ANUSANDHAN- AISECT University Journal
Vol. 06, Issue No. 12, September-2017, P-ISSN 2278-4187

Design and Performance Analysis of Integrated Solar Heat and Wind Power Plant

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Abstract – In the recent trends in application of renewable energy sources, integrated solar chimney wind power plant has been designed with different geometrical parameter for increase the accessibility of solar and wind energy due to increasing the rate of environmental pollution and lake of non- renewable energy resources. A solar chimney wind power plant (SCWPP) is a type of solar thermal system that use the thermal energy generated by solar and convert it into the electrical energy. In the recent few years there are many researcher have exposed strongest attention for exploration the performances of solar chimney wind power plant due to its economic, environmental and huge potential application. There are different geometrical parameters and operating conditions like chimney height, collector radius, throat radius, solar radiation, wind velocity, solar absorption coefficient, solar loss coefficient, chimney shapes which are play vital role for optimize the performances of solar chimney wind power plant. In this numerical investigation a computational model of Manzanares pilot solar chimney win power plant, Spain has been created with help of commercially availableness 14.5 software. The temperature, velocity, pressure and vector distribution were plotted and evaluated for examine the influence of chimney height, collector radius, throat radius, solar radiation, solar absorption coefficient, solar loss coefficient, and collector percentage and fraction factor on the performance of solar chimney wind power plant when other parameters are constant. The obtained result is illustrated that, the power of SCWPP has enhances as increases the chimney height, collector radius, collector percentage and solar absorption coefficient but throat radius and solar loss coefficient it gives inversely effect on the power. It has been also illustrated that the throat radius gives more effect on the power of SCWPP while the effect of collector percentage on power negligible. This study is also suggested a solar chimney wind power plant at chimney height 24.4 m with collector radius 38. 92 m and throat radius 0.7m,collector absorption coefficient 0.66 and collector loss coefficient 15it gives approximately 5.4 KW power output at Indian operating conditions means ambient temperature should be 303.15 K and solar radiation is 1000W/m2. From the study it can also revealed that for further improvement in power increase the solar absorption coefficient and reduce the solar loss coefficient in same working condition.

Index Terms— Renewable energy sources, SCWPP, Wind Power plant, Solar chimney, Electrical energy.

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I. INTRODUCTION

With the decrease of fossil fuel resources and increasing worldwide pollution problems, there is a growing need for an environmentally friendly renewable energy source.

It is vital that the utilization of this energy source be economically viable, especially for its possible use in third world countries. Engineers and scientists are increasingly looking to solar energy as a potential answer to this problem.

Man has already tried to harness energy from the sun in various different ways. These include parabolic trough solar power plant, Central Receiver power plants, Dish-Stirling systems, solar pond power plants and Photovoltaic power plant.

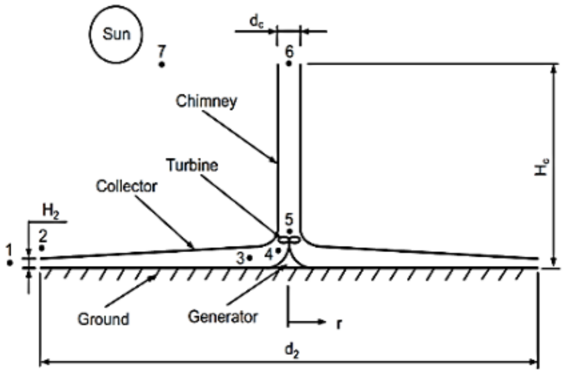


Fig. 1Schematic illustration of a solar tower power plant

Since the 1970's, the development of solar tower power plant have been investigated and have since become a good prospect for large scale energy generation. The solar tower power plant consists of a translucent collector (located a few meters above ground level) with a central tower which houses a turbo-generator at its base, as shown schematically in fig. 1.1

The operation of such a solar power plant is relatively simple. Solar radiation heats the ground beneath a clear glass collector. Underneath the collector, the heated ground heats the air, causing the air to rise. The warm air is trapped under the collector but rises through the central tower, driving the turbine and consequently generating electricity.

Solar tower power plants have some advantage over the above mentioned power generation schemes, such as the Parabolic Trough and Central Receiver solar power plants. These include the use of both beam and diffuse radiation, while energy is stored naturally in the ground during the day is released at nighttime, thus producing electricity over a twenty –four hour period. Solar tower makes use of simple technologies, are built from low cost materials and have no water requirements.

II. LITERATURE REVIEW

Solar energy has important role in aspects of accessibility of resources and diversity of energy conversion. Renewable energy are none as the best option for solving the energy shortage and CO2 emissions trouble due to increase the rate of environmental pollution and control on fossil fuel resources , the use of sustainable energies seem to be inevitable and absolute need for the world. Solar chimney wind power plant is best option for utilize the renewable energy resources so it is important factor to analysis the behaviour of the SCWPP in different running parameter. There are many investigator have done the experiments for optimize the performances of solar chimney wind power plant.

Some of the important paper related to analysis of solar chimney wind power plant have been reviewed and discuss here.

A.Asnaghi et al.[1] in their report a solar chimney power plant (SCPP) is proposed to be built as the first national SCPP in central regions of Iran. Studies of DLR MED-CSP project show that Iran can be a part of the Mediterranean solar power generation chain in 2050 to provide electrical power demand of Europe.

Fei Cao et al.[2] studied the solar chimney power plant (SCPP that it is a promising technology for the large-scale utilization of solar energy. Due to the significant difference of weather conditions, the performance of SCPPs varies from one place to another, and thus specific design work is required for different regions.

Wei Chen et al. [3] in their paper, the chimney is assembled with porous absorber for the indirect-mode solar dryer. Local thermal non-equilibrium (LTNE) exists in the porous absorber, so the double energy equations and Brinkman-Forchheimer extended Darcy model are employed to analyze the heat transfer and flow in the solar porous absorber, and the k-ε turbulent model coupled with the above equations are also used to investigate the influences of the porous absorber inclination and the height of drying system on the heat transfer in the solar dryer.

Y.J. Dai et al. [4] analyzed a solar chimney power plant, which is expected to provide electric power for remote villages in northwestern China, in this paper. The solar power plant chimney, in which the height and diameter of the chimney are 200 m and 10 m, respectively, and the diameter of the solar collector cover is 500 m, is able to produce 110~190kW electric power on a monthly average all year.

