ORIGINAL RESEARCH PAPER

Engineering

KEY WORDS: Renewable Energy, Solar Chimney, declination angle and Local apparent time (LAT)

A REVIEW PAPER ON SOLAR CHIMNEY

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ABSTRACT

In this research article the review is done on solar chimney. The solar radiation is abundant in nature and the radiation energy is used to convert into sustainable energy. The radiant energy is used to heat the fluid (air). The inclined canopy helps the air to move towards the tower having the lift force. The lift force is used to run the turbine to produce electricity. The fluid temperature decreases and moisture in air condensed to water and can be used in various applications such as drinking or in boiler. The area under canopy can be used as green house farming. Therefore, the solar chimney is new horizon in scientific and engineering community.

INTRODUCTION

Solar energy might be feasible to the ever-increasing problem. It is readily available in nature—a non-conventional energy source that has to be aligned to be beneficial to society. Solar power plants are designed to convert solar radiation into electrical energy through a numerical or natural cycle.Few, on either, can store enough energy every day to maintain a stream at night and when energy from the sun is relatively low. This storage's critical capacity is typically far too high to be practical.

Weather Data

The essential factor is solar radiation. Direct radiation and diffuse radiation are the two kinds of radiation that exist. The sum of both is referred to as global radiation. The heat from the sun varies depending on location, but it is approximated to be 1000W/m2 here.[1]The estimated variation of sun declination would be calculated using formula 1.

$$\partial = 23.45^\circ \sin\left[\left(360^\circ \frac{284+n}{365}\right)^\circ\right] \qquad (1)$$

Where, δ is declination angle and n is a particular day of the year.

Graph 1:Variation of Sun's declination angle

The equation of time correction for the sun is given b equation:-

	E=229.18 (0.000075+0.001868 cos B-0.032077 sin B-0.014615 cos 2B-0.04089 sin 2B)	**(2)**

Therefore, now we can LAT

	Local apparent time (LAT)= standard time ±4 (standard time longitude-longitude of location)+E	**(3)**

LITERATURE REVIEW

2.1 K. **Lovchinov et al.** [2] conducted extensive wind tunnel experiments and appropriate theoretical research to design and commission 50-kilowatt test plants. This plant was built at Manzanares and had a collector with a diameter of 240 metres and 195 metres. Various features and effects on their research, including:

- The durability and structural feasibility of various roof coverings on plant performance were investigated—effects of climatic conditions on plant performance.
- Algorithms for mass flow control have been tested.
- The operating costs and maintenance requirements were analysed.

Several plant sizes were evaluated using a thermodynamic model, and the dimensions, cost, and efficiency of this plant provided multiple tables. He also studied the system's economic feasibility and found it identical to a traditional power generation system.He explains the findings of his research on the implications of water bags, which enhance ground storage capacity. According to this research, a water layer 0.2 meters deep water layer will level out the daily fluctuations in power output, resulting in a daily peak of roughly 50% of those of a similar plant with no water storage.

2.2 R. Mehdipour et al.[3] reported a simple evaluation of the Solar Chimney, eliminating temperature and pressure variations due to height and chimney losses. There were suggested expressions for total efficiency.

2.3 R. Mehdipour et al. [4] derive relevant governing differential equations that characterise Chimney performance. They then presented the findings of research findings on the viability of moderate to large-scale power generating and also rural power generation. They recently studied the implications of geometrical and operational factors on the solar chimney's overall performance.

2.4 P. Das and C. V.P[2]investigated the validity of several driving potential models for prevailing ambient circumstances surrounding the Solar chimney (particularly elevation-dependent variables). They demonstrate that power production rises with humidity and that condensation in the chimney can occur.

2.5 To evaluate the Solar Chimney's limited efficiency and performance**. Zuo et al. [6]** used an ideal air standard cycle analysis. Following that, the cycle was improved to incorporate a simple collector model and system process.

2.6 Guo et al. 2020[3]This study for data centres presents a unique solar chimney-based direct airside free cooling (SC-DAFC) technology to conserve electricity. Under specified climate circumstances, a conceptual model of the SC-DAFC system is created to analyse the data centre's internal thermal conditions, ventilation flow rate, and energy recovery.The impacts of increased ceiling heightand turbo pressure drop mainly on chilling system performanceare investigated using 3D numerical simulations. Calculating the project's present valueand dynamic assetrecovery time is also part of the economic study.The study demonstrates that under favourable climate situations, the temperature in the SC-DAFC data centre can fulfil cooling needs and that such a project is highly profitable. The SC-DAFC device is both technically and commercially practical, resulting in energy-saving and operational-cost-cutting solutions.

2.7 Zuo et al. 2020[4]The focus of this research is to examine the impact of operational and structural elements on the WSCPPDW's performance and, therefore, to evaluate the flow field characteristics. The previously suggested mathematical model of WSCPPDW could barely explain the influence of structural parameters and flue gas jet. Utilising CFD ANSYS Fluent, a 3D numerical simulation of WSCPPDW was performed.Simulations with various turbine rotational speeds, nozzle lengths, chimney outlet radiuses, and chimney mixing section lengths were performed to find optimal operational and structural characteristics of WSCPPDW. The findings demonstrate that the flue gas jet can create a high-temperature, high-speed jet region in the chimney, entrain the surrounding airflow. Furthermore, as the rotational speed of the turbine increases, the freshwater yield decreases, and the turbine shaft power increases initially, then declines, peak at 200rpm. The freshwater gain and turbine shaft power increase and then decrease as the nozzle length increases; the freshwater yield and turbine shaft power increase and decrease as the chimney outlet radius increases; as the chimney mixing section length increases, the freshwater gain and turbine shaft power increase and then decline.

