HEAT LOSSES
FROM A RADIATOR TO A GLAZED FAÇADE

1. Introduction

The heat losses through an external wall behind a radiator (Figure 1) are higher than the ones estimated by a standard wall heat loss calculation. This is mainly due to radiation.
An example shows how to investigate the supplementary radiation heat loss and how to evaluate improvements such as radiation shields.

Figure 1. Radiators in front of a glazed façade (building Alma III, Heverlee)

2. Standard heat loss simulation (EN ISO 6946)

BISCO data [radiator_window_0.bsc]

Standard calculation procedures for heat losses through external walls such as EN ISO 6946[1] assume an internal global heat transfer coefficient h_i = 7.7 W/m^{2}K. The value is representative for natural convection (about 2.5 W/m^{2}K) and infrared radiation (about 5.2 W/m^{2}K) from the interior of the building to the internal wall surface.
For the configuration shown in Figure 1 such a 2D standard calculation was done.
The indoor environment is modelled using the BC_SIMPL type. Although the radiator is present, no interaction with the glazing and floor is considered. Figure 2 shows the isotherms and heat flow lines. The total heat loss through window and floor amounts to **76.2 W/m**.

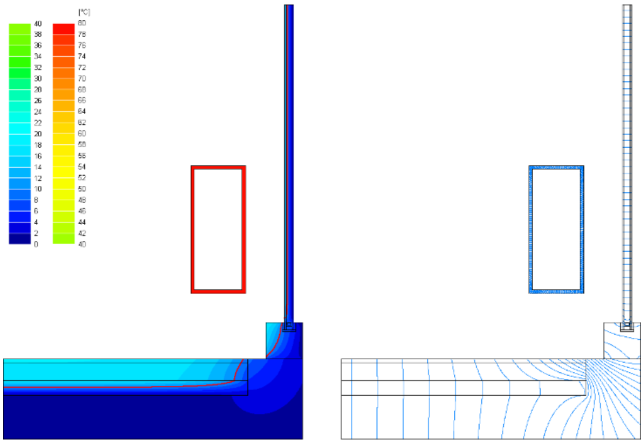

Figure 2. Simulation with global heat transfer: isotherms (left, colour increment 2 °C, line increment 10 °C) and heat flow lines (right, increment 1 W/m).

[1] EN ISO 6946: 2017 Building components and building elements -- Thermal resistance and thermal transmittance -- Calculation methods

3. Radiation and convection heat loss simulation

BISCO data radiator_window_1.bsc

Using the BC_SKY type (part of the RADCON feature) instead of the BC_SIMPL type, the radiation and convection are modelled separately. Figure 3 shows the equivalent resistance network. Radiation exchange between each couple of elementary surfaces and between each elementary surface and "the sky" is simulated using a view factor based radiosity model. The user only needs to define the surface emissivity ε and the sky temperature.
In the example ε = 0.9 for all material surfaces and θ_{sky} = 20 °C are assumed. Convection exchange between each elementary surface and the air temperature is simulated using a convective heat transfer coefficient h_c. A value h_c = 2.5 W/m^{2}K is applied. A higher value can be expected on the glazing behind the radiator and therefore the data could be improved. Also a much higher value can be expected for the radiator surface, but this will not affect the heat loss through the building envelope.

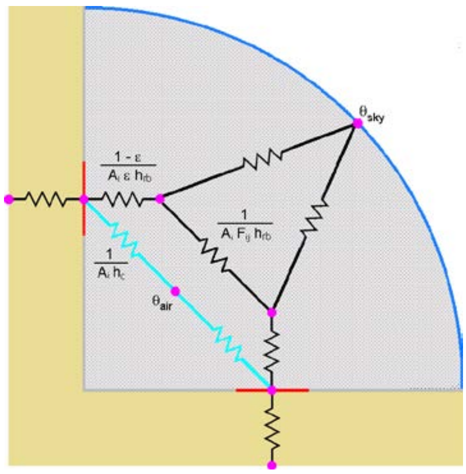

Figure 3. BC_SKY resistance network

Figure 4 shows the isotherms and heat flow lines. The total heat loss through window and floor amounts to **141.9 W/m** (+86 % compared to the standard procedure result of 76.2 W/m). The heat flow density behind and under the radiator are much higher now.
As high surface temperatures occur on the glazing (38 °C) it can be expected that the convective heat transfer coefficient will be higher than 2.5 W/m^{2}K and therefore the result above is conservative.

