

1. Introduction

The standard ISO 10077-2:2017¹ allows 2 methods for simulating the heat transfer in air cavities:

1. The single equivalent thermal conductivity method.
In BISCO the **EQUIMAT** type uses this method.
The standard Annex I contains the validation examples.
2. The radiosity method.
In BISCO the **TRANSMAT** type (requiring the RADCON module) uses this method.
The standard Annexes G and H contain the validation examples.

The examples are calculated using the program BISCO version 13 and compared to the standard figures.

2. Summary of results for Annex I examples (examples of window frames)

Table 1 contains the two-dimensional conductance L^{2D} and the frame thermal transmittance U or the linear thermal transmittance Ψ for the examples of Annex I. The simulations were done using the single equivalent thermal conductivity method, using EQUIMAT for cavities.

The validation criterion (maximum deviation of 3% on the L^{2D} -value) is fulfilled for all examples.

Table 1 – Results for Annex I examples (window frames)

Example	I.1	I.2	I.3	I.4	I.5	I.6	I.7	I.8	I.9		I.10
L^{2D}_{REF} [W/mK]	0.550	0.263	0.424	0.346	0.408	0.659	0.285	0.181	0.207		0.481
L^{2D}_{BSC} [W/mK]	0.553	0.264	0.428	0.345	0.406	0.666	0.283	0.182	0.207		0.480
$\Delta L^{2D}_{BSC-REF}$ [%]	0.5	0.4	1.0	-0.4	-0.5	0.3	-0.8	0.6	-0.1		-0.1
U_{REF} [W/m ² K]	3.22	1.44	2.07	1.36	2.08	4.67	1.31	1.05	3.64	Ψ_{REF} [W/mK]	0.08
U_{BSC} [W/m ² K]	3.25	1.45	2.11	1.35	2.07	4.70	1.26	1.03	3.63	Ψ_{BSC} [W/mK]	0.08
$\Delta U^{2D}_{BSC-REF}$ [%]	0.9	0.7	2.0	-0.7	-0.6	0.6	-3.8	-2.0	-0.4	$\Delta \Psi_{BSC-REF}$ [%]	-0.0
Number of nodes [-]	54484	104605	61031	65106	71569	42788	40747	159913	184924		64637
DFX input file	I1_EQ	I2_EQ	I3_EQ	I4_EQ	I5_EQ	I6_EQ	I7_EQ	I8_EQ	I9_EQ		I10_EQ
BISCO data file	I1_EQ	I2_EQ	I3_EQ	I4_EQ	I5_EQ	I6_EQ	I7_EQ	I8_EQ	I9_EQ		I10_EQ

¹ EN ISO 10077-2:2017 Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – Part 2: Numerical method for frames

3. Summary of results for Annex H examples (examples of window frames)

Table 2 contains the two-dimensional conductance L^{2D} and the frame thermal transmittance U or the linear thermal transmittance Ψ for the examples of Annex H. The simulations were done using the radiosity method, using TRANSMAT for non-ventilated cavities and using BC_SIMPL ($h = 3.33 \text{ W/m}^2\text{K}$) for slightly ventilated cavities. The validation criterion (maximum deviation of 3% on the L^{2D} -value) is fulfilled for all examples.

Table 2 – Results for Annex H examples (window frames)

