Environmental Engineering and Management Journal

July 2025, Vol. 24, No. 7, 1509-1519
http://www.eemj.icpm.tuiasi.ro/; http://www.eemj.eu
http://doi.org/10.30638/eemj.2025.118

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OPTIMIZING MESH CONFIGURATIONS IN SOLAR CHIMNEY SYSTEMS: A COMPUTATIONAL FLUID DYNAMICS (CFD) BASED APPROACH FOR ENHANCED ENERGY EFFICIENCY AND PERFORMANCE

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Abstract

The present study investigates the effect of mesh configurations on the performance of a solar chimney (tower) system using Computational Fluid Dynamics (CFD) simulations. This research focuses on optimizing mesh density to enhance the accuracy of temperature, velocity, and pressure predictions in the solar tower, which significantly impact energy efficiency. Unlike previous studies, which primarily focused on geometrical design and system layout, this article introduces a novel meshing strategy that balances computational efficiency and simulation accuracy. Four different mesh types were analyzed, with the finest meshes (M3 and M4) showing the closest alignment to experimental data, achieving an error margin below 4%. The results revealed that finer meshes provided more accurate representations of temperature profiles, pressure gradients, and velocity distributions, particularly near the chimney's axis, optimizing the overall system's performance. The minimum total pressure values for meshes were 5.61 Pa, 6.25 Pa, 6.61 Pa, and 6.86 Pa, respectively, indicating how mesh density influences internal pressure dynamics. This study highlights the importance of mesh selection in CFD simulations and recommends future designs to incorporate adaptive mesh refinement techniques for better simulation efficiency. The findings offer valuable insights into the design and optimization of solar tower systems, promoting enhanced power generation and efficiency, which are essential for scaling renewable energy projects. Future research could explore broader applications of this methodology to optimize other renewable energy systems.

Key words: Computational Fluid Dynamics, mesh effect, numerical analysis, solar energy, solar tower

Received: August, 2023; Revised final: October, 2024; Accepted: November, 2024; Published in final edited form: July, 2025

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