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A REVIEW OF FLAT PLATE COLLECTOR AND MODIFIED FLAT PLATE COLLECTOR

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Abstract: 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. The market of solar water heater of natural circulation type (thermo-siphon) is fast growing in India. Initial cost of the solar water heater system at present is high. It is because of store type design of the system. For making the product more popular it is necessary to reduction the cost. The cost can be reduced by reducing the area of liquid flat plate collector. This paper is based on review of flat plate collector and modified flat plat collector.

Keywords: Solar water heating system, flat plate collector, Thermo-Siphon.

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INTRODUCTION

Solar energy is the primary source of energy for our planet. Solar energy is very large, inexhaustible and clean source of energy. The power from the sun intercepted by the earth is many thousand of times larger than the present consumption rate on the earth of all commercial sources. Increased utilization of solar energy in India could result in all around benefits, both in terms of cleaner environment and monetary gain.

The market for solar water heater of natural circulation type (thermo-siphon) is fast growing in India. Initial cost of the solar water heater system at present is high because of store type design. To make the product more popular by reduction in cost. Hence it is essential to make it in affordable range of the general public. This will drastically reduce the electricity consumption for domestic and industrial hot water which is required to be 85^0C (low grade energy). Presently the dimensions and other quality standards are governed by the IS 12933 issued by Bureau of Indian standards for the best performance. However experience shows that a solar flat plate collector having higher diameter of copper tube of flat plate collector has better performance than the ISI flat plate collector. The present research work is an experimental study on the comparative performance of ISI flat plate collector with modified flat plate collector. The test will be conducted for the natural circulation mode of operation of the collector. One standard ISI solar flat plate collector will be tested simultaneously for directly comparison.

Literature Review:

Dyer J.R. [1] in this paper author used the concept of a theoretical and experimental study of laminar natural- convective flow in heated vertical duct. The ducts are open ended and circular in cross section and their internal surfaces dissipate heat uniformly. Temperature and velocity fields and the relationship between Nusselt and Rayleigh numbers were obtained by solving the governing equations by step-by-step numerical technique. Two Rayleigh numbers are introduced expressing in terms of the uniform heat flux and the other in terms of the mean wall temperature. The effect of the prandlt number on the relationship between the Nusselt and Rayleigh numbers is discussed. Three inlet conditions were examined they all gave the same Nusselt relationship at small Rayleigh numbers. It is also observed that the difference between the Nusselt numbers obtained at large Rayleigh number were only small. Experimentally determined Nusselt numbers with air as the convicted fluid, agreed satisfactorily with the theoretical relationship.

Dr.V.R.Bhore.et.al [2] This paper describes a method for testing of 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 difficult to use. In the recent years, solar water heating systems are gaining wider popularity throughout the country. A wide variety of solar water heating systems, having innovative concepts are marketed throughout the country. This paper proposes a simple method for testing of 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, can be used with minimum instrumentation and provides absolute performance index with a greater accuracy for direct comparison of the different collectors.

Wen-Shing Lee.et.al [3] has studied the thermal performance of latent heat storage in two phase thermo-siphon solar water heater, which utilizes the superior heat transfer characteristics and eliminates drawbacks found in the conventional solar water heater. This study also examines the functions of charge and discharge thermal behaviors in a two phase thermo-siphon solar water heater. The present article is to provide a two phase thermo-siphon solar water heater in which a passive type of control is adopted to eliminate the above drawbacks observed in the conventional solar heating system.

Yasin Varol.et.al[4] This paper describes the concept of Natural convection heat transfer and fluid flow were investigated inside a wavy and inclined solar collector, numerically. Parameters that affect the flow and temperature field are Rayleigh number, inclination angle, aspect ratio. The heat transfer is increased with increasing Rayleigh number and aspect ratio.

Dr.S.V.Prayagi.et.al [5] Present work deals with solar water heating system in particular. Performance of the solar collectors can be determined by using empirical correlation. This helps in understanding logically the effect of parameters like tube length, tube diameter and fluid flow characteristics for buoyancy induced flow through pipes. The analysis is simple for the forced convection situation, where the flow rate is artificially maintained constant to a desired value. The heat transfer coefficient can be easily predicted using the information available in the literature. However the natural convection situation is very difficult to analyze as appropriate correlations for predicting the value of induced mass flow rate. Because of the thermo-siphon effect and the associated heat transfer coefficient are not available. The aim of present investigation therefore, is to establish correlations for heat transfer and flow characteristics for the buoyancy induced flow through inclined tube in case of solar water heating system. Considering complexity of the problem, experimental approach is preferred. In order to produce required data experiment were performed using increasing tube diameter, and reducing riser length. Experiments were performed to establish heat transfer characteristics where Nusselt number is directly proportional to 2^{nd} power of the tube diameter also the induced flow rate characteristic where Reynolds number is directly proportional to the 2^{nd} power of diameter.

