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Review of Flat Plate Solar Collectors And Solar Energy Utilization In India

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ABSTRACT

Technological advancement and increased population, the demand for power supply is growing enormously. To meet the demand, various energy sources are explored by researchers and government. Carbon emitting fossil fuels are been progressively banned in many countries. With global warming and pollution aspects the governments of developed and developing countries are promoting renewable sources for sustainability and environmental protection. Environmental sustainability requires promotion of renewable and non-conventional sources of energy. Renewable sources such as wind, solar, biofuels, tidal, geothermal energy etc. are been exploited by developed countries for energy. Solar energy is still not used up to potential in most of the countries. In India Wind energy and solar energy are pivotal due to the geographical location. Different types of solar collectors are employed for collecting solar energy. Experimental works related to varying the parameters such as working medium, environment, size are taken in account for optimizing the design. Flat plate solar collectors is one of the common type in solar collectors which is highly used for efficiency and low cost. This paper is a critical study of solar potential and the research carried out in performance and optimization of flat plate collectors.

KEYWORDS—solar energy, solar collectors, flat plate collectors, evacuated plate collectors

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INTRODUCTION

Hybrid energy production implies getting source from two or more sources. In India there are five grids northern, western. Southern, eastern and north-eastern. Western grid provides the high output compare to others. The pv type solar plates are used in rooftops of the house, industries etc. Wind plant is placed in urban and rural areas. Energy demand should match the energy production levels. But for climatic problems there are fluctuation in the energy production. Solar energy is available throughout the year but the wind power source is comparatively less considering the climatic conditions. Solar power plant erection cost is less compared to wind power plant. According to MERRA analysis report solar energy's availability is more than wind energy and the also cost efficient[1]. India, it is one of the developing countries of the world. In today's world electricity is inevitable. Though India is a developing country still some villages in India not even has a facility of the street lamp. It shows about the dark side of our nation both in the aspects of economic condition and the development of science and technologies in our country. The Government is ready to invest in producing the electricity to the village areas. In poor communities the people uses kerosene as a fuel for lighting, the emission of carbon dioxide from the burning of kerosene lamps will cause some significant health issues. For reducing the usage of kerosene and also in the aspect of promoting the villages the government has undergone the Solar Power production[2]. Government of India is targeting 175 GW of solar power generation by 2022. As the land resource in India and per CapitaLand availability is low, the selection of offshore solar power plant is commendable. Solar project the land resources availability in India so the select offshore power plant the use of executive the use of estimation done then with the years of geography information system development the map with difference class for corresponding solar energy result show the average GHI and estimated solar power generated in study area or 5.9wg/ per day 9372twh per day, respectively[3]. Out of the various sources of renewable energies, the utilization of solar energy has its advantages, especially in a country like India where the country is bestowed upon with profuse sunlight for most of the months in a year. Being closer to the equator, it is positive to say that the use of sunlight for the production of electricity using solar panels is inevitable and the technique has its advantages. The performance of solar panels and their efficiency is seriously challenged by various environmental factors such as temperature, dust, and humidity. The usage of hybrid solar panels commonly known as Photo Voltaic Thermal Hybrid (PV/T) is proven to be more effective than the Photo Voltaic cells works in conjunction with the cooling media. In the PV/T hybrid systems, the incident solar energy is first converted into thermal energy which is utilized in the generation of electricity. For the purpose, the place selected for the installation of the panels should be conducive for maximum electricity generation with minimum losses. To fulfil this reason, it is inevitable to calculate Global Solar

