and efficient.In1909,William Bailey tailored the Kemp's SWH system, by segregating it into two major parts ;the solar thermal collector for collecting solar radiation along with storage tank for storing the produced hot water. Further, to prevent heat losses the storage tank was insulated. the first time in the SWH field, William Bailey introduced the thermosyphon principle to aid the circulation of water in the collector and storage tank [6]. In 1950, Japan's first commercial SWH was designed by Yamamoto by getting an inspiration from a view of a large bathtub, filled with water that was kept outside in the sunshine for a longer period of time. Later, SWH units based on the closed-pipe system were introduced. Solar heated water was utilized for several applications. Until 1930, hot water for domestic purposes and for space heating was mainly engaged by the coal-fired boilers [7]. SWH become a commercial product in the early1960s.A typical SWH is of a thermo syphon kind that uses an absorber area of 3–4m2 flat-plate type solar collectors to energize a capacity of 150–180 l storage tank. One of the popular types of SWH systems is the forced circulation water heating system. Except for solar collectors, other accessory items such as the storage tank incorporate with piping, pump, and differential thermostat are usually kept indoors. Solar assisted systems not only rely on the conventional mode of utilizing energy but also other systems, such as heat pump (HP) and photovoltaic thermal(PV/T).In1927,HP technology was first patented by an English inventor T. G. N. Haldane [8]. However, before the 1960s,due to a record poor reliability of the HP units, the commercial distribution was very limited. Since then, research focus was directed on, and by the year 1970,the HP technology has been improved in quality and reliability. Moreover, the researchers had been motivated to find new alternative energy sources for energy production since the big oil crisis in1973.This further aided the application of HP technology and it became widespread for both heating and cooling purposes. Although solar HP technology has shown higher efficiencies(400–600%)in respective functions, its capital cost is high, and hence it may not be suitable in places where cost of the system becomes a constraint [9,10].

III. LITERATURE REVIEWS ON MODIFIED SOLAR WATER HEATERS

A. Experiment Setup.1

A CARRILLO ANDRE´S and J. M. CEJUDO LO´PEZ†: Investigated on the experiment on new TRNSYS model for solar domestic water heaters with a horizontal storage and a mantle heat exchanger has been developed. Some new features have been added to the standard cost, a cx specific heat capacity of the fluid TRNSYS model Types 45 and 38. Heat transfer inside the tank can be treated with a fixed node approach or a plug-flow approach, including all possible combinations of both approaches. The mantle heat exchanger is modeled by setting the heat balance between the nodes of a discretized external annulus and the storage W/m2 /K tank. The resulting system is solved by a second order implicit method. Inlet mixing is allowed by the definition of a mixing zone around the inlet. The storage tank model has its own time step, independent from the TRNSYS simulation time step. Fluids in the primary and secondary loops can be different (i.e.glycol–water and water). When the model-predicted energy delivered by the system is compared with experimental data results are excellent (less than 3% of error for daily energy). In terms of draw-off temperature, the model reproduces the distributed discharges quite well but shows some discrepancies in large discharges. The one-dimensional model must be improved if tails of discharges want to be matched. Despite this drawback, this model can be used to compute the energy delivered by the fixed system with good precision. It can be concluded that it is better to select distributed discharge profiles, as in the European standard EN12976-2 because they are a better representation of the real operation of the system and allow a better extrapolation of the annual system performance. On the contrary, local standards, such as those used in Andalusia, define large discharges. These are not so representative and more difficult to match with 2one dimensional models. [11].

