

Floating Solar Chimney Technology

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Abstract-The purpose of this paper is to present the Floating solar chimney (FSC) technology and to have the utmost benefits of this technology. The solar power plant chimney is also known as updraft power plant and their chimneys are of reinforced structures .The cost of the Floating Solar Chimneys (FSC) is lower than the Concrete Solar Chimney.

FSC technology is appropriate solar technology and can replace fossil fuel for large scale electricity generation. The main reasons are: It is the cost competitive, it can operate continuously (24x365) thus it can replace coal fired base load power plants, demands no water for its operation, power plant of FSC technology are made of recyclable existing in the market.

Keywords-Floating Solar Chimney, Solar Aero Electric Power Plant.

I .Introduction

The aim of this paper is to present the Floating solar chimney (FSC) technology, explain its working and principle of operation and figure out its various significant benefits. It can be used for large scale solar electricity generation especially in desert or semi desert areas of our planet and it can play a vital role for the global warming elimination. The construction cost of the concrete solar chimneys the solar up-draft tower technology is high and requires large initial investment. That is why the solar chimney technology has not yet been applied although it is a solar technology of many advantages. Floating Solar Chimney is a low cost alternative of the solar concrete chimney. It can be split into small unit of several MW each. The Floating

Solar Chimney Power Plant, named by the author as Solar Aero-Electric Power Plant (SAEP) due to its similarity to the Hydro-Electric power plant, is a set of three major components.

- **The Solar Collector.** It is a large greenhouse open around its periphery with a Transparent roof supported a few meters above the ground.

- **The Floating Solar Chimney (FSC).** It is a tall fabric cylinder placed at the centre of the Solar collector through which the warm air of the greenhouse, due to its relative Buoyancy to the ambient air, is up-drafting.

- **The Turbo-Generators.** It is a set of air turbines geared to appropriate electric Generators in the path of up-drafting warm air flow that are forced to rotate generating Electricity. The gear boxes are adjusting the rotation speed of the air turbines to the Generator rotation speed defined by the grid frequency and their pole pairs.



Fig.1. A view of the Manzanares Solar Chimney Power Plant

II .History

Many researchers around the world have introduced various projects of solar tower. The idea of using a solar chimney to produce electricity was first proposed in 1903 by the Spanish engineer Isadora Cabanyes. Another earlier description was elaborated upon in 1931 by the German science writer Hans Gunther. He proposed a design in the 25 August 1903 issue of "La Energia Eléctrica", entitled "Projecto de motor solar". In 1926, Prof Engineer Bernard Dubos proposed to the French Academy of Sciences the construction of a Solar Aero-Electric Power Plant in North Africa with its solar chimney on the slope of the high height mountain after observing several sand whirls in the southern Sahara. The author claims that an ascending air speed of 50 m/s can be reached in the chimney, whose enormous amount of energy can be extracted by wind turbines.

The basic physical principles of centralized electricity generation with solar chimney power plants (SCPP's) were described by Haaf et al in 1982.

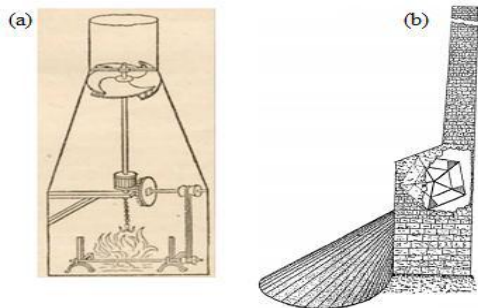


Fig.2. (a) The spit of Leonardo da Vinci (1452-1519) (Library of Entertainment and Knowledge 1919). (b) Solar engine project proposed by Isodoro Cabanyes.

III. Working Principle and component of SAEPP

- A large solar collector open in its perimeter with a transparent roof (glass is the best option). Below of this large greenhouse the air is warming, due to the solar irradiation (the greenhouse).
- A tall lighter than air hollow cylinder placed in the center of the solar

collector that is up-drafting the warm air, through its open top to the upper atmosphere (the Floating Solar Chimney FSC).

