LINEAR THERMAL TRANSMITTANCE OF A GLAZING SPACER ACCORDING TO EN ISO 10077-2

1. Introduction

The calculation of the linear thermal transmittance of a glazing spacer according to EN ISO 10077-2 requires two BISCO simulations. A first one, with a standardised insulation panel instead of the glazing, results in the thermal transmittance of the frame (U_f). From this value and from a second simulation, with a specific glazing, the linear thermal transmittance of the glazing spacer can be derived.

2. Case study

BISCO data sample_frame_glazing_spacer_0.bsc
BISCO data sample_frame_glazing_spacer_1.bsc
BISCO data sample_frame_glazing_spacer_1_transmat.bsc

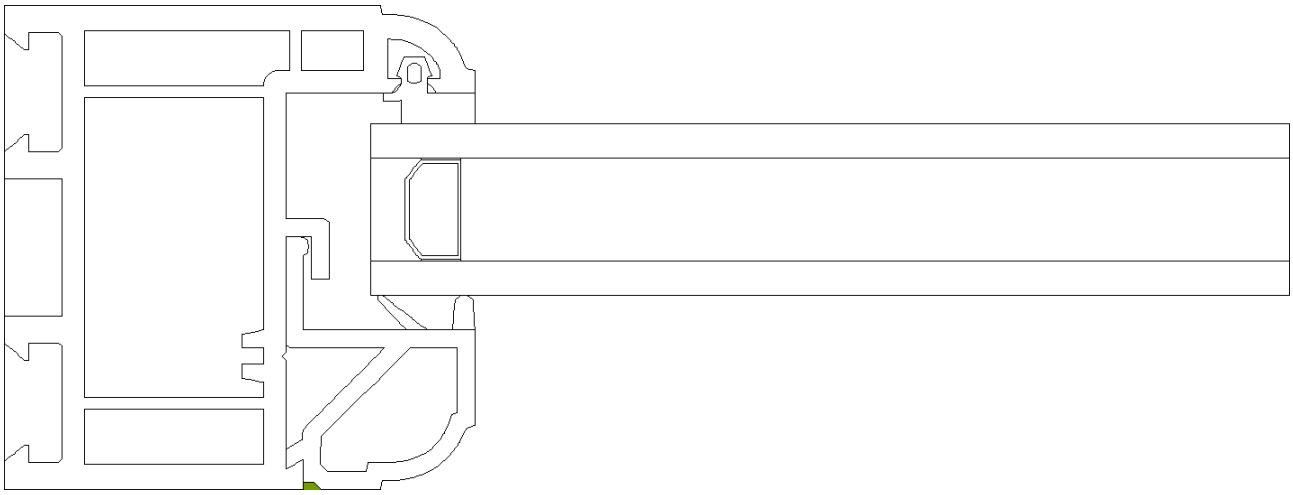

Figure 1. Window frame and glazing section.

The glazed PVC frame shown in Figure 1 is used as an example.

Double-glazing data:
- glazing of 4 mm with low emissivity coating ε = 0.02
- argon filled cavity of 12 mm
- glazing of 4 mm.

The U-value of this glazing according to EN 673 is 1.19 W/m^{2}K.

In accordance with EN 10077-2, the calculation of the linear transmittance of the glazing spacer ψ_{spacer} needs 2 numerical simulations:
- Simulation 1: Section of Figure 1 with the glazing replaced by an insulation panel in order to derive the thermal transmittance of the frame U_f.
- Simulation 2: Section of Figure 1 with glazing in order to derive the linear transmittance ψ_{spacer}.

3. Simulation 1: with insulation panel[1]

The U-value if the frame is derived from the simulation results using the formula:

$$U_{frame} = \frac{L_{2D} - U_{panel} w_{panel}}{w_{frame}}$$

U_{frame}	thermal transmittance of the window frame	[W/m²K]
L_{2D}	two-dimensional conductance calculated by BISCO	[W/mK]
U_{panel}	thermal transmittance of the insulation panel	[W/m²K]
w_{panel}	width of the insulation panel	[m]
w_{frame}	width of the window frame	[m]

In this example (BISCO data sample_frame_glazing_spacer_0.bsc) U_{frame} = 1.48 W/m²K.
The graphical results are shown in Figure 2.

