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Review of Concentrating Solar Thermal Collector for Performance Optimization Approach

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ABSTRACT:

This review will collect and analyze published data on focused solar research collected over the past eight years. The aim of this study is to determine the usability of alternative energy models for solar energy products. The results of the data are presented in the context of the design model to enable a comprehensive analysis of renewable energy systems and identify areas of future research for the entire field.

INTRODUCTION

Worlds energy demand increasing rapidly , this rapid increment in demand making it impossible to fulfill demand with the aid of conventional energy resources in longer run . In this case, the sun is one of the pleasant dependable power sources. power efficiency and stellar era are critical elements of any domestic energy design .The sun may be a massive reservoir of energy with out pollutants, so the energy of the sun's rays reaching the earth is called renewable and clean energy. The energy received is often directly or indirectly converted into various forms of energy that humans can use, such as thermal and electric energy. Since the sun is expected to erupt at a constant rate for millions of years, it will be considered an inexhaustible source of useful energy. Other sources of electricity have been used since prehistoric times, but with very old methods. Before the 1870s, a handful of countries had done some research and development on more efficient energy use, but most of the work was still at an academic level. After oil prices rose in the 1870s, many countries began to analyze and develop more efficient energy sources.

LITERATURE REVIEW

1.   Asim Ahmad , Om Prakash , ……………2024

This paper discusses the possible merits and encounters of using parabolic trough solar collectors. One of the prime advantages of parabolic trough solar collectors is their scalability. They can be used to generate electricity on a small scale, such as for domestic or commercial applications, or on a large scale, such as for a power plant. Parabolic trough solar collectors are also reliable and have a long lifespan. They are not as susceptible to weather damage as other types of solar collectors, such as photovoltaic panels. However, there are some challenges associated with using parabolic trough solar collectors. One challenge is that they require large land areas. Another challenge is that they can be expensive to maintain. Despite the potential, further research is essential to address these issues. Future prospects lie in optimizing land use, enhancing maintenance strategies, and advancing collector technology to harness the full potential of parabolic trough solar collectors. Overall, parabolic trough solar collectors are a promising technology for generating electricity from solar energy.

2.   Mohammed Arfa Umar Farooq Praveen Partibhan …………et al 2023

This project methodology starts with the preliminary design of all the components of the CSP plant which includes gathering and scrutinizing the design information from existing plants across the world, the latest research findings, and results from SolarPILOT software. In the second part, more detailed analysis in terms of the levelized cost of electricity of the plant is performed to select a configuration that gives us the lowest LCOE. Moreover, sensitivity analysis is also carried out on various design parameters to obtain the optimized configuration. In the next section, the results are compared with SAM (System Advisor Model) developed by NREL for economic analysis of renewable technologies. Lastly, the optical performance obtained from Solar PILOT is compared and the sun rays' path is visualized in detail with the SolTrace software.

3.   Vennila, . Muralikrishnan,………….......................et al 2023

This research aims to analyze the characterize of a solar thermal plant for a cold arid high DNI environment using a variety of analytical factors. Several important studies, such the impact of SM for soalr power production, impact of TES on power plant performance , central

receiver performance analysis, effect of DNI over CSP plant energy production performance, and CSP economical analysis, have been conducted. According to the results, the LCOE is decreased and the power plant capacity factor is increased when thermal energy storage is incorporated. In this study it has been observed that the plant efficiency is the section where the researchers can work in the future because the field optical losses are huge for the particular study. Field optical efficiency has a big impact on the plant overall efficiency. By optimizing the solar field optical efficiency it can be possible to increase the plant performance. So from the study it has been observed that Leh Ladakh region is highly solar potential region in the India with huge amount of DNI which is ideal for solar tower type CSP plant. From the study analysis it has been observed that the CSP CF, and CSP generation is high and the LCOE is also very low for this region. With proper design and optimization of the design parameter the Leh Ladakh region will become the solar energy power hub for India.

4. Design and optimization of CSP power plants for Pakistan: a comparative study   Kashif Liaqat*, and Juan C. Ordonez…………………et al 2022

The study evaluates the pros and cons of different CSP technologies at various locations through site assessment, modelling, optimization and economic analysis using the System Advisor Model. Quetta and Nawabshah were selected as the locations for modelling multiple scenarios of 100-MW plants, using central receiver systems, parabolic trough collectors and linear Fresnel reflectors. The plants were integrated with thermal energy storage and the storage capacity was optimized using parametric analysis. The results showed that a central receiver system for the location of Quetta was the most favourable option, with an annual energy yield of 622 GWh at 7.44 cents/kWh, followed by a central receiver system for Nawabshah (608 GWh, 9.03 cents/kWh). This study is the first to show that switching between line-concentrated and point-concentrated CSP technologies can open new opportunities for sites in Pakistan with relatively high solar resources, resulting in a 21.3% reduction in the levelized cost.