- A series of air turbines, placed with horizontal axis around the solar chimney in the paths of moving warm air from the open perimeter of the solar collector towards the bottom of the FSC and up-drafting through it. These air turbines geared to appropriate electric generators are transforming part of the thermodynamic energy of the moving stream of warm air to electrical energy. A SAEPP with Floating Solar Chimney under external winds is shown in fig.3

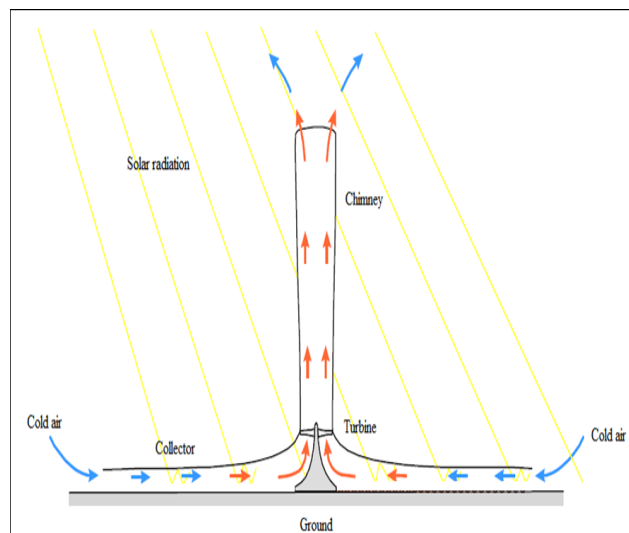


Fig 3: Indicative presentation of a SAEPP with FSC under external winds.

The operation of SAEPPs is similar to the operation of the hydroelectric power plants. The SAEPPs are using the dynamic energy of up-drafting buoyant warm air. Hydroelectric power plants use the dynamic energy of falling water due its gravity. Both are using turbines in order to transform part of their fluid's dynamic energy to rotational energy and through their geared

electric generators to produce electric energy. The efficiency of the SAEPPs is proportional to their solar chimney's height, as the efficiency of the hydroelectric power plant is proportional to the dam height.

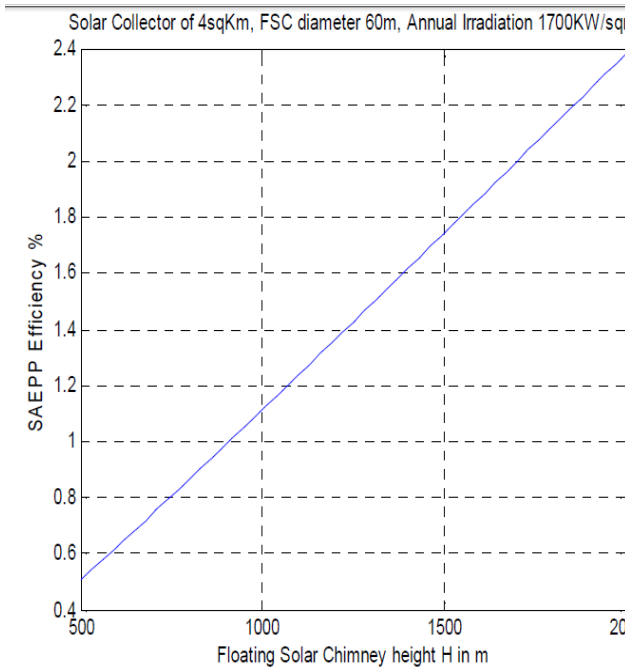


Fig. 3: Efficiency of a SAEPP as function of its FSC height

IV. Power production and cost of FSC Technology in comparison to coal fired Power Plant

According to initial design estimations an optimum SAEPP with a Floating Solar Chimney appropriate for desert area with a minimum annual solar irradiation of 1700 KW/m² should have the following characteristics:

- An annual electricity production approximately of 100 GWh
- A Floating Solar Chimney with a maintainable height of 1300m, and a reasonably proportional external diameter (of 1 to 20), define its internal diameter approximately to 60m

- The previous decisions can define approximately the area of the solar collector of the SAEPP in order to produce 100 GWh/year to 4 Km²
- Taking into consideration that the hours of operation for the rating power of the SAEPP are not less than 3000 hours, the rating power of air turbines gear boxes and electric generators is approximately 32 MW. The rating power of the SAEPP is defined as the maximum electric power produced at maximum irradiance on horizontal surface (as is the noon of a summer day). A solar farm of 16 identical SAEPPs with an overall rating power of 512 MW will be an electricity generating plant with an annual production of 1600 GWh. This SAEPP solar farm can be operated and maintained by a team of properly trained personnel, not bigger than the number required for the operation and maintenance of a coal-fired power plant producing the same annual amount of electrical energy, which would have approximately a rating power of 200MW.

V. Conclusion

Although electricity generation is a major carbon dioxide producer we should notice that electricity can replace all the energy activities related to fossil fuelled technologies. Thus a Solution to the global warming is possible if we succeed to generate zero emission clean electricity .

VI. References

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