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Energy conservation and potential of a sunspace: sensitivity analysis

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Abstract

The influence of different main design parameters on the heating/cooling potential of a sunspace connected with a building has been investigated in the present paper. The sunspace consists of a glazed enclosure, usually on the south side of a building and it is regarded as one of the most popular solar systems because of its potential as an energy collecting system and also because of its pleasant appearance. The dynamic thermal performance of the system for the winter and summer periods of the year and its operational limits have been calculated using an accurate transient thermal model environment. The simulated results showed that sunspaces can be an appropriate and effective system during the cold period of the year. However, they are, very often, responsible for overheating during the warm period of the year. An extensive sensitivity investigation is performed in order to analyse the impact of various main system's parameters, such as orientation, boundary conditions, glazing material, etc., on the energy potential of the system.

Keywords: Sunspace; Passive heating/cooling; Energy saving

1. Introduction

Energy management and conservation are the keys to using fuel and electrical energy in the most efficient way. Proper management can lead to big savings in the operating costs of a building. Many residential, industrial and commercial buildings have already undergone

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changes that have resulted in savings of both energy and money [1]. Heat losses from buildings occur mainly by conduction through external surfaces and by infiltration and ventilation through cracks and openings in the building envelope [2]. Reduced heat demand, brought about by improved insulation and draught sealing, results in a restriction of the heating season to the time of year which is least favourable for solar gains. Nevertheless, passive solar heating can still provide a significant contribution to energy saving. The design of the microclimate around the building should be the primary consideration to minimise heat losses and maximise the opportunities for solar gain. For the design of the building itself, various passive solar configurations have been developed and used mainly based on heat collection, storage and distribution. One of the most popular among passive solar systems is the sunspace. This is caused, firstly, by its potential as an energy collecting system and, secondly, by its good and pleasant appearance. Sunspaces and atria represent additional space with positive architectural qualities [3]. Sunspaces, as a retrofitting technique produced by glazing in balconies or as newly built extensions, could be one of the most useful techniques to store solar energy and therefore they are extensively used [4].

The main function of south facing sunspaces and conservatories designed to collect solar energy is to reduce the need for auxiliary energy. Energy saving from a sunspace is threefold: the buffer or insulation effect, the supply of pre-heated ventilation air and the supply of sun-heated air to the house when the sun is shining. The solar energy used depends on both the passive solar system and the existing climatic conditions.

In southern latitudes, passive solar design should provide space heating during the winter. Overheating problems during the summer are faced by using effective solar control and passive cooling systems, such as night ventilation and earth-to-air heat exchangers.

In temperate climates, although the conditions are more favourable, it is still necessary to design sunspaces taking into account the climate: effective shading devices, effective ventilation and sufficient thermal insulation so that the built environment would be comfortable. Even in northern climates, overheating could be a problem, and the design of sunspaces should include shading devices and adequate ventilation.

The objectives of the present paper are primarily the energy potential investigation of a sunspace connected with a building under real climatic conditions. Furthermore, it is intended to contribute to the analyses of the system's sensitivity to different design parameters, such as the sunspace's orientation, the glazing material and the boundary conditions on the sunspace's floor.

Buried pipes are used as a passive heating system for the cold period of the year, in order to improve the sunspace's thermal performance and as a passive cooling system during the summer for avoiding overheating. A sensitivity investigation has been performed in order to analyse the influence of the main design parameters of the buried pipes on the heating/cooling potential of the system.

2. Assessment of the sunspace energy potential

In order to investigate the influence of a sunspace on the thermal behaviour of buildings, a series of simulations have been performed using the TRNSYS [5] simulation programme.