2.8 Ramin Mehdipour, Baniamerian, et al. 2020)[5] In this report have two distinct features in comparison with other setups that were used in the prior arts:

2.1 Because the settings are indoor rather than outside, the environmental factors can be controlled entirely in this research,and a steady-state can be accomplished.Both arrangements can measure the collector's thermal performance and the solar chimney's performance. To analyse the influence of geometry on the actual efficiency of solar vents, several setups were used.

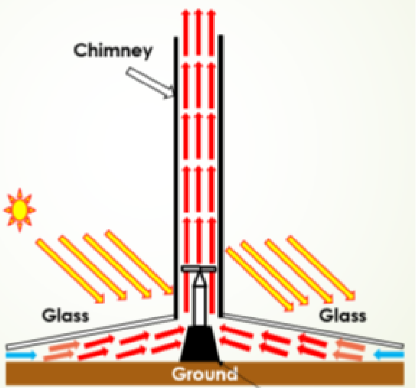
The thermal and hydraulic performances of popular forms of solar chimneys are shown to be insufficient in this research, and inadequate thermal behaviour of collectors is among the significant causes for solar chimneys' poor power output.Nusselt number (Nu), airflow velocity, and convective heat transfer coefficient (h) increased 1225 percent, 245 percent, and 603 percent, respectively, when the collector form is changed from circular to that of an innovative square shape.

2.9**Wang et al. 2020**[6]Because earlier optimisation designs have mostly neglected the effects of environmental wind, the impact of ecological wind on the optimal designing parameters are now examined. It has been verified that the external wind implies the optimal design parameters, which differ from those previously obtained results in the publications without taking the external wind into account. It was observed that under the external wind, the once determined optimal cavity depth of 0.2–0.3 m is no longer relevant, and the appropriate value rises to 0.4–0.5 m, or the same is true for inlet height/area.The efficiency of the solar chimney is improved in the presence of external wind, which is due to both the incoming wind flow from the room entrance and the reduced air resistance. Increased sun intensity has been shown to have negligible effects on overall airflow characteristics.The performance of the solar chimney was also generally improved. At the same time, the external wind speed was low, but a strong wind could dominate its version with slight variation, even when the wind angle was as large as 45 degrees. The airflow rates via the solar chimney are renowned for being hindered by a short cavity depth (less than 0.2 m) and intake height when revealed to the external wind. When the cavity depth and intake height are more than 0.2 m, the airflow profiles are less influenced.

2.10 Elsayed and Nishi 2020[7]Energy indicators are calculated in this research experiment to determine the solar updraft tower's (SUT). SUT uses a solar collector, a central building, and air turbines to generate electricity from hot air. The findings show that SUT's long-term viability increased as the plant's size expanded.

In addition, energetic ternary diagrams are constructed to make comparisons between SUT and other technologies easier. Wind energy and SUT, 200 MW, had the lowest resource-use efficiency of all the energy technologies investigated. Scenario analysis is utilised to explore future optimisation paths. The results show that the primary focus of SUT system development should be on lowering the portion of materials used in the manufacturing and assembly of solar collectors.

2.11**Yapıcı, Ayli, and Nsaif 2020**[8]An experimental investigation from the literature is performed to verify the results of a numerical model generated with CFD software. After confirming satisfactory agreement with the tests, the effects of chimney and collector geometry parameters and various configurations on SCPP performance are studied concurrently and additively. The study provides insight into performance enhancement techniques and predictionof the optimal SCPP model configuration, which constitute the essentialfoundation for a comprehensive prototype process. The optimum SCPP configuration is the disparate chimney that increases the produced power as per the numerical calculations.



2.12 He 2020[9]A generic model for solar chimneys is built using a plume of constant thickness as a thermal boundary and a momentum equation in the plume. The relationship between plume thickness and the channel Reynolds number, which is determined by plume velocity and channel hydraulic diameter, is illustrated in a series of graphs. In the Reynolds number range of 17 to 23,151 and Rayleigh number at half of the chimney height range of 4.54 109 to 2.12 1014, the model and 15 measured datasets had a fair agreement.According to the correlations, channel free convection is a mix of free convection (depending on Ra) and forced channel flow (dependent on Rech). Both natural, free convection and forced channel flow are compatible with the critical Rayleigh number at half the chimney height and the necessary Reynolds number.The supplied correlations and plume model may be used to calculate the mass flow rates of solar chimney systems with connecting ducts that are vertical and square-channelled.

Working

The direct sun's energy heats the air and causes it to move, resulting in wind. This phenomenon is caused by the "as thermosyphon effect". The wind has provided direction to its pivot point.

The air is heated by conduction and radiation, and the potential energy of the air is transformed into kinetic energy, which proceeds upward. The wind turbine is installed in the middle. As depicted in Figure 4, the wind blades convert wind (kinetic energy) into rotational energy, which is then turned into electricity with the assistance of a generator.

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