THE CFD ANALYSIS OF THE EFFECT OF INTERNAL PEAK ANGLE AND MASS-FLOW RATES ON THE THERMAL PERFORMANCE OF SOLAR AIR HEATER WITH TRIANGLE CROSS-SECTION

by

Walid BEN AMARA[a], Yashar ARYANFAR[b], Hasan KOTEN[c*], Abdallah BOUABIDI[a,d], Mouldi CHRIGUI[a], and Jorge Luis Garcia ALCARAZ[e]

[a] Mechanical Modelling, Energy and Material (M2EM),
National School of Engineering of Gabes (ENIG), University of Gabes, Gabes, Tunisia
[b] Department of Electric Engineering and Computation,
Autonomous University of Ciudad Juarez, Juarez, Chihuahua, Mexico
[c] Mechanical Engineering Department, Istanbul Medeniyet University, Istanbul, Turkey
[d] Higher Institute of Industrial Systems of Gabes (ISSIG), University of Gabes, Gabes, Tunisia
[e] Department of Industrial Engineering and Manufacturing,
Autonomous University of Ciudad Juarez, Juarez, Chihuahua, Mexico

Original scientific paper
https://doi.org/10.2298/TSCI220918046A

A new design of solar air heater with triangle cross-section is numerically studied. The thermal performance of solar air heater is studied at various mass-flow rates, inlet air temperatures, and solar irradiation intensities. The CFD model is developed using the software ANSYS FLUENT to study the fluid-flow and heat transfer in the solar air heater. The 3-D discretization is applied to study the thermal performance of solar collector with triangle cross-section. Mesh independence is performed in order to choose the adequate mesh. The discrete ordinate radiation model and the RNG k-ε turbulence model are used to study the radiative heat transfer and the turbulent flow inside the solar air heater. Particularly, effects of different internal peak angles (145°,126°, 100°, 80°, and 67.5°) under different solar irradiation intensities (from 620-1081 W/m^2) are studied to improve the thermal performance of the solar air heater. The results show a good agreement between the numerical model and the experimental data with an average error of 6%. The maximum outlet air temperature of the solar air heater reached 72 °C for the geometries with 12 and 16 channels (internal peak angles of 80° and 67.5°, respectively) under mass-flow rate of 0.0264 kg/s. The thermal performances of the solar air heater with 16 and 12 channels are 24.2% higher than standard geometry, respectively for solar irradiation intensity of 1081 W/m^2. The configuration with internal peak angle of 80° and 12 channels is selected as the optimal with a thermal efficiency of 79%, a low pressure drops compared to geometry with 16 channels and lower costs.

Key words: *solar air heater, CFD, heat transfer, simulation, thermal efficiency*

Introduction

In recent years, the development of thermal systems based on renewable energies has been booming and has been the subject of many works and achievements [1-3]. The particular case of solar collectors continues to develop, improve and become an important part of our dai-

* Corresponding author, e-mail: hasan.koten@medeniyet.edu.tr