Environmental Engineering and Management Journal

July 2024, Vol. 23, No. 7, 1429-1436
http://www.eemj.icpm.tuiasi.ro/; http://www.eemj.eu
http://doi.org/10.30638/eemj.2024.117

"Gheorghe Asachi" Technical University of Iasi, Romania

SIMULATION OF A DOUBLE-PASS SOLAR AIR COLLECTOR FOR RADIATION EFFECTS USING COMPUTATIONAL FLUID DYNAMICS (CFD)

Omayma Elakrout[1], Ons Ghriss[2], Wahiba Bendaikha[3,4], Humberto Garcia Castellanos[5], Abdallah Bouabidi[1], Ali Keçebaş[6], Yashar Aryanfar[7,8]*

[1]Laboratory of Mechanical Modeling, Energy & Materials (M2EM), UR17ES47, National School of Engineers of Gabes (ENIG), University of Gabes, Avenue of Omar Ib-Elkhattab, Zrig 6023, Gabes, Tunisia
[2]National Engineering School of Gabes (ENIG), Research Laboratory "Processes, Energetics Environment and Electrical Systems", Gabes University, Omar Ibn Kattab ZRIG, Gabes, 6029, Tunisia
[3]Centre de Développement des Energies Renouvelables, CDER, BP. 62 Route de l'Observatoire Bouzaréah, 16340, Alger, Algérie
[4]Thermal Energy Division, CDER, BP. 62 Route de l'Observatoire Bouzaréah, 16340, Alger, Algérie
[5]Engineering Sciences, Tecnológico Nacional de México IT Ciudad Juárez, Juarez, Chihuahua, Mexico
[6]Department of Energy Systems Engineering, Technology Faculty, Muğla Sıtkı Koçman University, 48000 Menteşe, Muğla, Turkey
[7]The National Key Laboratory of Water Disaster Prevention, Hohai University, Nanjing, Jiangsu 211100, PR China
[8]Thermo-Fluids Research Group, Department of Mechanical Engineering, Khazar University, Baku, AZ, Azerbaijan

Abstract

This research provides an in-depth analysis of solar radiation's impact on the thermal efficiency of a solar air collector. Using advanced Computational Fluid Dynamics (CFD) simulations in ANSYS Fluent, the study examines temperature distribution and airflow dynamics within the collector across varying levels of solar radiation. The simulations were carefully configured to replicate real-world solar radiation conditions, ranging from 680 W/m² to 1220 W/m², enabling a precise evaluation of the collector's performance under different environmental conditions. Results indicate that at the lowest radiation level (680 W/m²), the collector's outlet air temperature reached a peak of 26 °C, increasing progressively to a maximum of 29°C at 1220 W/m². Temperature patterns varied with radiation intensity, especially at the start of the collector's second pass, where temperatures rose from 30°C at the lowest radiation level to 34°C at the highest. Thermal efficiency calculations for each radiation level reveal that efficiency increases with radiation intensity, peaking at 26.25% at 1220 W/m². These findings highlight the effectiveness of the collector's design in heat absorption and retention, particularly in the second pass, indicating potential opportunities for enhancing solar air collector designs in the future.

Key words: CFD, double pass, radiation effect, solar air collector, solar energy

Received: August, 2023; Revised final: February, 2024; Accepted: March, 2024; Published in final edited form: July, 2024

* Author to whom all correspondence should be addressed: e-mail: yashar.aryanfar@gmail.com