Saeed Dehghani et al.[5]In their communication, a multi-objective optimization method is implemented using evolutionary algorithm techniques in order to determine optimum configuration of solar chimney power plant. Power output of the system is maximizing while capital cost of the component in minimized. The result shows that, power output of the plant increases linearly when solar irradiation increases and increase in ambient temperature causes slight decrease in power output of the plant.

F. Denantes al.[6]developed an efficiency model at design performance for counter-rotating turbine and validated. Based on the efficiency equation, an off-design performance model for counter-rotating turbines is developed. Combined with a thermodynamic model for a solar chimney system and a solar radiation model, annual energy output of solar chimney systems is determined. Based on the output torque versus power for various turbine layouts, advantageous operational conditions of counter-rotating turbines are demonstrated.

Hermann F. Fasel et al. [7] in their study investigated solar chimney power plants numerically using ANSYS Fluent and an-in house developed Computational Fluid Dynamics (CFD) code. Analytical scaling laws are verified by considering a large range of scales with tower heights between 1 m (sub-scale laboratory model) and 1000 m (largest envisioned plant). A model with approximately 6 m tower height is currently under construction at the University of Arizona. The flow inside the chimney is fully turbulent.

D.G.Kroger et al. [8] studied that several cost models for large-scale solar chimney power plants are available in the literature. However, the results presented vary significantly, even in cases where the input parameters and the used models are supposedly very similar. The main objective of this paper is to clarify this matter by comparing previous cost models to a newly developed alternative model. It is also shown that carbon credits significantly reduce the levelised electricity cost for such a plant.

Mehran Ghalamchi et al. [9] A solar chimney pilot power plant with 3 m collector diameter and 2 m chimney height was designed and constructed in university of Tehran, Iran. The report shows that reducing the inlet size has a positive effect on the solar chimney power production performance. The maximum air velocity of 1.3m/s was recorded inside the chimney. While the collector entrance velocity was around zero.

Ehsan Gholamalizadeh et al.[10]In their study developed a triple-objective design method for a solar chimney power plant system that simultaneously optimizes the expenditure, total efficiency, and power output. This paper provides a very useful design and optimization methodology for solar chimney power plant systems.

Ehsan Gholamalizadeh et al.[11] in their study underline the importance of the greenhouse effect on the buoyancy-driven flow and heat transfer characteristics through the system. The analysis showed that simulating the greenhouse effect has an important role to accurately predict the characteristics of the flow and heat transfer in solar chimney power plant systems.

BabakGhorbani et al.[12]in their study presented an improved concept design to increase the thermal efficiency of the rankine cycle of a typical steam power plant by combining a solar chimney and a dry cooling tower. Calculation have been iterated for different angle of chimney walls, slopes of collectors and the base ground to find their effects on the output power. A range of 360 kW to more than 4.4 MW power is captured by the wind turbine by changing the hybrid tower geometrical parameters. Obtained results reveal a maximum of0.538% increases for the thermal efficiency of the fossil fuel power plant.

Penghua Guo et al.[13]observed that in a solar chimney power plant, only a fraction of the available total pressure difference can be used to run the turbine to generate electric power. The optimal ratio of the turbine pressure drop to available total pressure difference in a solar chimney system is investigated using theoretical analysis and 3D numerical simulations. The values found in the literature for the optimal ratio vary between 2/3 and 0.97. This study may be useful for the preliminary estimation of power plant performance and the power-regulating strategy option for solar chimney turbines.

Peng-Hua Guo et al. [14] a three-dimensional numerical approach incorporating the radiation, solar load, and turbine models proposed in this paper was first verified by the experimental data of the Spanish prototype. The power output of the SCPP within the common diurnal temperature range was also found to be insensitive to ambient temperature.

Mohammad O. Hamdan [15] his work presents a mathematical thermal model for steady state airflow inside a solar chimney power plant using modified Bernoulli equation with buoyancy effect and ideal gas equation. The results show that the chimney height, the collector radius, the solar irradiance, and the turbine head are essential parameters for the design of solar chimney. The maximum power generation depends on the turbine head and the relation is not monotonic.

Atit Koonsrisuk et al.[16] in their study compared the prediction of performance of solar chimney plants by using five simple theoretical models that have been proposed in the literature. The power out and the efficiency of the solar chimney plants as functions of the studied parameters were used to compare relative merits of the five theoretical models. Models that performed better than the rest are finally recommended.

Atit Koonsrisuk et al. [17] in their study, a solar collector, chimney and turbine are modeled together theoretically, and the iteration techniques are carried out to solve the resulting mathematical model. Results are validated by measurements from an actual physical plant. Furthermore, it is shown that the optimum ratio between the turbine extraction pressure and the available driving pressure for the proposed plant is approximately 0.84. a simple method to evaluate the turbine power output for solar chimney systems is also proposed in the study using dimensional analysis.

Atit Koonsrisuk [18] in his present paper the performance of solar chimney power plants based on second law analysis is investigated for various configurations. A comparison is made between the conventional solar chimney power plant (CSCPP) and the sloped solar chimney power plant (SCSPP). The results obtained here are expected to provide information that will assist in improving the overall efficiency of the solar chimney power plant.

Haorong Li et al.[19] in his work studied that Buildings represent nearly 40 percent of total energy use in the U.S. and about 50 percent of this energy is used for heating, ventilating, and cooling the space. Conventional heating and cooling systems are having a great impact on security of energy supply and greenhouse gas emissions. Unlike conventional approach, this paper investigates an innovative passive air conditioning system coupling earth-to-air heat exchangers (EAHEs) with solar collector enhanced solar chimneys. The cooling capacities reached their peak during the day time when the solar radiation intensity as strong. The results show that the coupled system can maintain the indoor thermal environmental comfort conditions at a favorable range that complies with ASHRAE standard for thermal comfort. The findings in this research provide the foundation for design and application of the coupled system.

Jing-Yin Li et al.[20] proposed acomprehensive theoretical model is for the performance evaluation of a solar chimney power plant (SCPP), and has been verified by the experimental data of the Spanish prototype.

Weibing Li et al.[21]their paper develops a model different from existing models to analyze the cost and benefit of a reinforced concrete solar chimney power plant (RCSCPP) built in northwest china. Based on the model and some assumptions for values of parameters, this work calculates total net present value (TNPV) and the minimum electricity price in each phase by dividing the whole service period into four phases.

C.B. Maia et al. [22] found that Sustainable development is closely associated with the use of renewable energy resources. In order to achieve a viable development, from an environmental point of view, the energy efficiencies of processes can be increased using renewable energy resources.

