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Specialist article

In the frame for success: Influential variables in the thermal separation of metal windows, doors and façades

From the outside, efficient thermal insulation of aluminium windows is barely visible. Nevertheless, it is a key factor when it comes to having a comfortable and energy-saving living environment. In order to reduce the thermal transmission coefficient of the metal frame (U_f value), the external aluminium shell is thermally separated from the internal one. To do this, insulating bars made from engineering plastics (for example insulbar from Ensinger) are incorporated between the metal profiles, and direct heat dissipation via the aluminium is interrupted. Through this separation, an insulation zone is generated in the interior of the frame assembly. The design engineer has a variety of options available, when creating this zone, for optimising the thermal insulation and bringing about a desired U_f value using construction measures. At the heart of these are the different types of heat transfer.

Types of heat transfer

Heat is energy which, by means of thermal conduction (transmission), heat convection and radiation (emission), always flows towards where the temperature is lower.

Figure 1: Thermal conduction

Thermal conduction is dependent on the material. The energy, in solids, is passed on through the increased movement of the particles. In this way the heat energy is transferred to neighbouring particles. Example: Heating of water on a hob.

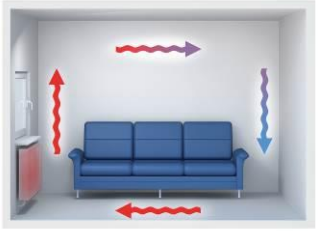

Figure 2: Convection

With convection, heat energy is transported by a moving fluid (liquid or gas). A typical hallmark is the convection cell in which liquid or gas circulates between heat source and heat sink. Example: Air circulation in a heated room.

With heat radiation, the energy is transported by means of electromagnetic (usually infra-red) waves. Example: The reflective surface on the inside of Thermos flasks reduces – by means of reflection – the loss of heat via heat radiation.

Figure 3: Heat radiation

Optimising the insulation zone

With non-thermally-separated metal frames, in a cool climate valuable heat is lost from the inside to the outside. Where the environment is hotter, heat penetrates from the outside into the inside of what is often an air-conditioned building. This results in high energy losses. However, the flow of heat can be greatly reduced through correspondingly optimised thermal separation. For efficient insulation tailored to the particular requirements, the combination and fine adjustment of several individual influential variables in the insulation zone is required. Here it is above all the individual types of heat transfer that form the starting point:

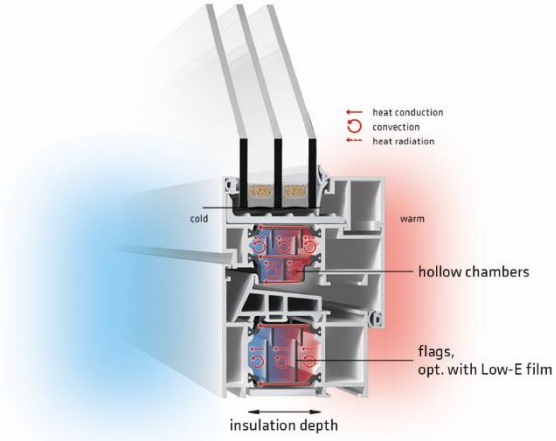

Figure 4: For efficient insulation of the metal frame, the combination and fine adjustment of several influential individual variables is required.

- In order to minimise heat conduction, thermal insulating bars made from material with low conductivity, but high strength are used, for example from glass fibre-reinforced polyamide 66.
- The reduction of wall thicknesses and increase in insulation depths of these insulating profiles are further possibilities for keeping the heat transfer through transmission at a low level.
- A reduction in the size of the hollow chambers within the insulation zone minimises the air circulation. Insulating profiles with hollow chambers or profiles with inwardly directed flags generate such smaller convection cells.
- A very effective method is the use of insulating bars with a flag onto which a thin Low-E film is applied. This aluminium foil ensures a high level of reflection of the radiation and works in a similar way to the Thermos flask principle.

Step by step to the desired U_f value

Figure 5 shows by means of sample cross sections how, using the above-named measures and with the aid of insulbar insulating profiles from Ensinger, the U_f value can be gradually optimised in heat technology terms. By changing the individual parameters, the thermal transmission coefficient is minimised down to the desired target value.

