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A REVIEW ON - SOLAR CONCENTRATORS, PERFORMANCE OF SOLAR COLLECTORS & ENERGY STORAGE

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ABSTRACT:

Parabolic trough concentrators are one type of concentrators which reflects the sunlight on the receiver (Line type) and gives us wet steam for water. It can be tried with any type of fluid. Presently solar collectors are used for residential and commercial use. These solar collectors require high maintenance and high installation cost, solar concentrators help us in these disadvantages. This review paper concentrates on solar concentrators and various fluids that can be used in receiver. It also focuses on surface shape measurement of solar concentrator in solar thermal power application. In order to capture maximum amount of solar energy it is required to orient the concentrator as per the position of the sun i.e. tracking is required .However some of the concentrators do not track and are referred as fixed concentrators. The objective of the project is to track the receiver instead of solar concentrator.

INTRODUCTION:

Increasing energy demands, shortage of fossil fuels, and the continuous increase in the level of green house gas emissions are the main driving forces to utilize various sources of renewable energy. Solar energy is environmentally clean, free and inexhaustible source of energy. The power from the sun reaching the earth is many thousands time larger than present consumption rate of all commercial energy sources. This makes it one of energy sources. This makes it one of the most promising renewable energy sources.

India is blessed with abundant solar radiation available almost throughout the year and over throughout its domain. One of the areas where solar energy is extensively used at presently is water heating. Solar water heaters are getting popularity, since they are relatively in expensive and simple to fabricate and maintain. They are viable supplement or alternative to electric or gas geysers. A solar water heater of 100 liters per day capacity can prevent over 30 tons of carbon dioxide emissions during 20 years of its life span.

The energy from the sun is virtually free, except the initial cost of the system The use of solar energy not only bridges the gap between the demand and supply of electricity but also reduces the use of conventional energy, reduces the use of conventional energy, usually results in a decrease in GHG emissions compared to the present rate of consumption. Use of solar energy in India is merely 0.5% compared to other energy resources.

Flat plate collectors are used for low temperature applications. Many industrial applications require temp. more than 100 degree Celsius, which is obtained by using concentrators line focus systems have cylindrical symmetry and are generally used when medium conc. Ratio is sufficient to provide the desired operating temp. Obtainable reaches to 500 degree Celsius.

A parabolic trough is a type of concentrating solar thermal technology, concentrating solar power (CSP) uses a reflector to focus direct normal solar radiation onto a receiver. The conventional solar trough tracks the sun during the day by rotating about a single axis. Typical collectors track sun from east to west by rotating about a north-south axis.

LITERATURE REVIEW:

