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R.B.S. ENGINEERING TECHNICAL CAMPUS, BICHPURI, AGRA

Case Study: Solar thermal hybrid chimney

SHUBHAM KUMAR SHARMA, SHIVAM VERMA, AVDESH TIWARI, TULSI RAM

Abstract- The present paper presents an overview of the main characteristic of solar thermal hybrid chimney because we have to make something which is suitable for indian energy increasing needs. The components basically are collector, chimney & turbines. All these components together make a huge power generating plant .which is run with its own manner no need the external source for the generation purposes & our project is just a prototype or model, larger plants generates more energy rather than little one, but it ,makes the little idea about the full energy solar thermal hybrid chimney.

***Index Terms*— projects, power generation, solar chimney, solar energy.**

I. INTRODUCTION

At present, a number of energy sources are utilized on a large scale , but as we know from the industrialisation occurred when the demand & profit increases people are utilizing and consuming more & more energy and industries need more power for production of their goods & services, but for every developing country need more energy to run their economy & we already know that india is developing country & also solar rich country but due to lack of information and money solar and green energy revolution not took placed. Our keen dependency of fossil fuels these are widely used & it emits CO2, MO, etc are hazardous to our environment & living beings also & this is not last present in the world because of huge population, deforestations, carbon emissions etc. may lead the global warmings if we say about india so our 80% approx. energy comes from coal, then nuclear rest on non-conventional. So our projects takes a keen interest how can we dropdown the carbon emission without braking the country need of energy .due to carbon emission our ozone layer going to be depleted , glaciers melt down which results increasing sea level may cause Tsunami, etc. whole world needs energy for the huge population & for future use.Fossil fuels are being exhausted at a fast rate, and utilization of fossil fuels together with net deforestation has induced considerable climate change in warming the atmosphere by releasing greenhouse gases (GHG) which may produce many negative effects including receding of glaciers, rise in sea level, loss of biodiversity, extinction of animals, and loss of productive forests etc.

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According to a Greenpeace study, the use of CSP(concentrated solar power) can prevent 154 million tons of CO2 emissions worldwide by 2020.A Solar Thermal Electricity generating system also known as Solar Thermal Power plant is an emerging renewable energy technology, where we generate the thermal energy by concentrating and converting the direct solar radiation at medium/high temperature (300ºC – 800ºC).The drawback ofmost of the renewable power technologies has been their unreliability as they can’t operate continuously for 24 hours or continuous operation is achieved only through hybrid systems using fossil fuels along with renewable energy sources or through expensive and sophisticated energy storage facilities.A wide range of existing power technologies can make use of the solar energy reachingEarth. Basically, all those ways can be divided into two basic categories: transformed for useelsewhere or utilized directly – direct – and involving more than one transformation toreach a usable form – indirect. The Solar Chimney Power Plant (SCPP) is part of the solarthermal group of indirect solar conversion technologies**.**

The basic physical principles of centralized electricity generation with solar chimney power plants (SCPP‘s) were described by Haaf et al. in 1982. After the pilot plant in Manzanares had gone into operation in June 1982, the first experimental results confirmed the main assumptions of the original physical model . Later, on the basis of experimental data from July 1983 to January 1984, a semi-empirical, parametrical model was proposed for predicting the monthly mean electrical power output of the pilot plant as a function of solar irradiation . The model predictions agreed reasonably with the experimental data for the exceptionally dry months July-October 1983, but the model failed to simulate the wet months following heavy rainfall in winter and spring 1984.

II. HISTORY

Many researchers around the world have introduced various projects of solar tower. Around 1500, Leonardo Da Vinci made sketches of a solar tower called a smoke jack (see figure 2.a-b) . The idea of using a solar chimney to produce electricity was first proposed in 1903 by the Spanish engineer IsodoroCabanyes (figure 2.a-b). Another earlier description was elaborated upon in 1931 by the German science writer Hans Gunther. In this bizarre contraption, a collector resembling a large skirt heats air, and carries it upwards towards a pentagonal fan

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inside a rectangular brick structure vaguely resembling a fireplace (without a fire).