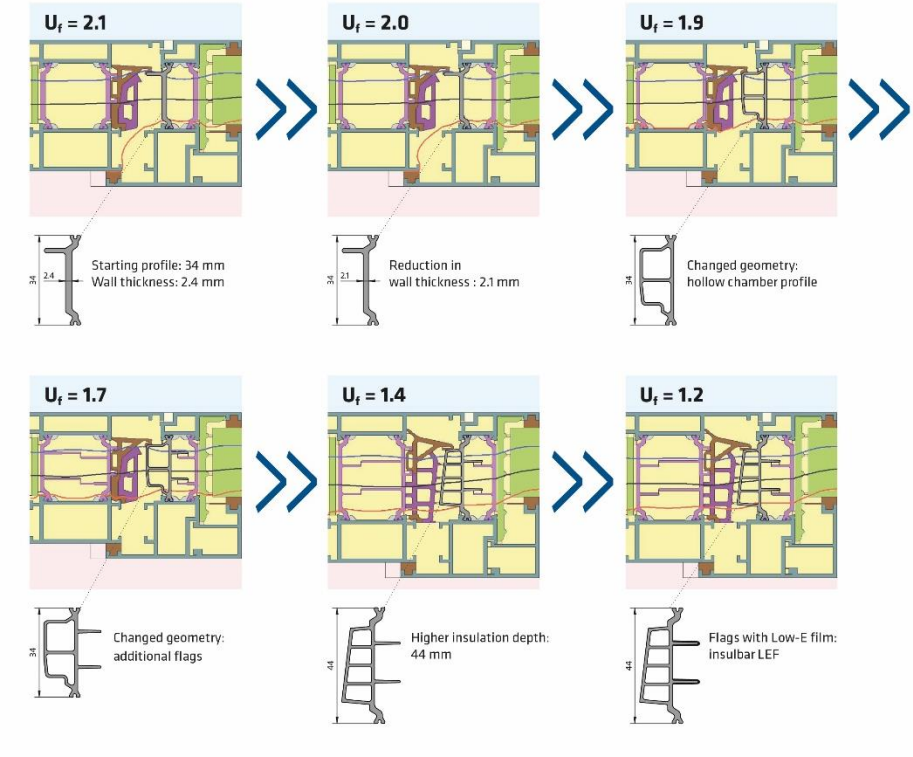

Figure 5: Step by step to the desired U_f value

Summary: A winning combination!

Across the world, non-thermally-separated metal systems are increasingly a thing of the past thanks to ever more stringent government regulations and rising energy costs. In order to thermally separate aluminium frames efficiently, the developer has several possibilities but must combine the individual adjustable elements with one another. This is because optimisation, in heat technology terms, using only one single influential factor has its functional and mechanical limits. For example, particular minimum wall thicknesses are needed to guarantee the required strength of the thermal insulating profile. A particular cost specification can also have a limiting effect on the design of the insulation zone. If, however, the named influential variables are carefully tailored to each other, then in combination the optimum thermal insulation and the desired U_f value can be achieved for the particular visible width. In this way valuable energy savings can be made and simultaneously the living comfort be significantly improved.

Picture credits: Ensinger GmbH

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About insulbar

Ensinger GmbH is among the world's leading developers and producers of insulating profiles for window, door and façade construction. The profiles marketed under the brand name insulbar® create a thermal separation between the inside and outside shells of metal frames. Insulation systems using insulbar profiles achieve optimum values in terms of energy savings and cutting the cost of heating and cooling. At the same time, insulbar profiles comply with the most stringent quality standards in every respect. They have already been in successful operation around the world for more than 40 years. For more information, go to www.insulbar.de/en

About Ensinger

The Ensinger group is engaged in the development, manufacture and sale of compounds, semi-finished materials, profiles and technical parts made of engineering and high-performance plastic. Ensinger makes use of a number of different manufacturing methods, in particular extrusion, machining and injection moulding. Employing a total workforce of 2,400 in 33 locations, the family firm is represented in many important industrial regions of the world with its own production plants or sales branches. For more information, go to www.ensingerplastics.com

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