The authors Iuliana sorgia & viorel badescu [1] states that 'The instantaneous performance of solar collectors depends on the thermal inertia of their components. The objective of their paper is to estimate how much dependent are the thermal inertia effects on the weathers characteristics. A mathematical model was been developed to describe the dynamic behavior of a flat plate water heating collector. The model was validated for a common collector geometry both in steady conditions, against data provided by manufacturer..The effect of thermal inertia and has been estimated in days characterized by different radiative regimes'. The authors H.Benoit, L.S.preafico ,D.Gauthier & G.Flamient[2] mention that' Thermodynamic cycle efficiency in the range 35-42% may be achieved with current liquid and two phase heat transfer fluids used in solar thermal power plants. Cycle efficiency of 50% and more are attainable with new HTF are stable at 700 degree Celsius in order to predict these fluids heat transfer coefficients ,Nusselt correlations can be applied. The coupling between heat transfer fluid characteristics liquid metal are efficient heat transfer that could lead to further development. It's also deals with recent development on HTF'. The authors Sh.Ghadarijifarbeigo, A.H.zamzamia, & M.yaghoub[3] stated that 'new perforated louvered twisted tape on the heat transfer coefficient and friction factor for an absorber tube of solar parabolic trough collector is determined numerically. High Nusselt number and friction factor are observed for lTT with respect to plain tube. 'With decreasing the value of the Reynolds number and twist ratio'. The authors Gianculuca Searle, Sara baronetto, Francesco goia,& Marco perino[4] states that 'The results of the numerical characterization and performance analysis of the slurry phase change materials based solar thermal collectors demonstrates that this system presents promising energy efficiency Improvements at least from the theoretical point of view. On average the instantaneous efficiency can increase up to 0.08 if compared to conventional, water based technology. It shows that temp. of slurry PCM heat carrier fluid is always lower than that of the water solution one. The authors-R.Silva M.pefez M.Berenguel L.Vannzuela & E.Zarza[5]States that ' The results show that although several low-level modeling factors of parabolic trough DSG solar plants carry relatively large magnitudes of uncertainty, most of them show a negligible influence on integrated higher level output design indicators after being propagated through model. Therefore a key finding in this work is that the selection of a particular design indicator has a very significant influence on the relative importance distribution of the sources of uncertainty in the design stage, leading to different combinations of complexity, completeness and robustness'. The author jun xiao Xiudong wei zhenwu lu Weixing yu & Hongsheng Wu[6] States that 'Three types for surface measurement methods of solar concentrators are discussed. The video scanning Hartman optical test is a procedure directly measure surface slopes and it is suitable to characterizes the optics of dishes and parabolic trough where it is sufficiently accurate . Photogrammetric is a method based on photographic process and widely used for the 3-D dimensional measurements of objects. It allows the measurements of objects. It allows the independent measurement the deflectometry is suitable for measuring large surfaces with high resolution particularly for measuring heliostats of a central tower system with a typical focal length of 100 or larger. Solar collector and thermal energy storage system are the two components. Different metal firms affect heat transfer in PCM'. The author Ojajunmao[7] states that 'Main geometrical configurations of IES system in CSP plants are cylinder and rectangle . Rectangular storage tank is popular for sensible heat storage in large scale system and cylinder storage tank is more extensive for latent heat storage in labscale system. Packed-bed encapsulated PCMs is future trend in TES system'. The author Ming liu N.H.steven tay stuart bell Martin belusko Rhys Jacob &Geoffrey will[8]States that 'The paper overviews the technical development in high temperature TES over the last decade to achieve cost effective TES for CSP Recent developments in latent TES aim to maximize the extraction rate of the stored heat from storage systems by reducing the thermal resistance between the PCM and the HTF through encapsulation ,utilizing heat pipes and making PCMs mobile. High temperature corrosion of the containment material is a severe problem experienced by all types of TES. The cost of the thermal storage is a function of both the storage and containment materials and the configuration associated with storage system. The author Gianpero colangeb,Ernani favale,Paola mighietta,Arturo de risi [9] stated that 'This paper has been focused on the recent development in the field of flat plate solar thermal collectors. These type of solar collectors are the most widely used in the world because of low cost and easy maintenance. In this paper different schemes of operation during summer day summer night winter day and winter night.Nanofluids can be employed in flat solar panels in order to increase efficiency of systems. Innovative materials, innovative heat transfer fluids in solar thermal collectors'.The authors Ricardo Vasquez dadilla,Gokmen demirkaya,D,yogi Goswami,Eias stefamaskos, Muhammad N.Rahman[10] states that 'A comprehensive heat transfer model for thermal analysis