Example	H.1	H.2	H.3	H.4	H.5	H.6	H.7	H.8	H.9	H.10		H.11
$L^{2D}_{REF} [\text{W/mK}]$	0.539	0.508	0.252	0.400	0.344	0.407	0.637	0.281	0.188	0.208		0.478
$L^{2D}_{BSC} [\text{W/mK}]$	0.537	0.506	0.252	0.400	0.344	0.407	0.630	0.282	0.190	0.208		0.479
$\Delta L^{2D}_{BSC-REF} [\%]$	-0.4	-0.4	0.0	0.0	0.0	0.0	-1.1	0.4	1.1	0.0		0.1
$U_{REF} [\text{W/m}^2\text{K}]$	3.11	2.83	1.35	1.86	1.34	2.07	4.44	1.23	1.06	3.64	$\Psi_{REF} [\text{W/mK}]$	0.08
$U_{BSC} [\text{W/m}^2\text{K}]$	3.10	2.82	1.35	1.85	1.34	2.07	4.37	1.24	1.07	3.65	$\Psi_{BSC} [\text{W/mK}]$	0.08
$\Delta U^{2D}_{BSC-REF} [\%]$	-0.3	-0.4	0.0	-0.5	0.0	0.0	-1.6	0.8	1.0	0.3	$\Delta \Psi_{BSC-REF} [\%]$	2.5
Number of nodes [-]	56277	56299	106110	64125	65155	69308	44034	42041	65947	188129		64686
DXF file	H1_TM	H2_TM	H3_TM	H4_TM	H5_TM	H6_TM	H7_TM	H8_TM	H9_TM	H10_TM		H11_TM
BISCO data file	H1_TM	H2_TM	H3_TM	H4_TM	H5_TM	H6_TM	H7_TM	H8_TM	H9_TM	H10_TM		H11_TM

4. Summary of results for Annex G examples

Table 3 contains the analytical and BISCO results for the 4 variants of example G.1.

Table 4 contains the analytical and BISCO results for the example G.2.

Figure 1 contains the analytical and BISCO results for the example G.3 (the grid temperatures obtained by BISCO rounded to 1 decimal are identical to the analytical ones (Graphic output → label node temperatures)).

Table 5 contains the BISCO results for the example G.4.

The validation criteria of the standard are fulfilled in all cases.

Table 3 – Results for G.1 example (concentric cylinders)

Variant	Radiation heat flow [W/m]		BISCO data file
	Analytical	BISCO	
A	44.12	44.07	G1A.bsc
B	5.15	5.15	G1B.bsc
C	8.29	8.29	G1C.bsc
D	3.42	3.42	G1D.bsc

Table 4 – Results for G.2 example (vacuum within a square cavity)

Surface	Temperature [$^{\circ}\text{C}$]		BISCO data file
	Analytical	BISCO	
S_{11}	4.67	4.67	G2.bsc
S_{12}	7.25	7.25	
S_{13}	9.18	9.18	
S_{14}	13.89	13.89	

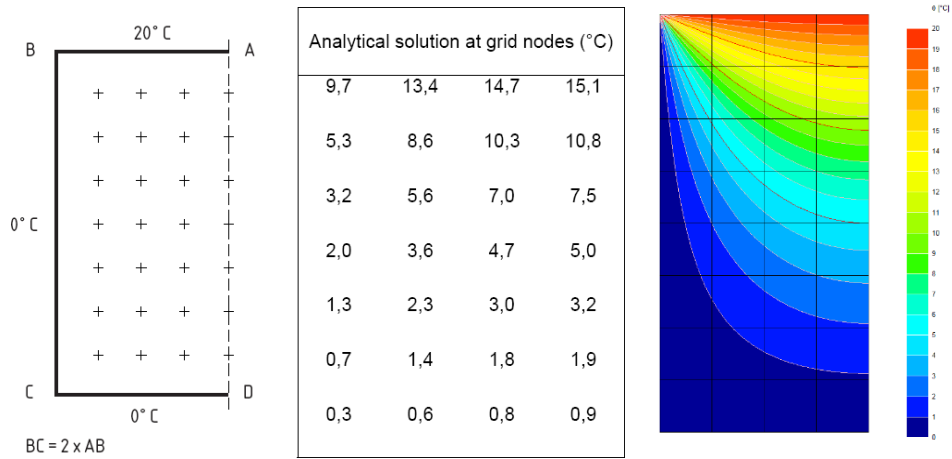


Figure 1. Data and results for G.3 example (half square column with specified temperatures) [G3.bsc](#).

Table 5 – Results for G.4 example (air cavity)

Cavity equivalent conduction direction	21.72 ° (21.8 °)	BISCO data file G4.bsc
Cavity equivalent conductivity	0.047 W/mK (0.048 W/mK)	
Total heat flow	0.828 W/K (0.826 W/K)	