Radiation (GSR). Several methods for the calculation of GSR with maximum possible accuracy were developed in the past decade. One of the methods is the utilization of a technique known as Artificial Neural Networks (ANN). ANN can work with the incorporation of data collected from the different sources using different models with the help of neurons and layers like input layers, hidden interconnection layers, and output layers. Weights were applied to the individual data and were calculated by the ANN in the form of Linear equations. On the interpretation of the results from the obtained linear equations, the results were compared with the predicted values using various methods for measuring errors like Mean Square Error (MSE), Fraction Variance (R2), Mean Absolute Percentage Error (MAPE), Root Mean Square Error (RMSE), Mean Bias Error (MBE), and Mean Percentage Error (MPE). The various environmental factors that can be used in a combination of varying degrees are The Maximum Temperature, The Mean Temperature, The Relative Humidity Daily Mean Air Temperature, The length of the days, Sunshine hours, the day of the year The Evaporation, The Wind speed, Daily Average Atmospheric Temperature. The location where the data is recorded. These environmental factors are used in various combinations and the corresponding data are recorded. The number of hidden layers, and the neurons incorporated with the layers in the data collection models may vary with the will of the researcher. The recorded data is then fed to the ANN from where the results are obtained. The obtained results are scrutinized by evaluating the various methods for checking the percentage error and variance. In doing so, the electrical efficiency of the system can be enhanced and thereby mitigating the most inhibiting factor in the vast incorporation of solar power plants in the place of much polluting thermal and nuclear power plants of today and thereby reducing the natural consequences such as the global warming. Thus, the utilization of ANN can be a technique that can certainly be cited as the most ingenious technique in the field of alternative and renewable energy production[4]. Study on the prediction of performance of energy loss, and degradation of roof integrated crystallized photovoltaic system, which is installed at the place Chandigarh in north India. This PV system used for predicting the generation loses and analysis of energy and its various inputs of parameters carried out for testing CF and performance ratio and losses from LID and DR predicted per year and LGBR produced by CEA to compensate the demand of increasing trends and to make a survey of energy demand and supply in a power system of energy generation in India. Here the power generation is produced from the thermal power plant using fossil fuels as the energy source of an energy. It is a renewable energy methods of electricity generation to promotes the depletion nature of fossil fuel.it issues and safety precaution were associated in conventional thermal power plant are considered being threats to society[5]. Solar wind renewable energy of the India the grid parity of the solar energy and the Indian power sector challenges and solar manufacturing and government supported and wind energy Indian

and generation based incentive and state wise tariff for wind power at the national clean energy fund allocation policy and solar wind renewable energy development and the Indian policy and regulatory and the barriers and to fiscal to the financial barriers the called renewable energy the aim presents and integrated and constrains and not only has the potential considerably reduce dependency in on fossil fuels generated electricity thus renewable energy to need the society which one purest form of energy with almost negligible or no carbon emissions[6].

FLAT PLATE COLLECTORS

A. Performance

Studies related to various types of solar collectors are carried out. For the steady-state tests according to CNS 15165-1:2008, the maximum thermal efficiency and heat loss obtained by linear regression from the test data for four glazed, metallic, flat-plate solar thermal collectors. The ratio of diffuse to global solar radiation is up to 50%. The change in the ratio profoundly affects the heat loss of the solar thermal collectors, but not the maximum thermal efficiency. Therefore, it is proposed that CNS standard can be revised, following ISO 9806:2013 standard without the strict requirement in the value of Iir*. Further, the present tests were conducted in a subtropical region. More data across a wide range of climatic and radiative conditions are necessary to comprehensively address the effect of diffuse solar radiation on the thermal performance of solar thermal collectors. The performance of a solar thermal collector depends on the amount of global solar radiation, Ig, the quality of the absorber plate and the heat losses, which all affect the energy savings of SWHs. Lab tests should be conducted to determine the parameters of the efficiency curve of a solar thermal collector and the data can predict the long-term performance of SWHs. The steady-state method implies all important variables remain constant throughout the test period. For ISO 9806:2013, it is an outdoor test method to determine the steady-state thermal performance of a solar thermal collector[7]. The energy o/p system of flat plate collectors can be improved by tracking. The tracking path of increasing the solar radiation received the collector. The inverse tracking a protecting the collector is over heat. Thermal energy o/p conversion is forward tracking is different radiation. Different program for a logical scheme is forward tracking, inverse tracking, maximum inverse tracking (or) fixing the collector[8]. Supply of pure water is a big problem in underdeveloped as well as developing countries. Along with food and air, water is a basic necessity for humankind. Man has been dependent on non-purified water from rivers, lakes and underground water reservoirs. But the pollution of rivers and lakes by industrial effluent and sewage has caused scarcity of pure water in many towns and villages near lakes and rivers. Consumption of non-purified water causes various water-related diseases to mankind. Pure and healthy water can be produced from FPCs either in