of parabolic trough solar receivers was developed. The heat collection element consists of an absorber surrounded by a glass envelope. In this paper a detailed one dimensional heat transfer analysis of a PTC is presented. The receiver and envelope were divided into several segments and mass and energy balance were carried out in each control volume'.The author Fatigun A.T,Fauneya E.B,Aduloju K.A,Falaiye O.A.[11] states that 'The line focus solar thermal collector was constructed using flexible plywood, wooden planks, silver coated acrylic mirror ,copper tube and glue. Experimental investigation was carried out on a three segment line focus concentrating collector in stationary mode. Study show that the effect of structural geometry is significant on the performance efficiency of a line focus collector .The useful gain rate of the system was estimated to be 9.6 kw while the heat loss coefficient was 4.637w/mk.The author G.O.G lof, D.A Feser ,J.A.Duffie[12] states that 'The shape factor is defined as the fraction of radiation specularly reflected from reflector which is intercepted by the receiver. The most probable reasons for the receiver size are mis positioning of the receiver and misalignment of the reflector.If a small receiver is centered a slight distance from the theoretical focus, the actual shape factor would differ from the measured shape factor used in calculating energy balances. The reflector focal length was one foot ,the rim angle was 114 degrees and the FIA was 0101.Incident solar radiations were measured with an eppley pyrheliometer mounted with sensing element parallel to aperture of reflector'. The author Devander Kumar Lamba[13] stated about parabolic trough collectors that, Parabolic trough technology is the most mature concentrated solar power design. PTCs effectively produce heat at temperatures ranging From 50 to 4000 C. These temperatures are generally high enough for most industrial heating processes and applications, the great majority of which run below3000 C. There is a series of curved mirrors in each parabolic trough which are used to concentrate sunlight on to thermally efficient receiver tubes placed in the trough's focal line through which synthetic oil, heated to approximately 400 ◦C by the concentrated sun's rays, is used as a heat transfer medium. As reviewed in the paper the key sectors are food and beverages including wine, textile, transport equipment, metal and plastic treatment,and chemicals. And the most suitable processes are cleaning, drying, evaporation and distillation, blanching, pasteurisation, sterilisation, cooking, melting, painting, and surface treatment,it can also be used in refrigeration and air conditioning. India have taken up the opportunity to harvest the solar resource. Projects based on PTC have the potential for power generation sources in the near future. World governments are actively announcing incentives for development of solar thermal power plants and establishing policy frameworks. The launch of The JNNSM by MNRE, Government of India is the first step in the promotion and establishment of solar energy as a viable alternative to conventional sources.The author Neha Jain[14] studied that, The concentrated solar power technology (CSPT) is being looked upon as solution of increasing energy requirement of the world of today. Parabolic-trough collectors can also drive absorption cooling systems or other equipment that runs off a thermal load. A dark surface is positioned to absorb sunlight and convert it to heat. Water or another heat transfer fluid passes along that hot surface to pick up the heat—either for direct use or for transfer through a heat exchanger to the end use. From the standpoints of technological feasibility, compatibility with existing facilities, conventional energy use reduction, and pollution and climate-change-gas emission reduction, the outlook is quite good. The technology is more limited geographically to areas of high solar resource and to larger facilities than technologies, but the economics are better. This is largely the reason for the fact that 97% of the total energy generated in the world through CSPT utilizes parabolic trough solar power.In India, Cargo Solar Power project in Kutch (Gujarat) and Corporate Ispat Alloys Limited project in Nokh (Rajasthan) are targeted to be finished by 2013, both being parabolic trough type plants. 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efficiency can be scaled higher in larger plants,however, the land requirement for the same also increases proportionally.7 The thermal losses during the transfer of synthetic oil in the pipes mesh also affects the efficiency of the system, a problem combated in power towers. The greatest and the most visible advantage of a solar power tower design above the parabolic trough design is attainment of higher temperature. Author Falah Abd Alhasan Mutlak [15],in this paper he carried out a experiment in which he formed a system in which it includes, construction of a matrix of mirrors to form the parabolic reflector (1.8 □ 2.8 m). They are aligned by a laser beam. Solar tracker has been constructed (using two-axis) to track PTSC according to the direction of solar radiation. Synthetic oil is used as a heat transfer medium because of its capability to have load of high temperature (□400 oC). The storage tank has been fabricated of stainless steel of size 50 litre.He also gave load two loads to it, the first load is designed as a solar cooker and the second one for space heating. In order to track the sun throughout the day for every day of the year, there are geometric relationships for the position of the collector with respect to the time