# DEVELOPMENT OF HYBRID CHIMNEY

Chandra Shekhar[1], Shahrukh Khan[2], Lakshay[3], Subodh Bhola[4], Kamlesh Prasad[5]

[2, 3, 4,5UG] Students, Department of Mechanical Engineering, JIMS Engineering Management Technical Campus, Greater Noida, Uttar Pradesh, India.

[1]Asst. Professor, Department of Mechanical Engineering, JIMS Engineering Management Technical Campus, Greater Noida, Uttar Pradesh, India.

## ABSTRACT

The hybrid chimney is a new electric power generating method for utilizing solar and wind resources. Solar radiation is converted to heat by a solar collector, which heats the air. This heated air rises due to the buoyancy effect thereby powering the turbine while flowing through the chimney. This cycle continues and electricity is produced via generators. The chimney serves as a link between the low air pressure to higher air pressure. Inside the chimney, the turbine converts wind energy into electricity.

## I.INTRODUCTION

India is situated in the equatorial sunbelt of earth, hereby yielding a great amount of radiant energy from the sun. Power can be generated by hybrid solar plants. The solar hybrid chimney is designed with the same concept. The solar hybrid chimney operates on the natural phenomena that deal with the use of thermal solar energy which revolves around the earth's surface heating it & therefore surrounding air also gets heated by the sunlight. This warm air expands, causing upward buoyancy force promoting the flow of air towards the earth's atmosphere. A system connected to turbine electricity, this entire concept of heating is based on the greenhouse effect.

## II.LITERATUREREVIEW

There were many researchers conducted researches on thermoelectric refrigerator some of which are:
The main purpose of using hybrid chimney is its eco-friendly behavior, cheap, compact, and it has low running cost as compared to other types of methods that are used to generates electricity.

i. This paper investigates a novel hybrid system combining thermal electrical generators and a wind turbine. In the proposed system, solar energy is converted to heat by an absorber plate. Wind current is accelerated before passing through the rotary engine. [Suhil kiwan, et all (2018)].

ii. This paper investigates that this type of system will produce some power. The sun will heat the collector, which will heat the air above it. The higher air temperature can expand the air, reducing air pressure. Air must move from high to low pressure through the chimney and pass the wind turbine, producing power. [Amit Sharma, et all (2018)].

iii. The paper investigates, as India is a country of large barren land, so this technology can have used to produce a large amount of electricity. It can be beneficial for countries like Asia, Africa and Australia which have unproductive land and a huge amount of solar energy. One of the drawbacks is that it needs a larger chimney for the large production of the energy. [Farhan Ali, et all (2016)].

iv. The generation of electricity using solar energy is a feasible alternative for power generation over conventional power plants like a thermal and hydraulic power plant. The review gives the basic principle and operation of this system. This method is adopted by many researchers because of the high construction of other power plants. [P.J bonsad, et all (2014)].

v. The solar chimney power plant is an interesting alternative to a centralized electricity generation power plant. The review discusses the principle and characteristics of such a system, its requirement, its construction and, its operation. It can be concluding that such systems need to be very large if they are to generate significant qualities of power. [Amel Dahari, et all (2013)].

vi. The hybrid solar chimney technique has been proposed and analyzed in the present work. It is very useful in countries like India and Pakistan. [Mohammad ayub, et all (2018)].

## III.COMPONENTS

### a. SOLAR COLLECTOR

The solar collector has low reflectivity and has complete black color such that most of the sunlight that strikes on it gets absorbed and converted into heat instead of reflecting.

A metal color scheme is efficient. However, the collector must absorb light well in the ultraviolet light, 44% visible light & 51% infrared light.

Hot air from the solar chimney is produced by the greenhouse effect via air collector consisting only of a glass or plastic film covering stretched approximately 2 to 6 m above the ground. Thus surface under the roof heats and transfers it to the air flowing radially above it from outside the chimney.

