Thermal improvement of windows by low-emissivity blinds

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1 Abstract

Low-e blinds can improve old windows to a 2x or even 4x better standard. Including sophisticated low-e blinds into new windows is a complication, which is worth it. Large windows can be used without any problems with overheating or cold drafts, as they can be improved as needed. Thermography is being shown as an easy method to measure insulating properties in situ. See http://www.veronica.cz/passiv.

2 Introduction

Nighttime insulating properties of standard passive-house windows can hardly be much improved by common blinds. But there is a possibility to use low-e blinds, with aluminium surfaces. The only need is to prevent spoiling the aluminium by a paint. Any paint has emissivity near to 0.9, a clean aluminium below 0.10. By using aluminium with just a natural oxide layer, the radiative transfer can be reduced 10x.

3 Rough considerations

Let's consider a tight layer with an emissivity of 0.1 put *between two uncoated glasses*. The radiation transfer is reduced from the usual 4 W/m^2K to about 0.5 W/m^2K, making it small with respect to the transfer by air (about 2 W/m^2K). An air-filled gap between two ordinary glasses has a thermal resistance of some 0.17 m^2K/W. Dividing the gap by an aluminium layer means creating two gaps with conductivities of about 2.5 W/m^2K each, i.e., getting a thermal resistance glass-to-glass of about 0.8 m^2K/W. Installation of such a layer into an old double window means improving its U-value from some 2.7 W/m^2K to some 1 W/m^2K.

Outer shades are often made from aluminium, but from a painted one. When tight, they add just 0.17 m^2K/W to the thermal resistance of window at most. If an outer shade would have a clean Al inner surface, it could add up to 0.4 m^2K/W. a value interesting even for passive-house windows.

4 Verification

These values depend on the air-tightness. There exist blinds which are not tight at all. Assessing the true benefits of them is possible just through measurement. This can be done by *thermography*. Seeing is believing.

A flux through the window is roughly proportional to the temperature difference of a window pane and an unheated/uncooled *reference piece of glass*, being thermally insulated from the window and facing the same space. Adjacent windows have been compared this way. Direct assessment of thermal flux per one square metre of the glass has been made using a *heated reference glass*, thermally compensated from behind.

4.1 Roller shade

A roller shade has been installed into a traditional double window. Straight wooden sticks (of about 1.5 cm thickness) were mounted to the sides of the window box, at the interior side from the foil. A cold air in the exterior-side cavity pressed the foil to them making the shade tight. The outcome: the *Al-covered foil improved the whole window more than twice*, to value close to “U 1.0”. A nice feature is the remaining visual transparency of 3 %.

A second foil can be added. With a sacrifice that just 0.1 % of light will pass, we can get a window with U close to 0.6 at night (the daytime properties are good enough).

4.2 Venetian blind

We have installed such a blind in a window with a broad gap. The spoiled low-e property of the aluminium was restored by gluing a new Al foil onto the strips.

Surprisingly, the benefit of the closed blind at night was rather small. The insulation properties of the window improved not even by one third. Thermal flux through the window corresponded to U of about 2.3. Seems that convection inside the window became a lot stronger. Nevertheless, even a mild improvement like that is of some interest.

5 A novel standard

Our recommendation of an alternative passive-house window: a low-iron *glass, a generous air gap with two roller blinds, and the best available low-e double pane* with a coated surface at the interior glass. Solar gains can reach 0.7, night U-value 0.4. For the optimal performance in all circumstances, the blinds are to be driven by an automated system – an option which is not common yet.