5. Alessandro Buscemi1, Valerio Lo Brano, ……….…et al 2020

This paper projected model, supported real monitored knowledge, the energy balance of the collector and therefore the partial load potency of the Sterling engine, are often used simply to simulate the annual energy production of such systems, creating use of the radiation info, with the aim of encouraging a larger development of this technology. The projected methodology was accustomed measure the history of mirror dirtying for the observation amount, that shows a powerful correlation with the recorded sequence of rains and mud depositions. The results of this study emphasise however desert mud transport events, frequent occurrences in components of the Mediterranean, will have a dramatic impact on the electrical power generation of dish-Stirling plants.

6. Evangelos Bellos and Christos Tzivanidis…………………….et at 2020

This work studied completely different expressions regarding the thermal potency of a PTC with a scientific approach. The LS-2 PTC module is examined with a developed numerical model within the Engineering Equation problem solver for various operative temperatures and solar beam irradiation levels. This model is valid mistreatment experimental literature information. The found information area unit approximated with numerous polynomial expressions with up to 6 unknown parameters in each case.

7. Ahmed Bilal Awan , Muhammad Zubair , R.P. Praveen , ……....et al 2019

In this work The technical comparison is performed based on solar to electrical efficiency, electrical output, capacity utilization factor, and land use factor while economic comparison includes net present value (NPV), net capital cost (NCC), levelized cost of energy (LCOE), and payback period. CSP plants have better electrical output and capacity utilization factor compared to PV plants while PV plants exhibit far better economic performance. Tabuk site is proven to be the best location for both CSP and PV plants. The best case CSP plant has 33.3% more electrical energy generation compared to the best-case PV plant. The capacity utilization factor of the CSP plant is 45.4% vs. 30.2% for PV plant. The CSP plant has 4.5 times higher NCC compared to PV plant. The LCOE of CSP plant is 2.73 times higher than that of PV plant. Overall CSP technology has better technical performance while PV technology is economically more feasible than the CSP technology.

8. Dr. Hassane Darhmaoui………………...………………………et al 2019

The methodology of this work could be a style try of a CSP Stirling dish that includes a solar pursuit system to maximise the star irradiance throughout the day. the look can comprehend several engineering stages beginning by understanding all the parameters and aspects poignant the energy conversion method normally, then study every thought specifically by analyzing the connected equations. during a unclean atmosphere, it's necessary to say the role AN anti-soiling coating for the solar furnace. additionally, this work can embrace a 3D model of the receiver created victimisation the software package SolidWorks and on that the testing are going to be undertaken. The thermal analysis are going to be conducted victimisation elementary equations. Finally, the results square measure to be simulated victimisation stand out wherever the various parameters furthermore as weather information are going to be incorporated. Finally, the empirical results square measure summarized and taken.

9. Fabian Dählera, Michael Wilda, Remo Schäppia, Philipp Hauetera, Thomas Coopera, ………..………et al 2018

The design, fabrication, and on-sun characterization ofa reflector concentrating systemfor playacting the twostep thermochemical oxidation-reduction ripping of H2O and greenhouse gas is conferred. It includes a primary sun-tracking four.4m-dia. reflector concentrator coupled to a secondary platelike rotating reflector. This optical arrangement permits the operation of 2 (or more) star reactors side-by-side for playacting each oxidation-reduction reactions at the same time by alternating the star input between them whereas creating continuous and uninterrupted use of the incoming focused daylight. On-sun

characterization of the entire concentrating system disclosed a peak star concentration magnitude relation of 5010 suns and a median of 2710 suns measured over the 30mm-radius aperture of the star reactor. an in depth optical analysis elucidates measures to extend the optical potency and concentration magnitude relation.

10. **Tikrit, Yaseen H. Mahmood…………………..…et al 2018**

Two solar furnace concentrators (SDC) with diameter of (2 m) are designed for water heating purpose. This study applied on star steam heater (SSWH). each of the dishes coated with thick layer of steel (galvanized), whereas its interior surface lined with a reflector layer. the primary dish interior surface lined with a layer of reflectivity up to eightieth, whereas the other lined by a items of mirrors with a reflectivity of ninety fifth. The receivers are mounted within the focal position of each dishes. The measuring of temperature and solar energy for each sorts are documented and recorded. The optical energy for the first dish is 1909 W, the ultimate energy is 1551 W, and also the potency is sixty one nothing, whereas the optical energy for the ordinal dish is 1607.68 W, the ultimate energy is 1853 W, and also the potency is seventy three nothing. The obtained results thoroughbred that the materials employed in this analysis area unit economic, with prime quality to get star concentrator, however the dish that is roofed with items of mirrors is healthier, and it are often used for water heating.