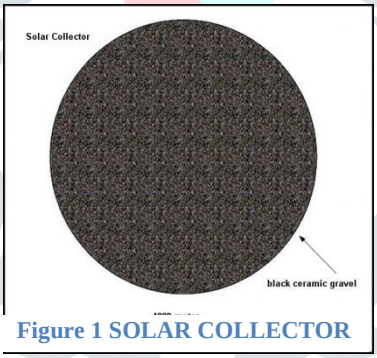



**Figure 1 SOLAR COLLECTOR**

### b. CHIMNEY

It converts pressure energy into kinetic energy. The chimney is the plant's actual thermal engine. The air shaft has low friction losses because of its optimal surface volume ratio. The upward thrust generated in the collector is proportional to the temperature rise of air.

**Figure 2 CHIMNEY**

### c. TURBINE

Turbines are the powerhouse of the plant. It generates the K.E into electric energy via generators situated at the base of the chimney. The speed of the turbine is governed by the airflow inside the chimney.


Figure 3 TURBINE

## IV. METHODOLOGY

This is quite simple concept. The solar chimney has a large chimney at the center of the field, which is covered with glass. The solar heat generates hot air in the gap between the ground and the glass collector which is then passed through the central tower to its upper end due to density difference between comparatively cooler air outside the upper end and hotter air inside the tower of the tower. While travelling up this air drives wind turbines locate inside the tower. These systems needs comparatively fewer components and were purported to be cheaper. Glass pipe are used below the solar collector in which water is kept.

These water pipes receive sunlight in the day time and the water inside these water tubes gets heated. In the night time when there is no energy from the sun, these water pipes emit heat and the air between the collector and the ground gets again heated and due to density difference between the hotter air. The cooling air outside the chimney air moves toward chimney and drives the turbine-generator system. There by generating electricity in day as well as at night.

It is a hybrid combination which makes use of two improven technologies of solar and wind power for producing electricity thereby increasing effeciency

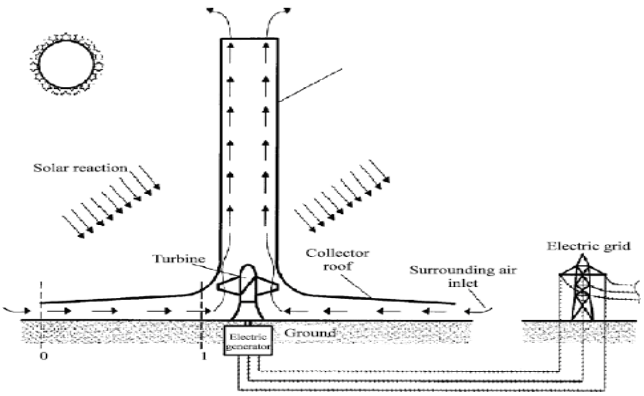
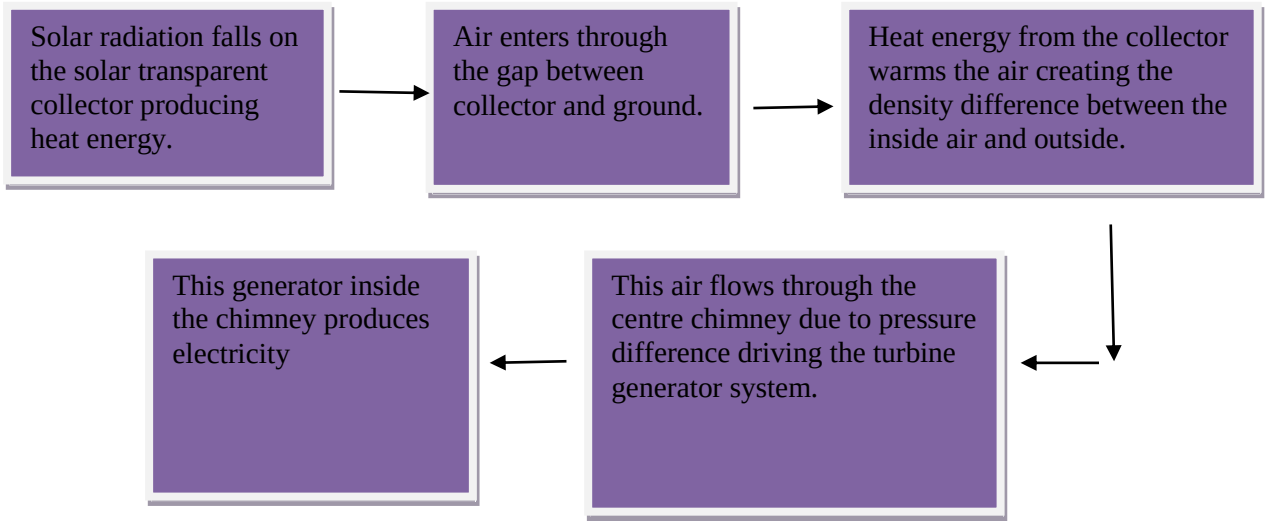