ChiemekaOnyekaOkoye et al. [23] his present work investigates the feasibility of installing a solar chimney power plant (SCPP) under north Cyprus (NC) condition. The method utilized for the simulation of electricity production was compared and verified by the experimental recording of the prototype in Manzanares, Spain, before carrying out performance predictions for different plant sizes, collector diameter and chimney heights. The results showed that SCPP investment cost, capacity of the plant and chimney height are critical in assessing the project viability.

Sandeep K. Patel et al. [24] their present work is aimed at optimizing the geometry of the major components of the SCPP using a computational fluid dynamics (CFD) software ANSYS-CFX to study and improve the flow characteristics inside the SCPP. The overall chimney height and the collector diameter of the SCPP were kept constant at 10 m and 8 m respectively. The temperature inside the collector is higher for the lower opening resulting in a higher flow rate and power.

RoozbehSangi [25] in his study evaluate the performance of solar chimney power plants in some parts of Iran theoretically and to estimate the quantity of the produce electric energy the solar chimney power plantis a simple solar thermal power plant that is capable of converting solar energy into thermal energy in the solar collector. The solar chimney power plant with 350m chimney height and 1000m collector diameter is capable of producing monthly average 1-2MW electric power over a year.

Ming Tingzhen et al.[26] have carried out Numerical simulations on the solar chimney power plant system coupled with turbine. The whole system has been divided into three regions: the collector, the chimney and the turbine, and the mathematical models of heat transfer and flow have been set up for these regions. Using the Spanish prototype as a practical example, numerical simulation results for the prototype with a 3 blade turbine show that the maximum power output of the system is a little higher than 50kW.

Xinping Zhou et al. [28] in their study the maximum chimney height for convection avoiding negative buoyancy at the latter chimney and the optimal chimney height for maximum power output are presented and analyzed using a theoretical model validated with the measurements of the only one prototype in Manzanares. Current in a solar chimney power plant that drives turbine generators to generate electricity is driven by buoyancy resulting from higher temperature than the surroundings at different heights. The result based on Manzanares prototype show that as standard lapse rate of atmospheric temperature is used, the maximum power output of 102.2kW is obtained for the optimal chimney height of 615m, which is lower than the maximum chimney height with a power output of 92.3kW. Sensitivity analyses are also performed to examine the influence of various lapse rates of atmospheric temperatures and collector radii on maximum height of chimney. The result shows that the maximum height gradually increases with the lapse rate increasing and go to infinity at a value of around 0.0098K m-1 and that the maximum height for convection and optimal height for maximum power output increase with large collector radius.

III. COMPUTATIONAL FLUID DYNAMICS (CFD)

Computational fluid dynamics (CFD) is a computer based simulation method for analyzing fluid flow, heat transfer, and related phenomena such as chemical reactions. This project uses CFD for analysis of flow and heat transfer. Some examples of application areas are: aerodynamic lift and drag (i.e. airplanes or windmill wings), power plant combustion, chemical processes, heating/ventilation, and even biomedical engineering (simulating blood flow through arteries and veins). CFD analyses carried out in the various industries are used in R&D and manufacture of aircraft, combustion engines, as well as many other industrial products.

It can be advantageous to use CFD over traditional experimental based analyses, since experiments have a cost directly proportional to the number of configurations desired for testing, unlike with CFD, where large amounts of results can be produced at practically no added expense. In this way, parametric studies to optimise equipment are very inexpensive with CFD when compared to experiments.

The work for this project was carried out on a HP Pavilion laptop with dual processors totaling 2 GHz RAM, running on Linux Operating System downloaded free from Caelinux. The download from Caelinux included open-source software Salomé for geometry construction and meshing, Open FOAM for the CFD calculations, preview for visualization of results, along with other useful scientific and mathematics related software. Calculations for this project were carried out for approximately 50,000 cells (CFD calculations are often made for 12 million cells – or more). On my system, the steady state solvers took between 13 hours to finish calculations, while the transient simulation took 23 days running in parallel on both processors.

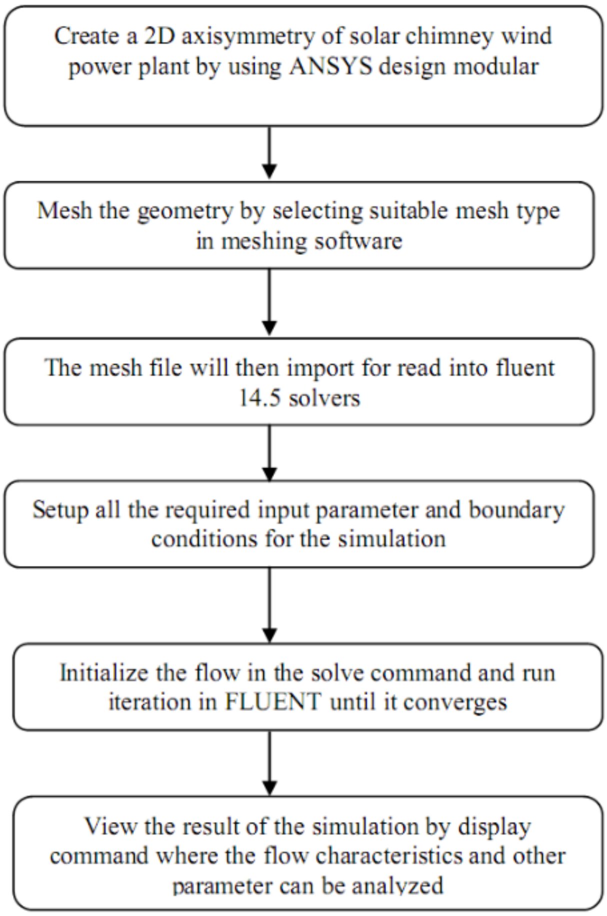
One of the purposes of this project is to use all open source CFD software instead of commercial software for the simulations. This type of software is advantageous for smaller companies to use, as the cost of commercial CFD package licenses can be prohibitive

IV. METHODOLOGY

(a) Algorithm - Basic Steps Corporate for the Investigation are tabulated at Table 1

Table 1

Block diagram of procedure



(b) CFD Analysis of solar chimney wind power plant by using Ansys Fluent:

2D axisymmetry model of solar chimney wind power plant new generated by using Ansys Design modeler. The solar chimney and the solar air collector were modeled for CFD Analysis. The model was created on the x-y plane on 2D axisymmetry. The overall height of the SCWPP was 194.6m and the solar air collector was 122 m in radius and chimney radius is 5.08m.