series or in parallel and the basin water is circulated through FPCs by a pump. The temperature difference between the evaporating and condensing surfaces is increased by feeding the additional thermal energy from the flat plate collector into the basin of the solar still. The water in the basin is circulated through FPC either in a natural circulation mode or a forced circulation mode depending upon the requirement. The experimental study is related to the different numbers of FPC arrangements for efficient distillation using a single slope, the single basin active solar still in Indian coastal climate in peak summer conditions[9]. With the increase of thermal energy usage, improving the thermal efficiency of the solar collector is very crucial. Efficiency of a system can be improved by increasing its components efficiency. Evacuated Tube collector comprises copper heat pipe and heat transfer fin. ETC is used for personal and industrial water heating. Absorber reflector tandem is the most common type of solar absorber. Solar paint is applied on the cover of the solar absorber. It is a combination of pigment, resin, solvent and additives. A commercially available solar paint on different thickness of aluminum substrate. Thus it is concluded that based on thermal collector efficiency equations thermal performance of the ETC increases with the decrease in thickness of aluminum fin solar absorber[10]. Investigation on flat plate solar collector efficiency at different flow rate. We are using a program called SOLEFF which is to compare the measured efficiency experiment have been conducted for checking. This efficiency of the plate solar collector. This plate solar collector is there and being constructed in Denmark. The experimental result is being compared and described by a graphical method representation. The year thermal performance deals about the fluid temperature of the solar collector we are comparing between the collector with ETEE foil and without ETEE foil for finding the efficiency we should also consider the incident angle modifier [11]. Most industries and home application uses flat plate type solar collectors. Energy collection and energy conservation are two major paths in solar collectors. The solar collector's efficiency is based on the temperature and size of the collectors[12]. Prototype flat plate collector constructed at Gazipur, Bangladesh on January 2015, efficiency strongly depending on the solar radiations. It gives about 51% without reflectors and 61% with reflectors. It increased by 10% approximately by using the reflectors with the collection of heat[13]. Introducing Nano fluids as the working medium can enhance the efficiency of the flat plate solar collectors. By using Nano fluids, thermo-physical properties are exhibited, and it is superior to conventional working fluids[14]. Nanoparticles used as working fluid are investigated. The nanoparticles Al_2O_3, CuO, SiO_2, and TiO2 has the different sizes nanoparticles that are 25, 50, 75, 100nm. The artificial neural network it has otherwise called as ANN and it was easier and accurate method using "MATLAB "software Neutral network will consider the three layers that is, the input layer, hidden layer and an output layer. The solar plate with silver- water Nano fluid to know about the heat transfer and to analyse the thermal efficiency. Components used in the flat plate

are heat exchanger, coolant tank, liquid pump, and flowmeter. Volume concentration is 0.01%, 0.03% and 0.04%.this experiment is conducted for 180 minutes each. It shows an agreement between measured and predicted values. It is for solving a complex problem[15].Evaluation of a solar water collector's performance and it the characterization from the conventional test methods that related to the international standard. The predicated values formed to be in Close agreement with the 0.9469, 3.13 and 6.98 of determined. Iran-tehran meteorological data in over the train the network. They use ANN for modelling the efficiency of solar collectors structure other models may have difficulty we obtained experimental data using a flat shaft solar collector during the summer reason in north Cyprus efficiency is calculated using radiation from the sun. Energy logic is a multi _valued look logic that uses approximate values them of OI for reasoning. In fuzzy inference each inference rules has a left side and right had side according to the degree of each antecedent. In the forecasting stage rules that do not contain empty are fired. Evaluation of performance of the proposed FIS and compared it so of multiple regression .The population is the world is increasing every, and it is better to use free energy therefore alternative be the order to use in everyday life [16]. There is two step method which is used in preparation of the Nano fluid. The collector is tested by ASHRAE standard. There are two terms called Time constant and Time attempt these are the specifications of the collector[17]. Solar air collector are used for space heating and dry process the thermal efficiency of general flat plate solar air collector is low so that it can be used improve thermal performance of solar air collector. The converting heat transfer between the flowing air of the observer plate solar air collector has some physical properties of transparent cover is the observer solar radiation per area by the collector observe red plate. According to law of uncertainty combination and law of error propagation the relation between combined standard uncertainty of thermal efficiency by the fitting model and uncertainty in the steady state test method is presented[18]. Angular variations solar radiation observed by the collector effect on collector do it was predicted by annually. A flat plate bottom reflector can be analyzed theoretically. Inclination of optimum collector can be varied according to the season. While summer this very low and during winter it is very higher. Every month last date to maximize the daily solar radiation observed why the collector at 300 degree north latitude and altitude. Collector name is the range between 0.5 to 2.0 respectively. Width and length of collectors are equal[19]. The consumption of global energy will be 33.33%. And the combustion of fossil fuel is 66.66%.In industrial sector the drying process for about 12-20%. One of the dryer will be used namely, solar dryer. It will amount of heat to open sun drying .the main components of solar dryers is heating chamber, solar collector etc. the collector will be acting as a heat exchanger. There are two categories in the solar collector they are, stationary & sun tracking solar collectors. The collector classified as glazed and covered un- glazed transpired type solar collectors. The plywood, it

