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# A Review….. Design of solar chimney for passive ventilation Systems

Santosh P. Basare[1], Prof. S. V. Devkare[2,] Prof. A. S. Dayma[3]
Department of mechanical Engineering
University of Mumbai
S.S.Jondhle College of engineering and Technology
Asangaon 421601
*basaresantosh@gmail.com, Santosh.devkare@gmail.com, asdayma@gmail.com*

***Abstract*** **-** The solar chimney power plant (SCPP) otherwise called 'solar updraft tower' is a non-concentrating sun powered warm innovation, which utilizes both sun oriented and twist vitality to work. The plant basically comprises of three fundamental parts; a vast nursery authority, which encompasses a tall stack and a wind turbine outfitted to a generator at the base of the smokestack. Hot air is delivered by the sun under a vast glass rooftop. Immediate and diffuse sun based radiation strikes the glass rooftop, where particular portions of the vitality are reflected, consumed and transmitted. The amounts of these portions rely on upon the sun oriented optical attributes of the glass, for example, the refractive file, thickness. The authority, bolstered a couple meters over the ground, is secured by a straightforward coating. The authority, upheld a couple meters over the ground, is secured by a straightforward coating. The authority changes over sunlight based radiation into warm vitality by method for nursery impact to warm the air underneath. The weight contrast between the smokestack base and encompassing weight at the outlet can be evaluated from the thickness distinction. This thus relies on the temperatures of the air at the gulf and at the highest point of the smokestack. The weight contrast accessible to drive the turbine can be lessened by the grating misfortune in the stack, the misfortunes at the passageway and the way out active vitality misfortune. Lightness drives the hotter air into the fireplace, which is situated at the focal point of the gatherer. A turbine is set in the way of the wind current to change over the motor vitality of the streaming air into power. The draft delivered can likewise be utilized to give common ventilation

***Index Terms:*** *Solar Chimney, Design, Passive Ventilation.*

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## I.INTRODUCTION

A solar chimney is a solar power generating facility, which uses solar radiation to increase the internal energy of air flowing through the system, thereby converting solar energy into kinetic energy. The kinetic energy from the air is then transformed in electricity by use of a suitable turbine. The stack pressure difference generated can also be used for natural ventilation. The pressure difference which in turn drives the air inside the chimney is used for providing natural ventilation for a building.

A solar chimney consists of three main components:

(1) The solar collector or the greenhouse

(2) The chimney and

(3) The turbine.

The collector, supported a few meters above the Ground, is covered by a transparent glazing. Its main objective is collecting solar radiation to heat up the air mass inside it. Buoyancy drives the warmer air into the chimney, which is located at the centre of the collector. A turbine is set in the path of the airflow to convert the kinetic energy of the flowing air into electricity. The collector can be equipped with a water storage system to increase the power production during the night.

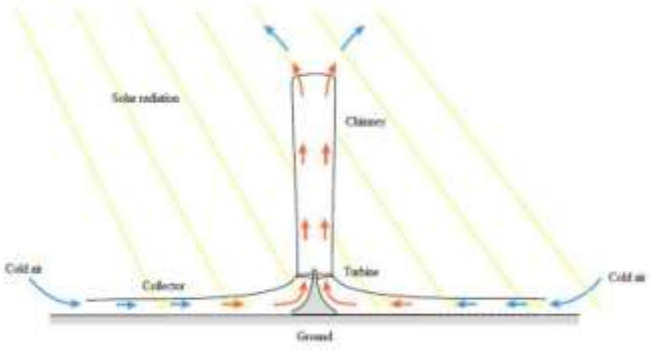


Fig. 1 solar chimney

### *A. Working Principle*

A Solar Updraft Tower converts solar radiation into electricity by combining three well-known principles:

1. The greenhouse effect
2. The tower and
3. Wind turbines.

Hot air is created by the sun under an extensive glass rooftop [3]. Immediate and diffuse sun oriented radiation strikes the glass rooftop, where particular divisions of the vitality are reflected, consumed and transmitted. The amounts of these parts rely on upon the sun oriented occurrence edge and optical

qualities of the glass, for example, the refractive file, thickness and annihilation coefficient. The transmitted sun based radiation strikes the ground surface; a part of the vitality is ingested while another part is reflected back to the rooftop, where it is addition reflected to the ground. The different impression of radiation keeps, bringing about a higher part of vitality consumed by the ground, known as the transmittance-absorptance result of the ground. Through the instrument of normal convection, the warm ground surface warms the adjoining air, making it rise. The light air ascends into the fireplace of the plant, in this way attracting more air at the gatherer edge and in this manner starting constrained convection which warms the authority air all the more quickly. Through blended convection, the warm authority air warms the underside of the gatherer rooftop. A percentage of the vitality consumed by the ground surface is directed to the cooler earth underneath, while radiation trade additionally happens between the warm ground surface and the cooler authority rooftop. Thusly, through regular and constrained convection, the authority rooftop exchanges vitality from its surface to the encompassing air contiguous it [4]. As the wind streams from the authority border towards the fireplace its temperature increments while the speed of the air stays around consistent in view of the expanding gatherer tallness. The warmed air goes up the stack, where it cools through the smokestack dividers. The fireplace changes over warmth into motor vitality. The weight distinction between the smokestack base and encompassing weight at the outlet can be evaluated from the thickness contrast. This thusly relies on the temperatures of the air at the delta and at the highest point of the stack. The weight distinction accessible to drive the turbine can be diminished by the grinding misfortune in the stack, the misfortunes at the passageway and the way out dynamic vitality misfortune [3]. As the authority wind streams over the turbine(s), the active vitality of the air turns the turbine sharp edges which thusly drive the generator(s)

### *B.* [4].*Solar Collector*

It is one of the most important component of solar chimney. The collector is also termed as the greenhouse. It is a special kind of heat exchanger that transforms solar radiation into internal energy of the transport medium. The collector provides the main natural source of heat to the plant. The collector for the solar chimney plant makes use of both the direct and the diffuse solar radiations to generate thermal energy. The material used for the collector roof is either plastic or glass, stretched horizontally two or six meters above the ground [5]. The covering or what is termed as the glazing admits the short wave solar radiation component and retains long-wave radiation from the heated ground, in that way the air beneath gets heated. The collector comes in various configuration based on the materials used for its roof (fig 3.1)

[6]

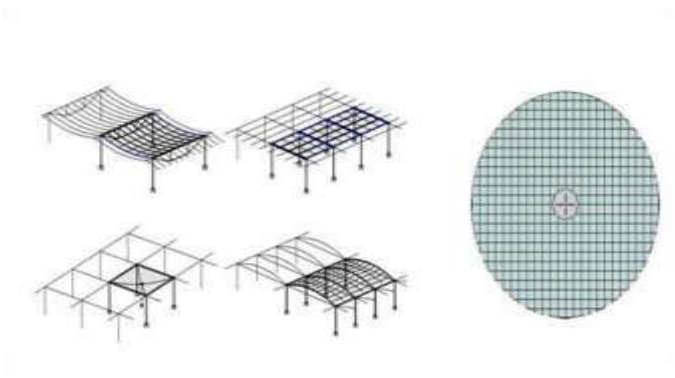

Fig 2. Solar Collector [6]

### *C. Chimney*

Chimney is the main characteristics of the solar chimney station. The tower which acts like a large chimney is located at the centre of the green house canopy and is the thermal engine for the technology. The chimney creates a temperature differential between the cool air at the top and the heated air at the bottom. The change in the air temperature induces a pressure differential, which drives the air from the bottom of the chimney out of the top. The chimney of the plant is extremely high and will need a stable base while still allowing the free flow through turbine.