Generation of the model of solar chimney wind power plant was done at different chimney height 194.6, 400, 600, 800, 1000 (m) respectively at constant collector radius 122 m and chimney radius 5.08 m. Two samples are shown at fig 1 and 2.

The model of solar chimney wind power plant at different collector radius 122,150,200 (m), at constant chimney height 194.6 m and chimney radius 5.08 m were generated Samples shown at fig 3 & 4.

Generation of the model of solar chimney wind power plant at different throat radius, 4.75, 4.5, 4(m) at constant chimney height 194.6 m and collector radius 122 m was done and analysed Samples are shown at fig 5 & 6.

The model of solar chimney wind power plant was generated at different R.F, 0.18, 0.20, 0.25. Samples are shown at fig 9 and 10.

The meshing of solar chimney wind power plant at different chimney height was analysed at 194.6, 400, 600, 800, 1000 (m). At constant collector radius 122 m and chimney radius 5.08 m. Samples are shown at fig 9 & 10.

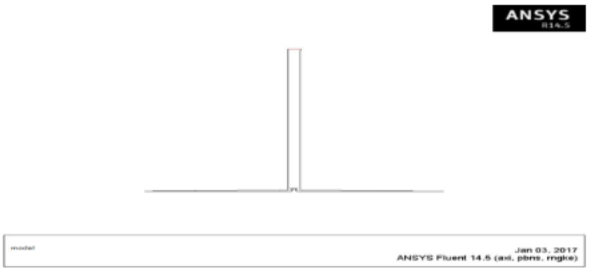


Fig.1 Chimney hight at 194.6 m

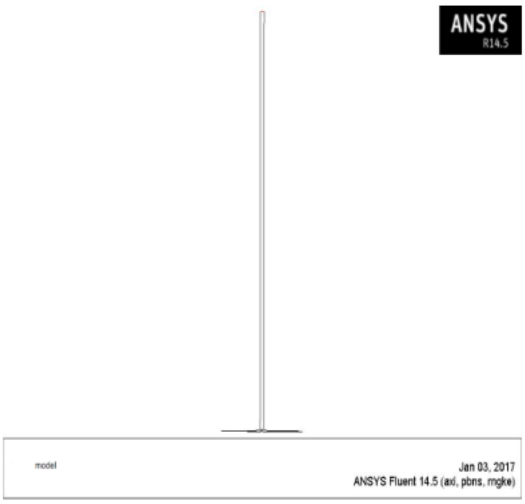


Fig.2 Chimney hight at 1000 m

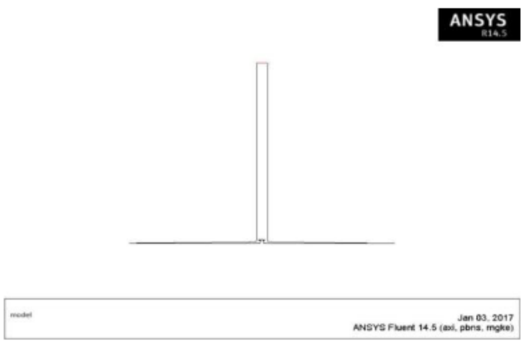


Fig 3. Collector radiuses at 122 m

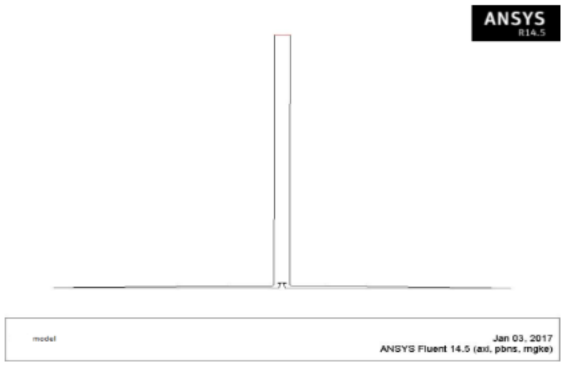


Fig. 4 Collector radius at 200 m

Fig. 5 Throat diameters at 4.75m

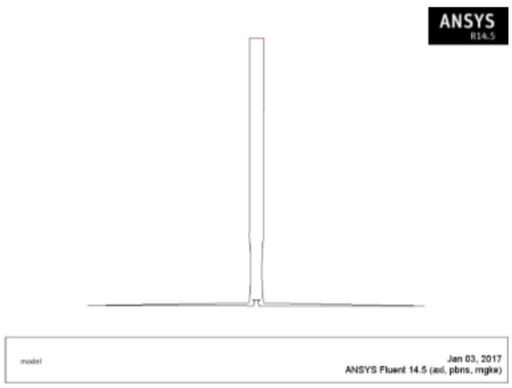


Fig. 6 Throat diameter at 4 m

Fig 7 at R.F= 0.18

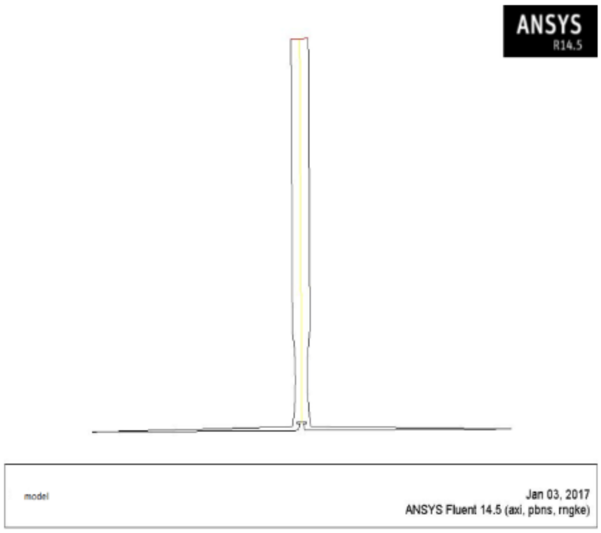


Fig. 8 at R.F= 0.25

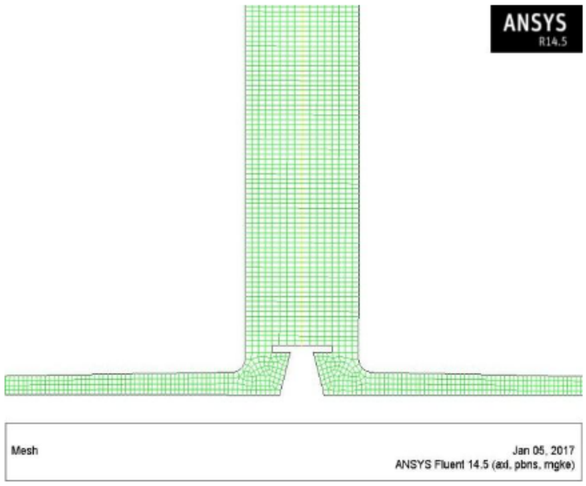


Fig.9 (b) Magnify view of Chimney height at 194.6 m

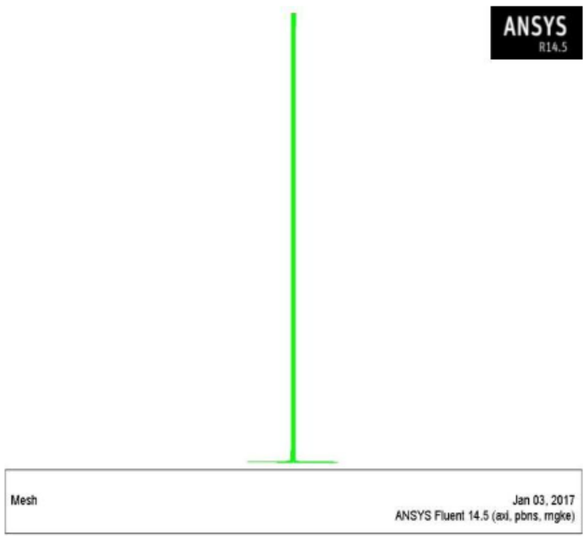


Fig 10 Chimney Height at 1000 m

5. PROBLEM SETUP IN FLUENT

(a) **Problem Type:** 2D axisymmetry

(b) **Type of Solver**: Pressure-based solver

(c) **Physical model**: Energy

1. Viscous-RNG k-e, standard wall function

(i) **Material Property**: Flowing fluid is air.

: Density of air= boussinesq: 1.225 kg /m3

: Specific heat: 1006.43j/kgK

: Thermal conductivity: .0242W/mK

: Viscosity: 1.7894e-05kg/ms

: Thermal expansion coefficient: .00331/k

(ii) **Boundary condition:**

(a) Boundary condition of existing SCWPP model with different chimney height, different collector radius, different collector percentage with respect to chimney height, different throat radius is same i.e.

Operating condition: pressure: 101325pa

: Temperature: 291.65k

Inlet: pressure inlet: gauge total pressure: 0 pa

: Turbulent intensity: 1%

: Hydraulic Dia.: .04

: Temperature: 291.65k

Outlet: Pressure outlet: Define the same outlet condition for all the fan outlet Gauge pressure = 0 Pa

: Turbulent intensity: 1%

: Hydraulic Dia.: 10.16

Axis: axis

Collector: wall: heat flux: 367.5 W/m2

Ground: wall-temp: 300.15 k

Boundary condition for Indian condition SCWPP model with optimize throat radius (3.5 m) at different solar radiation is

Operating condition: pressure: 101325pa

: Temperature: 303.15k

Inlet: pressure inlet: gauge total pressure: 0 pa

: Turbulent intensity: 1%

: Hydraulic Dia.: .04

: Temperature: 303.15