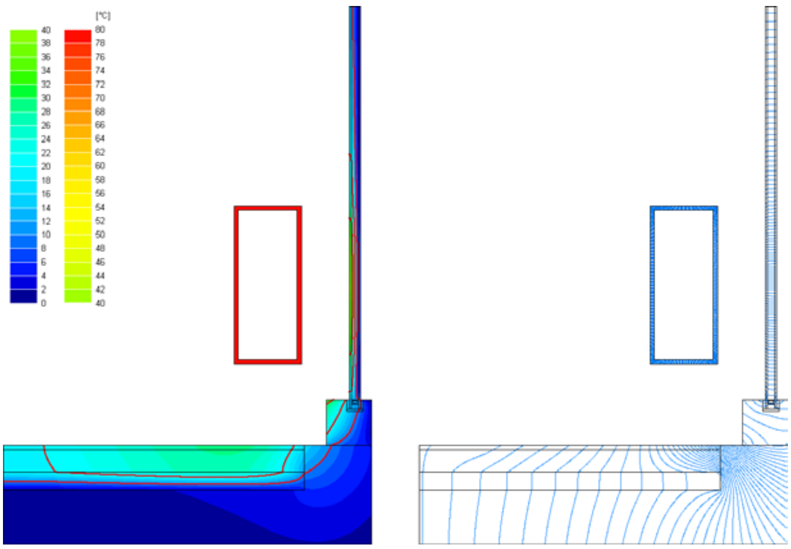

Figure 4. Simulation with radiation and convection:
isotherms (left, colour increment 2 °C, line increment 10 °C)
and heat flow lines (right, increment 1 W/m).

4. Radiation and convection heat loss simulation with shielding

BISCO data [radiator_window_2.bsc]

Compared to the previous simulation only a shielding (made of insulation, plywood and aluminium paper with emissivity ε = 0.1) is added to the configuration. Figure 5 shows the isotherms and heat flow lines. The total heat loss through window and floor amounts to **69.5 W/m** (-9 % compared to the standard procedure result of 76.2 W/m). The heat flow density behind and under the radiator are much lower now. The shielding is very efficient.

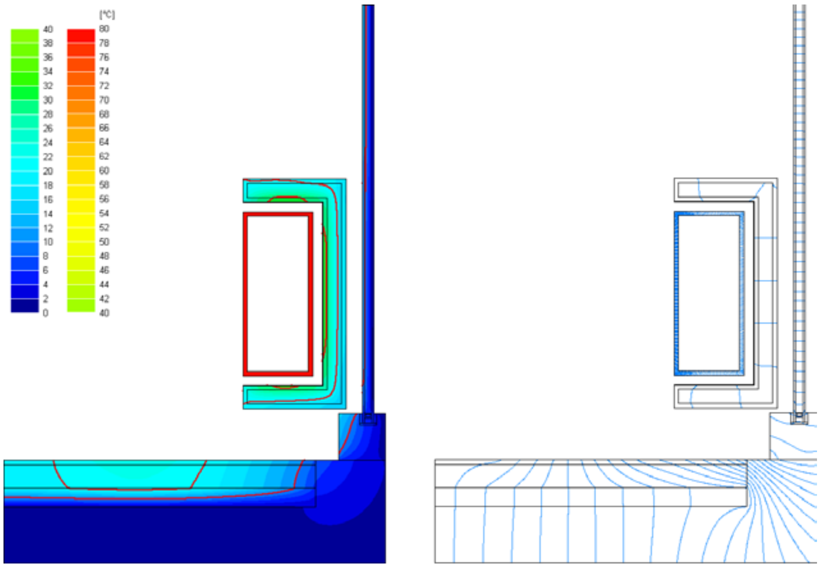

Figure 5. Simulation with radiation and convection with shielding:
isotherms (left, colour increment 2 °C, line increment 10 °C)
and heat flow lines (right, increment 1 W/m).