

Performance Issues with Muntin Bars in Sealed Insulating Glass Units

by A.H. Elmahdy

Muntin bars have become popular as a decorative element in insulating glass units. This Update discusses some performance issues encountered with the use of muntin bars, which can actually undermine the quest for aesthetics.

Innovations in the design and manufacture of insulating glass units (IGUs) over the past decade have improved their thermal performance and durability. The incorporation of muntin bars between the sheets of glass in an IGU, however, is a development that is merely decorative, in that they simulate the look of old colonial windows. The grille created by the horizontal and vertical muntin bars (as shown in Figure 1) gives the appearance of true divided lights without actually penetrating the glass or dividing it into separate lights. Recent IRC research has determined that the presence of muntin bars can reduce the R-value and condensation resistance of an IGU.¹ It was found as well that certain muntin bars release volatile organic materials upon exposure to ultraviolet radiation, causing fogging of the glass.

Tests for R-Value and Condensation Resistance

Six IGUs were tested for R-value, interior glass surface temperature and temperature index (condensation resistance). Test units were 1 m x 1 m, double-glazed, either air- or argon-filled, with either aluminum or vinyl muntin bars,

and a low-emissivity (low-e) coating on one surface of the glass. Two control units (no bars) were also tested. (See Table 1.)

The temperature index, which relates the interior surface temperature of a window to the exterior temperature and the thermal characteristics of the window, is a measure of condensation resistance. (See “Principles of Condensation Control” in Construction Technology Update No. 5.)²

Results

Table 2 provides a summary of the R-value test results. The R-values of the units with muntin bars were found to be 2.3% to 7.3% lower than those of the units without muntin bars. The reduction in R-value is due to thermal bridging in the area of the glazing unit adjacent to the muntin bar. This can be expected because the muntin bars, made of materials such as aluminum (anodized or painted), vinyl, or silicone foam, usually have a higher thermal conductance than the air in the cavity. (Although not a prime consideration here, the gas-filled units had about a 7% higher R-value than the air-filled units, consistent with previous research.)

Figures 1 and 2 show the glass surface temperatures and the temperature indexes for two of the six IG units.

Table 1. Test conditions

IGU filling	Muntin bar type		
	None (control)	Aluminum	Vinyl
Air	•	•	•
Argon	•	•	•

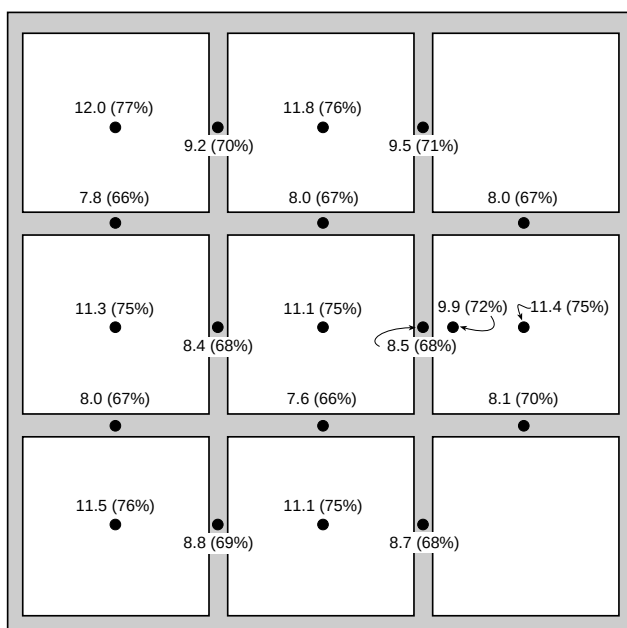


Figure 1. Glass surface temperatures and temperature indexes for air-filled, vinyl grille unit

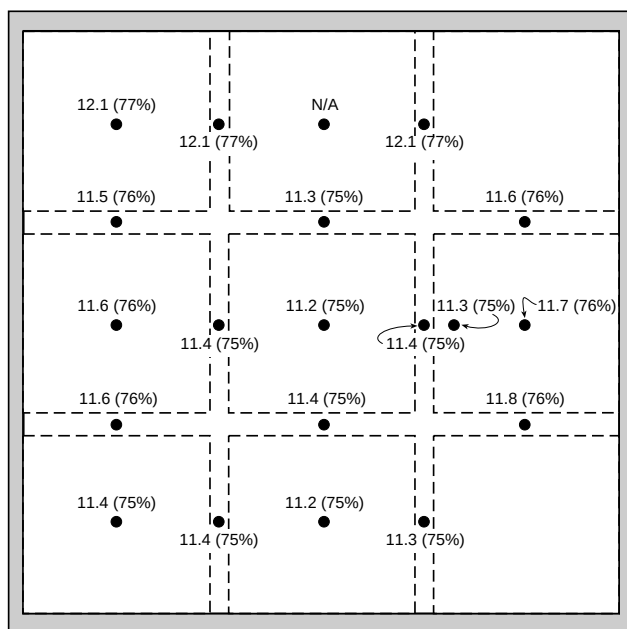


Figure 2. Glass surface temperatures and temperature indexes for air-filled, no grille control unit

