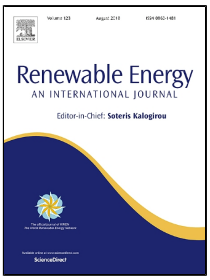
Accepted Manuscript



Numerical simulation of solar chimney power plant adopting the fan model

Rayan Rabehi, Abla Chaker, Tingzhen Ming, Tingrui Gong

PII:	S0960-1481(18)30422-1
DOI:	10.1016/j.renene.2018.04.016
Reference:	RENE 9974
To appear in:	*Renewable Energy*
Received Date:	03 December 2017
Revised Date:	28 March 2018
Accepted Date:	04 April 2018

Please cite this article as: Rayan Rabehi, Abla Chaker, Tingzhen Ming, Tingrui Gong, Numerical simulation of solar chimney power plant adopting the fan model, *Renewable Energy* (2018), doi: 10.1016/j.renene.2018.04.016

Numerical simulation of solar chimney power plant adopting the fan model

Rayan Rabehi[1], Abla Chaker[1], Tingzhen Ming[2, 3], Tingrui Gong[4]

[1] Department of physics, Constantine 1 University, Constantine, Algeria

[2] Department of Built Environment and Energy Engineering, Wuhan University of Technology, China; [3]China Energy Group, Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA

[4]Microsystem and Terahertz Research Center, China Academy of Engineering Physics, Chengdu, China

Abstract:

Numerical simulations and design of solar chimney power plant adopting the fan model was presented in this study. A mathematical model describing fluid flow and heat transfer has been set up for the three regions of solar chimney power plant: collector, chimney and turbine. The Spanish prototype was chosen as an example for numerical simulation that incorporates turbine model, simulation during turbine operation and no load conditions were compared. For this purpose a simulation of 3D solar chimney power plant system with the standard k-ε turbulence model was developed, using CFD Ansys Fluent. Furthermore the effect of turbine operation and the influences of pressure drop across the turbine and solar radiation were investigated and the results revealed that the variation of solar radiation has an evident effect on the flow and heat transfer characteristics. Meanwhile the influence of turbine pressure drop on the collector efficiency was slight, while has a considerable effect on the power output.

Keywords: Numerical simulation, solar chimney power plant, fan model, no-load condition, turbine pressure drop, solar radiation.

Introduction:

The exploitation of non-renewable resources implies limited availability. Furthermore, from the ecological perspective, the excessive consumption of fossil and nuclear resources is the cause of many environmental problems. Actually there is increasing interest in acquiring renewable energy technology to protect the environment and provide electricity from a clean source. The solar chimney power plant (SCPP) is simple and modern energy source represents a possibility for the use of solar energy as a clean energy. A traditional SCPP system consists of four main components: (i) –a large collector which generates the greenhouse effect, (ii) - a high chimney which enhances the fluid flow due to its stack effect (iii) – a several pressure-based wind turbines which will continuously converse the air potential energy and kinetic energy to mechanical energy, and (iv) an energy storage layer which can absorb and store the solar radiation and release energy continuously[1].

In 1982, a 50 kW prototype SCPP was constructed and successfully operated in Manzanares, Spain. The basic principles and reported preliminary test results were presented by Haaf et al.[2, 3]. Following this series of tests, many studies have been conducted up today.

A few experimental studies have been carried out and many pilots SCPP of different sizes have been constructed. In 1983 Krisst [4] reported a small scale SCPP with power output of 10 W. Pasumarthi and Sherif [5]built a demonstration model of SCPP in Florida; they carried out experiments on the