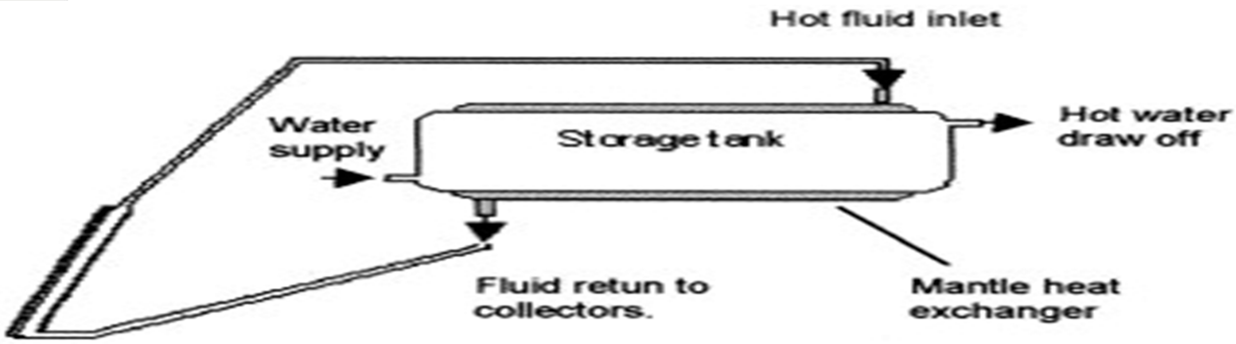


Fig.2. Scheme of a thermosiphon solar water heater with horizontal store and a mantle heat exchanger.

B. Experiment Setup.2

Y.C. Soo Too, G.L. Morrison *, M. Behnia: Performed on the experiments on the characteristics of a solar water heater incorporating a vertical mantle heat exchanger with a narrow annular spacing of 3 mm and a two-pass arrangement has been studied. The measured overall heat transfer coefficient-area product of the narrow gap mantle heat exchanger was found to be 150–213 W/K for flow rates of 2–3.8 L/min. Measurements also showed that the heat transfer in a narrow gap mantle heat exchanger is dominated by forced convection, and the pressure drop across the mantle is minimal.Both measured mantle side and tank side heat transfer correlations were developed and implemented in a TRNSYS model to predict the annual performance of pumped-circulation solar water heaters incorporating a narrow gap vertical mantle heat exchanger. The performance simulation showed that the annual solar contribution for daily and seasonal load conditions in Sydney, as specified in the Australian Standard (AS4232) drops from 79% for a direct-coupled system (stratified routine) to72% for a system with a mantle heat exchanger in the collector loop. The loss of performance may be acceptable given the advantage of freeze protection that the mantle heat exchanger provides, however, with improved heat-exchanger design it may be possible to reduce the heat exchanger penalty by improving tank thermal stratification.[12]

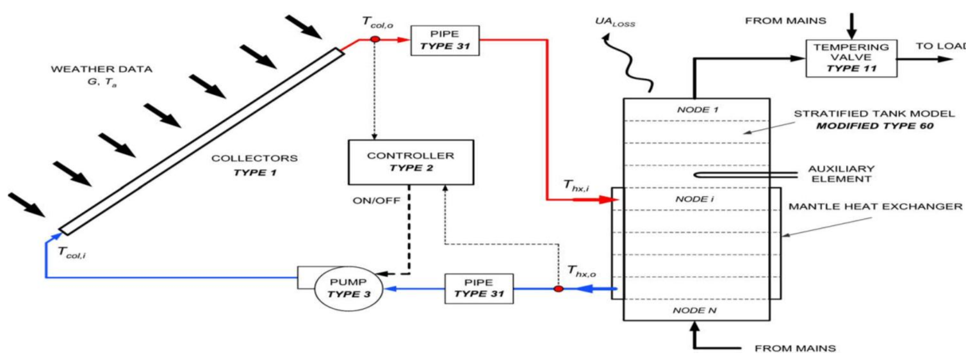


Fig. 3. Schematic of a TRNSYS model for a solar water heating system with a mantle heat exchanger.

