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ScienceDirect

Energy Procedia 113 (2017) 1 – 8

Energy Procedia

International Scientific Conference “Environmental and Climate Technologies”, CONECT 2016, 12–14 October 2016, Riga, Latvia

Experimental characterization and energy performances of multiple glazing units with integrated shading devices

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Abstract

Modern architecture is characterized by the use of large glazed surfaces. New technologies ensure thermal insulation by multiple glazing units so that, maintaining good solar gains, highly glazed buildings can achieve good energy performance during the heating season. More complicated is the management of the energy performance during the cooling season due to high permeability to solar radiation. External shading devices are a suitable solution but they are often neglected for functional and aesthetic reasons. Solar protection devices can be, however, introduced in the air gap of multiple glazing units, providing solar protection without interfering with the building envelope. Solar and thermal properties of several solution of glazing units with in-gap shading devices were measured with advanced experimental set-up, to be compared with conventional systems. Numerical analyses were also performed to estimate the impact of this technology on the energy performance of office buildings.

Peer-review under responsibility of the scientific committee of the International Scientific Conference “Environmental and Climate Technologies”.

Keywords: shading devices; solar properties measurements; U-value measurements; energy performance of buildings

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Peer-review under responsibility of the scientific committee of the International Scientific Conference “Environmental and Climate Technologies”.
doi:10.1016/j.egypro.2017.04.002

1. Introduction

The building sector account for more than 40 % of the energy consumption in Europe and has a significant impact on the achievement of the environmental and energy targets, at national and European level [1, 2]. According to the relevant EU Directive [3], the energy performances of building should be addressed to the whole relevant energy services, while efforts were focused on the space heating systems until few years ago.

One of the key elements for improving the energy efficiency towards the near zero energy building are the solar shading systems. They enable adjustment of the properties of windows and facades to the weather conditions and the need of the occupant providing a good impact on comfort and energy consumption [4, 5]. Despite this they are still under-utilized for functional and aesthetic reasons. Solar protection devices can be, however, introduced in the air gap of multiple glazing units, providing solar protection without interfering with the building envelope [6].

In this context objective of this study is an assessment of the potentialities of double glazing units with shading devices in gap to improve the energy performances of commercial buildings, respect to un-shaded glazing units or with internal shading devices. This aspect is worth of investigation, because modern architecture makes large use of glazed facades with no external solar protections. The intrinsic properties of glass make such building vulnerable during the heating and cooling seasons.

Solar and thermal properties of several solution of glazing units with in-gap shading devices were measured with advanced experimental set-up, to be compared with conventional systems. Moreover numerical analyses were performed to estimate the impact of this technology on the energy performance of office buildings.

2. Methods and samples

Shading systems integrated in the gap of multiple glass units (MGU) can improve the thermal response of transparent building envelope basically in two way: 1) it increases the thermal resistance of the systems, thus increases its insulation power; 2) it lowers the solar gains through the MGU, with increased solar control performance respect to the MGU without shading or with the latter mounted inside.

A relevant issue is the fact that actual standards can be applied on a limited amount of shading materials and products [7, 8], with the consequence that few data about the impact of such products on the energy performance of buildings are available. In order to quantify the energy savings of such solutions, three phases were identified:

1) Optical and thermal experimental characterization of the selected materials;
2) Solar factor calculation starting from measured quantities;
3) Assessment of the energy performances of building equipped with different glazing technologies.

Even if the market of this technology is still limited due to several restraints, many technological solutions are available. Three different double glazing units (DGU), with shading in gap, were analyzed in this study. No spectral data were provided for the single glasses and blinds. Main properties are following described:

- DGU_A. The composition is the following: external 6 mm laminated glass; 27 mm 90 % argon and 10 % air gap; internal 6 mm low-emissivity (0.03) laminated glass. The DGU has a low-emissivity blackout roller blind in gap;
- DGU_B. The composition is the following: external 6 mm laminated glass; 27 mm 90 % argon and 10 % air gap; internal 6 mm low-emissivity (0.03) laminated glass. The DGU has a honeycomb roller blind in gap. The test was carried out also inverting the layer sequence, i.e. the internal glass was moved to the external side;
- DGU_C. The composition is the following: external 6 mm low-emissivity (0.03) laminated glass; 27 mm 90 % argon and 10 % air gap; internal 6 mm laminated glass. In this case the low-e coated glass was placed as external layer, to test its performance as solar filter unit. The DGU has pleated low-emissivity venetian blinds in gap. The lamellae are low-e coated on the convex side.

No spectral data were provided for the single glasses and blinds. Several configurations were tested for the optical characterisation, details about the test configurations are provided in the Results section.