Where large temperature gradients across the air cavity of IGUs occur, units with muntin bars may exhibit lower glass surface temperatures than units without muntin bars, particularly in the areas adjacent to the muntin bar. When air circulates inside the cavity of an IGU under the influence of natural convection, a localized high air velocity exists between the glass and the

surface of the muntin bar. The result is a higher rate of heat transfer through the glass, and hence, a lower glass surface temperature. This occurs mainly in the vicinity of the muntin bars. A lower glass temperature may lower the window's resistance to condensation so that condensation is more likely to form, especially in the vicinity of the muntin bars.

The glass surface temperature and temperature index at the location of the muntin bar are substantially lower than those at a similar location in an IGU without a muntin bar. The extent of the reduction in glass surface temperature and temperature index depends on the material that the muntin bar is made of. Units with vinyl muntin bars showed a lower glass surface temperature in the area adjacent to the bars than units with aluminum bars. This does not mean that vinyl has a higher thermal conductivity than aluminum; it does, however, indicate that the environment around vinyl muntin bars is more conducive to condensation than that around aluminum bars. It is suspected that the gap between the muntin bar and the glass surface is not the same in each case, or that in some cases the bar may actually have touched the glass surface. (Under large temperature gradients across the IGU cavity, the pressure inside the cavity decreases, causing the glass to deflect inwards. This can result in a decrease in the gap between the glass surface and the muntin bar.)

Fogging Tests

As part of normal quality control, IGUs undergo an extensive testing program to examine the seal integrity and their overall durability. The Canadian (CGSB 1990) and American (ASTM E773, E774, 1994) standards used do not include specific tests for units equipped with muntin bars and hence IGUs are being installed in buildings without testing in accordance with any recognized standards. (Note: the Canadian standard is now being revised to cover muntin bars.)

Ultraviolet ("fogging") tests were conducted on 54 IGUs, representing many variations in design and configuration: spacer bars made of metal, corrugated metal strip and silicone foam, and muntin bars made of aluminum, vinyl and silicone foam.

The volatile (fogging) test serves to identify the potential for failure due to degradation of the organic materials and subsequent release of volatile compounds, which form chemical deposits in the IGUs. This test

Table 2. R-value test results

Unit description	Argon concentration (%)	R-value $\text{m}^2 \cdot \text{K/W}$	Percentage variation from the control unit (%)
Air filled, no grille (control unit for air-filled units)	N/A	0.41	N/A
Air filled, white aluminum grille (3 x 3)*	N/A	0.38	-7.3
Argon filled, white aluminum grille (3 x 3)	86.0	0.43	-2.3
Air filled, white vinyl grille (3 x 3)	N/A	0.38	-7.3
Argon filled, white vinyl grille (3 x 3)	92.1	0.42	-4.5
Argon filled, no grille (control unit for argon-filled units)	83.6	0.44	7.3 relative to air filled

* 3 x 3 grille means that the IG unit is divided into three sections (vertical) and three sections (horizontal) by means of two vertical muntin bars and two horizontal muntin bars (see Figure 1).

Both the Canadian and American standards on the durability of IG units include a test to assess the degradation of organic materials in the IGU on exposure to UV radiation. However, there are differences in the standards: The American standard calls for off-angle viewing (whereas the Canadian standard calls for straight-on viewing) but requires less time for UV exposure than the Canadian one.

was performed according to the procedure described in the CAN/CGSB 12.8 standard (CGSB, 1990).³

For each of the 18 IGU configurations, three units were tested. Two units of each set contained a low-e coating on one glass pane, while the third unit — the control unit — was made up of clear glass on both panes. For the test, the units were exposed for seven days to ultraviolet radiation emitted from a standard sun lamp with a minimum output of 0.4 mW/cm^2 when measured with a sun lamp tester at a

distance of 300 mm (see Figure 3). The units were mounted in a box equipped with the sun lamp and a cold plate. When the ultraviolet radiation is applied, volatile materials evaporate. These materials then condense under the cold plate. (During the test, the cold plate was placed on the surface of the low-e glass pane (for one unit) and on the clear glass pane of the second coated glass unit. This was done to examine the influence of the low-e coating on the detection of the volatile deposits.)

After exposure, the units were examined individually in a viewing box for the presence of chemical deposits. In practice, an IGU fails the standard fogging test when the operator, viewing at a right angle, observes any oily deposits or traces of fogging on the surface of the glass. When viewed at a right angle, most IGUs pass the test. In the IRC tests, viewing was done at both a right angle and an off-angle. When viewed at a right angle, most of the units tested by IRC showed no sign of deposits. However, when viewed at an off-angle, many units showed traces of deposits because the reflection/refraction of light through the thin film deposits makes them more visible.

In the case where the cold plate was placed on the low-e glass pane, volatile materials were observed under the plate (indicating failure). The control units (no coating) showed no fogging. The low-e coating evidently enhances the visibility of the chemical deposits. This can be ascribed to the coating's relatively rough surface (at the microscopic level) compared to the surface of float glass. If the deposits are smaller than the valleys in the low-e coating, the deposits tend to settle in these valleys and become more visible.

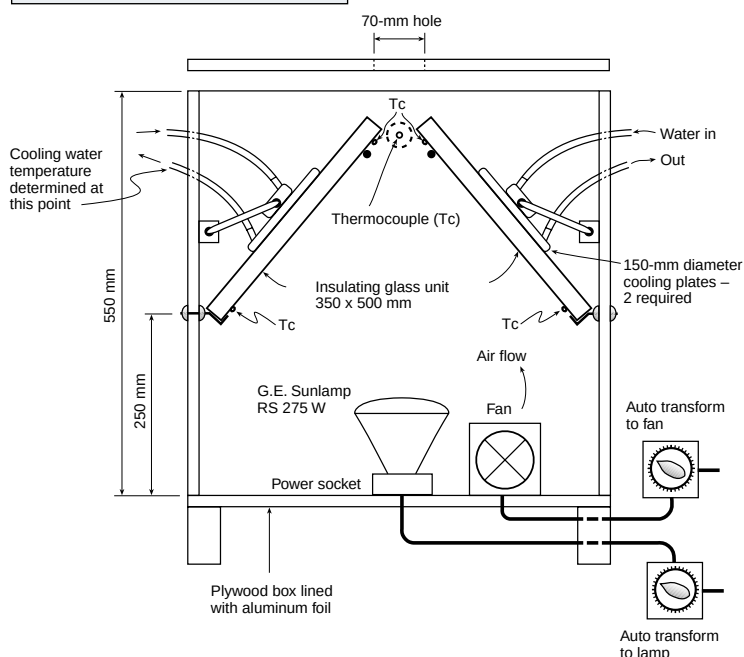


Figure 3. Volatile (fogging) exposure box

Material Degradation With UV Exposure

The degradation of organic compounds under ultraviolet (UV) exposure has been a known phenomenon for years. IGUs may fail the test for fogging deposits whether or not there are muntin bars in the cavity. This is because organic materials are used in most common sealants or other components in the IGU. The incorporation of muntin bars introduces an additional source of volatile material that may cause failure. It is unlikely that there is any in-plant problem with the paints that are baked on or anodized on the aluminum bars, but there could be if touch-up paint is used on flaws or chips in the anodized coat.

Muntin bars made of silicone foam are an exception: no problems were detected with them. With metal bars, preparation includes cutting, usually involving the use of lubricants and coolants. The result can be the introduction of oil into the IGU. This happens often, particularly when the muntin bars are not properly washed after cutting. Oil in the IGU also could be the result of handling the glass sheets and other components with contaminated gloves or fingers.

More research is needed to determine why IGUs without muntin bars can also fail the fogging test. It is possible that the sealants, edge seals, or dessicants, or some combination thereof, are responsible for the failure.

Implications for the Industry

The presence of muntin bars inside the IGUs has considerable effects on the interior glass surface temperature and the temperature index of the IGUs. The reduction in glass surface temperatures on the warm side adjacent to the muntin bar reduces the condensation resistance in that area. (The presence of the muntin bar leads to a smaller gap within the IGU, which increases the air velocity in the cavity, increasing the thermal coefficient and decreasing the surface temperature of the glass.) These reductions are not large, however, and in all likelihood most homeowners would not notice any difference in heating bills as a result.

The issue of fogging may be of greater concern. Most homeowners would notice fogging of the units because they would normally look out their windows at many different angles. They may believe that the fogging problem is one of condensation

between the panes caused by a failed seal. Until further research is done, architects, builders and renovators should think carefully about whether or not to use IGUs with internal muntin bars, as they introduce an additional source of volatile material that can cause aesthetic failure.

As an alternative, the aesthetic of muntin bars can be achieved by installing wood grilles on the room side of the windows. The grilles can have a solid frame that is pinned tightly to the sash. The window would, of course, be more difficult to clean on the inside.

Summary

Tests conducted by IRC on insulating glass units with muntin bars between the panes revealed performance issues that are a concern, such as lower R-values, lower interior glass surface temperatures and hence lower condensation resistance in the vicinity of the muntin bars. An additional problem identified was fogging between the panes that occurred because of the release of volatile organic materials from the muntin bars on exposure to ultraviolet radiation.

References

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