Outlet: Pressure outlet: Define the same outlet condition for all the fan outlet Gauge pressure = 0 Pa

: Turbulent intensity: 1%

: Hydraulic Dia.: 10.16

Axis: axis

Collector: wall: heat flux: 103.5, 235.5, 367.5, 499.5, 631.5 (W/m2) respectively

Ground: wall-temp: 311.65 k

Boundary condition of SCWPP at Indian condition with different fraction factor is:

Operating condition: pressure: 101325pa

: Temperature: 303.15k

Inlet: pressure inlet: gauge total pressure: 0 pa

: Turbulent intensity: 1%

: Hydraulic Dia.: .04

: Temperature: 303.15k

Outlet: Pressure outlet: Define the same outlet condition for all the fan outlet Gauge pressure = 0 Pa

: Turbulent intensity: 1%

: Hydraulic Dia.: 10.16

Axis: axis

Collector: wall: heat flux: 367.5 W/m2

Ground: wall-temp: 311.65 k

Boundary condition of SCWPP at Indian condition at fraction factor (.20) with different collector absorption coefficient (α) is.

Operating condition: pressure: 101325pa

: Temperature: 303.15k

Inlet: pressure inlet: gauge total pressure: 0 pa

: Turbulent intensity: 1%

: Hydraulic Dia.: .04

: Temperature: 303.15

Outlet: Pressure outlet: Define the same outlet condition for all the fan outlet Gauge pressure = 0 Pa

: Turbulent intensity: 1%

: Hydraulic Dia.: 10.16

Axis: axis

Collector: wall: heat flux: 367.5, 407.5, 457.5, 507.5(W/m2) respectively

Ground: wall-temp: 311.65 k

(b) Boundary condition of SCWPP at Indian condition at fraction factor (.20) with different collector loss coefficient ($\cup$)

Operating condition: pressure: 101325pa

: Temperature: 303.15k

Inlet: pressure inlet: gauge total pressure: 0 pa

: Turbulent intensity: 1%

: Hydraulic Dia.: .04

: Temperature: 303.15

Outlet: Pressure outlet: Define the same outlet condition for all the fan outlet Gauge pressure = 0 Pa

: Turbulent intensity: 1%

: Hydraulic Dia.: 10.16

Axis: axis

Collector: wall: heat flux: 367.5, 406.5, 445.5, 484.5(W/m2) respectively

Ground: wall-temp: 311.65 k

(iii) Solution:

Solution method: Pressure- velocity coupling – Scheme SIMPLE

: Pressure – Standard

: Momentum – Second order

: Turbulent Kinetic Energy (k) – First order

: Turbulent Dissipation Rate (e) - First order

: Energy: Second order

Solution Initialization: Initialized the solution to get the initial solution for the problem

Run Solution: Run the solution by giving 2000 no of iteration for solution to converge and to find out the required results.

VI. RESULT & DISCUSSION

For analysis the performance of SCWPP the result can be viewed and interpretation in various format of images like temperature distribution, pressure distribution, velocity distribution, vector profile, and various graphs and tables.

(a) Computed Value of Different Parameter of Solar Chimney Wind Power Plant

The Value of Pressure drop, mass flow rate, turbine inlet velocity, chimney height, collector radius, collector percentage, throat radius ,solar radiation, fraction factor, collector absorption coefficient, collector loss coefficient, power are computed using function in post-processor. Then these values are put in tabular form and also plotted by using Microsoft excel software.