Ramesh Tiwari [6] In this paper author used the concept of a 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.

[7] Dong Zhang et al modified from the conventional liquid solar collector. Three working modes were presented, named (A) air heating, (B) water heating and (C) air-water compound heating. Mathematical models for air and water heating modes were developed to investigate the effect of mass flow rate on the thermal performance. An experimental set-up was established in order to test the actual performance of collector. The experimental results show that the average collector efficiency in mode A and B can achieve 51.3% and 51.4% while the mass flow rate of fluid is 0.024 kg/s and 0.13 kg/s, respectively. The maximum temperature rise of air and water reach 60.4 °C and 59.8 °C in the respective two modes. The average of total collector efficiency based on the mode C can reach 73.4%, higher than that of mode A or B. The mass flow rate is a major factor to affect the efficiency, outlet temperature of fluid and heat transfer effectiveness. When the water flow rate exceeds 0.10 kg/s, the heat removal factor increases insignificantly. To balance the efficiency and outlet temperature of fluid, the air flow rate between 0.02 kg/s and 0.025 kg/s is recommended in mode A and the water flow rate between 0.06 kg/s and 0.08 kg/s is recommended in mode B.

[8] R.Chandra et al studied The performance of a modified reverse flat-plate collector with air as working fluid is studied. The results are compared with the corresponding results of a reverse flat-plate collector originally proposed as well as with normal flat-plate collectors operating under single and two pass modes. It is found that much higher fluid temperature can be obtained with the new reverse flat-plate collector.

[9] Himangshu Bhowmik et al introduced a new technology to improve the performance of the solar thermal collectors. The solar reflector used here with the solar collector to increase the reflectivity of the collector. Thus, the reflector concentrates both direct and diffuse radiation of the sun toward the collector. To maximize the intensity of incident radiation, the reflector was allowed to change its angle with daytime. The radiations coming from the sun's energy were converted into heat, and then this heat was transferred to the collector fluid, water. A

prototype of a solar water heating system was constructed and obtained the improvement of the collector efficiency around 10% by using the reflector. Thus, the present solar water heating systems having the best thermal performance compared to the available systems.

[10] N.D.Kaushika et al studied theoretical analysis of the performance of a flat plate solar collector with the heat removal fluid undergoing a phase change. The resultant efficiency expression is a modified Hottel-Whillier-Bliss equation. Numerical computations are made to investigate the effect of vaporisation and operational parameters on the collector's performance. The collector's efficiency increases with the increase in liquid length until a point is reached when the region of superheating the vapour disappears. The efficiency is higher when a heat removal fluid of high latent heat of vaporisation is used in the collector. An increase in the saturation temperature of the working fluid (with increase of pressure) in the collector reduces its efficiency.

[11] R.C.Tiwari et al studied the thermal performance of flat-plate solar collectors manufactured indigenously in India is reported; the thermal performance of the collectors is evaluated on the basis of test results obtained at the Solar Energy Centre. It is seen from the results that the values of $F_R U_L$ for the tested collectors ranges from 5.139 to 7.024. It is observed that these values may, however, be improved by using advanced manufacturing techniques, better materials and good bonding methods.

[12] V.K.Goel et all studied the reverse flat-plate collector is a non-concentrating collector. It can collect solar heat at high temperatures which cannot be achieved by conventional non-concentrating collectors. In this paper, the authors have proposed a number of modified versions of the originally proposed reverse flat-plate collector. The new designs are of single, as well as double, absorber type. The thermal performance of these modified reverse flat-plate collectors is compared with that of a single absorber reverse flat-plate collector, as well as with the corresponding normal flat-plate collector. It is found that the new design having two absorbers gives the best thermal performance as compared with other configurations. The analytical models presented in this paper very well describe the experimental results.

CONCLUSION:

The solar water heating system with modified flat plat collector is not over complicated as compare to flat plat collector and will be straight forward to use and easy to maintain. A system suitable for testing solar flat plate collector operating under natural circulation mode is used. Simultaneous testing of number of various collectors will be possible. The data collection is very simple. Test can be carried out any location. The modified flat plate collector by increasing tube diameter and reducing riser length will perform better than ISI design flat plate collector from efficiency point of view. Also this system could well serve in rural areas due to reduction in the cost, electricity consumption of solar water heater and other similar part of the world in need of hot water.

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