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WINDOWS
THE HEAT TRANSFER COEFFICIENT IN DIFFERENT TYPES OF WINDOWS

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1. Windows – the heat transfer coefficient in different types of windows.

The thermal conductivity of a building element is expressed by the U-value in W/m²*K.
In the case of windows, the value – U(w) (windows) – is given by the manufacturer and may be specified as two values: U(g) the value for the glass and U(f) (frame) – the value for the window frames.

The U-value varies depending on the thickness of the pane, the type of glass, the type of glazing: single, double, insulated double or triple glazed unit.

The U-value is expressed in $\mathbf{W/m^2K}$ and defined as the amount of heat passing across $1m^2$ of a flat building element (e.g. window, wall, etc.) in 1 hour with 1K (1°C) temperature difference between the two sides of the element (internal / external).

The range of products now includes casement windows intended for historic buildings. The window frames, inspired by period architecture, have been designed especially for use in and old-style and listed buildings. They combine stylish appearance with excellent technical characteristics, such as thermal insulation or soundproofing properties.

Suburban manor houses, luxury villas or historic town houses are buildings that require dedicated window and door joinery solutions to match the period style. Meanwhile, the increasingly strict energy efficiency standards necessitate the use of solutions with sufficient insulating properties.

2. Multiple benefits in one window

In response to the needs of discerning customers, valuing both style and innovative technical solutions, the product range was extended to include new casement windows combining traditional-style design and optimum performance. The state-of-the-art design is based on a single frame of glued-laminated pine wood, ensuring better rigidity, stability and thermal properties. The heat transfer coefficient for a reference window: Uw=1.1 W/m2K. The outer sash, 68 mm thick, features an insulated glass unit with an insulating glass spacer and low-E coated Thermofloat glass characterised by very good insulating properties with Ug=1.0 W/m2K. The window may be additionally fitted with special features ensuring better protection against cold, noise or burglary.

Apart from standard filling, glass units are also available with improved soundproofing properties, burglar-proof up to and including class P4, with the “mirror” effect, self-cleaning glass or thermo panels. The construction of optimum rigidity is characterised by the highest resistance to wind in class C3.

At customer's request, the windows can be glazed with ornamental or body-tinted glass (Antisol) for a highly decorative, colourful appearance, typical of windows in palaces or churches. Multiple pane division options are possible with 5 types of glazing bars: structural, inserted in both sashes, Vienna grilles and aluminium GBG grilles.

Casement windows are available in 5 opening options: from fixed to tilt-and-turn windows. Additionally, decorative wooden trims are available, imitating carved window elements. Thanks to the endless possibilities of adjusting the appearance and functional properties of casement windows, they can be also used in the renovation of listed historic buildings, which are often subject to highly detailed requirements.

3. Energy first

At present, great significance is attached to the issues of energy efficiency. The requirements laid down by construction law are becoming increasingly strict. Pursuant to an amended EU directive, in 2013 the obligation will be introduced to specify the energy efficiency coefficient EP of buildings for rental or sale. Since windows provide one of the ways of escape of energy, it is worth choosing models with good insulating properties. Wooden-framed windows of this type have very good technical characteristics, which significantly improve the heat balance of the building. The heat transfer coefficient is exceptionally low: **Uw=0.77 W/m^{2}K** according to EN 14351-1:2006+A1:2010 for a reference window sized 1230x1480mm. This effect has been achieved by using a triple glazing unit 4x16x4x16x4 with a heat transfer coefficient U=0.5 W/m^{2}K according to EN 673, filled with argon. The window is equipped with an additional insulating glass spacer (SGG Swisspacer), which ensures excellent thermal properties and reduces the risk of condensation on the glass surface. Three glazing gaskets provide protection against penetration of cold air and noise. An **EC 90** window, with a sound reduction index **Rw=35 dB**, guarantees quiet interiors even in buildings situated in locations with high noise levels. The soundproofing properties of windows are a great benefit that will ensure peace and quiet in the household.

The above data show that, while a single-glazed casement window has a heat transfer coefficient of ca. 1.8–2.2 W/m2K, then by applying a insulated glass unit the coefficient is reduced to 1.5 or even 1.1 W/m2K (depending on the gas used to fill the space between the panes). And an insulated triple glazed unit (4x16x4x16x4) filled with argon reduces the heat transfer coefficient to Uw=0.5W/m2K, which is particularly important for large glazed surfaces.

However, one must also keep in mind the historic character of window elements and before taking the decision to replace the windows with more energy-efficient ones, an energy survey of the building with the old windows has to be carried out and to determine whether the savings after window replacement will be significant with respect to the heating demand of the building.

