**wind supercharged solar chimney power plant**

Abstract

A solar air updraft tower (also known as a solar chimney or solar updraft tower) is a type of renewable energy technology that uses the natural process of convection to generate electricity.

The tower is typically a tall, hollow structure with a large diameter base that is wider than its top. The base of the tower is covered with a large glass or plastic canopy that traps solar energy and heats the air underneath. This creates a temperature difference between the air inside the tower and the air outside, which causes the hot air to rise up through the tower.

As the hot air rises, it passes through a series of turbines located near the base of the tower. These turbines are connected to generators, which convert the kinetic energy of the moving air into electrical energy.

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Based on the prototype Spanish solar chimney power plant (SCPP), the physical, mathematical models are built, the performance of WS-SCPP and SCPP are compared and the relationship between chimney height increment and supercharging effect is discussed. The results show that: with the help of unpowered wind pressure wheel, the performance of WS-SCPP improves greatly. At the same turbine rotational speed, the shaft power of WSSCPP is always higher than that of SCPP. When the speed is 100 rpm, the shaft power of SCPP increases from 37.8kw to 57.03kw, with an increase of 50.9%. The net income and NPV of WS-SCPP are always higher than those of SCPP. The lowest electricity selling price is significantly lower than that of SCPP, with a decrease of 20.1%. When the chimney height of SCPP is increased by at least 80 m, the performance is comparable to WS-SCPP. Wind supercharging technology is one of the effective ways to improve the efficiency and commercial application of SCPP.

Diagram

Description automatically generated

This study is to investigate to what extent the ambient wind speed affects internal air updraft velocity generated in the chimney tower of SCPP. Measurements were conducted to SCPP prototype, utilizing high accuracy measuring systems for three days under different climatic conditions and wind speed levels. From the obtained results, the following major points can be drawn:

• Wind speed at the top of the chimney plays a significant role in enhancing the system updraft velocity by creating a negative pressure zone able to suck air upward in the chimney tower as an air ejector installed above the chimney.

• High wind speed >6 m/s during night times, in the absence of buoyancy effect, can generate an updraft velocity almost equal to that generated during the daytime under high solar insolation.

• During the daytime, high wind speed significantly enhances the heat losses from the collector surfaces and reduces the buoyancy effect to generate an updraft air stream.

• During the night time, for a wind speed lower than 2.1 m/s the ejector effect is elapsed and a downward air stream into the chimney tower is possible.

• Without a solar collector, ambient wind can create updraft air inside the chimney of SCPP, and the updraft velocity can attain 24% of the ambient wind speed.

• For small-scale SCPP, high wind speed eliminates the effect of solar collector, due to the heat losses increase, and the updraft velocity is mainly induced by the wind effect over the chimney tower.

• Thermal and aerodynamic models are urgently required to describe the air zone over the chimney tower and ejection process.

Economic benefit comparison of WS-SCPP and SCPP

|  |  |  |  |
| --- | --- | --- | --- |
| Parameters | SCPP | WS-SCPP | Amplification |
| Electricity benefit (Million yuan) | 8.09 | 12.21 | 51.0% |
| CO2 benefit (Million yuan) | 0.105 | 0.159 | 41.9% |
| Electricity price (yuan/kW h) | 1.69 | 1.35 | -20.1% |

3.Expansion of Potential: Co-generation Use

Diagram

Description automatically generatedOther solar technologies, such as collectors that use solar radiation to convert water to steam or photovoltaic (PV) arrays, generate substantial excess heat. In the case of PV, high temperatures diminish their power generation capacity. Using the solar updraft tower in combination with solar collectors or PV arrays can improve the efficiency of both systems. The constant wind flow can air-cool the collectors while increase the energetic output per area of land used, making the solar updraft tower a more efficient proposition. Things to consider in terms of the efficiency of combining these systems include the loss of some direct solar radiation as a result of its deflection by the membrane, and the amount of cooling that can ideally be achieved.

4.Advantages

They are relatively inexpensive to build and maintain, it can also work for 24 hours, where can scpp can used in agriculture areas and they do not require large amounts of land or water resources. They can also be located in remote areas where traditional power sources may not be available.

5.Disadvantages

They require a large temperature difference between the air inside and outside the tower to function properly, so they are most effective in areas with high levels of solar radiation and significant diurnal temperature fluctuations. They also have a relatively low energy conversion efficiency compared to other renewable energy technologies, which means they may not be suitable for large-scale energy production. The study shows that even if the chimney is as high as 1000 m, the efficiency was only 3.22% . However, the structural size of SCPP above the megawatt level is too large, which is difficult to build. Since the initial investment cost is so high, so far, no commercial SCPP has been built. Therefore, it is necessary to study the efficiency enhancement technology of SCPP and analyze the economy of SCPP.