acts as a good insulator. & it has the thermal conductivity of 0.13wk-1m-1.the coating composition will be named as aluminum, zinc, silicon. For this V-ribbed metal sheet will be used. This metal sheet has the absorber of UTSC. It is used for the agriculture purposes[20]. The performance and withstand ability of flat plate solar collectors for access to this efficiency, an aging test with outdoor acceleration is conducted which accommodate with spraying of salts. Air used for testing these collectors with working fluid and circulation is prompted. This method proposed with three evacuation technique and used on temperature for the collector's outlet, in the outdoor temperature[21]. Radiative cooling system with the flat plate solar collector: Flat plate collector comprises a storage tank, pumps, connecting Pipes and radiator. Radiative cooling is a system which gives Cool at the night sky radiator and convection. Radiator placed on top of the storage tank and connected with pumps. Inlet pipe is connected with several connecting pipes to the outlet Pipe. The pipes are made up of copper tubes. The water will come out from the top layer of the storage tank and distributed to the tubes and delivered to bottom of the tank. The Heat will be loosed by an uncovered portion of radiator to sky at night. At night the heat temperature will be minimized by 1 degree Celsius and it will cool water at night time[22]. The validation of the plot/site realized and bound the European assignment project in Sun. Investigation focuses on the outcome of a Solar Thermal field which provides the process of the heat for a meat factory. This plot uses the flat plate collectors and which is within the overall area of 1070 meter square. Few years back in the year of July 2014, the main purpose was, the bin method which had analyzed and concluded. At last it concluded that the medium-term achievement has investigated and analyzed the data from the three consecutive summers, which exhibit the constant efficiency with no proof of performance decay. This issue has been still in the process that many research scholars has been still finding it difficult to a good performance in the process of heat[23].

B. Optimization

Most of the solar power plants uses flat plate solar collectors which gains more generation in most of the countries. But parabolic trough are the most efficient and prominent collectors among all the concentrated solar plates (CSP). This journal is about the comparison between the optimum control and cost between the flat plate and concentrated solar plates. Concentrated solar panels, Flat plate solar panels types of the plates are erected in individual fields. Both the fields are maintained properly to get the maximum power at low cost and monitored regularly. The final cost records are recorded finally. As the result the CSP method is found to be cost effective method[24]. Solar thermal collectors for construction and the usage of the heat transfer liquid which flows through the heat that interchange the flow channels in the absorber. Flat plate absorber which made through a tube bond

by the thermally conducting plate or the success of the lower thermal resistance and pressure bubble of drop is by using the flooded panel or micro channel model. The pressure drop is at the low level should minimize the power of inputs to pass around the pump. A way been demonstrated for choosing the optimum passage of hydraulic diameter subject to the geometric similarity and the power of the pimping will constrain. Both the channels of the micro and serpentine systems of the tube which have a basic minimum way for the optimum diameter for passage, which is for the different reasons. The two types like the double-pass and the flooded power panel designs are considered being the most special channel for micro channel cases. To maintain the proper efficiency and the power pumping which is per unit area must rise the way of length. Further that the optimum power of pumping will rise in operating cost out weights which also make to increase the efficiency of the collector[25]. Various thermal solar collector are used in heating domestic water. In this FPC is widely used because of the design and efficiency. But this too has a certain lag in productivity because of the static design if we design it in the dynamic manner we can get more productivity with effective use of solar energy. If we design the dynamic model based on the azimuth angle of morning noon and afternoon. To eliminate the hindrance of the system the dynamic table moment is programmed by electronic system comparative to the static Fpc dynamic is more user-friendly and gives high productivity and because of the monitoring display in the dynamic Fpc electronic control monitor we can also know the status of the dynamic Fpc[26]. Studies of optimization of a vapor filled flat plate solar collector reveals Solar Thermal collectors which plays a prominent and eminent role in decreasing the energy consumption in building. At this modern era the noteworthy Endeavour are being made to seek a new track way to increase their ability of showing. An appearing of different approach in studying, the work is based on the thermodynamics result. This study of result says that how the thermodynamics 2nd- law analysis can be made use of the complement of the 1st law which is based on the approach of Flat-Plate Solar Collector (FPSC) in the restricted area of air in spacing between the occupier and the glass cover which has been interchanged by the stream. Through this investigation of the survey which comes to a judgment that the parameters which as the solar irradiation, inclination of an angle, and also the usage of the absorbers with the various number of emission level of values are verified and the research survey done successfully[27]. The study about the design, construction and instantaneous efficiency about the solar water heater were carried out. The analysis shows that the solar water heater for heating water which could avoid the emission of carbon dioxide gases in atmosphere. It is achieved by thermosyphon mechanism reaction where a component of solar collector present in heater collects the transferred energy and send it to the storage tank for further use. The experimental setup of a solar water heater is designed on a commercial software NX8.0 and the results were discussed. The