Figure 4 PROCESS OF HYBRID CHIMNEY




## V. DESIGN

The design of the hybrid chimney module is created with the help of the Solid Works software for the proper and efficient analysis of the respective module design. This gives an option of analyzing the problems related to the design and provides us the solutions to overcome them and come up with Thebes's efficient module design possible.

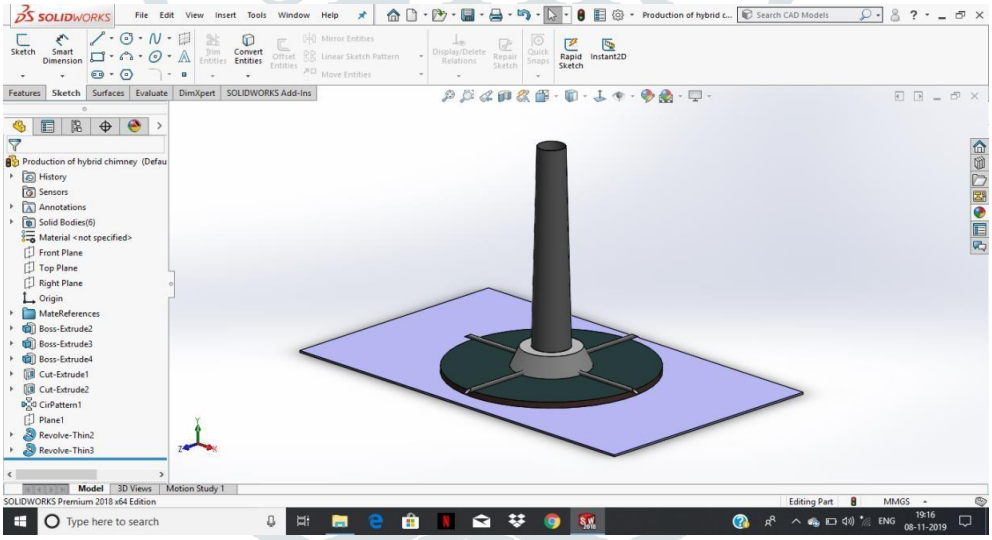


Figure 5 Solid work Design of Exterior of Hybrid

### a) COST

The initial investment cost of a hybrid chimney power plant is much higher than that of conventional coal power plants. But, the operating cost of the HCPP is much more economical than other resources.

| Variables | Solar Chimney Pf/kWh | Coal Pf/kWh | 2 x C.C. Pf/kWh |
|---|---|---|---|
| Investment | 11,32 | 3,89 | 2,12 |
| Fuel | 0,00 | 3,87 | 6,57 |
| Personnel | 0,10 | 0,78 | 0,31 |
| Repair | 0,52 | 0,92 | 0,83 |
| Insurance | 0,01 | 0,27 | 0,12 |
| Other running costs | 0,00 | 1,16 | 0,03 |
| Tax | 2,10 | 0,69 | 0,37 |
| **Total** | **14,05** | **11,58** | **10,35** |

Commissioning in 2001
Power: 400 MW
Running hours: 7445 h/a
Yearly energy: 2978 GWh

Own investment 1/3 at 13,5%
External investment 2/3 at 8%
Total interest rate: 10,67%
Tax rate: 30%

Table 1 Production cost

## b) SOLAR CELL TEMPERATURE

The graph shows the variation of solar cell temperature between design "A" & "B". Both designs make an angle of 45 degrees with a horizontal line. System "A" with inbuilt glass cover gained a temperature of 67 degrees Celsius at noon. Hence, glass cover helps to boost the temperature of the air over solar collector.

