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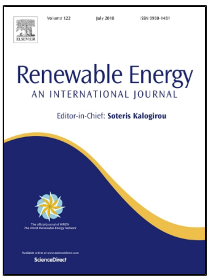

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Celine Garnier, Tariq Muneer, John Currie

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Numerical and empirical evaluation of a novel building integrated collector storage solar water heater

Celine Garnier[1], Tariq Muneer[1] and John Currie[1*]

[1] School of Engineering and the Built Environment; Edinburgh Napier University, 10 Colinton Road, EH10 5DT, Edinburgh, UK

[*] Corresponding Author, j.currie@napier.ac.uk

Abstract

Integrated collector storage is a long established simple low cost solar water heater configuration combining the solar collector with a storage tank into a single unit. Previous studies have shown the potential of integrated collector storage solar water heaters to significantly reduce domestic energy requirements for water heating, however challenges still remain to integrate them in roof/façades and ensure appropriate domestic hot water demand. In this article, a novel integrated collector storage solar water heaters is being investigated. The configuration and geometry proposed incorporates an embedded heating element to provide a self-contained domestic hot water system and consider roof integration restriction allowing the unit to be embedded within a structural insulated roofing panel system. The proposed system also utilizes an inlet diffuser designed to reduce the disruption to the stratification within the storage during and following draw-off. This article presents a Computational Fluid Dynamic analysis of internal flows and heat transfer regimes within this new collector configuration and compares its performance against previous developed prototypes using empirical testing. The increased aspect ratio of the new design was shown to significantly alter the heating and cooling characteristics of the collector, both gaining and loosing heat at a greater rate than the original prototype. The computational analysis showed that the collector charges effectively with some stratification. Higher draw-off rates however resulted in higher bulk water outlet temperatures, providing better energy delivery efficiency. The inlet diffuser was also shown to improve the thermal efficiency of the unit overall. The empirical testing shows the improvement in performance of this novel integrated collector storage solar water heaters against previous developed prototypes. The study highlights the need to review the effect of draw-off regime upon the performance of such systems in order to identify optimal regime and control strategy.

Key Words

Integrated Collector Storage, Solar Water Heater, Building Integration, Simulation, CFD

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