global efficiency of solar water heater was estimated as 30.2%. The energy absorbed by the water heater is 10.5 MJ in 11 hours of solar radiation. Therefore, the solar water heater reduces the carbon dioxide emission by0.57 kg [28]. The process of conversion of thermal solar energy is based upon heat transfer. Also, the solar air collectors are based on thermal condition and cost effectiveness. Here solar air collector is the simplest form of energy conversion. Here solar radiation is transformed into thermal energy. Solar air collectors are used to supply the hot air in to the building or other requirement areas. The impinging air jets are used to transfer the heat. Impinging jet solar thermal collector performances computed by mathematical models. Some important energy assumptions are steady state condition, negligible heat condition, and negligible edge effects. There are fourteen steps to calculate the energetic efficiency. There are different conclusions that increases the efficiency Low Reynolds number, Temperature increases, and Energy of solar air collector should be high. Diameter ratio should be 0.065[29]. The solar energy is widely used throughout the world for drying, heating and other water treatment. The characteristics techniques of solar energy are optical and mechanical test. Based on the system optical and durability test are taken. The durability test is further classified into moisture test, salinity test and weathering test. The optical test is further divided into absorptive spectrum reflectivity spectrum and emissions spectrum. The test is performed mechanically and optically to characterize the original coating of material like epoxy and acrylic. The result allow confirming the epoxy coating has more characteristics than other preventive and corrosive maintenance of the solar heating system. The results show similar hardness among all coatings. The studies are essential for the coating are most adequate techniques for preventive and corrosive maintenance of the flat plate solar collector[30].

C. Temperature

The variation in the radiant flux during sunrise and sunset which shows the dynamic behavior of the flat plate solar energy collector. The function of time and position along the collector derived by using closed form mathematical formulae for fluid and absorber plate temperature function. Diurnal heating and nocturnal cooling periods are provided with several mathematical forms. Samples were derived graphically by using derived formula. In temperature expression were derived for the limited number of the dimensionless group are presented in dimensionless form. In flat plate solar collectors, the radiant flux is change while the intensity of solar radiations changes. Therefore, more energy obtained for some time and very low energy is obtained for some time[31]. Enhancing product quality and reducing product damage is a very important post-harvest process in fruit drying. Though it is a simple method, it requires a higher amount of energy for heating the oven and for the fan operation. Thailand is situated on the equator, use of alternative energy such as biomass or solar

