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Triple IGU – the future standard? Durability, safety barrier glazing and acoustics in building practice

1 Reducing the importance of triple insulating glazing to the U_g - and g -values

In view of the amendment of the Energy Conservation Regulations, the glass industry is under pressure to make its contribution to the overall U -value of windows and facades. Thanks to the fact that glass manufacturers have long been aware of the advantages of their products, of the many combination options of existing coatings, configurations and gas fillings, the U_g -value has been optimised very quickly thanks to using triple IGU. Fig.1 illustrates the development from single glazing to the current product. The hoped-for production of vacuum glass is still in the development process and is not yet available in serial production quantities in the short term.

2 Production quality and durability

The first aspect is that of fitting the glass panels in the glazing rebate, a job carried out by window joiners and glaziers. Due to the specific nature of triple IGU there are certain imponderabilities that need to be considered:

- ? The offset of the 3 glass panes has to be kept within workable limits.
- ? Load transfer must not rely on just one edge of the glass.
- ? Cover of the two spacer frames should be the same.

- ? The face clearance of the externally applied sealing compound must be able to accommodate without damage the loads resulting from the increased internal pressure.

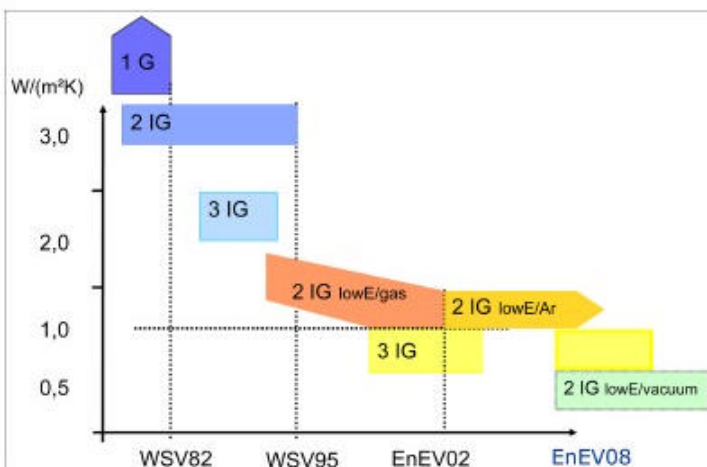


Fig. 1
History of the U_g -value



The pressure differences of the two cavity compression processes) must provide for the mandatory tolerances in terms of the overall thickness of the unit and in addition, for gas tightness of the two cavities.

The consequences resulting from the manufacturing tolerances could be as follows:

- ? glass breakage due to excessive loads on the edges of individual panes,
- ? failure of setting blocks due to excessive linear loads,
- ? insufficient edge seal cover by the 12 mm edge cover of glazing beads and/or rebate overlap in commercially available window systems.

Up to now the glass industry, associations and test institutes have not agreed on uniform requirements for acceptable tolerance, because the manufacturing process does not differentiate exactly between triple and double glazing.

This also applies to the test methods set out by the European product standard. EN 1279 stipulates basic testing of a 'representative test specimen' – the term used in the standard is 'insulating glass unit'. It is left up to the manufacturer to decide how many panes this refers to for level 3 classification.

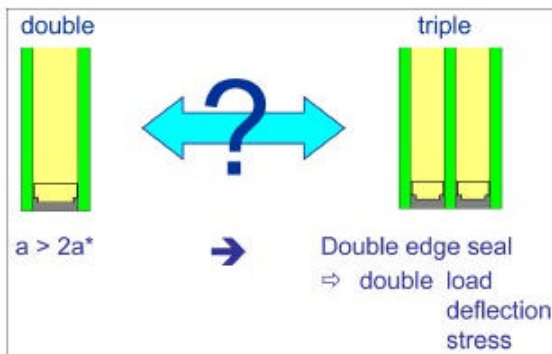


Fig. 2 Edgeloads in triple IGU

This takes us to the topic of durability. According to Section 3 of the data sheet 003 "Leitfaden zur Verwendung von Dreifach- Wärmedämmglas" (Guideline for using triple insulating glass units) [3] issued by the Bundesverband Flachglas (Federal Float Glass Association) the edges of triple IGU are exposed to higher loads (Fig. 2).

Additional cavities and the neutral function of the middle sheet in symmetrical configurations considerably increase the edge load. The above-mentioned effect resulting from two repeated compression processes in the production of triple IGU has not yet been investigated. There may also be a difference in the gas tightness of the two cavities.

3 Technical regulations for the use of safety barrier glazing (TRAV)

In the scope of application of "Technische Regel für absturzsichernde Verglasungen" (technical regulations for the use of safety barrier glazing) (TRAV, 2003-01) the term "Mehrscheibenisoliertes Glas" ('insulating glass unit) is used. This can be interpreted to mean that the application is not limited to two glass panes. On the other hand, Table 2 'Glass configurations with proven impact safety' only describes configurations with two panes which have been tested several times and have been approved by a test report. These were the prerequisites for the results to be included as generally applicable in the body of rules and regulations.

In a test series three-pane configurations have been tested for pendulum impact resistance as per EN 12600 based on the method set out for two-pane configurations. The objective of increasing the quantity of test specimens and obtaining a greater number of test results is to establish supplementary data to Table 2 (TRAV) for triple IGU and have these approved by the German Institute for Building Technology (DIBt).



At present, use of triple IGU for safety barrier glazing of categories A, C2 and C3 is subject to individual approval on a case by case basis or to a national approval applied with the building control authorities.

As a comparison, the significant improvement of the U_g -values is shown in the Fig. with the described parameters.

4 Sound insulation

Sound insulation is another special characteristic frequently required for glazing systems. It would obviously be a very welcome effect if, based on the additional mass, it would be possible to achieve a significant improvement of the sound reduction value in addition to the good improvements of the U_g -value.

Unfortunately, the test series carried out at the acoustic laboratory of the ift Rosenheim have shown that sound insulation does not increase in proportion to the increase in mass per unit area. Sound insulation is subject to its own specific laws. Table 1 shows some examples of comparisons between test results from the ift archive. The R_w -values in each case relate to the test specimen dimensions of 1.23 m x 1.48 m, which are the dimensions listed in the tables in Appen-

5 Conclusion

If triple IGU or IGU configurations of higher sound insulating performance are to become the generally accepted transparent building components to be used in our windows and facades, it will be necessary to establish and publish data of the other functions that are relevant for glass systems to make it possible for manufacturers and end customers to think and look beyond the confines of the U-value. It will be necessary, step by step, to supplement the application tables and technical rules and regulations with the requirements for IGU units featuring more than two panes.

In view of the considerable additional weight these configurations will have in window case-ments, it will also be necessary for the glazing and window fitting technologies to press ahead with developments.

Tab. 1 Sound reduction indices of double and triple IGU

	Configuration			R_w (c.c.t.) dB		U_g W/(m²K)*			R_w (c.c.t.) dB		U_g W/(m²K)*	
	double	triple	gas	double	triple	double	triple	gas	double	triple	double	triple
mass per unit area in kg/m²	4-12-4 20	4-12-4-12-4 30	Ar	30 (-1; -3) 33 (-2; -6)	32 (-1; -4) 33 (-2; -6)	1,3	0,7	Kr	k.W.	32 (-1; -5) 32 (-1; -5)	1,1	0,5
mass per unit area in kg/m²	6-12-4 25	6-12-4-12-4 35	Ar	33 (-1; -4) 33 (-1; -5)	36 (-2; -6) 36 (-1; -5)	1,3	0,7	Kr	35 (-3; -6) 34 (-2; -6) (6-10-4)	38 (-2; -6)	1,0 (6-10-4)	0,5
mass per unit area in kg/m²	8-12-4 30	8-12-4-12-4 40	Ar	35 (-1; -4) 36 (-2; -5)	37 (-1; -6) 38 (-1; -5)	1,3	0,7	Kr	k.W.	k.W.	1,1	0,5
mass per unit area in kg/m²	8-12-6 35	8-12-4-12-6 45	Ar	35 (-1; -4) 36 (-2; -5)	39 (-2; -5) 39 (-1; -4)	1,3	0,7	Kr	36 (-2; -6)	38 (-1; -3) 38 (-2; -5)	1,1	0,5

* Coating on position 3 (double) / on position 2 and 5 (triple)
Emissivity 0,03
Gas filling 90 %



Useful information in brief

What are the relevant properties of triple IGU to be taken into consideration?

- 1 The main advantage of triple insulating glazing is its improved U_g -value.
- 2 Production quality and durability have to be guaranteed.
- 3 At present the safety barrier function is subject to individual approval on a case by case basis. It is hoped that this will be simplified by supplementing the TRAV data for standard configurations in the future.
- 4 Sound reduction indices will be improved, with asymmetric configurations providing better values.
- 5 Special characteristics, such as sound insulation, burglar resistance and fire resistance are subject to separate verifications/approvals, just as in the case of IGU.
- 6 Because of the greater weight of the glass units, consideration must be given to the stability of window casements regarding corner joints and the load-bearing capacity of hinges etc.



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Born on January 14, 1961 in Erlangen

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| 1980 | Obtained university entrance qualification at the Leibniz-Gymnasium in Altdorf |
| 1980 – 1981 | First year of vocational training as joiner at Nuremberg Vocational School |
| 1981 – 1982 | Vocational training as joiner, obtaining qualification from the Central Franconia Chamber of Handicraft |
| 1982 – 1983 | Worked as journeyman joiner |
| 1983 – 1989 | Studied for diploma in Wood Technology at Rosenheim Polytechnic University with work placements in metalwork and in interior conversion and mortarless construction |
| 1989 | Diploma in Wood Technology |
| since 1989 | Staff member at ift Rosenheim; areas of responsibility: building materials testing area (insulation glass, sealants, combined metal-polymer profiles adhesives) |
| since 11/2003 | Head of Material Testing Department |
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