ORIGINAL RESEARCH PAPER

Engineering

A CASE STUDY ON SOLAR THERMAL CHIMNEY POWER PLANT IN BHOPAL

KEY WORDS: Non-conventional Energy, Solar Thermal Energy and Sun radiation.

Ashok Kumar Singh*	Research Scholar, RKDF College of Technology. *Corresponding Author
Poonam Wankhede	Assistant Professor, RKDF College of Technology.
Vijaykant Pandey	Assistant Professor, RKDF College of Technology.
Pankaj Kumar Singh	Research Analyst, Sunrise CSP India Pvt. Ltd.

ABSTRACT

The demands and application of electronics goods increase the electricity generation load from non-conventional sources such as wind, solar, and hydro. This clean and green energy laid down the track for future energy demands and reduce carbon emission from the environment. To harness the non-conventional energy, we need to focus on the metrological behaviour to understand solar power generation's smoothness index. To estimate that we need to track down the two crucial parameters, one motion of the sun and another wind flow and its magnitude and direction. Metrological data will help us design the plant for the desired location "Bhopal" and no working days. Therefore, this research paper focused on solar power improvement using metrological data.

INTRODUCTION

Present-day electricity production from fossil fuels like natural gas, oil or coal is harmful to the environment and bares the inadequacy that it relies on non-renewable energy sources. Numerous developing countries cannot meet the expense of these conventional energy sources, and in particular of these sites, nuclear power is well-thought-out an unacceptable risk. It has revealed that a lack of energy maybe a couple to poverty and poverty to people explosions. An environmentally friendly and cost-effective electricity-producing structure is thus evident and will become more prominent in the future.

A potential resolution to the ever-increasing problem is solar energy. It is abundant in nature—the non-conventional source of energy that only needs to be tie together to be of use to humankind. Solar power plants in the creation are equipped to transform solar radiation into electrical energy via a numeral cycle or natural phenomena. However, few can store enough energy during the day to keep a stream during the night and when the solar radiation is insignificant. The vital capacity of this storage is usually too high to be practically viable.

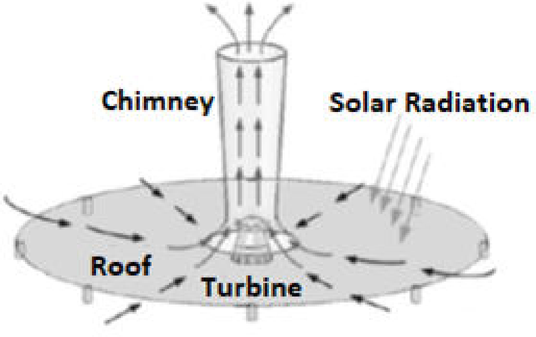

Figure 1: Diagram of Solar Chimney Power Plant

LITERATURE REVIEW

K. Lovchinov et al. [1] conducted detailed theoretical Research and extensive wind tunnel experiments thought by the design, and commissioning of 50 kilowatt experimental plants. This plant was set up in Manzanares and had a 240 m diameter collector and a 195 high chimney. Various properties and affects their studies, namely:

- Different roof coverings where tested for durability and structural suitability on plant performance.
- Effects of ground temperature and humidity and on plant performance.
- Mass flow control algorithms from where tested.
- Running cost and maintenance requirements were evaluated.

Various plant sizes were studied using a thermodynamic model and the dimensions cost and performance of this plant entertains numerous tables. He also researched the system's economic viability and found that it approached conventional power generating system. He discusses the results of his studies into the effects of water bags used to improve the ground storage capability these studies reveal that are water layer 0.2 metres thick will even about the daily fluctuation in power generation, at approximately half that of the day peak of a similar plant with no water storage.

R. Mehdipour et al. [2] presented a simple analysis of the Solar Chimney, neglecting the variation of temperature and pressure of air with variation in height, and losses in the chimney. Expressions for the overall efficiency where suggested.

Relevant governing differential equations that describe Chimney performance is derived by **R. Mehdipour et al.** [3]. Later, they presented the results of their study of the viability of medium to large scale power generation and power generation in rural areas. More recently, they discussed various effects of geometrical and operating parameters on the solar chimney's overall performance.

P. Das and C.V.P [4] studied the validity of the various driving potential model for prevailing ambient conditions (especially conditions that are elevation-dependent) around the Solar chimney. They show that power output increases with humidity and that condensation may occur in the chimney.

L. Zuo *et al.* [5] applied an ideal air standard cycle analysis to the Solar Chimney to find its limiting efficiency and performance. This cycle was then refined to include a simple collector model and system process.

CASE STUDY
Weather Data

Location: Bhopal (23.2599° N, 77.4126° E)

The critical factor is solar radiation. The radiation is basically of two types of direct radiation and another is diffuse radiation. The sum of both is global radiation. The heat coming from the sun is varies at different places, but here it is considered as 1000W/m^2.[6] The daily variation of sun declination over the year would be estimated using formula 1.

