World Academy of Science, Engineering and Technology
International Journal of Energy and Power Engineering
Vol:11, No:10, 2017

Numerical Analysis of a Pilot Solar Chimney Power Plant

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Abstract : Solar chimney power plant is a feasible solar thermal system which produces electricity from the Sun. The objective of this study is to investigate buoyancy-driven flow and heat transfer through a built pilot solar chimney system called 'Kerman Project'. The system has a chimney with the height and diameter of 60 m and 3 m, respectively, and the average radius of its solar collector is about 20 m, and also its average collector height is about 2 m. A three-dimensional simulation was conducted to analyze the system, using computational fluid dynamics (CFD). In this model, radiative transfer equation was solved using the discrete ordinates (DO) radiation model taking into account a non-gray radiation behavior. In order to modelling solar irradiation from the sun's rays, the solar ray tracing algorithm was coupled to the computation via a source term in the energy equation. The model was validated with comparing to the experimental data of the Manzanares prototype and also the performance of the built pilot system. Then, based on the numerical simulations, velocity and temperature distributions through the system, the temperature profile of the ground surface and the system performance were presented. The analysis accurately shows the flow and heat transfer characteristics through the pilot system and predicts its performance.

Keywords : buoyancy-driven flow, computational fluid dynamics, heat transfer, renewable energy, solar chimney power plant
Conference Title : ICSPSMT 2017 : International Conference on Solar Power Systems and Modern Technologies
Conference Location : New York, United States
Conference Dates : October 05-06, 2017