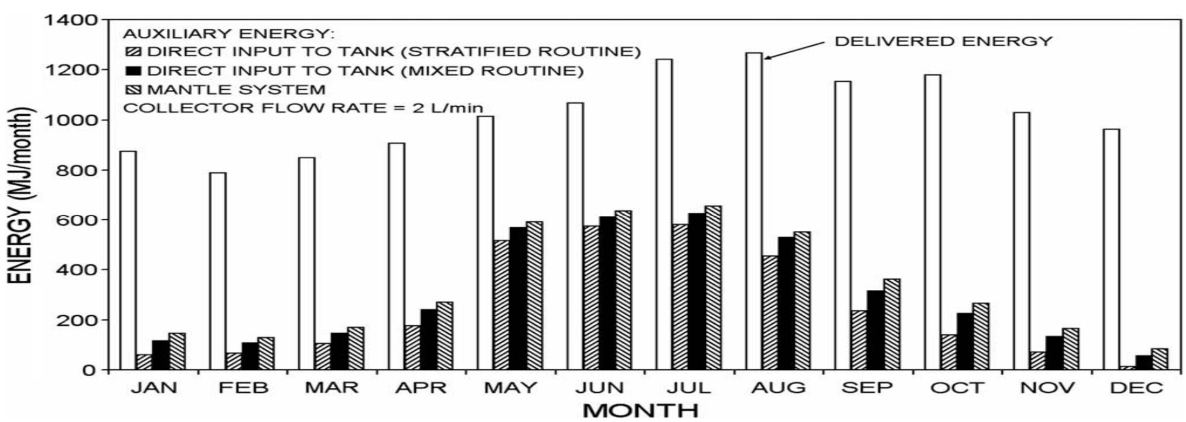


Fig. 4. Delivered energy and auxiliary energy for solar water heaters in Sydney Australia with and without a collector loop mantle heat exchanger.

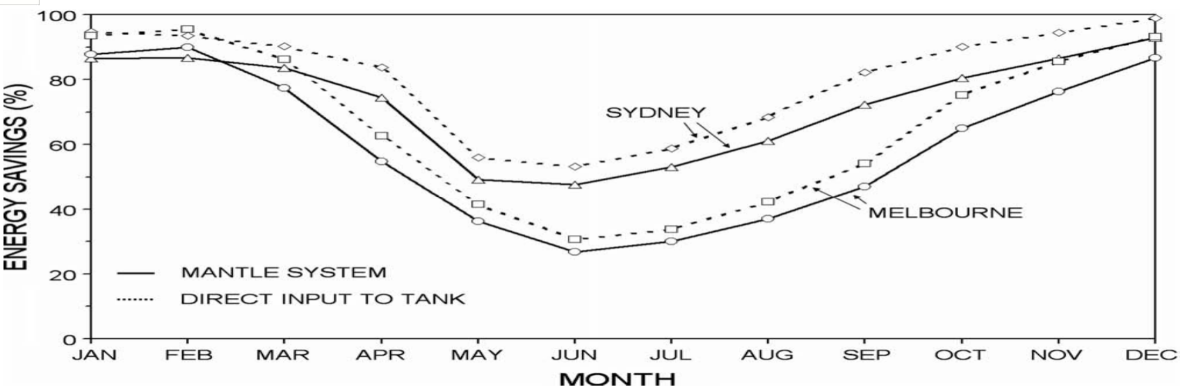


Fig. 5. Comparison of energy savings of solar water heaters in Sydney and Melbourne with and without a collector loop mantle heat exchanger.

C. Experiment Setup.3

H. Sheng Xue: Investigated on the experiments on the domestic solar water heater with solar collector coupled phase-change energy storage. Due to the low thermal conductivity and high viscosity of the PCM, and absent intensification of thermal conductivity and heat transfer, heat transfer in the PCM module is repressed; thermal performance of the DSWHSCPHES underexposure is inferior to that of the TWGETSWH with an identical collector area and to the collector running at a constant flow rate test. Radiation and initial water temperature have impacts on system performance; increasing the proportion of diffuse to global radiation and initial water.[13]