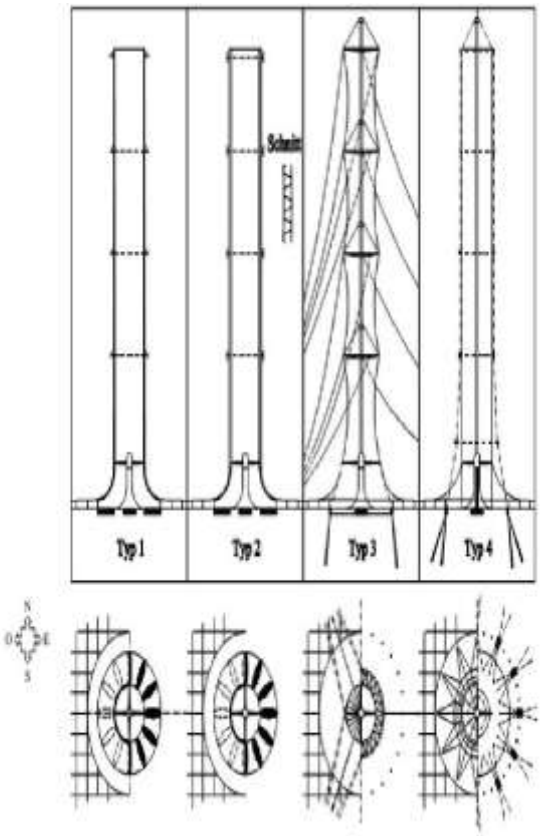


Fig 3. Chimney Types [6]

*D. Turbines*

Turbines extract the energy from the air and transmit to the generator. Turbine converts kinetic energy of air into mechanical energy of rotor. Turbines have to withstand high temperature. The typical solar chimney turbine is of the axial flow type. It has characteristics between those of wind turbines and gas turbines: it has more blades than the typical 2or 3 of wind turbines, but not as many as gas turbines; the rotor blades are adjustable, like those of wind turbines, but, as in gas turbines, the flow is enclosed, and the solar chimney turbine may have radial inflow inlet guide vanes. The main function of the turbine is the efficient conversion of fluid power to shaft power. A secondary function of solar chimney turbines is flow and output power control by adjustment of its blade angles.

The turbine used is of lift type of turbine.

## II.EQUATIONS

A. *Mass flow rate:* Mass flow rate can be calculated by,

[3]

$$m = \frac{ACH\ V_{room}\ \rho}{3600}$$

B. *Chimney height:* Pressure balance for the chimney can be given as,

$$\Delta P_{chimney} = \Delta P_{Chimney_{loss}} + \Delta P_{Collector_{loss}} + \Delta P_{acceleration} + \Delta P_{room_{loss}} + \Delta R_{L/d_{loss}}$$

Where,

$$\Delta P_{chimney} = \rho\ g\ H\ \beta\ \Delta T$$

$$\Delta P_{Chimney_{loss}} = \frac{4\ f\ H\ v_c^2}{2\ g\ D}$$

$$\Delta P_{Collector_{loss}} = \frac{f\frac{D_1}{2}\ \rho\ v_{co}^2}{2\ h}$$

$$\Delta P_{acceleration} = 2\ \rho \left(\frac{2\ m}{\rho\ \pi\ D^2}\right)^2$$

C. *Energy balance for collector:* Losses due to convection and radiation between absorber plate and collector with convective loss due to wind and reradiation can be given as,

$$\frac{q_l}{A_p} = h_{p-c_1}\left(T_{pm} - T_c\right) + \sigma\left(\frac{\left(T_{pm}^4 - T_c^4\right)}{\left(\frac{1}{\varepsilon_p}\right) + \left(\frac{1}{\varepsilon_c}\right) - 1}\right) = h_w\left(T_c - T_a\right) + \sigma\,\varepsilon_c\left(T_c^4 - T_{sky}^4\right)$$

Equation for useful energy can be calculated as,

$$m\ C_p\ (T_4 - T_3) = \left(\left(I_{gh}\ \tau\alpha_{avg}\right) - \left(U_t\ \left(T_{pm} - T_a\right)\right)\right)A_p$$

Using above two equations Tpm and Tc can be calculated.

D. *Heat transfer coefficient between absorber plate and cover plate:* Heat transfer coefficient between cover plate and absorber plate can be calculated as,

$$h_{p-c} = \frac{Nu_l\ K}{h}$$

## III.UNITS

SOLAR RADIATION CALCULATION IN $W/M^2$

DIAMETER IN TERMS OF METER

TEMP. IN TERMS OF DEGREE CENTIGRADE

FLOW VELOCITY IN TERMS OF M/S

PRESSURE IN TERMS OF $N/M^2$

MASS FLOW RATE IN TERMS OF KG/S

DENSITY OF AIR IN TERMS OF $KG/M^3$

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