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Improved Spacer Bar Design Enhances Window Performance

by A.H. Elmahdy

This article presents key results of recent research carried out by NRC's Institute for Research in Construction on innovative spacer bar designs, commonly known as warm-edge technology.

Cet article présente les résultats clés de la recherche récemment menée par l'Institut de recherche en construction du CNRC sur les concepts novateurs de liteaux d'écartement (technologie des bordures chaudes).

Heat loss through the insulating glass (IG) units of windows can cause condensation leading to mould growth and deterioration of windows and wall sections, especially in cold climates. The high thermal conductivity of aluminum or steel spacer bars conventionally used to separate the panes in an IG unit, results in relatively high heat loss through the bars and the surrounding area of the window (known as the edge-of-glass region). This increases the potential for condensation. The edge-of-glass region extends about 60 mm (2.3") from the edge of the frame or sash to the point where the glass surface temperature is the same as that of the center of the glass. IG units with higher surface temperatures in the edge-of-glass region are less prone to condensation. The temperature in this region is a function of factors including spacer bar design and frame material. The *overall* thermal performance of a window will be determined by the type of spacer bar, the glazing and the frame (for fixed windows) or sash (for operable windows). Thus, although a window with a high temperature in the edge-of-glass area will perform well in terms of condensation resistance, it may not necessarily show good overall thermal performance.

The use of spacer bars with lower thermal conductivity than conventional metal spacer bars in the edge-of-glass region is known as Warm-Edge Technology (WET). WET spacer bars have either a thermal break in the spacer assembly or are constructed of materials with low thermal conductivity. WET reduces the heat flow from the warm side to the cold side of the glazing, thereby decreasing condensation. This is especially true of high-performance IG units with low-emissivity coatings on the glass and using an inert gas, such as argon or krypton, as an insulator in the sealed cavity.

A number of innovative spacer bars have been developed in the past decade. In order to evaluate the thermal performance of these new spacer bars, NRC`s Institute for Research in Construction (IRC) conducted a study. The study assessed the performance of ten different types of spacer bars (nine WET and one conventional) in IG units without window frames (unmounted) and with window frames (mounted) of various materials.

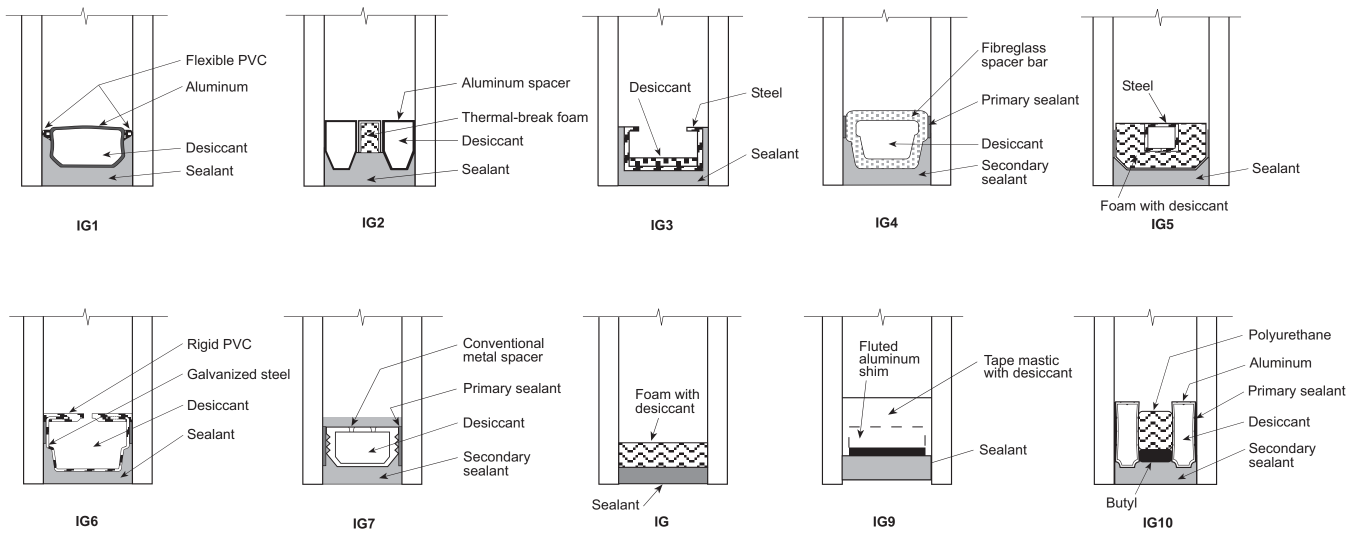

Figure 1. Spacer bar assemblies IG1 to IG10

IG Units without Window Frames

Ten IG units, fabricated by different manufacturers (Figure 1), were tested for heat loss, by measuring their surface temperatures at the mid-height of the glass. All units were 152 mm x 1200 mm (6”x 48”), air-filled and made of clear glass.