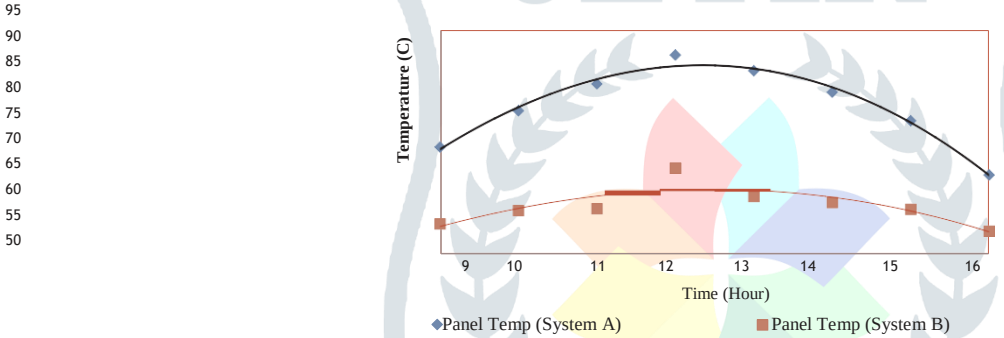



Figure 6 The Temperature difference in system A&B

## c) AIR VELOCITY

The average velocity diagram shows a positive trend with time, the outlet air temperature reached its minimum value due to the reduction in absorption. These trends are common in a chemical chimney. The diagram confirms that speed level in "A' was greater than system "B".This conclusion is used for determining the optimum location of the wind turbine.

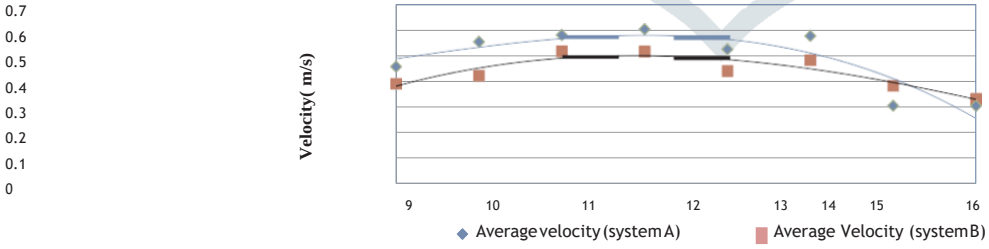



Figure 7 Variation of average air velocity for two systems during the day

## d) ELECTRIC POWER

Electric power depends on solar radiation and heat gain. The electric power generated also tends to drops when the temperature of the panel becomes higher than that of the design temperature.

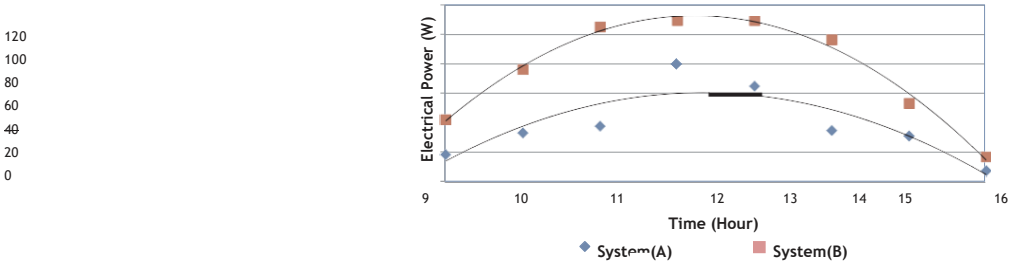



**Figure 8 The variation of electrical power produced from the two systems**

# VI. CONCLUSION

The Hybrid chimney design is a substitute method for generating energy as dependency on fossil fuels might lead to a catastrophic future for the upcoming generation.