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

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 sun is given b equation:-

$$E=229.18\,(0.000075+0.001868 \cos B-0.032077 \sin B-0.014615 \cos 2B-0.04089 \sin 2B) \quad (2)$$

Therefore, now we are able to LAT

$$\text{Local apparent time (LAT)= standard time} \pm 4\,(\text{standard time longitude-longitude of location})+E \quad (3)$$

Working

The direct sun radiation helps to hat the air and generates motion into the air, causing wind. This phenomenon is due to "thermosyphon effect". In our research, the wind has given direction towards its pivot point, as shown in figure 2 and 3.

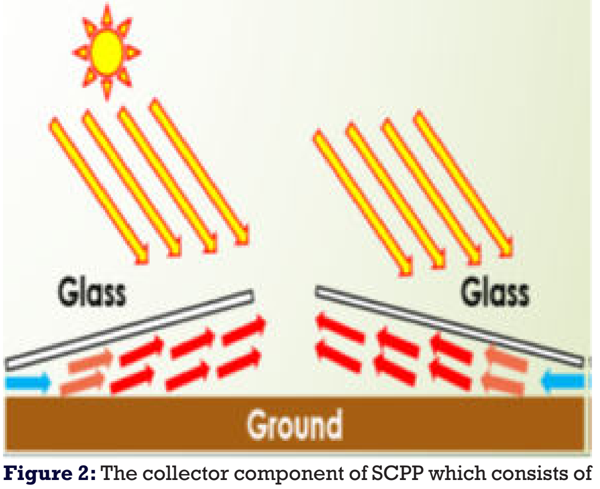

Figure 2: The collector component of SCPP which consists of a transparent cover roof and ground absorber

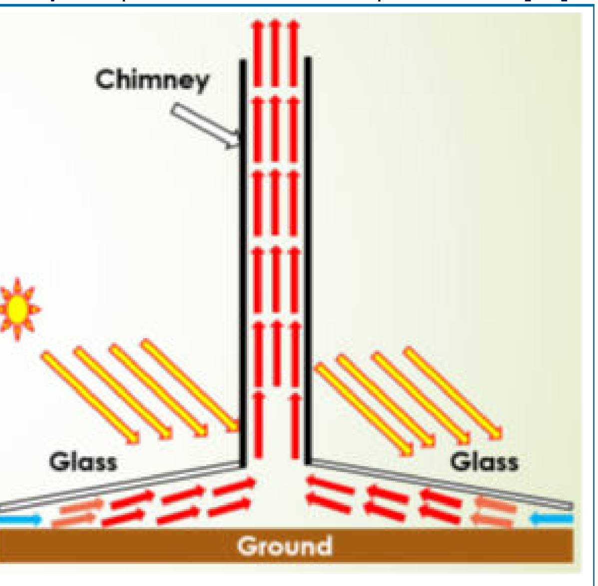

Figure 3: The chimney component of the SCPP

Due to conduction and radiation, the air is heated and the potential energy of air is converted into kinetic energy which moves upward in direction. In the middle of the wind turbine is installed. The wind blades convert wind (kinetic energy) into rotational energy which is further converted into electricity with a generator's help as the detail is shown in figure 4.

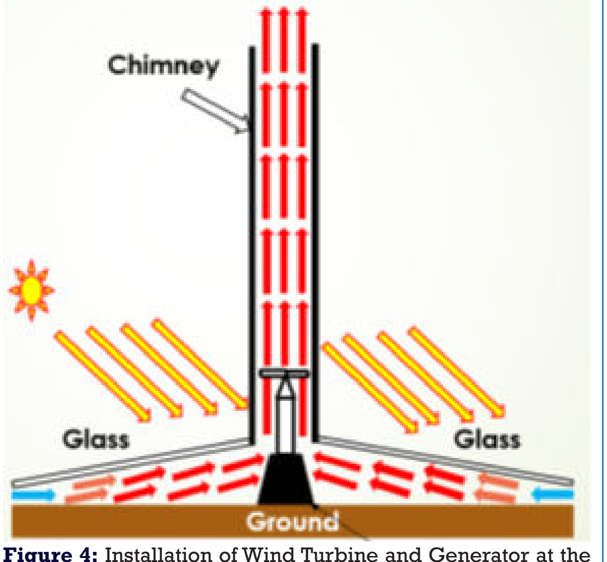

Figure 4: Installation of Wind Turbine and Generator at the Chimney Base

CONCLUSIONS

The ongoing help us in producing green and clean power from solar energy with no carbon emission. Its objective is to investigate the optimization of a large-scale solar chimney power plant, through the pursuit of obtaining the thermal and optical dimension of plant, enhancing its performance, and exploring its dynamic and static control over the power plant's power output.

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