Figure 2 shows the warm-side glass surface temperatures for the ten IG units without frames, when exposed to a temperature difference of 38 K [293 K (20°C) on the warm side and 255 K (-18°C) on the cold side]. Unit IG8 had the highest glass surface temperature at the edge-of-glass region, making it the best in terms of reducing condensation. IG7 had the lowest glass surface temperature in the edge-of-glass region. Although the temperature difference between the best- and poorest-performing IG units was only about 6^{o} K in the edge-of-glass region, it could have a considerable effect on condensation resistance. Figure 2 also shows that the glass surface temperatures on all ten IG units, away from the edge-of-glass region were similar.

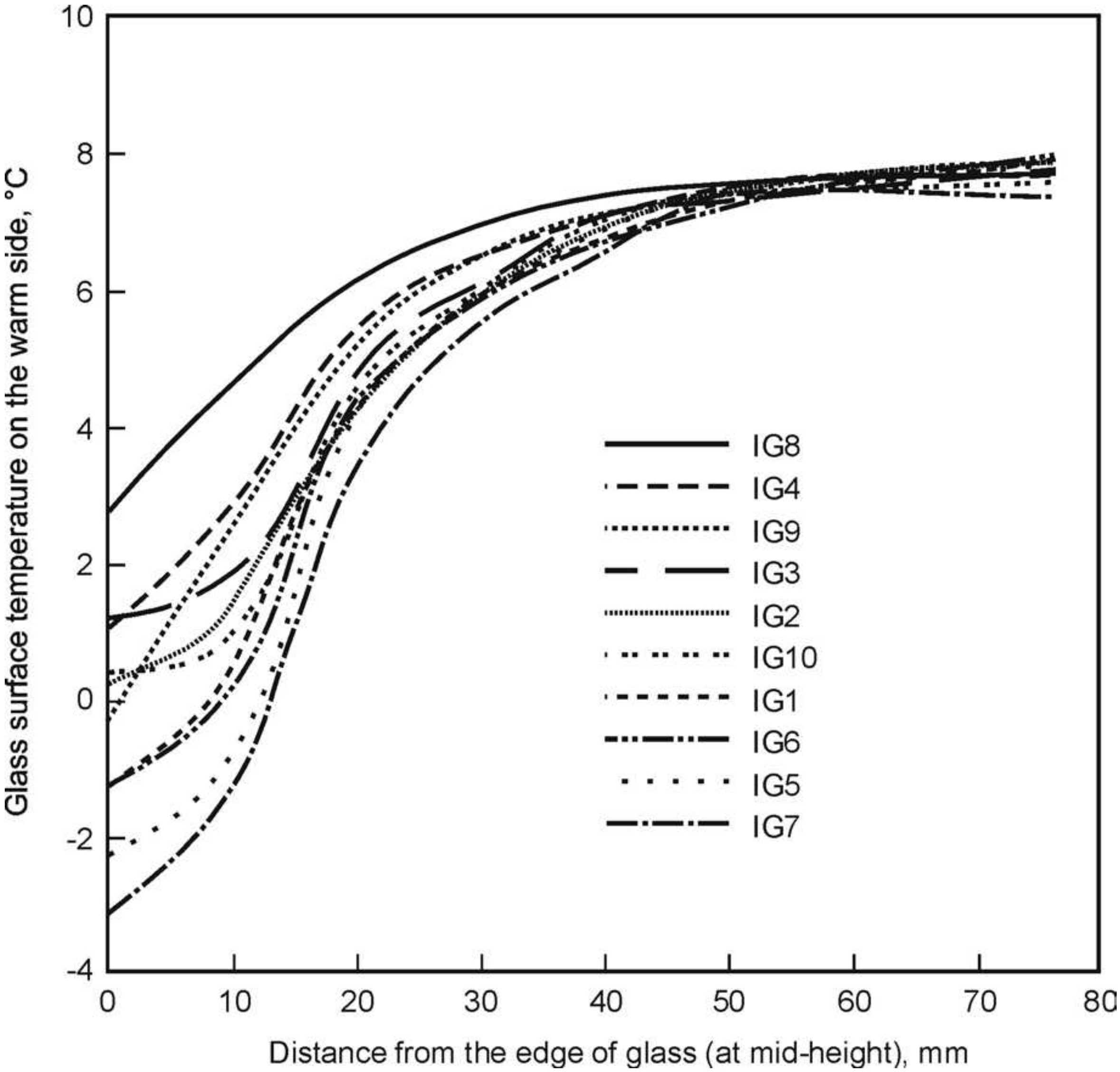

Figure 2. Warm-side glass surface temperatures for IG units

IG Units Installed in Window Frames
The IG units with ten different spacer bar configurations were then tested as part of a complete fixed window assembly. Temperatures were measured at different horizontal planes on the warm side of the window. Four different types of frame specimen, FR1 (redwood), FR2 (vinyl), FR3 (thermally broken aluminum) and FR4 (foam-filled fibreglass), were also used, to determine whether the type of frame had any influence on the spacer bar performance.