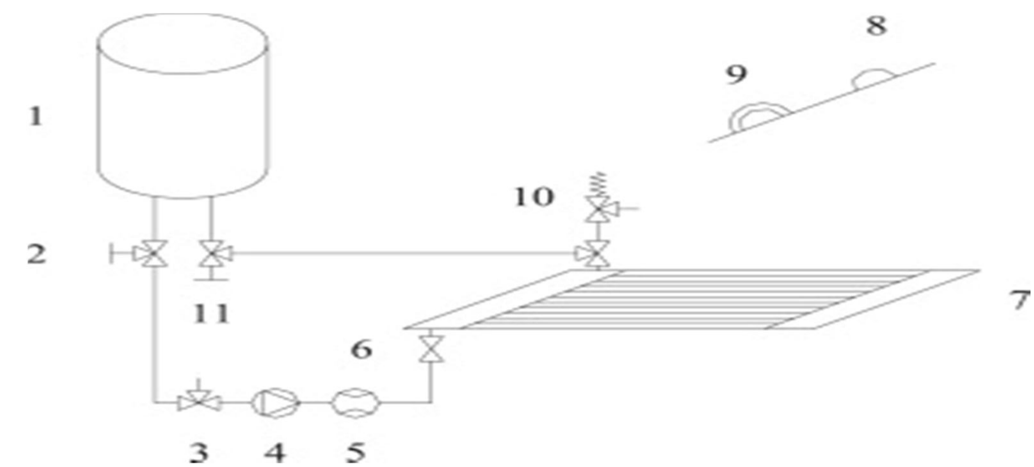


Fig. 6. Schematic diagram of the test rig. (1.Water storage; 2,11. Temperature sensor; 3. Three-way valve; 4. Pump; 5. Flow meter; 6. Valve; 7. All-glass evacuated tubular solar collector; 8. Pyranometer; 9. Shaded pyranometer; 10. Safety valve).

D. Experiment Setup.4

V. Rajive: Presented the research works on the Thermal performance of Modified V-through solar water heater It may be seen that man has changed everything which is available in nature, according to his need. Solar is naturally available, the Inexhaustible source of energy. By proper recognition, this energy could supply all the present and future be utilized in many ways. It can also be used for power generation. We throughout the project work have projected on the utilization of solar energy with the help of parabolic trough as a solution to energy crisis. The novel stationary V-trough solar water heater with the maximum solar concentration ratio of 1.8 suns has been proposed to improve the thermal efficiency of the whole system. The advantages of the new proposal are that easy to be fabricated, cost-effective and high thermal efficiency. The collected data has shown that the prototype has achieved the optical efficiency of 70.54% or1.41 suns and the temperature of 85.9 _C. The prototype can be easily constructed through DIY using off-the-shelf materials with a total cost of RM 1489.40 and a total payback period of 12.2 years for discounted form or 8.9 years for undiscounted form.[14]

Fig no: 7 Construction of v-trough

E. Experiment setup. 5

Laurence Gill, Joanne Mac Mahon, Kevin Ryan: Performed the research work for an evacuated tube solar hot water system. The analysis of the performance of an evacuated tube solar hot water system installed on a domestic house in Dublin has shown the typical variations in solar radiation experienced at this latitude and such a climate with the majority of radiation reaching the panel in diffuse form. The detailed analysis over a year has given a realistic assessment of the retrofit installation of a system at such a northern latitude installed flush to a typical roof pitch (i.e. at 29) and really hot water demand from a family of 5 over the course of a year, including periods when the family was absent. The study has shown that the system produced 1216 kW h of useful heating energy at a system efficiency of 62.8%. These results are lower than other trials carried out under more controlled conditions (using synthetic hot water demand profiles) at more optimal panel angles. Indeed, the results have been used to show that ideally, it would be more effective to have the panel angled between 59 and 69 at this latitude for the best net solar energy heating across the year. An economic analysis has shown that the retrofit installation of such a system under the current financial climate in Ireland is not financially worthwhile over an expected 20-year lifespan; the system, however, has saved an estimated 1.1 tonnes CO2eq emissions. Hence, the installation of such a solar hot water system could be promoted on the basis of protecting energy security and reduce carbon emissions by providing a net reduction in the use of conventional, fossil fuel derived, energy resources. An interesting aspect of the study has indicated that there appears to be some link in the patterns of hot water use for the residents in the house who are now more aware of their hot water production and conservation and consequently more likely to use hot water following periods of sunny weather. Another finding is the high energy losses from the installed hot water tank as typically supplied commercially in Ireland, which clearly should be improved by adding insulation. The volume of the tank, however, did seem to be adequately sized for this combination of collector size and household hot water demand. This study has therefore given an assessment of the expected performance of a retrofitted solar hot water system into such typical terraced houses in the city which incorporates realistic design limitations with regards to roof area available, roof pitch as well as the space needed inside in which to install the requisite large hot water tank.[15]

