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# Numerical investigation on performance of solar chimney power plant by varying collector slope and chimney diverging angle

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## *Abstract*

In this study, a parametric three dimensional computational fluid dynamics (CFD) analysis of solar chimney power plant was performed to illustrate the effects of collector's slope and chimney diverging angle on performance of Manzanares prototype. Numerical models were incorporated with solar load, DO (discrete ordinates) and RNG k- $\epsilon$  turbulence models. Firstly, CFD simulations results were validated by comparing them with the experimental data of Manzanares prototype and then, on the basis of robustness of numerical methods adopted, several numerical simulations were performed on varying collector's slope and chimney diverging angles to improve the performance of solar chimney. Numerical simulations were performed at chimney diverging angle =  $1^0$ - $3^0$  and at collector slope =  $4^0$ ,  $6^0$ ,  $8^0$  and  $10^0$  sequentially, while all other parameters were kept constant. Based on computed results, it was discovered that both velocity and temperature increases with increasing collector's slope due to enhanced heat transfer and mass flow rate, but simultaneously higher collector slopes also deteriorate the smooth air flow by developing vortices and recirculation of air, which obstructs the air flow and may reduce the overall performance. In addition, chimney diverging angle =  $1^0$  raises the velocity from 9.1 m/s to a remarkable value of 11.6 m/s; therefore, this diverging chimney approach is conceived to be a beneficial tool in improving performance of solar chimney power plant.

## *Keywords*

Solar chimney power plant; Computational fluid dynamics; Collector slope; Diverging chimney

## *1. Introduction*

Needless to say, energy plays a role of backbone for the socio-economic development of any country. Incessantly rising population and high living standards ask for endless energy resources to fulfill heightening energy demand. It is pragmatic that non-renewable energy resources (fossil fuels) are limited in nature and are being over utilized, so need to be restrained. Likewise, far-reaching consumption of fossil fuels has polluted our environment severely, endangering life on our planet. This entire scenario necessitates the advancements in clean and sustainable energy

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