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Natural Ventilation Using Glazed Solar Chimney and Hot Water Collector Production

Preeda Chantawong*

Energy Engineering Technology program, College of Industrial Technology, King Mongkut's University of Technology North Bangkok, 1518 Pracharat 1 Road, Wongsawang, Bangsue, Bangkok 10800, Thailand.

Abstract

This paper presents a report on the development and experiment thermal performance of a multi-purpose glazed solar chimney and hot water collector production (GSC-HWC) under the tropical climate conditions in Thailand. The GSC-HWC configuration consists of double pane layers 0.60 m height and 0.50 m width. The external layer is a glazed solar hot water collector, with non-reflective painted black pipes 0.01 m diameter to produce approximately 10 liters of hot water. The internal layer was a clear glass pane with a thickness of 6 mm. The GSC-HWC has 0.08 m air gap with two openings 0.24 m x 0.12 m located at the bottom of interior glass pane and at the top of exterior glass pane. The openings exhaust hot air to the ambience and covered with anti-insect screens. The panes can be removed for easy maintenance. Comparing the experimental results between GSC-HWC and a single clear glass window (SG) of the same size (0.60m high, 0.50m width and 0.006m thick,) revealed that indoor temperature of the GSC-HWC room was significantly less than the SG room,. Furthermore, the finding indicated that the GSC-HWC can induce ventilation and reduce heat from sunlight whereas the daylight gain was nearly the same as single glass window room. The water temperature of GSC-HWC was relatively high and sufficient for domestic use. As a result, the GSC-HWC is expected to promote the growth of solar energy usage; save energy in heating, cooling and ultimately help the environment.

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Keywords: Domestic Hot Water, Glazed Solar Chimney - Hot Water Collector Production (GSC-HWC), Tropical Climate of Thailand:

* Corresponding author. Tel.: +0-2555-2000 Ext. 6413; fax:+0-2585+0691.
E-mail address: cpreeda@yahoo.com, preedac@kmutnb.ac.th.

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1. Introduction

Western architecture has influenced buildings and housing in Thailand; windows and glass walls are widely used. To cope with the heat of sunlight penetrating through the windows, there are varieties of solutions. The most popular ones are fan, air-conditioner, overhangs of high quality clear glass pane with special feature, etc. In general, existing solutions are expensive and harm the environment. At present, the increases in electricity consumption [1]-[3] are; 20% for light, 60% for air conditioning, and 20% for appliances. Heat gains and losses through the windows of commercial buildings have a large impact on the overall building's energy use and electric utility demand. Previous studies of the energy saving commonly realized that the heat gains associated with the daylight passing through windows can be controlled by a shading device. Today new window technology developments offer a wide range of glass and products such as gas-filmed; thin film coating, low emissivity coatings [4]-[6], etc. However, the drawback in promotion and implementation of these new technologies is stemmed from their high cost. It is not uncommon that the use of windows with exterior and interior venetian blinds could minimize solar heat gain while preserving their lighting. It might be one of the attractive methods for conserving energy in residential building. Further studies have been carried out, considering the influence of shading that occurs in photovoltaic integrated blind system. Changes in the photovoltaic façade due to ventilation and its effects, also examined via a heat exchange network analysis and panels in dual window efficiency. The study was extensively investigated and reported in Refs [2], [6]. Other experimental studies concerned heat gain reduction and providing indoor illuminance through new design configurations such as the Partially-Glazed Modified Trombe Wall [7], the Glazed Solar Chimney Wall (GSCW) [8]-[9], and the Double Glass Wall (DGW) [10]. As the name suggests, DGW is composed of two glass panes with an air gap; opening air vents at the top and bottom of the unit. Not only experimental works, but numerical models were also presented. The results indicated that GSCW and DGW appear to be suitable for hot climate both for heat gain reduction and enhancing indoor air ventilation. The results of the study associated with the solar collector walls or roofs for domestic hot water, heating and cooling applications for ventilation and hot water production can be seen in [11]-[14].

Nomenclature

Tgo	outer temperature of the external clear glass pane (°C)
Tgi	inner temperature of the external clear glass pane (°C)
Tco	outer temperature of the internal clear glass pane (°C)
Tci	inner temperature of the internal clear glass pane (°C)
Tair grill	air grill temperature (°C)
Troom	air room temperature (°C)
Tpipes	surface pipes temperature (°C)
Tin	inlet air temperature (°C)
Tout	outlet air temperature (°C)
Tmiddle	middle air temperature (°C)
Tin	inlet cold water temperature (°C)
Tmiddle	middle of collector temperature (°C)
Tout	outlet hot water temperature (°C)
Tstorage	hot water storage tank temperature (°C)
Tamb	ambient temperature (°C)
Home 1	house model with Glazed Solar Chimney and Hot Water Collector Production: GSC-HWC
Home 2	house model with Single Glass: SG
HF 1	Heat flux of Home 1 with GSC-HWC, (W/m^2)
HF 2	Heat flux of Home 2 with SG, (W/m^2)

The objective of this research is to investigate both thermal performance and visual efficiency of a new concept of glass windows or walls design. Indeed, the study attempts to ensure a promising multi-function of the new