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The function of solar absorbing window as water-heating device

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ABSTRACT

While window glazing will be more and more extensively used in modern architecture, the increase in space thermal load as a result will deteriorate the global environment, incurring problems of air pollution and climate change. By connecting the cavity of a double pane window to a water-flow circuit, absorbed solar heat at the window glasses can be readily removed by the water stream. The water passage in this way can effectively lower the glass pane temperature, reduce room heat gain and therefore, the air-conditioning electricity consumption. Thermal comfort can be enhanced. Furthermore, the water-flow window can function as a hot-water preheating device. This article reports the integrative thermal performance of a water-flow absorbing window as compared to the conventional single and double pane absorptive glazing. The results based on the operation in health club environment are very encouraging. This demonstrates its good application potential in domestic–commercial buildings with stable hot-water demands.

1. Introduction

Window glass occupies a major area of the building facade. While glazing will be more and more extensively used in modern architecture, the increase in space thermal load as a result has given much pressure on the global environmental issues, such as the battles against air pollution and climate change. Traditional absorptive glazings, available in a range of colors like bronze and grey, allow greater reduction in visible transmittance than in solar heat gain coefficient. Tintable smart windows give dynamic daylight and solar energy control [1]. Using multiple panes of glass with air-sealed cavities makes possible the increase in window insulation significantly. Many studies have been reported in recent years on comparing the energy performance of different combinations of multi-pane windows against the single pane options, including the effects of sun-shades and coatings [2–8], as well as phase-change materials [9–11]. Single/dual airflow window performance has been analyzed [12–14]. Emerged from the ventilating cavity concept has been the solar-screen glazing system, that seeks to limit radiant transfer in summer while preserving the benefits of solar heating in winter. The system consists of a reversible window frame holding a clear pane (that provides a weatherproof seal) and an absorptive pane (having top and bottom vents for airflow). The occupant may wishfully rotate the window so that the absorptive pane may face either the room (for space heating in winter) or the outside (for reducing unwanted heat in summer). The potential application of solar-screen windows in different geographical locations has been evaluated extensively [15–17]. The findings confirm that the reversible window frame can be suitable for places with distinct heating and cooling seasons.

2. Window designs for warm climate

For warm climate applications there are two basic principles in sustainable window design: (i) to minimize the solar transmission in particular the infrared portion; and (ii) to utilize the incident solar radiation as a renewable energy source and thereby to reduce the air-conditioning load.

Hong Kong is a subtropical city occupied by tall buildings. While the government promotes the use of solar energy, how to make full use of the vertical building façades for solar energy application is an important area to be explored [18]. The possible use of solar-screen ventilated (SOLVENT) glazing in Hong Kong has been studied [19]. The results show that the window reverse mechanism is not required in office buildings of Hong Kong, since it is space cooling (rather than spacing heating) that is generally required in winter. A SOLVENT window set for summer ventilation mode is able to reduce the inner glass pane temperature sufficiently. By varying the optical properties and air gap width, the annual space cooling load was found readily reduced to 66% of the reference case with single absorptive glazing at the same southwest orientation.

An extension of the above work was the development of photovoltaic (PV) ventilated glazing technology. By applying PV

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