power solves the problem imported energy. The solar air heater has the dimension of 1.20 meter x 1.60 meter x 0.20 meter, having a black flat plate of galvanized steel of size 3.04 square meters attached below the covered glass solar air collector. The solar heater experimented with various inclination degree of 12, 13, 14, 15, 23.5, 30, 31, 32 and 33 degrees, and it was found that 15 degrees angle is the best inclination angle as it had a maximum temperature of 83.92 degree Celsius during 12:00-12:30 hours. The hot air transfer to the spray dryer was at 52.58 degree Celsius, the best temperature of all angles. The installation of a solar air heater into a spray dryer uses 130.08 unit of electricity over 8 hours, reducing power consumption up to 30.12 units per hour (120.48 Baht). The thermal efficiency of 75.26 percent was achieved. The cost of the module was 8,645 baht with the cost of 778.05 baht constant per year and 475.47 baht of interest. Maintenance cost is 133.30 baht per year. It produces the profit of 8,284.9 Baht per year with 34 days of payback period when the system is in operation at 5.25 baht per electricity unit[32]. Demonstration of hybrid solar desalination system consisted of humidification and dehumidification parameters. The water flows accuracy is 0.5hp. The measuring range is selected from 0.12-0.21 l/min. renewable energy is demand because of scarcity and depletion. The solar collector will capture the radiation of solar it will turned into thermal energy. The max temperature is 5.3, 6.51L/min. The average temperature is 29.2 degree Celsius. The flow rate will be 5.3L/min and 6.51L/min[33]. From this enhancing technique, the thermal solar collector can produce more storage mechanism and more energy collection. Thermal collectors can also use to produce more compact energy. The flat type solar collector comprised absorber which made up of high thermal conductivity material such as aluminum. Copper with tubes integrated. The back side and base of the flat type solar collector is made up of insulating material to prevent radiation losses in the collector. The cover sheet allows the sunlight to cause through the absorber to insulate the space above the absorber to prevent moisture content. Hence, solar radiation passes through the transparent glass cover and hits the absorber plate. The plate heats, transferring the heat to the fluid flow line. It converts the thermal energy into heat. For this process, air is a working fluid and also used to store water. There are five regions in the flat plate solar collector, they are glass cover, air gap, insulation, fluid and absorber. The plate is made up of eight tubes and two headers. In industries, the cost of fuel has been saved when saving solar pre heated water and this process can increase day by day like propylene glycol can also increase by incorporating of the particular work. The thermal conductivity of water is less than pure water. This shows that increase in pG concentration will increase in leaking of fluid. The fluid viscosity has increased largely which can lead to the pump energy. That energy power can compare with enhancement of consumption. The temperature difference can increase percentage of propylene glycol and it becomes computational and also become an experimental efficiency. This makes the model validated. The

temperature increase and the flow rate of the PG increase[34]. Parabolic trough solar collector was tested to determine the collector efficiency and thermal losses with two types of receiver selective coatings, combined with three different receiver configurations: glass envelope with either vacuum or air in the receiver annulus, and glass envelope removed from the receiver. As expected, collector performance was significantly affected by each variation in receiver configuration. Performance decreased when the cermet selective coating was changed to a black chrome coating, and progressively. Examination is conducted of the wind coefficient commonly adopted for evaluations of the external heat transfer from the cover glasses of solar collectors subjected to a range of wind speeds. The wind coefficient, derived from McAdams (1954) and from Jurges (1924), includes a radiation term. This inclusion of a radiation term in the wind coefficient implies that analysts of collector models may have doubly accounted for radiative heat transfer from the cover surface. All substances, solids, liquids and gases, at temperatures above absolute zero, emit energy in the form of electromagnetic waves and assumed that acceleration remains constant over a small time[35]. Heat transfer of the wind coefficient commonly adopted. In the meantime solar collector for cover glass. It depends on wind speed. Comprise radiation term on wind coefficient and its collector from the models are Cover surface for heat transfer radiation. A solar thermal collector to collect heat from absorbing sunlight. To applied to solar hot water panels, may be used denote complex installation as solar air heat. In collector performance are the dynamic (or) unsteady mode. The solution of the partial differential in position and time in equation[36]. Today the solar collectors which depend on organic fluid are used which increases the efficiency and performance of the collectors. The fluid used was a mixture of ethylene glycol and copper Nano particles. Conventional collectors which use air or water are less efficient. Further CO was utilized as the working fluid in the solar collectors. The collector has its own specifications. It is a serpentine type flat plate collector. It consists of cover, absorber, copper tube and insulation at the back and edges. In this type of collector there are two types of losses known as optical loss and thermal loss. Three organic fluids used are R-134a, R-227ea, R-365mfc. The collector is provided an artificial source of radiant energy known as solar simulator. Thus it is concluded that the derived algorithm can be used to solve and find the fluid mean temperature, fluid heat gain, absorber temperature along the flow direction. Thus it solved by HFC-134a refrigerant. The flow is turbulent if the mass flow rate and Reynolds number increases. There are two working fluids R-134a and HFE-7000 are compared. Experimentally it is found that R-134a gives higher efficiency than HFE-7000 at given conditions[37].

CONCLUSION

With the use of non-renewable resources such as fossil fuels our atmosphere has suffered many problems. For counteracting the problems the dependence on fossil fuels must reduce and renewable energy sources must be used. Solar energy utilization in can be improved in India by promoting flat plat collectors in rooftops, highway lamps and industrial units. Even for agricultural purpose the conventional modes can be replaced by solar energy.

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