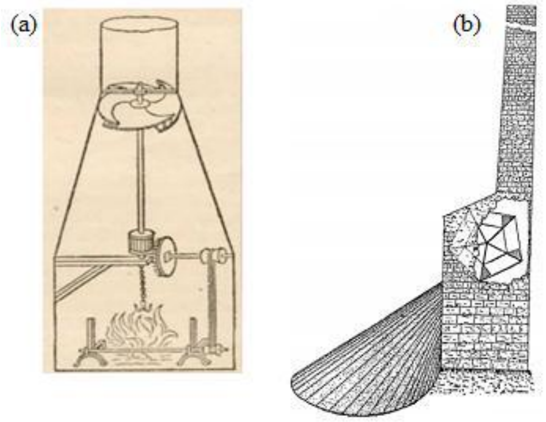

Fig.1.(a)The spit of Leonardo da Vinci (1452-1519) (Library of Entertainment and Knowledge 1919). (b) Solar engine project proposed by IsodoroCabanyes.

The academy recommended the Dubos's idea be followed up, especially in French North Africa, which has no fuel and needs power. As a matter of fact Dubos had the North African Atlas Mountains in mind when he developed his plans .In 1956; he filed his first patent in Algeria. It was artificially generate ancestry atmospheric vortex in a sort of round-shaped Laval nozzle and recover some energy through turbines. Nazare received a French patent for his invention in 1964 (figure 1.b).

III. WORKING PRINCIPLE

A Solar Updraft Tower converts solar radiation into electricity by combining three well-known principles: the greenhouse effect, the tower and wind turbines in a novel way. First the green house effect when the sun Hot air is produced and strikes the collector surface because of the large glass roof . Direct and diffuse solar radiation strikes the glass roof, these radiations can cause the specific fractions of the energy are reflected, absorbed and transmitted. The high amount of quantities of these fractions depend on the solar incidence angle and optical characteristics of the glass, such as the refractive index, thickness and extinction coefficient. When the solar radiation strikes the ground surface some transmitted, a part of it reflected back why we called this is a green house effect because it works on the same principle like green housework's. Whole collector and the sun solar radiations may cause a huge amount of heat radiation penetration like when the wind comes from it the collector heat up most of the wind which will further. The multiple reflection of radiation continues, resulting in a higher fraction of energy absorbed by the ground, known as the transmittance-absorptance product of the ground. Through the mechanism of natural convection, the warm ground surface heats the adjacent air, causing it to rise. Second case turbines when the buoyant air rises up into the chimney of the plant, thereby drawing in more air at the collector perimeter and thus initiating forced convection which heats the collector air more rapidly. Through mixed convection, the warm collector air heats the underside of the collector roof & this warm air results extremely powerful wind rises upwards which rotates the turbine the pressure exerted by the warm wind rotates it rapidly more the revolution per minute more the energy created but it also depending on the turbines ratings but mainly the rotation rpm is must of it to run the turbines more turbines means more generation of energy. Third case the chimney when the turbines rotates, so it draws huge amount of air so need out of the power plant so turbines provides an outlay for all warm winds as we know this air just for no use except in the turbines so we also think that why not we have to put two or three turbines inside the chimney more warm air can cause more heat to generates electricity. all of above conclusion taken into account all we need proper management to take whole things into correct position .Fig 2.shows how this solar chimney power plant works.

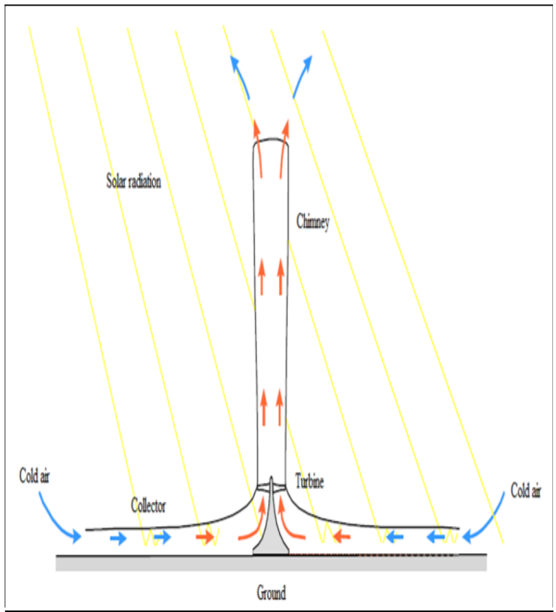

Fig.2. Solar chimney power plant description.