(b) Result of existing SCWPP model with different chimney height

Table 1

Chimney Height(m)	Mass Flow Inlet(kg/s)	Turbine-Pressure Drop (pa)	Turbine Inlet Velocity (m/s)	Power (W)
194.66	794.0054	63.4439	11.68162	48044.0938
400	1038.593	115.7378	15.24137	114352.6645
600	1205.413	148.3987	17.58019	169122.2394
800	1351.519	203.057	19.86091	261435.2646
1000	1458.723	217.9338	21.28376	300690.7056

The table 1 shows the result obtain form the fluent solver for Solar chimney wind power plant with different chimney height (194.66m – 1000m) at constant collector radius (122m), average roof height (1.85m), ambient temperature (291.65),and solar radiation 1000(W/m2). In table result of mass flow rate turbine pressure drop, turbine inlet velocity and power is calculated. From the table 5.1 it has been observed that the power is enhance as increases the chimney height. It also has been observed that Mass flow inlet; turbine pressure drop and turbine inlet velocity also increases as the Chimney Height increases.

(c) Result of existing SCWPP model with different collector radius

Table 2

collector radius(m)	Mass flow inlet(kg/s)	turbine-pressure drop (pa)	turbine inlet velocity (m/s)	Power(W)
122	794.0054	63.4439	11.68162	48044.0938
150	900.985	86.3839	13.26227	74267.31657
200	1006.212	107.8849	14.83184	103729.6123
250	1092.522	125.2797	15.97944	129774.4867
300	1101.818	138.5214	16.25754	145988.5392
350	1110.307	137.369	16.44059	146404.0852
400	1122.617	139.7278	16.47706	149248.3725

The table 2 show the result obtain form the fluent solver for Solar chimney wind power plant with different collector radius(122m - 400m) at constant chimney height (194.6m), average roof height (1.85m), ambient temperature (291.65), and solar radiation 1000(W/m2). In table result of mass flow rate turbine pressure drop, turbine inlet velocity and power is calculated. From the table 2 it has been observed that the power is enhance as increases the collector radius. It also has been observed that Mass flow inlet; turbine pressure drop and turbine inlet velocity also increases as the Collector radius increases.

(d) Result of existing SCWPP model with collector percentage with respect to chimney height

Table 3

Collector percentage (%)	Chimney height with %	Mass flow inlet(kg/s)	turbine-pressure drop (pa)	turbine inlet velocity (m/s)	Power(W)
0%	0	794.0054	63.4439	11.68162	48044.0938
10%	19.46	794.0979	63.3374	11.67878	48951.78393
20%	38.92	797.9033	64.134	11.83947	49222.95119
30%	58.38	800.2995	64.3931	11.76823	49124.43186
40%	77.84	802.7017	64.8049	11.804	49588.85781
50%	97.3	805.8514	65.4775	11.95649	50750.79547

(e) Result of SCWPP at Indian condition with different fraction factor

Table 6

R.F.	Chimney height(m)	collector radius(m)	Mass flow inlet(kg/s)	turbine-pressure drop (pa)	turbine inlet velocity (m/s)	power
0.18	21	35.028	9.322625	13.52778	4.413589	3870.485814
0.20	24.4	38.92	12.36664	15.77164	4.812185	4920.012771
0.25	30.5	48.65	22.44221	21.60471	5.61153	7859.171933

The table 6 shows the result obtains form the fluent solver for solar chimney wind power plant at different R.F. at constant throat radius (.7m), ambient temperature (303.15) and solar radiation 1000W/m2. In table result of mass flow rate turbine pressure drop, turbine inlet velocity and power is calculated. From the table 5.6 it has been observed that the power is enhance as increases R.F. It also has been observed that Mass flow inlet; turbine pressure drop and turbine inlet velocity also increases as the fraction factor increases.

(f) Result of SCWPP at Indian condition at fraction factor (.20) with different collector absorption coefficient (∝)

Table 7

collector absorption coefficient (∝)	Mass flow inlet(kg/s)	turbine-pressure drop (pa)	turbine inlet velocity (m/s)	Power(W)
0.66	12.36664	15.77164	4.812185	4920.012771
0.70	12.78653	16.87063	4.97741	5443.544485
0.75	13.27674	18.20035	5.170282	6100.157253
0.80	13.73818	19.49833	5.352036	6764.933036

The table 7 shows the result obtains form the fluent solver for solar chimney wind power plant at different collector absorption coefficient (∝) at constant R.F(.20), throat radius (.7m), collector radius (24.4m), chimney height (38.92m) ambient temperature (303.15) and solar radiation 1000W/m2. In table result of mass flow rate turbine pressure drop, turbine inlet velocity and power is calculated. From the table 5.7 it has been observed that the power is enhance as increases R.F. It also has been observed that Mass flow inlet; turbine pressure drop and turbine inlet velocity also increases as the collector absorption coefficient (∝) increases.

(g) Result of SCWPP at Indian condition at fraction factor (.20) with different collector loss coefficient (∪)

Table 8

collector loss coefficient (∪) W/m^2K	Mass flow inlet(kg/s)	turbine-pressure drop (pa)	turbine inlet velocity (m/s)	Power(W)
15	12.36664	15.77164	4.812185	4920.012771
13	12.77802	16.84758	4.973957	5432.335867
11	13.16299	17.88765	5.1256	5943.538213
9	13.5301	18.90786	5.270134	6459.681354

The table 8 shows the result obtains form the fluent solver for solar chimney wind power plant at different collector loss coefficient (∪) W/m2K at constant R.F (.20), throat radius (.7m), collector radius (24.4m), chimney height (38.92m) ambient temperature (303.15) and solar radiation 1000(W/m2).In table result of mass flow rate turbine pressure drop, turbine inlet velocity and power is calculated. From the table 5.8 it has been observed that the power is enhance as decreases collector loss coefficient (∪).It also has been observed that Mass flow inlet; turbine pressure drop and turbine inlet velocity also increases as the collector loss coefficient (∪) decreases.

(a) Graphical Plots of SCWPP with Different Geometrical Parameter and Running Condition

Validation of Result of Presented Model with Reference [20] for Chimney Height and Collector Radius.