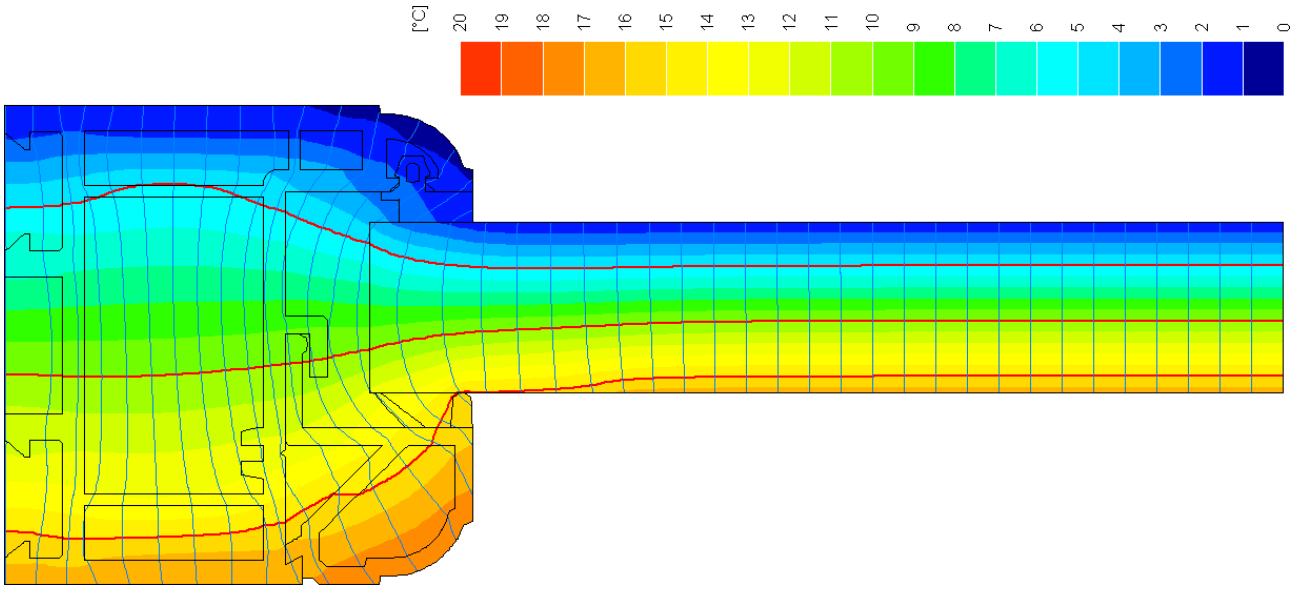

Figure 2. Simulation 1: isotherms and heat flow lines (increment 0.1 W/m).

[1] 10077-2:2017 provides 2 methods to determine the heat transport within air cavities. For the examples in this document the Equivalent thermal conductivity' method is applied (type EQUIMAT).

4. Simulation 2 : with glazing

A numerical simulation is done for the frame with the double-glazing. For the glazing cavity an equivalent thermal conductivity is derived from the U-value of the glazing, using the formula:

$$U_{glazing} = \frac{1}{\frac{1}{h_e} + \frac{d_{glass}}{\lambda_{glass}} + \frac{d_{cavity}}{\lambda_{cavity}} + \frac{1}{h_i}}$$

$U_{glazing}$	thermal transmittance of the glazing	[W/m²K]
h_i, h_e	internal and external surface coefficient	[W/m²K]
d_{glass}	total thickness of the 2 glass sheets	[m]
λ_{glass}	thermal conductivity of glass	[W/mK]
d_{cavity}	cavity width	[m]
λ_{cavity}	equivalent thermal conductivity of the cavity	[W/mK]

In this example (spreadsheet glazing_cavity_lambda_eq.xlsx) λ_{cavity} = 0.0181 W/mK.

The linear transmittance of the spacer ψ_{spacer} is derived from the simulation results using the formula:

$$\Psi_{spacer} = L_{2D} - U_{frame} w_{frame} - U_{glazing} w_{glazing} \quad [W/mK]$$

ψ_{spacer}	linear transmittance of the spacer	[W/mK]
L_{2D}	two-dimensional conductance calculated by BISCO	[W/mK]
U_{frame}	thermal transmittance of the window frame[2]	[W/m²K]
w_{frame}	width of the window frame	[m]
$U_{glazing}$	thermal transmittance of the glazing	[W/m²K]
$w_{glazing}$	width of the glazing	[m]

In this example (BISCO data sample_frame_glazing_spacer_1.bsc)

ψ_{spacer} = 0.2761 - 1.48 x 0.0549 – 1.189 x 0.0951 W/mK

ψ_{spacer} = 0.082 W/mK

The graphical results are shown in Figure 3.