that is needed to be known. The earth revolves around the sun every 365.25 day in an elliptical orbital called eclliptic plane, and it completes a full rotation about its axis every 24 hours. The earth – sun distance is smallest on December 21 (perihelion, 1.47 □ 1011 m) and highest on June 21 (aphelion, 1.52 □ 1011 m) . The axis of rotation of the earth is tilted at an angle of 23.45° with respect to its orbital plane, as shown in figure. This tilt remains fixed and is the cause for the seasons throughout the year. A parabolic trough solar collector with automatic two-axis solar tracking system was constructed, operated and tested to overcome the need for frequent manual tracking. This procedure causes an increase in the out put power of the PTSC by making the solar angle of incidence between the beam of the solar radiation and the normal on the surface of the trough equal to zero (the geometrical losses becomes zero). Results indicate a beneficial effect when the receiver is painted black. Moreover, using glass cover protective apparently proved benefit to the overall performance. Authors namrly Matthias Günther, Michael Joemann , Simon Csambor [16] and reviewers Amenallah Guizani Dirk Krüger Tobisas Hirsch reviewed and studied the parabolic trough technology. The energy flow in a parabolic trough power plant has the following structure: Direct solar radiation is concentrated and converted into thermal energy. The thermal energy is converted into pressure energy of vapour, which is converted into kinetic energy. The kinetic energy is finally transformed into electrical energy, the final product of the power plant. The collector, the parabolic trough, is a trough the cross-section of which has the shape of a part of a parabola. More exactly, it is a symmetrical section of a parabola around its vertex. The main requirements for appropriate mirror materials are their reflective properties. The reflectivity must be high. The reflectivity of a surface is a number that indicates the fraction of the incident radiation that is reflected by the surface. In general, the reflectivity is different for different wavelengths so that it has to be specified for a given wavelength or a given wavelength range, for instance for the visible light range. In the case of solar applications, the solar spectrum is of interest. Generally, a “solar weighted reflectivity” is indicated that takes into consideration that there are different energy contents at different wavelengths in the solar spectrum. The solar weighted reflectivity indicates, hence, the fraction of solar energy that is reflected on a mirror. The bearing structure of a parabolic trough has the function to carry the mirrors in the right position, to give stability to the troughs and to allow an exact Sun tracking. Theoretically, the parabolic troughs in the solar field of a CSP plant can have any horizontal orientation. Sun tracking is always possible. However, there is a preferred orientation, which is the north-south alignment with the respective east-west tracking. East-west alignment with the respective north-south tracking was applied only for experimental purposes. The reasons for the preference of the north-south alignment will be explained in the section “Solar field”. Receivers for parabolic trough power plants have the task to convert the radiation that is projected onto them into heat and to transport the heat to the pipes, which leads it further to the power block. Important are high radiation absorption and low heat losses. A constructive challenge is the heat expansion of the receiver due to the changing temperatures between operation and non-operating state. It has also to be taken into account that the receivers in a parabolic trough power plant are moveable parts which require flexible pipe connections. The receiver has to fulfil several geometrical and physical requirements. The reflected radiation has to hit the absorber surface, which implies geometric constraints. The radiation has to be converted as completely as possible into heat and the optical and thermal losses at the surfaces of the receiver components should be as small as possible. Special coatings and thermal insulation measures are applied to achieve this. The authors, Charles Wyman, James castle & Frank Kreith [17] stated that collector technology is available temperature up to 350 degree F .the technology and thermal performance of intermediate temperature solar collector is summarized and status of

thermal and thermo technology storage method revived .current collector technology can provide linear concentrating collector for capable of heating a working fluid to 300 degree centigrade at peak efficiency up to 60%.heliostat with central receiver can be used for higher intermediate temperature. Thermal energy can be stored in internal energy of a material as S.H and L.H heat of reaction or combination. Solar radiation is intermitted fissile fuel backup for energy storage must meet energy need at night during cloud cover. The optimum energy storage duration is usually that which provide minimum final delivered energy cost.

CONCLUSION:

Considering the low carbon emission there will be huge demand for solar systems in the future, as current non-conventional sources of energy are satisfying only 6.9% of the total potential of the renewable sources in India. A current study shows that maximum 60% efficiencies can be achieved with current collector technology.

The evacuated receiver is preferable to get temperature in the range of 130-140^{0}C, its cylindrical shape leads to receive reflected and deflected radiations from the focus [15]

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