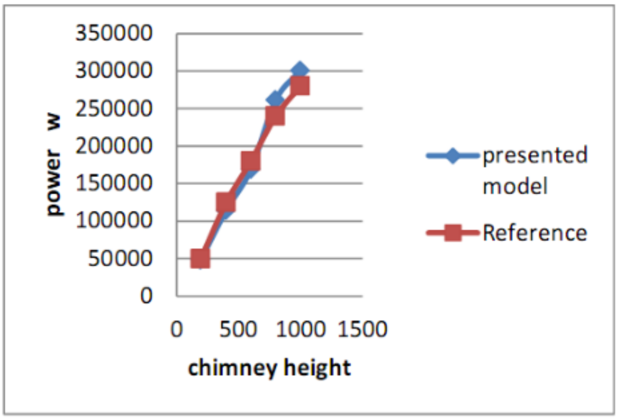


Fig 22(i) Comparison of chimney height versus power between presented model and reference of [20]

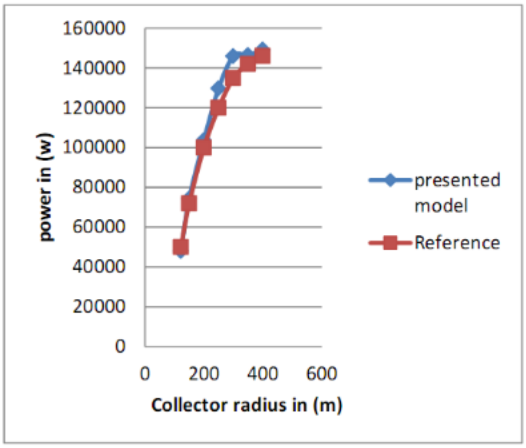


Fig 23(ii) Comparison of Collector radius (m) versus power between presented model and reference of [20]

Fig 23(i),(ii) show the comparison between result of presented numerical model and the data of [20] for chimney height and collector radius versus power respectively. From these two figures it can be observed that the value of presented model and data of [20] is very near to close. The negligible difference between both the parameter (chimney height and collector radius) due to the mesh and solving control method. There for the present numerical model is reliable and can be used to study the effect of different geometrical parameter and running conditions of solar chimney wind power plant.

(b) Graphical representation existing SCWPP model with different chimney height

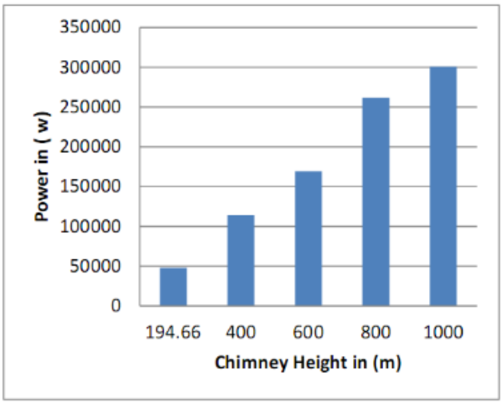


Fig. 24 Variation of chimney height with power in existing SCWPP model with different chimney height

Fig. 24 shows the variation of chimney height with power in existing solar chimney wind power plant at same running condition from the entire figure it has been observed that At constant collector radius, average roof height, and same boundary condition of ambient temperature and solar radiation, power of SCWPP is enhance as increases the chimney height in existing model of Manzanares pilot plant.

(c) Graphical representation existing SCWPP model with different collector radius

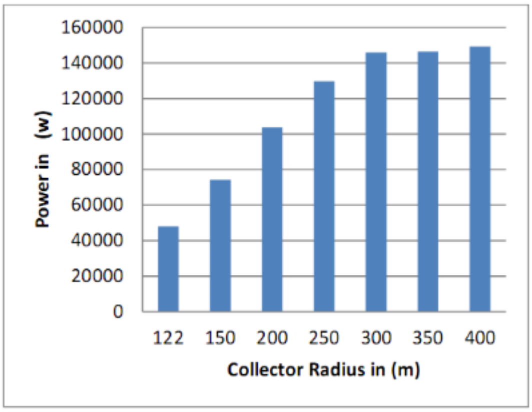


Fig 25 Variation of collector radius with power in existing SCWPP model with different collector radius

Fig 25 shows the variation of collector radius with power in existing solar chimney wind power plant at same running condition from the entire figure it has been observed that. At constant chimney height, average roof height and same boundary condition of ambient temperature and solar radiation. Power of SCWPP is enhance as increase the collector radius in existing model of manzanares pilot plant.

(d) Graphical representation existing SCWPP model with collector percentage with respect to chimney height

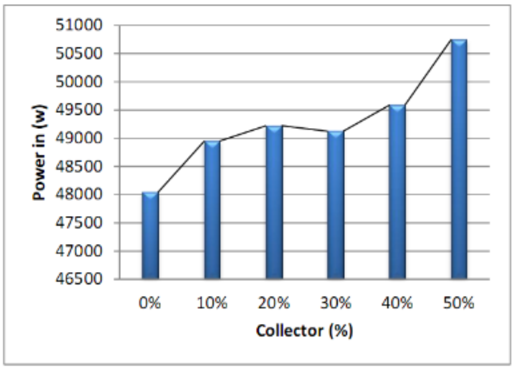


Fig 26 Variation of collector (%) with respect to chimney height with power in existing SCWPP model

Fig 26 shows the variation of collector percentage with power in existing solar chimney wind power plant at same running condition from the entire figure it has been observed that At same boundary condition of ambient temperature, solar radiation and constant collector radius, chimney height, average roof height, the power of SCWPP is slightly enhance as the percentage of collector covering is increases in existing model of manzanares pilot plant.

(e) Graphical representation of existing SCWPP model with different throat radius

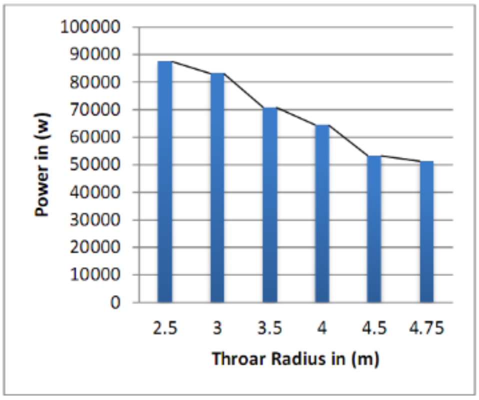


Fig 27 Variation of throat radius with power in existing SCWPP model

Fig 27 shows the variation of throat radius with power in existing solar chimney wind power plant at same running condition from the entire figure it has been observed that At constant chimney height, collector radius, average roof height, and same boundary condition of ambient temperature, and solar radiation the power of SCWPP is enhance as reducing the throat radius but it gives the best performance at throat radius is 3.5 m due to after this there is chance of chocking in existing model of manzanares pilot plant.