4. Costs of heating – comparison

Type of building	Costs of heating		
	Standard	**Energy-efficient**	**Passive**
U-value of external walls [W/m^{2}K]	0.289	0.211	0.104
U-value of the roof [W/m^{2}Ka]	0.269	0.204	0.137
Seasonal heating demand index E [kWh/m^{2}a]	96.1	37.2	12.3
Gas GZ 50 (EUR 96)	PLN 3023 (EUR 755)	PLN 1169 (EUR 292)	PLN 385
Fuel oil (EUR 164)	PLN 5145 (EUR 1286)	PLN 1990 (EUR 498)	PLN 656
Electric power (EUR 126)	PLN 3939 (EUR 985)	PLN 1924 (EUR 481)	PLN 502
Wood fuel (EUR 64)	PLN 2004 (EUR 501)	PLN 755 (EUR 189)	PLN 255

5. What are passive houses?

They are often confused with energy efficient houses, which are designed to use relatively little energy for heating. That is the type of house usually built in our country – well-insulated and carefully built and finished, they can use up as little as 30 kWh/(m^{2}a)). Passive houses is our climate is a completely different story. The record holder is said to use only 1.5 litres of fuel oil per year per m^2 of surface. The concept of the passive house originated in Germany, where architects first took up the challenge of designing a house which, by definition, would use very little energy. The accepted threshold value is 15 kWh/m^2 per year. The *Passive House Institute in Darmstadt* was also established to promote this type of construction.

6. References

1. Pol-Skone Drzwi i Okna.
2. Oknotest.pl
3. Pro-Went Dom Pasywny

7. **Further information:** Old windows – protect or replace? By prof. dr.hab. inż. arch. Jan Tajchman.

Window – a window opening, varying across the ages, and its wooden filling, constituting the basic architectural elements of the façade. Minor window divisions are often essential for the completion of the architectural design, whereas installation of new windows without such divisions visibly interferes with the original architectural concept.

Window replacement should be based on a detailed inventory and where the old windows only need regular maintenance, they should be left as they are in the building, preserving their historical and architectural features. Deteriorated windows should be replaced with new copies of the old frames that do not affect the aesthetic value of the façade. Old windows, as an inseparable element of the exterior wall finish, present an artistic and historical, or documentary value, but only if their material has not been damaged.

When deciding on the steps to take, each historic building and each window needs an individual approach. By conducting a careful appraisal of old window frames, always in conjunction with the exterior wall finish and in the historical context of a particular building, it is possible to determine the appropriate extent of treatment.

New windows – advantages or disadvantages.

Looking at the streets around us, we can easily notice where the old wooden windows have been replaced with new plastic or glued-laminated wooden frames. While in the case of listed buildings a change of window division and colour scheme will not be permitted by the conservation officer, in the case of other houses and structures, not under the supervision of conservation authorities, newly installed windows often differ from the original ones in terms of division and colours, which spoils the initial appearance of the exterior wall.

What appears to be the main advantage of the new single-frame windows, i.e. their very good air tightness, is at the same time their chief disadvantage, because the air in occupied rooms must be exchanged continuously 1.5 times per hour. Modern windows do not ensure this rate of air exchange, even with trickle ventilation system, since they are usually intended and designed for buildings provided with continuous ventilation or air-conditioning systems. With airtight windows and room temperature set to 22C, insufficient air exchange causes accumulation of water vapour and creates ideal conditions for the growth of mould that generates toxic substances, harmful to human health. Thus, after window replacement, rooms have to be constantly aired or, what is worse, windows have to be kept open all the time, which completely contradicts the purpose of thermal upgrading through window replacement.

What should be done?

At the beginning of a repair project it is necessary to correctly appraise the historical and architectural value of the window frames. It is often sufficient to carry out restoration works – strip the old paint coats, repair small timber elements, fix the hardware, replace single panes with double glazing and seal the inner lights with an extra gasket, without eliminating air infiltration altogether. The outer lights should not be sealed.

While recoating, the previous, exposed colour should be used (not necessarily the latest one), according to the colour scheme of the wall finish. If multiple coats are to be used, care must be taken to coat the rabbets only once. More paint coats might prevent the window from closing completely. Another suitable solution for single windows (np. krosnowych) is to leave them and install single-frame sashes on the inside, to form a casement window. For casement windows (especially those with muntins), the outer sashes should be left, and the inner sashes may be replaced with single-frame ones. As a result, a triple-glazed window will be obtained, which will improve both thermal and acoustic conditions. Natural inner casements should not be divided so as not to double the muntins in a perspective view.

Such windows meet all requirements without spoiling the appearance of the façade. Where the outer sashes are in a very poor state of repair, it is possible to reconstruct them, adding

single-frame windows on the inside. The use of single-frame windows entails a certain annoying problem, namely the conspicuous insulating spacers, situated on the inner perimeter of the glazing units. The spacers are particularly noticeable in windows coated with coloured paint or wood stain. It is important to select the insulating spacers according to the colour of the frame, from the range of several colours available. Otherwise they should be carefully painted, so as not to cover the perforations.