A. SOLAR CHIMNEY COMPONENTS (CONSTRUCTION AND MATERIALS)

1. Collector

The collector is the main component of solar thermal hybrid chimney because when the sun radiation strikes the surface of collector, it provides the green house effect. Solar energy collectors are special kind of heat exchangers that transform solar radiation energy to internal energy of the transport medium. The collector is the part of the chimney that produces hot air by the green house effect. This roof is made up of roof made up of plastic film or glass plastic film. The collector or roof material is stretched horizontally depending upon the surface & area the collector is above the ground about 2-3 or may be more. The height of the roof increases adjacent to the chimney base, so that the air is diverted to the

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chimney base with minimum friction loss. The covering of the collector admits the short wave solar radiation component and retains long-wave radiation from the heated ground. Thus the ground under the roof heats up and transfers its heat to the air flowing radially above it from the outside to the chimney. The structure of the collector changes to the covering material we used.

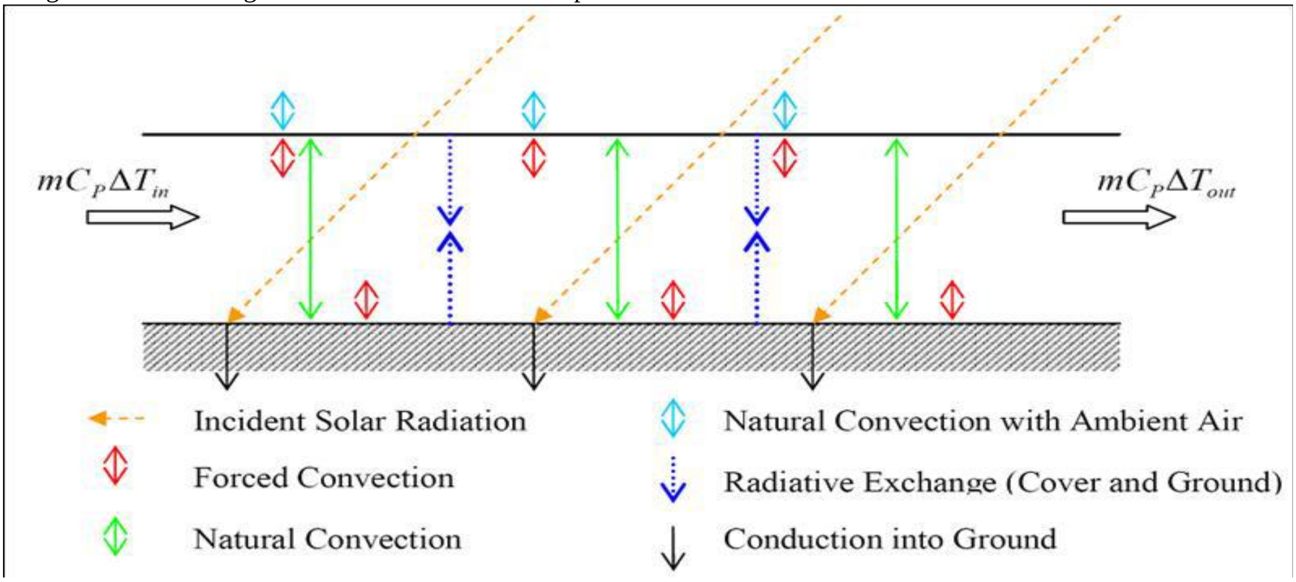

Fig.3. Collector thermal balance scheme

2. Chimney

The Chimney or tower tube; is the main characteristic of thesolar chimney station. The chimney, which acts like a large chimney, is located at the centre of the greenhouse canopy and is the thermal engine for the technology. The main role of chimney is to creates a temperature differential between the cool air at the top and the heated air at the bottom. This creates the chimney effect, when the pressurised warm air flows from the bottom of the tower out of the top. The chimney of the plant is extremely high and will need a stable base while still allowing free flow of air through the turbine. There are various different methods for constructing such a tower: free-standing reinforced concrete tubes, steel sheet tubes supported by guy wires, or cable-net construction with a cladding of sheet metal or membranes. The design procedures for such structures are all well established and have already been utilized for cooling towers; thus, no new developments are required. The detailed static and structural-mechanical investigations have shown that it is expedient to stiffen the tower in several stages, so that a relatively thin wall material will suffice. The tower must be connected or attached by some external means supporting, provide must be enough to provide strength and stability because tower or chimney rages from 100m-1000m so at this condition the wind flowing capacity and which means that if wind velocity from naturally comes from natural wind from 300-800 km/h may cause huge disruption to the tower. Our solution is to use bundles of strands in the form of —flat—spoked wheels which span the cross-sectional area of the tower. The only real structural novelty in these towers as compared to existing structures which is base level to exceeding one.