11. **Zhongguang Fu, Gaoqiang Zhang ……….et al 2018**

The variation performance of integrated star combined cycle (ISCC) is conferred victimization energy, standard exergy and advanced exergy analysis strategies to supply data regarding exergy destruction of parts and efficiencies of overall plant. Moreover, the speculation of dividing the exergy destruction of main parts into un avoidable/avoidable and exogenous/endogenous elements permits for additional understanding the $64000 potentials for rising. Besides, the exergy destruction rate and exergy potency of parts also as overall plant were hourly analyzed at intervals a typical day. Results indicate the exergy destruction rate of overall system drops from forty nine.79% to 44.65% in summer and reduce from forty nine.79% to 47.59% in winter. because the star irradiation intensity rises, the star field potency reaches to forty two.16% in winter and forty seven.5% in summer. The solar-to-electric energy potency gets to thirteen.69% in winter and fifteen.46% in summer. additionally, with the rise of alternative energy input to the ISCC system, the exergy destruction of Brayton cycle parts decreases; but, the exergy destruction of temperature unit cycle parts will increase. moreover, the exergy destruction of star field includes a massive extended from fourteen.55 MW to fifty eight.03 MW. Moreover, the warmth recovery steam generator (HRSG) and also the steam turbines have the biggest exergy destruction rate of eleven.26% and 13.63% at 15:00 p.m

12. **Ahmad Alzahrani, PouryaShamsi ,CihanDagli……..et al 2017**

This paper presents a method to predict the solar irradiance using deep neural networks. Deep recurrent neural networks (DRNNs) add complexity to the model without specifying what form the variation should take and allow the extraction of high-level features. The DRNN is used to predict the irradiance. The data utilized in this study is real data obtained from natural resources in Canada. The simulation of this method will be compared to several common methods such as support vector regression and feedforward neural networks (FNN). The results show that deep learning neural networks can outperform all other methods, as the performance tests indicate.

13. **Ruby Nageema, Jayabarathi Rb ………………..et al 2017**

This paper proposes a new method for forecasting the power output from a solar panel using multi input Support Vector Regression model. The performance has been analyzed and compared with Analytical PV power forecasting model. Both the models are simulated and performance evaluation is done using MATLAB. Mean Absolute Percentage Error and Mean Absolute Error are used to assess forecasting models

14. **Premalatha Neelamegam , ………...et al 2016**

The main objective of this work is to develop an ANN model for accurately predicting solar radiation. Two ANN models with four different algorithms are considered in this study. This study confirms that prediction accuracy of the ANN model depends on the complete set of data being used for training the network for the intended application. The developed ANN model has a low mean absolute percentage error (MAPE) which ascertains the accuracy and suitability of the model to predict the monthly average global radiation so as to design or evaluate solar energy installations, where the meteorological data measuring facilities are not in place in India.

Critical assessment of research papers and research gap:

Concentrating solar collector collect the solar radiation in large area and focused the radiation in a point called focal points that heat can be utilize in many aspects and the performance of system is largely affected by the following parameters.

1   DNI (daily normal irradiance) of the zone

2   Collector type weather flat parabolic or disc.

3   Optical efficiency of the reflector

4   emissivity of the receiver

5   Utilization of waste heat.

Performance of concentrated solar collector can be improve by varying certain optical properties of reflectors and receivers materials lot of research work has been conducted over the years but some area of research has been untouched till now.

- ➢ Csp system has not been designed and applied for house-hold purpose.

- ➢ Csp system has not been optimize and applied for various reflector quoting and receiver material

- ➢ Csp can be optimize by using smart memory alloy

- ➢ Heat collected by the system can be utilize for power generation with Stirling engine for house hold purpose in order to meet the domestic requirement.

- ➢ Heat rejected by engine can be taken for water heating and purification system.

RESULTS:

The overall outcomes of the researchers show that positive impact importance of performing the renewable solar energy that is a perfect alternative to the fossil fuels such as coal and petroleum products for thermal power plants. In general, all recommendations prompted governments and private sectors to put the road-map plan for taking practical approaches to using solar energy concentrating collector system. Based on the facts mentioned above, the establishment of the proposed concentrating collector systems is highly recommended not only in India. However, also in many other countries, which have similar political and economic conditions.

CONCLUSIONS:

During the study, the capability of using solar thermal electricity from Middle East countries is available and more precisely using the concentrating solar collector because the average thermal efficiency has reached 50%. thermal efficiency of winter more than in the summer about 5% through. Also, the outcomes varied and depended on months of the year and the locations. Most researchers advise the governments and private sector to catch up the valuable potential of the solar energy in the different countries, to using solar concentrating collector systems for different applications.

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