The initial cost of the plant to more as compared to other systems. But the operation is much more economical than existing methods of power generation. The review discusses basic concepts, working, and components of power plants. This paper also includes various aspects of the solar chimney power plant.

# REFERENCE


- Burkhart G, Dearie T, Swiler D. When Black is White. Paint &Coatings Industry.12/22/2000.
- Schaech J. The Solar Chimney: Electricity from the Sun. Stuttgart: AxelMenes, 1995. p.36.
- Enviro Mission Limited. Http:// www. Enviromission.com. au. Enviro Mission Prospectus. 11,20.
- Nielsen-Gammon J. Sea Breezes, Land Breezes, and Coastal Fronts. Texas A&M University Meteorology Department.
- http://www.met.tamu.edu/class/Metr151/yut/seabr/sea9.html.
- Atlas for the Solar Radiation Data Manual for Flat-Plate and
- Concentrating Collectors. U.S. Solar Radiation Resource Maps. Values derived from the 1961 – 1990 National Solar Radiation DataBase (NSRDB). http://rredc.nrel.gov/solar/old data/nerds/atlas/Redbook/.
- eFunda.com. Engineering Fundamentals. Properties of Air. eFunds, Inc. Sunnyvale, CA. http://www.efunda.com/materials/common-matl/showgas.cfm?Mat1Name=Air0C.
- The Danish Wind Industry Association. Wind Energy Reference Manual. Part 1: Wind Energy. Concepts. http://www.windpower.org/stat/unitsw.htm.
- The Danish Wind Industry Association.http://www.windpower.org/stat/unitsw.htm.
- Schlaich J. The Solar Chimney. P. 54.
- Schlaich J. The Solar Chimney. P. 54.
- Schlaich J. The Solar Chimney. P. 20.
- Nielsen-Gammon J. Sea Breezes, Land Breezes, and Coastal Fronts.Texas A & M University Meteorology Department
- http://www.met.tamu.edu/class/Metr151/tut/seabr/sea9.html. Bhattacharya, S.C., A.H.M.R. Siddique, C.P. Manandari and H.L.Pham,(1998). A Study on Improved.
- Institutional Biomass Stoves. A Report of the Renewable EnergyTechnologies in Asia RET's in Asia. Energy Program, Asian Institute of Technology, Bangkok.
- Sherif, S.A., "Solar Chimneys." In Natural Resources, Vol. 3, Adams, M., Coyne, M., and Allin, C. (Editors), Salem Press, Inc., California, 1998.
- Pasumarthi, N. and Sherif, S.A., "Performance of a Demonstration Solar Chimney Model for Power Generation. "Proceedings of the 35th Heat Transfer and Fluid Mechanics Institute, F.H.Reardon (Editor), California State University at Sacramento, Sacramento, California, May 29-30, 1997.
- Padki, M.M. and Sherif, S.A., "On a Simple Analytical Model for SolarChimneys." International Journal of Energy Research, Vol. 23, No. 4, March25, 1999, pp. 345-349.

- Schlaich, J.Das Aufwindkraftwerk: Strom aus der Sonne. Stuttgart: DeutscheVerlagsanstalt, 1994, ISBN 3-421-03074-X.
- Schlaich, J.; Schiel, W.; Friedrich, K.Abschlussbericht Aufwindkraftwerk: Ubertragbarkeit der Ergebnisse vonManzanares auf grobere Anlagen. Bmft- Foerderkennzeichen 03242490.Schlaich Bergermann und Partner 1990.Solarthermische Anlagen. Technologien im Vergleich. Springer-Verlag,Berlin, Heidelberg, New York, 1992.
- VDEWVereinigung deutscher Elektrizitatswerke: Stromerzeugungskostenvergleich
- 1990 in Betrieb gehender grober Kern- und Steinkohlekraftwerksblocke.
- Heise, OSchadensvermeidung. Ein Weg zur Abschatzung der externen Kosten derEnergieversorgung.
- website: www.solarmissiontechnologies.com.