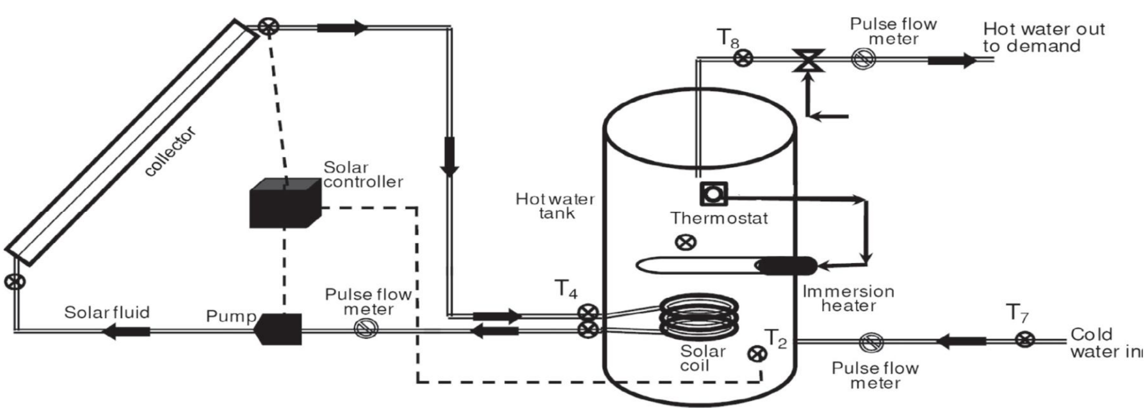


Fig. 8. Schematic of evacuated tube solar thermal system with instrumentation (modified from Ayompe et al., 2011).

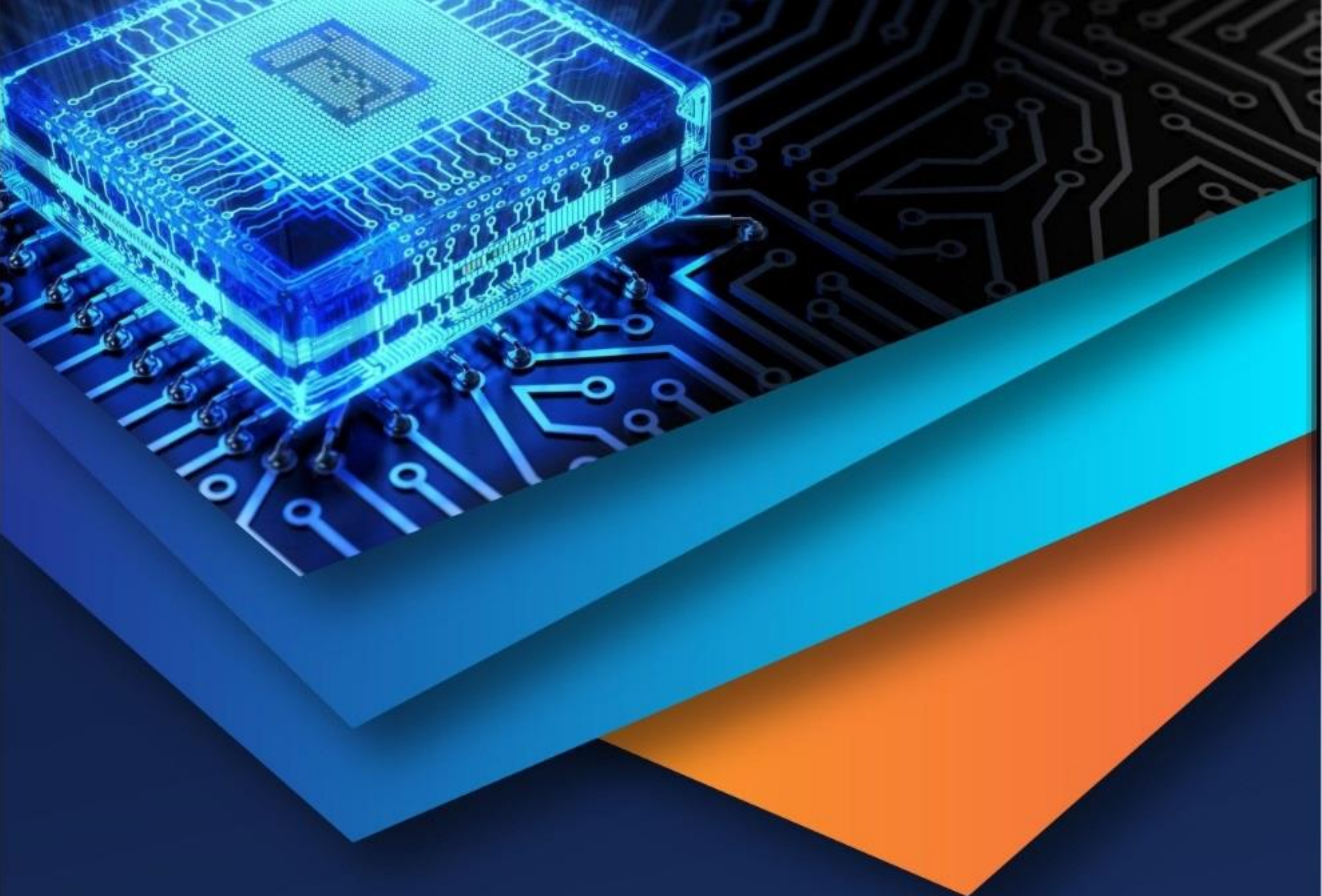
Fig. 9. Photograph (facing north) of radiometers measuring diffuse and global solar radiation and position of evacuated tube solar system.

