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Aspects of Heat Insulation Efficiencies for Modern Windows

László ELEK, Zsolt KOVÁCS
Institute of Product Development and Technologies, University of West Hungary, Sopron, Hungary

Introduction

Windows generally make a smaller proportion of a building's façade, yet they are responsible for a high proportion of the total heat loss; even a well-insulated window's thermal performance is inferior to that of the walls. In this sense windows are the most important week points of a building's envelope; it would be ideal to enhance their thermal insulation to the level that wall systems provide. However, with the materials and structural solutions currently used with the window products of best technical parameters we are approaching the upper limits of attainable thermal performance. Further increase of the windows' performance cannot probably be realised unless by using smart materials, intelligent solutions and control technique.

Performance of windows

The heat transfer characterised by the *U*-factor of a window is defined by the glazing system, the material and profile of the frame and casement(s), way of fitting the casement(s) to the frame and by the method of jointing the window to the wall. The heat flow directed outwards through a window is composed of the heat transfer by transmission and the convective flow due to the air permeability of the window (KOVÁCS 2000). Quantification of the heat flow through the frame and casement members including the effect of thermal bridge effect is stipulated in the standard ISO 10077-1:2000.

Smart windows

In the course of the last few years the development in information technology speeded up very importantly. Customers are not fully satisfied by products that are aesthetic and functional only; expectations are growing and invoke certain extra functions. An intelligent product, as its name implies, provides the customer more than an average everyday product does. It fulfils certain extra tasks most often through the application of special materials or information technology. Smart materials and intelligent products are able to sense several parameters of their immediate environment's physical and chemical state, they process these signals then give a quick and unequivocal respond to the environmental changes by significantly changing their own state. The control of a window and its accessory devices can be examined from different points of view. We are considering the categories as follows:

Automatic ventilation

Today windows are closing more and more airtight. The ventilating device built in the window frame is no more a novelty, but the kind of device responding to the outside air pressure and decreasing the aperture with the increase of wind speed is less widespread. Thanks to it the airflow from the outside can be kept at constant rate, independent of the weather conditions.

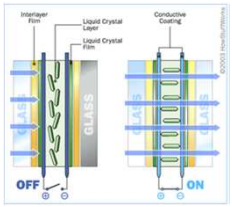
Glasses of changing performance

Changing performance is typical to the *photochromic glasses*; UV radiation causes to decrease light transmission. Such solutions of the smart windows were blocked in the development phases by a number of obstacles, despite of the successfully application of this technology in the case of sunglasses. The principle working in small surfaces could not be adapted to large window panes.

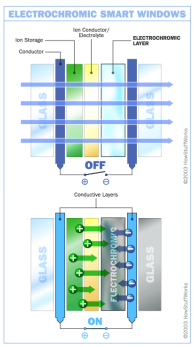
Glasses of changeable performance

Thermochromic windows, as their name implies, alter their properties under the effect of heat. Researchers experimented with several technologies among which the gel-based coatings appeared the most promising. This thin synthetic foil that changes its properties according to the environmental temperature can be applied on all types of windows.

The first available smart window was based on *liquid crystal technology*. When the apparatus is switched off liquid crystals have random orientation. Sunshine can only go through in the oriented state of the crystals after switching on. This solution was not energy-efficient enough.



Electric field causes to change the transparency of *electrochromic glasses*. Chemical reaction induced by electric voltage changes the properties of the material. Due to the moving ions the material reflects or absorbs light, turning the glass temporarily darkened. The multi-layer assembly has to be kept under voltage to maintain the opaque state. As soon as the voltage is released the ions leave the electrochromic layer and the glass regains its transparency.



Proposals of development

We are making proposals of development for the enhancement of energy utilisation and improvement of interior climate:

- heating of the glass spacer and glass pane in winter to mitigate thermal bridging and reduce surface transmittance;
- Low-E coating responding to environmental effects;
- coating the glass surface with foil that is transparent but becomes reflective from a certain angle of light incidence;
- pre-heating of the air flowing inward through the built-in ventilator in winter;
- sensing the pollution level of inside air for the control of ventilation system.

Conclusion

Properties of commercially available glazings for windows relating transparency and thermal performance vary in a wide range; however, such windows or glazings that comply with the extreme requirements dealt with are currently not available. The primary objective of developments remains unchanged: a window system should transmit the lowest possible amount of heat. The window system that is able to adapt to the changing conditions, will be capable of optimising the heat and energy utilisation of the building through the control of heat flow. For the development of smart glazings it is important to take into consideration that in our country glazings of at least 60% of solar energy transmission are recommended, otherwise their use can not be economical because of the diminishing solar gain and the need for increased artificial lighting.

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