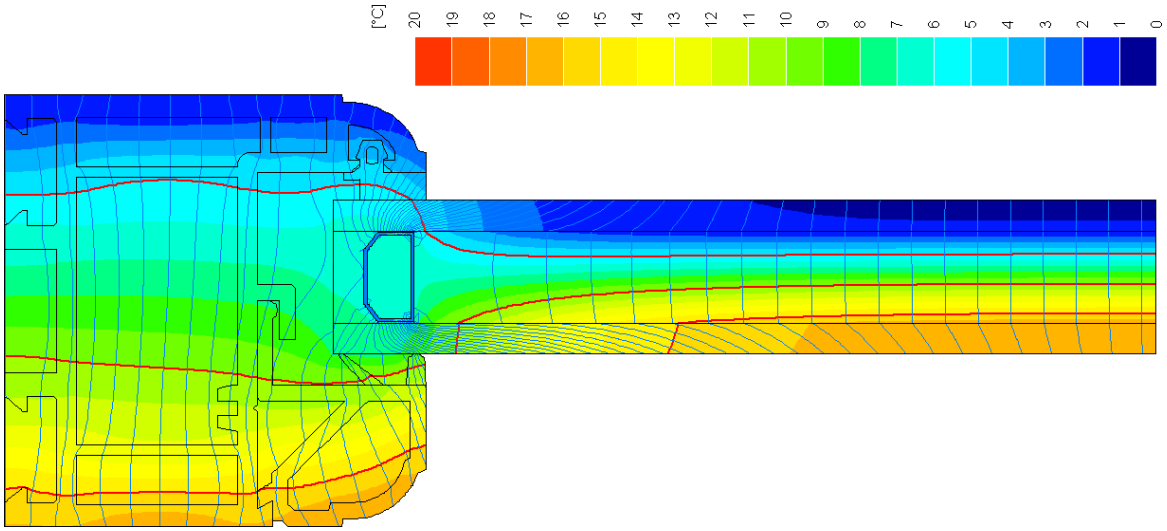

Figure 3. Simulation 2: isotherms and heat flow lines (increment 0.1 W/m).

[2] Imposed in the 'Window Border U-value' via the column 'Enforced U-value'

5. Alternative simulation 2.

BISCO with the RADCON module allows treating the glazing cavity as a transparent gas (type TRANSMAT). In this way the infrared radiation between the cavity surfaces and the conduction through the gas (Nusselt = 1) are simulated separately.

The procedure for using the RADCON module in this example is as follows:
(BISCO data sample_frame_glazing_spacer_1_transmat.bsc)

- define the glazing cavity as a TRANSMAT type with a thermal conductivity of argon = 0.01684 W/mK (according to EN 673)
- apply a coating on the upper glass (colour 16) and define λ = 1 W/mK (glass) and e = 0.02 (the emissivity of the coating)
- define the emissivity of glass (colour 18) e = 0.837 (non-coated according to EN 673)
- in the Calculation Parameters, use linear radiation with a black radiation coefficient = 5.15 W/m^{2}K (according to EN 673).

The calculation of the linear transmittance is as described in section 4.

ψ_{spacer} = 0.281 - 1.48 x 0.0549 – 1.188 x 0.0951 W/mK

ψ_{spacer} = 0.087 W/mK

The heat flow is somewhat higher than in the value found without the TRANSMAT type (section 4), but is physically more correct.
The graphical results are shown in Figure 4. There are no heat flow lines in the cavity, because of the combined conduction and radiation. Heat flow lines can only be visualised in case of pure conduction.

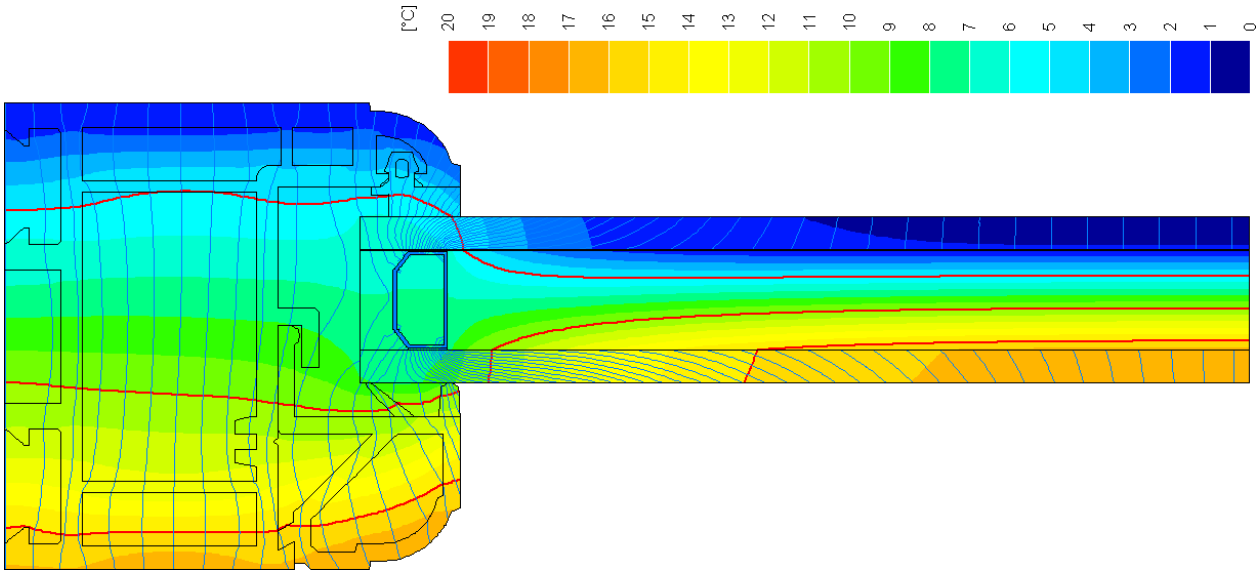

Figure 4. Alternative simulation 2: isotherms and heat flow lines (increment 0.1 W/m).

6. References

EN ISO 10077-2:2017: Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 2: Numerical method for frames

ISO 12631:2012: Thermal performance of curtain walling - Calculation of thermal transmittance (ISO 12631:2012)