IV. CONCLUSION

The review of the literature on a modified solar water heater, widely investigated both analytically and experimental by a different researcher.A modified solar water heating system is a great way to reduce energy cost associated with heating water.A remarkable increase in efficiency of the current study in comparison with existing solar water heater that can be achieved such as reducing the thermal energy loss and cost.Some modified solar water heating design has been introduced in the market and is more commonly utilized in the tropical regions of developing countries.

REFERENCES

[1] Sanjay Kumar Sharma, Fabrication and Experimental Investigation of V-Through Flat Plate Collector in Hot Climatic Conditions of Rajasthan: A Case Study of Jaipur, International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 5, May 2013.
[2] BAA Yousef, Performance analysis for flat plate collector with and without porous media, Journal of Energy in Southern Africa ,Vol 19 No 4,November 2008.
[3] The Encyclopedia of Earth. /http://www.eoearth.org/article/De_Saussure,_ Horace_B%C3%A9n%C3%A9dictS.
[4] Butti K, Perlin J.A golden thread.London, UK: Marion Boyars Publishers Ltd; 1981. [10]BD Chiaro, Solar water heating, how California can reduce its dependency on natural gas; Environment California Research and Policy Center, April 2007. /http://www.environmentcalifornia.org/uploads/at/56/at563bKwmfrtJI6fKl9U_ w/Solar-Water-Heating.pdfS.
[5] BD Chiaro,Solar water heating,how Californiacan reduce its dependency on natural gas;Environment California Research and Policy Center,April 2007. /http://www.environmentcalifornia.org/uploads/at/56/at563bKwmfrtJI6fKl9U_w/Solar-Water-Heating.pdfS.
[6] Butti K, Perlin J.Early solar water heaters, A Golden Thread. New York: Van Nostrand Reinhold Company;1979p.117-127.
[7] Kalogirou SA. Solar energy engineering: processes and systems. London: Elsevier; 2009.
[8] The Equitable Building Heat Pump System. A National Historic Mechanical Engineering Landmark.Dedicated May 8, 1980, in Portland, Oregon. /Http:// www.bookrags.com/research/heat-pump-woi/S (access date:January25,2008).
[9] The unitary heat pump industry-25 years of progress./http://adsabs.harvard.edy/abs/1977ASHRA.19.15PS(access date:September 19/2007).
[10] Zhang X, Pattern A, Shen.Green property development practice in China: costs and barriers.Building and Environment 2011;46(11):2153–60.
[11] A Carrillo Andres and J.M.CejudoLo'pez ."TRNSYS model of a thermosiphon solar domestic water heater with a horizontal store and mantle heat exchanger" (2001) ww.elsevier.com/ locate / sooner
[12] Y.C. Soo Too, G.L. Morrison *, M. Behnia."Performance of solar water heaters with narrow mantle heat exchangers Solar Energy" 83 (2009) 350–362 www.elsevier.com/locate/solener.
[13] H. Sheng Xue." Experimental investigation of a domestic solar water heater with solar collector coupled phase-change energy storage. "Renewable Energy 86 (2016) 257e261 www.ScienceDirect.com
[14] V. Rajive "Thermal Performance of Modified V-Trough Solar Water Heater." Volume 4 Issue V, May 2016 .
[15] Laurence Gill , Joanne Mac Mahon, Kevin Ryan: The performance of an evacuated tube solar hot water system in a domestic house throughout a year in a northern maritime climate (Dublin) Solar Energy 137 (2016) 261–272 www.ScienceDirect.com



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY