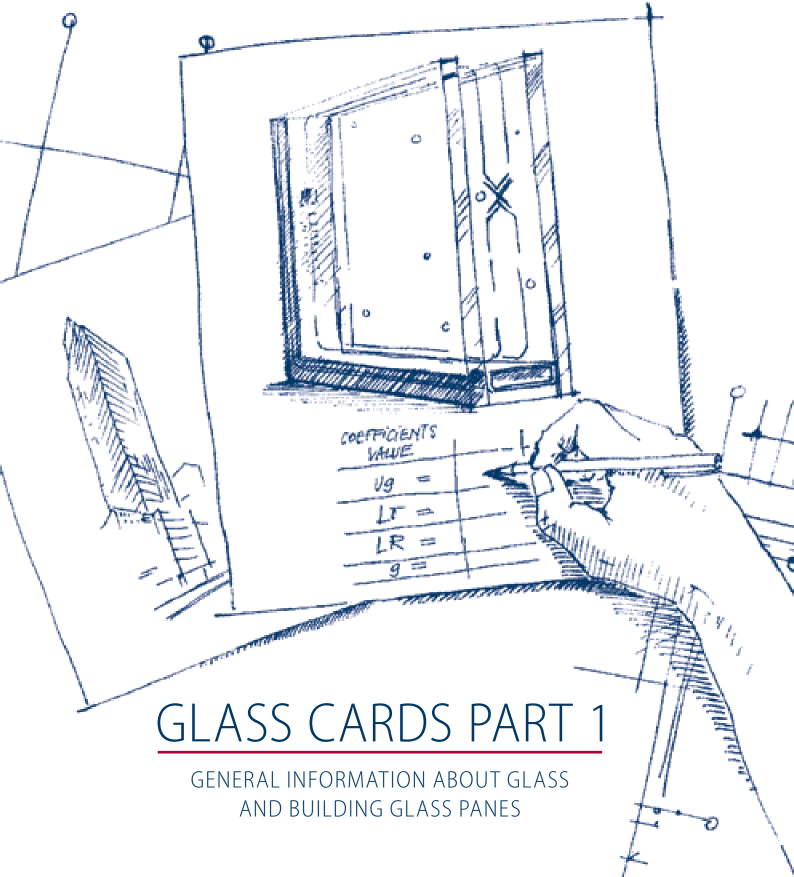


GLASS CARDS PART 1

GENERAL INFORMATION ABOUT GLASS
AND BUILDING GLASS PANES

WHAT IS FLOAT GLASS?

By the time the float method was invented for building purposes, vertical glass drawing, called the Pittsburgh method, was used.

Waviness of drawn glass is its main disadvantage. It means the glass surface is deformed by mild concavities and convexities, and hence the image watched through the glass is distorted. Glass made with this method often contains bubbles and splinters. The defects prevent or make it difficult to use drawn glass to produce modern coated, tempered or laminated glass panes, which determine advanced applications of float glass.

Modern glass architecture would not be created without float technology invented in 1952. A characteristic and patented process involves creating a flat glass surface by horizontal pouring of molten glass on a liquid tin surface. The process takes place as a result of the difference in the density of tin and molten glass.

After annealing, a process of controlled and uniform cooling leads to obtaining glass in a form of flame polished product with parallel surfaces and free of optical deformation. Glassworks operate continuously for about 15 years after after furnace ignition.

Basic building glass, called float glass, has a slightly greenish hue, which is particularly visible on the edges. The thicker the glass, the more saturated the shade. Iron oxides from raw materials molten in the furnace are responsible for the colour. It is possible to obtain decolourized glass by modifying the composition of ingredients and removing the oxides.

Building float glass is produced in glassworks, in standard pane sizes of 6,000 x 3,210 mm. It is also available in smaller and bigger sizes.

WHAT IS THERMOFLOAT?

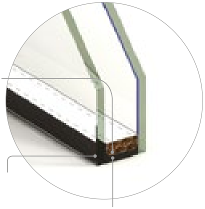
What are functional coatings applied to float glass?

Functional coatings commonly used in building engineering are applied to the glass surface during its production or on a later stage. That is why they are called on-line coatings (pyrolytic/hard coats) or off-line coatings (soft coats). The majority of coats made for building purposes nowadays are off-line coatings. They consist of many thin metal layers and metal oxides responsible for transmission and reflexion of light, thermal energy and for durability of the whole coat. The main intermediate layers responsible for functional characteristics are made of silver. All coats are applied by magnetron sputtering. Electrons bombard the bars placed above the passing glass panes, which results in precipitation of oxides and their deposition on the glass panes.

The total thickness of the coats is normally about 100 nm (nanometers, i.e. 10-9^{-9} m).

The most basic types of coats prevent heat transmission and are called heat--insulating or low-emission coats. Every producer of basic glass uses their own name for the low-emissivity coats applied to the glass. Their heat-insulating properties do not differ, though. That is why Press Glass uses its own name - Thermofloat - for heat-insulating glasses from all manufacturers. With regard to the fact that their shades may vary slightly, Press Glass follows the rule of using only one type of heat-insulating glass for a project.

WHAT IS AN IGU AND WHAT DOES IT CONSIST OF?



First modern tight IGUs were developed in 1950s, but they started to be produced and used commonly in buildings about 20 years later. The technology owes its development to the deficit in generation of thermal energy to heat buildings.

The design of double- or triple-glazed units was based on a combination of two or three glass panes with spacers used on the edges of two glass panes along the whole circumference, which results in closing the air tightly in the space between the glass, called the air space. That was a milestone which reduced heat transmission through glass in windows.

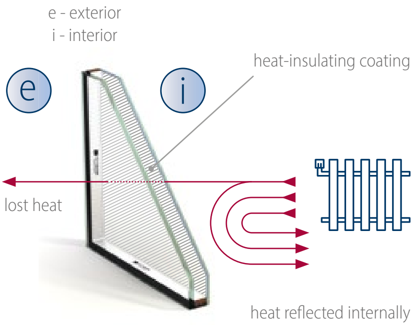
WHAT IS Ug VALUE?

„Ug" (g - glazing) [$W/m^2 \cdot K$] is a coefficient of heat transmission through glass in its central part. It means the quantity of heat, expressed in Watts [W], which is transmitted externally through the glass per 1 m2, at an indoor and outdoor temperature difference of 1 Kelvin. The lower the value of the glass heat transmission coefficient (Ug), the better it prevents heat losses.

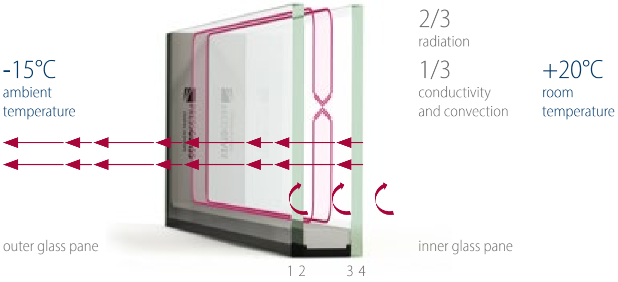
Experimental IGUs, based on vacuum technology, can reach the Ug value up to 0.1 - 0.2. They are no longer produced for building engineering on an industrial scale due to technological limitations. IGUs production technologies, including vacuum technologies, are gradually improved and perhaps one day they will be commonly used in building partitions.

Developing IGU production technology was a milestone towards reduction of heat transmission through glass partitions, which reduced heat transmission through glass e.g. in windows nearly twice - to Ug = 3.2 - 2.8, as compared to glazing with one or two individual glass panes - Ug = 5.6 - 5.8. Another breakthrough solution was to use heat-insulating (low emissivity) coatings on glass, whose development contributed to another two-fold reduction in heat transmission (double-glazed glass Ug = 1.4 - 1.6 and triple-glazed glass Ug = 0.7 - 0.8).

The solution was made complete with noble gas such as argon or krypton in the air space, which reduced the value of Ug by another 0.3 W/m^2K. Introduction of warm edge spacers made of materials with much lower heat conductivity than the originally used aluminium spacers led to reduction in the heat transmission value of windows (Uw). The influence of spacers on heat transmission reduction is not taken into account in the value of Ug. Typical double-glazed IGUs nowadays reach the value of Ug = 1.0 - 1.1



WHAT PHENOMENA ARE RESPONSIBLE FOR HEAT TRANSMISSION THROUGH GLASS?



Heat transmission through an IGU is caused by several physical phenomena. Heat accumulated in a room, coming from heating, and the so called domestic heat are accumulated in all objects in the room, and in its envelope, i.e. in walls and ceiling/floor. Heat is also accumulated in the air in the room. The air can take over heat from objects and partitions and give it back to them. It is caused by convection, i.e. movement of air particles as a result of temperature difference. Heat is transferred externally from the room, when the outdoor temperature is lower than the indoor temperature. First, air particles which are continuously moving (i.e. subject to convection), take heat from objects, building partitions, humans and animals and then touch the glass surface and transfer the heat to the glass. The glass takes over the heat. Then the heat is conducted by the glass pane and emitted to the air space. The quantity of emitted heat depends on the surface emissivity. Glass with no functional coatings has a high emissivity coefficient and gives back a lot of heat in short time. That is why glass is coated with low-emissivity coats which significantly reduce glass capability to emit heat to the air space. The heat emitted to the air space is taken over by gas particles included in the air space and then is transmitted to the other glass pane through convection. The process is repeated until the heat is emitted from the outer glass pane (of IGU) externally. In the case of triple-glazed units where two low-emissivity coatings are used, the coating in the outer air space is responsible for reducing the ability of glass to take over the heat from the air converting in the air space.

WHAT IS THE DIFFERENCE BETWEEN Ug AND Uw?

Uw [W/m^2·K](w - window)

Uw is a coefficient of heat transmission of the whole window, which, excluding the heat transmission through the central part of the glass Ug, takes into account heat transmission through the window frame (Uf, f – frame), in which the glass is seated, and heat transmission through the edge zone in the connection point of the glass and frame, which is expressed with the Greek letter Ψ (Psi) and called a linear thermal conductivity. The value is not equivalent to heat transmission value along the IGU circumference. The value of Ψ can then be calculated only for a complete window or façade construction.

WHAT IS A WARM EDGE SPACER?

Aluminium has much lower thermal conductivity than other IGU components. A spacer, which is an essential component of an IGU, at gradually improving values of thermal conductivity coefficients of window frames and glasses turned out to be the weak point of IGUs with aluminium frames.

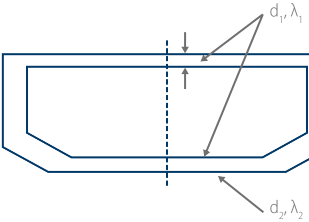
A warm edge spacer has a number of advantages. It improves heat-insulating properties and thus reduces the heating costs and increases the comfort of using the windows as it minimises the possibility of vapour condensation on the glass pane and frame edge, which in turn prevents the growth of pathogenic fungi.

According to a draft European standard, a spacer with improved heat parameters, i.e. a warm edge spacer is the one whose thermal conductivity fulfils the following equation:

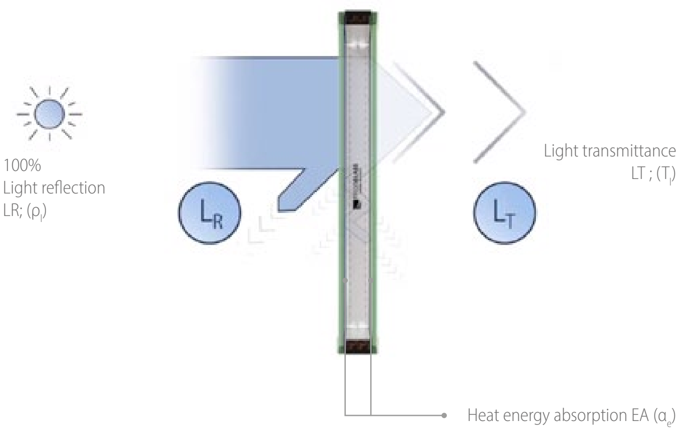
$$\sum (d_i \lambda_i) \leq 0{,}007 \ [W/K]$$

where:

d_i – material wall thickness, λ_i – coefficient of thermal conductivity of the spacer material [W/mK] Example: $2(d_1\lambda_1) + (d_2\lambda_2) \leq 0.007$ [W/K]



WHAT ARE THE COEFFICIENTS Lt AND Lr?



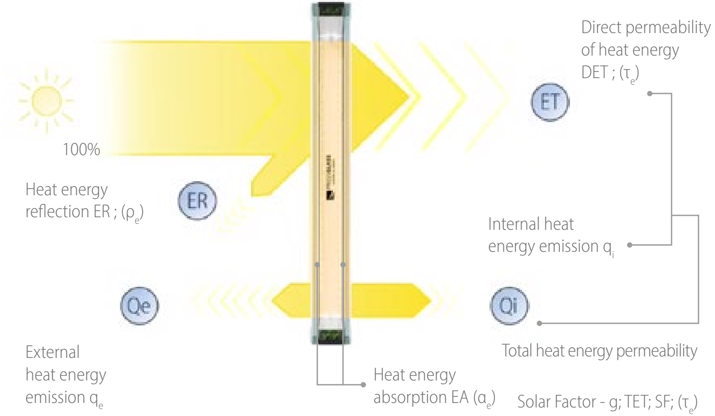
Lt [%] (Light transmittance) and Lr [%] (Light reflection)

The coefficient of Light transmittance (Lt) identifies the quantity of sunlight reaching the outdoor glass surface which is able to penetrate into the room. The value is expressed in per cent.

Some light rays reaching the outer surface of the glass are reflected from the glass. The quantity of the reflected light is identified by Lr coefficient and given in per cent.

Lt stands for the difference between the amount of sunlight reaching the glass outer surface and the amount of reflected sunlight.

WHAT IS COEFFICIENT g?



Coefficient„g" (TET – total energy transmission) [%] means the total amount of solar energy penetrating through the glass from outside to the inside of a room. The process is affected by several phenomena, and solar energy is subject to multiple reflection and absorption inside an IGU to be finally emitted externally or internally. Similarly to coefficient Ug, once heat energy has been absorbed inside the IGU, the final amount of heat getting inside the room also affects heat conductivity, emission, transfer and convection.

The phenomena are described by the following coefficients:

ET - direct heat energy transmission
ER – heat energy reflection
EA – heat energy absorption
QE (Q – the symbol commonly used to identify flow; E - exterior) - emitting heat energy outside the building
QI (Q – the symbol commonly used to identify flow; I - interior) - emitting heat energy inside the building

WHAT IS SELECTIVITY INDEX „S”?

S [-] (selectivity) – Identifies the ratio of sunlight quantity to the amount of energy transmitted by the glazing.

$$S = Lt / g$$

The value of the parameter is used e.g. to differentiate between solar control glass and heat-insulating glass. The general function of solar control glass is to transmit sunlight (Lt) while simultaneously transmitting as little solar energy (g) as possible. Higher selectivity is assumed to refer to glass with more advanced technical parameters. Technological development contributed to shifting the limits of maximum glass selectivity, which currently exceed 2.

WHAT IS THE COLOUR RENDERING INDEX „Ra”?

Ra (CRI - colour rendering index) – It describes the degree of natural perception of objects seen through a glass pane. The higher the index, the better the colour rendering and the more natural appearance of objects.

Ra of 100 means that the colours of objects seen through the glass are rendered as if the objects were not seen through the glass.

PS: Lighting producers claim that the minimum Ra value should be 80 so that artificial light renders the colours of the environment in a good way.

WHAT IS THE SHADING COEFFICIENT „b”?

B [-] (Shading coefficient) – Identifies the ratio of thermal energy transmitted through specific glazing in a building to thermal energy transmitted through double-glazed unit with 4 mm float glass, with no functional coatings, characterised by the mean value of g = 0.8.

The coefficient is taken into consideration when calculating the cooling energy demand of a building.

$$b = g / 0{,}8$$

g - coefficient of total solar energy transmission for the applied glazing

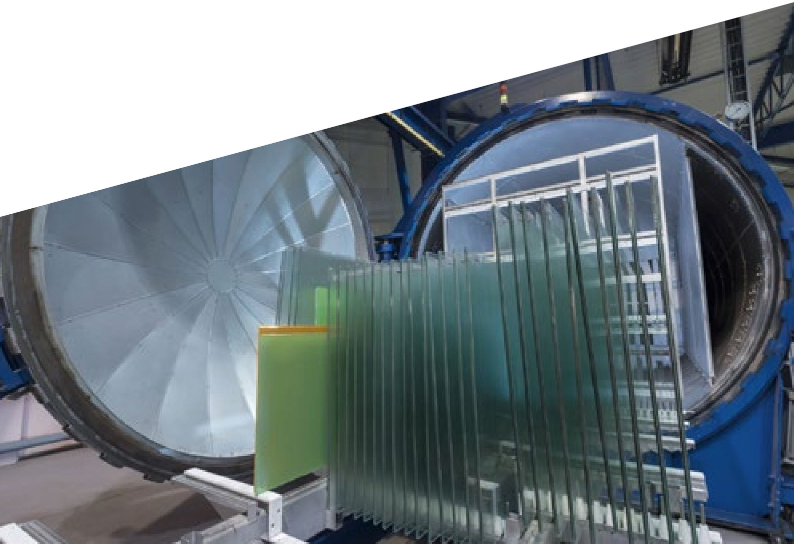
HOW ARE IGU SIDES IDENTIFIED?

Press Glass identifies the sides of glass panes in an IGU as #1, #2, #3, #4, #5 and #6, where #1 stands for the outer surface of a glass outside the building, and #6 represents the outer surface of a glass inside the building.

Descriptions of all glasses also start on the outside. For glasses intended for indoor use, the presented description and numbering system shall be followed in order to glaze the pane correctly in the structure - it applies to all glass panes with non-symmetrical construction and shape.

WHAT DOES „VSG" STAND FOR?

VSG is an acronym used commonly in Poland and internationally, which originates from the German term „Das Verbund Sicherheits Glas", to mean safety laminated glass. In other words, VSG is glass produced by lamination, i.e. composed of at least two glass panes bonded with special foil.



WHAT IS TEMPERED GLASS AND WHAT DOES „ESG" STAND FOR?

(GER. ESG - DAS EINSCHEIBEN-SICHERHEITGLAS)

Glass is naturally brittle. Owing to tempering, changes in internal stress of the glass structure occur, which improve its bending strength. Tempered glass means safety. Once broken, the glass pane shatters into small pieces with blunt edges. Owing to this property, tempered glass is used in places where a high breaking hazard occurs and which are exposed to strong sunlight.

WHAT IS TVG CHARACTERISED BY?

(GER. TVG - DAS TEILVORGESPANNTES GLAS)

Semi-tempered TVG has a different cracking pattern than ESG when the glass pane is damaged. The cracking pattern makes each part of the broken glass stay in the frame when the glass pane breaks, which prevents body injury.

This makes TVG an interesting alternative to ESG tempered glass. Formally, TVG is not classified as safety glass e.g. in Poland.

PS.: Also known as semi-toughened glass, heat-strengthened glass or semi-hardened glass.

HST - DO YOU KNOW WHAT THE ACRONYM STANDS FOR?

HST stands for Heat Soak Test which means a thermal shock test.

A modern product, such as tempered glass, reveals a weakness of float glass. The disadvantage is the small particles of nickel sulphide (NiS) which can occasionally get to the glass mix during float glass production. Once heated during tempering, a nickel sulphide particle in the glass pane changes its volume. Sudden cooling of the glass pane after heating, which makes the glass tempered, deprives a nickel sulphide particle of the time it needs to regain its initial volume. It is „frozen" in such a condition, which creates additional stress in the glass. The mechanism acts like a retarded bomb. If a tempered glass pane with embedded nickel sulphide particle is installed in a facade and then heated by solar radiation, the nickel sulphide particle volume is released, which leads to additional increase in internal stress. If such a particle is located in elongation stress zone, the acceptable stress level is highly likely to be exceeded and the glass pane will break spontaneously.

The phenomenon occurs extremely rarely but if such glass is mounted in highly responsible structures, the hazard shall be prevented by annealing the tempered glass. During annealing the contaminated glass panes are eliminated from delivery.

Press Glass makes it possible to carry out HST for the whole range of tempered glass.

TYPES OF SOLAR CONTROL GLASS

ABSORPTIVE - float, transparent, body-tinted (green, grey, brown, blue) glass used to reduce internal transmission of solar energy. The glass can be used individually or in IGUs.

REFLECTIVE - float, transparent glass, transparent, body-tinted (green, grey, brown, blue) glass, or clear, coated with metal oxide, in order to achieve the right reflection, indoor sun exposure control and to reduce internal solar energy transmission. The glass can be used individually or in IGUs, depending on the coat type.

SELECTIVE - float, transparent glass, clear or body-tinted (green, grey, brown, blue) glass, coated with several layers of metal oxide, in order to achieve the right reflection, indoor sun exposure control and to reduce internal solar energy transmission, as well as to ensure high thermal insulation. This kind of glass can be used only in IGUs.

WHAT IS THE DIFFERENCE BETWEEN THIOKOL AND SILICONE?

It is a sealant for IGUs.

What is thiokol?

A bi-component sealant and glue based on polysulphides (thiokols), developed for secondary sealing of IGUs.

What is silicone?

Mono-component, elastic sealant with a neutral hardening system for IGUs production. It provides highly elastic and durable sealing, characterised by very good adhesion to glass and spacer materials (aluminium, plastic and varnished steel). The silicone demonstrates very good adhesion to wood and majority of building materials.

WHAT IS BETTER - KRYPTON OR ARGON?

The gas which fills the space between the glass panes, called air space, plays an important role in the thermal insulation level. Air, argon, krypton and xenon can be used for filling the air space. Still, only two kinds of gas - argon and krypton, are nowadays used in practice. The characteristics of krypton help IGUs achieve the best heat parameters for 10 - 12 mm wide air spaces. For argon the value ranges from 15 to 20 mm.

Krypton is much more expensive than argon, and that is why it is only used whenever there are limitations concerning the glass package maximum width while maintaining heat insulation which characterizes 15 - 20 mm wide air spaces.

A supplement with a pinch of salt :)

MOST COMMON MURPHY'S LAWS

1. Don't believe in miracles - depend on them.
2. Dimensions will always be given in the least useful units.
3. If something can break down, it certainly will.
4. If you let things go their way, they will turn from bad to worse.
5. If everything seems to operate well, you must have missed something.
6. The weight of a dropped object is directly proportional to the degree of complexity and price of the hit area.
7. An object randomly selected from a group with 99 per cent reliability will belong to the remaining 1 per cent.
8. Despite all efforts, you will always misspell a word.

The laws are true in life and business because although we all do our best, life writes unexpected scenarios.

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