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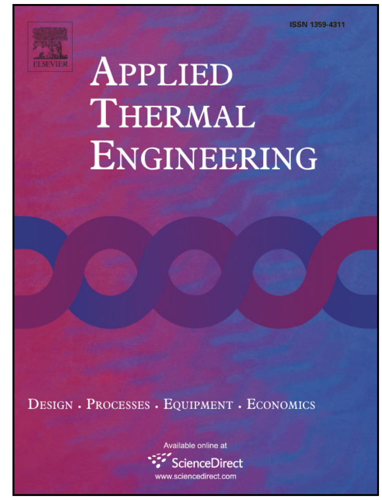

Research Paper

Analysis of Fluid Flow and Heat Transfer on a Solar Updraft Tower Power Plant Coupled with a Wind Turbine using Computational Fluid Dynamics

Ehsan Gholamalizadeh, Jae Dong Chung

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Analysis of Fluid Flow and Heat Transfer on a Solar Updraft Tower Power Plant Coupled with a Wind Turbine using Computational Fluid Dynamics

Ehsan Gholamalizadeh, Jae Dong Chung*

Department of Mechanical Engineering, Sejong University, Seoul, Republic of Korea

Abstract:

The objective of this study was to develop a more realistic numerical model for solar updraft tower power plants. To accomplish this, a three-dimensional (3-D) simulation for the geometric parameters of the Manzanares prototype coupled with a real turbine was carried out using computational fluid dynamics (CFD). The RNG k-ε turbulence closure, discrete ordinates (DO) non-grey radiation model and solar ray-tracing algorithm were employed. In addition, a comparatively simpler simulation using a reverse fan model to implement pressure drop across the turbine was conducted. The pressure, velocity and temperature distributions through the system were considered, and the results of the simplified model were compared to those of a system coupled with a real turbine, to assess the proper pressure jump value to be assigned in the reverse fan model. Results showed that, compared to the real turbine model pressure drop, the reverse fan model with a 43.7% lower assigned pressure jump predicted the same performance. The numerical model developed in this study provides a highly accurate and reliable approach for predicting the performance of a solar updraft tower power plant, taking into account all the main phenomena of the system.

Keywords: Computational fluid dynamics, Renewable Energy, Solar Updraft Tower Power Plant, Wind Turbine

*Corresponding author: Tel.: +82 2 3408 3776; fax: +82 2 3408 4333;
E-mail addresses: jdchung@sejong.ac.kr (J.D. Chung), ehsan@sejong.ac.kr (E. Gholamalizadeh).