(f) Graphical representation of Indian condition SCWPP model with optimize throat radius (3.5 m) at different solar radiation

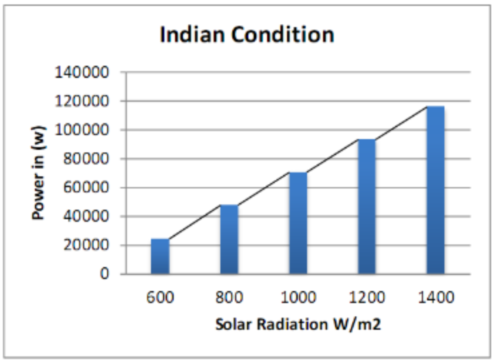


Fig 28 Variation of solar radiation with power in Indian condition SCWPP

Fig 28 shows the variation of throat radius with power in Indian condition solar chimney wind power plant at same running condition from the entire figure it has been observed that In Indian condition at optimize throat radius (3.5m) and constant collector radius, chimney height, average roof height the power of SCWPP is enhances as the solar radiation is increases in existing model of manzanares pilot plant.

(g) Graphical representation of SCWPP at Indian condition with different fraction factor

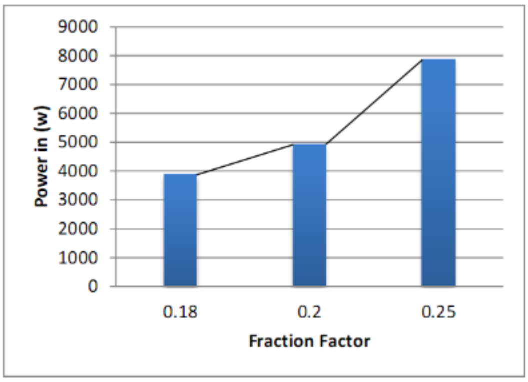


Fig 29 Variation of R.F. with power in Indian condition SCWPP

Fig 29 shows the variation of R.F. with power in Indian condition solar chimney wind power plant at same running condition from the entire figure it has been observed that In Indian condition at constant throat radius and same boundary condition of ambient temperature and solar radiation, the power of SCWPP is enhance as fraction factor is increases. And also observed that at the R.F. = 0.2 it gives power approximately 5 KW.

(h) Graphical representation of SCWPP at Indian condition at fraction factor (.20) with different collector absorption coefficient (∝)

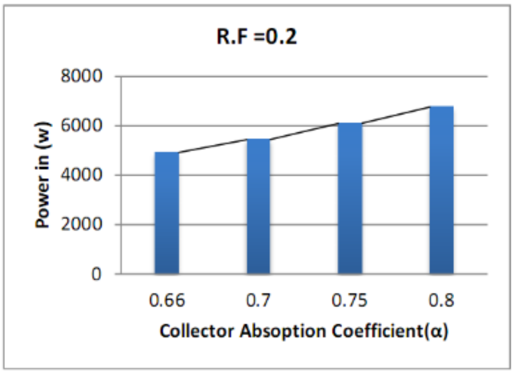


Fig 30 Variation of collector absorption coefficient (∝) with power at Indian condition SCWPP

Fig 30 shows the variation of collector absorption coefficient (∝) With power in Indian condition solar chimney wind power plant at same running condition from the entire figure it has been observed that In India condition at constant R.F, throat radius, collector radius, chimney height and same boundary condition of ambient temperature and solar radiation, the power of SCWPP is enhances as the collector absorption coefficient (∝) is increases.

(i) Graphical representation of SCWPP at Indian condition at fraction factor (.20) with different collector loss coefficient (U)

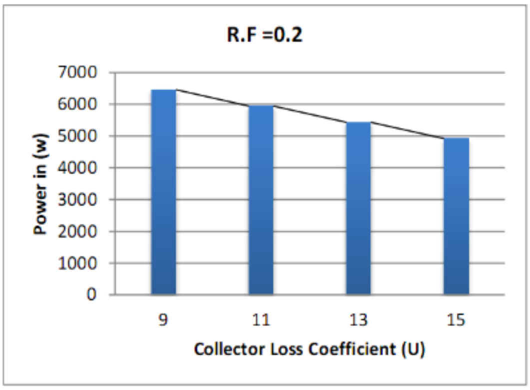


Fig 31 Variation of collector loss coefficient (U) with power in Indian condition SCWPP

Fig 31 shows the variation of collector loss coefficient (U) With power in Indian condition solar chimney wind power plant at same running condition from the entire figure it has been observed that In India condition at constant R.F, throat radius, collector radius, chimney height and same boundary condition of ambient temperature and solar radiation, the power of SCWPP is enhances as the collector loss coefficient (U) is decreasing.

VII. CONCLUSION

Following points worth noting from the present exploration on computational analysis form performances characteristics of different geometrical parameter and running condition of solar chimney wind power plant.

(a) At constant collector radius, average roof height, and same boundary condition of ambient temperature and solar radiation, power of SCWPP is enhance as increases the chimney height in existing model of manzanares pilot plant.

(b) At constant chimney height, average roof height and same boundary condition of ambient temperature and solar radiation. power of SCWPP is enhance as increase the collector radius in existing model of manzanares pilot plant.

(c) At same boundary condition of ambient temperature, solar radiation and constant collector radius, chimney height, average roof height, the power of SCWPP is slightly enhance as the percentage of collector covering is increases in existing model of manzanares pilot plant.

(d) At constant chimney height, collector radius, average roof height, and same boundary condition of ambient temperature, and solar radiation the power of SCWPP is enhance as reducing the throat radius, but it gives the best performance at throat radius is 3.5 m due to after this there is chance of chocking in existing model of manzanares pilot plant.

(e) In Indian condition at optimize throat radius (3.5m) and constant collector radius, chimney height, average roof height the power of SCWPP is enhances as the solar radiation is increases in existing model of manzanares pilot plant.

(f) In Indian condition at constant throat radius and same boundary condition of ambient temperature and solar radiation, the power of SCWPP is enhance as fraction factor is increases. And also observed that at the R.F. = 0.2 it gives power approximately 5 KW.

(g) In India condition at constant R.F, throat radius , collector radius, chimney height and same boundary condition of ambient temperature and solar radiation, the power of SCWPP is enhances as the collector absorption coefficient (α) is increases.

(h) In India condition at constant R.F, throat radius , collector radius, chimney height and same boundary condition of ambient temperature and solar radiation, the power of SCWPP is enhances as the collector loss coefficient (U) is decreasing.

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