History of chimney or tower: Schlaich (1994) suggested the reinforced concrete as a building material structure towers high. Studies have shown that practically this method of construction is the alternative most sustainable and cost-effective. Such towers can also be constructed using other technologies including: guyed steel towers which frame is covered with nets of steel cables, membranes or trapezoidal metal films (1994). The maximum height for solar chimney is 1000 m. To support high chimney structure and gigantic solar, compression ring stiffeners are installed with a vertical spacing.

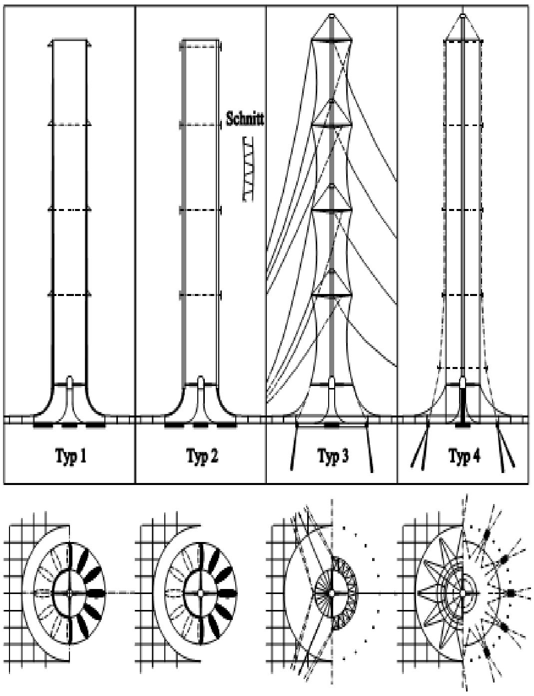

Fig. 4. Chimney construction shapes (Bernardes, 2004)

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3. Turbines

The turbine of the solar chimney is an important component of the plant as it extracts the energy from the air and transmits it to the generator. It has significant influence on the plant as the turbine pressure drop and plant mass flow rate are coupled. The turbines are composed of several ratings depending upon the type of their Rpm , power generation &how many installation of turbines associated inside the chimney or below so turbines played a curical role for all the generation of clean energy perspective .They both convert large amounts of energy in the air flow to electrical energy and feed this into a grid. But there are also various important differences. The following characteristic are typical for solar chimney turbines in contrast to wind turbines. In solar chimneys power plant the turbines are ducted, and their maximum theoretically achievable total efficiency is therefore 100% the Betz-limit, which is the one to duct. The direction of the oncoming air flow is known and remains constant. The turbines are protected from harsh weather conditions but have to cope with higher temperatures. The large volumes of collector and chimney act as a buffer preventing large fluctuations in air flow speed, i.e. dynamic loads on the turbine blades and all the other rotating components are comparably low. Furthermore, the turbine pressure drop in SCCPs is about 10 times bigger than in wind turbines

Various turbine layouts and configurations have been proposed for solar chimneys power conversion unit (PCU). A single vertical axis turbine without inlet guide vanes was used in the pilot plant in Manzanares. Configurations with multiple vertical axis turbines has been proposed as well , and so have turbine layouts consisting of one pair of counter-rotating rotors, either with or without inlet guide vanes .

