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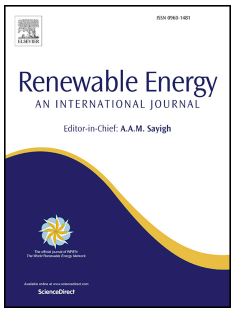

The experimental evaluation and improvements of a novel thermal diode pre-heat solar water heater under simulated solar conditions

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ABSTRACT

This paper presents the development through experimental performance characterisation of a pre-heat Integrated Collector Storage Solar Water Heater using a novel thermal diode operation to reduce ambient heat loss during non-collection periods. Using a solar simulator facility at Ulster University, the novel prototype pre-heat Mark IV unit was tested and evaluated. The concept has been designed and developed to be a sustainable pre-heat alternative to other types of solar water heating systems traditionally used in domestic hot water installations. The highest 6 hour collection efficiency was 36.17% under solar simulated conditions. The lowest system 'U' value was 0.98 $Wm^{-2}K^{-1}$ with no draw-off conditions. When the current prototype ICS units are compared with other conventional ICS systems, particularly in terms of thermal retention during non-collection periods, an improved performance is clearly demonstrated. The measured thermal losses were approximately 40% less than other similarly measured systems.

Keywords

ICSSWH, pre-heat, solar simulation, thermal diode

1 Introduction

The Energy Performance of Buildings Directive (EPBD) requires that Renewable Energy Systems (RES) are actively promoted in offsetting conventional fossil fuel use in buildings. A better appreciation of solar thermal system (STS) integration will directly support this objective, leading to an increased uptake in the application of renewables in buildings. Meeting building thermal loads will be primarily achieved through an extensive use of renewables, following standard building energy saving measures, such as good insulation or advanced glazing systems. Solar thermal systems are expected to take a leading role in providing the thermal energy needs, as they can contribute directly to the building heating, cooling and domestic hot water requirements.

Integrated Collector Storage Solar Water Heaters (ICSSWH) are simple, low cost solar devices and as such offer a suitable technology to partially meet the demands of the EPBD. The first ICSSWH systems consisted of exposed tanks of water left out to warm in the sun. Used on a few farms and ranches in the Southwest of the USA in the late 1800s, they were reportedly capable of producing water hot enough for showering by the late afternoon on clear days [1]. The first solar water heater, manufactured commercially under the trade name 'The Climax Solar-Water Heater' was an ICSSWH patented in 1891 [2]. The development of these systems is detailed in Smyth et al [3] and more recently by Singh et al [4], along with their tendency to suffer significant ambient