Figure 3 shows the effect of WET spacer bars on the temperature measured at 10 mm from the sight line, for each type of IG unit and frame specimen, when exposed to a temperature difference of 38^{o} K. The combination of FR4 and highly insulated spacer bar IG8 offered the warmest glass-surface temperature at the 10-mm plane (and at almost all the horizontal planes in the edge-of-glass region). Conversely, the combination of FR3 and hybrid spacer bar IG6 produced the lowest glass-surface temperature in the edge-of-glass region.

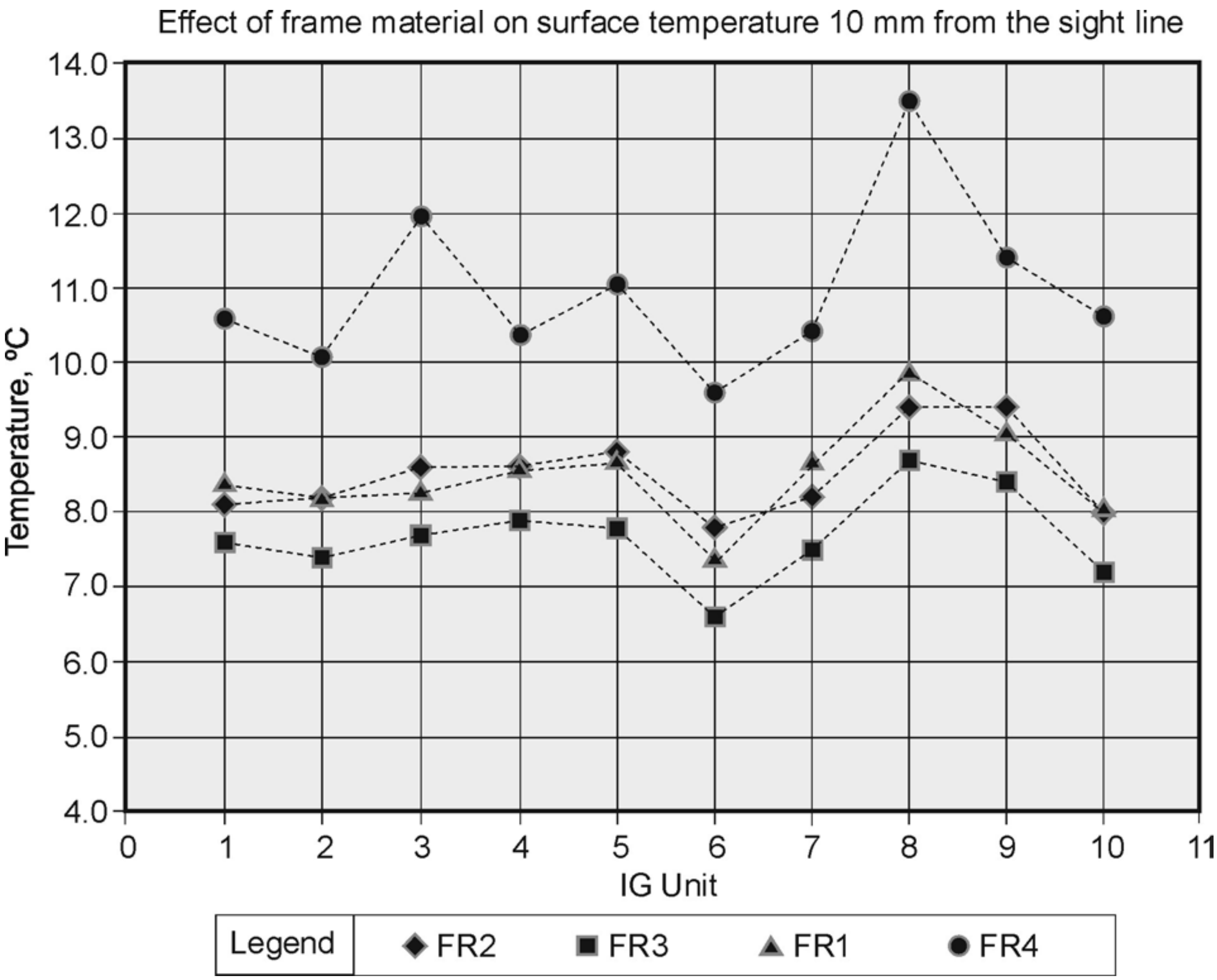

Figure 3. Effect of frame material on glass surface temperature 10 mm from sight line

R-value Performance

The overall R-value of a window is dependent on the type of spacer bar, glazing, and in particular, the thermal properties of the frame material. However, even with non-conductive frame materials, poor design may reduce the thermal performance of the window.

In general, wood has a high thermal resistance and therefore, the FR1 specimens had the best overall R-value, irrespective of which spacer bar was used. The only exceptions were spacer bars IG4 and IG6, where the R-values for FR2 specimens and FR1 specimens were about the same. The FR1 frames combined with the poorest-performing (with respect to R-value) WET spacer bar (IG6), had an R-value only slightly lower than when it was combined with the best performing WET spacer bar (IG8).

Concluding Notes

Manufacturers can use these results as a benchmark for choosing suitable combinations of spacer bars and frame materials to enhance the performance of windows. The results, however, are specific to the spacer bars and frame specimens tested and cannot be extrapolated to other window configurations without further testing.

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