4. Turbine coupling

Using the Spanish prototype as a practical example, Tingzhen et al (2008) carried out a numerical simulation of a solar chimney power plant system coupled with a 3 blade turbine. This study showed that the average velocity of the chimney outlet and the mass flow rate decrease with the increase of turbine rotational speed. The authors concluded that the average temperature of the chimney outlet and the turbine pressure drop inversely, while the maximum available energy, power output and efficiency of the turbine each has a peak value . Koonsrisuk et al. (2010) conducted a study in which the collector, chimney and turbine are modelled together theoretically, and iteration techniques were then carried out to solve the mathematical model developed. It was developed to estimate power output of solar chimneys as well as to examine the effect of solar heat flux and structural dimensions on the power output. Results from the mathematical model were validated by measurements from the physical plant actually built. The results show that the plant size, the factor of pressure drop at the turbine and the solar heat flux are the important parameters for the performance enhancement .3-D Numerical simulation of the SUPPS couple with turbine conducted by Ming et al.indicated that it is a little difficult to simulate the turbine region and much more meshes are needed to accurately describe flow, heat transfer and output power performances of the system. It was concluded that it is impossible to realize the simulation procedure simultaneously including regions of the solar chimney power plant system, the ambience and the 3-D turbine due to the limitation of grids number. The research work conducted by Pastohr et al. indicated years ago that it is also an efficient way to realize the object by simplifying the 3-D turbine to be a 2-D reversed fan with pressure drop across it being pre-set. This method was also verified by Xu et al. and Ming et al. and was proven to be effective to alleviate the mesh pressure by 3-D turbine region without significantly total performance of solar chimney power plant. Ming et al. conducted a study considering the turbine as a reversed fan with pressure drop across it being pre-set although 3-D model for the SUPPS and the ambience is selected. The results of comparison between the simulated model and the Spanish prototype with a 3-blade turbine show that with the increase in the turbine rotational speed, the average velocity of the chimney outlet and the system mass flow rate decrease, the average temperature of the chimney outlet and the turbine pressure drop inversely, while the maximum available energy, power output, and efficiency of the turbine each has a peak value.\

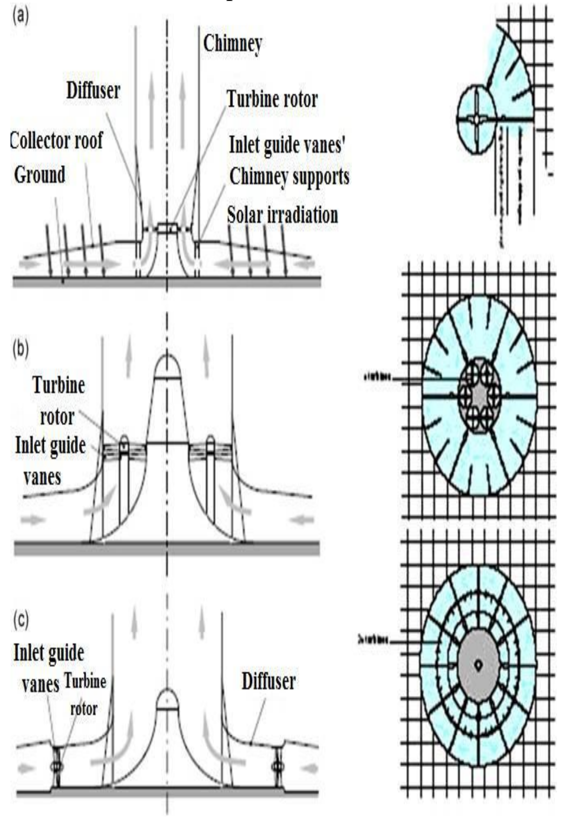

Fig 5.Vertical view and top view of three turbine configurations: (a) single vertical axis type; (b) multiple vertical axis type; (c) multiple horizontal axis type.

Fig.6. Proposed Project

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