THE CONCEPT OF MESHING IN BISCO (V13) AND THERM (V7.8)

1. Introduction

This document discusses differences in mesh settings between BISCO and THERM. In the first part, two abstract test cases are modelled using both programs. In the second part, a wooden and an aluminum window frame are analysed. The simulations were performed with BISCO version 13.0.05 and THERM version 7.8.

Finite Element Mesh in THERM

THERM automatically divides a 2D component's cross-section into non-overlapping quadrilateral elements for heat-transfer analysis. Its Quad Tree mesh parameter (range: 1–9) controls mesh fineness, with higher values creating finer meshes but requiring more computation time. The default "Mesh Parameter" value is 6 and 10% for the "Maximum % Error Energy Norm".

Setting	Value for NFRC Modeling
Quad Tree Mesh Parameter	6 or greater
Maximum % Error Energy Norm	10%
Run Error Estimator	must be checked

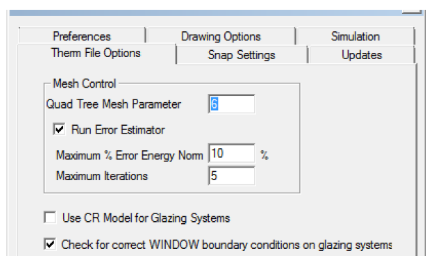


Figure 1. Options setting for THERM modelling

Triangulation Mesh in BISCO

BISCO uses a Delaunay triangulation mesh, connecting contour and inner nodes to maximize the smallest triangle angles. This produces a well-shaped mesh, resulting in a well-conditioned system for fast and stable solutions. Users can adjust the mesh size to achieve the desired level of detail, and results for various mesh settings are compared against the THERM reference case.

Measures

Col.		Width [pix.]	Width [m]	Height [pix.]	Height [m]	Area [pix.]	Zones	Triang. [pix.]
		1	0.0001	1	0.0001			
All		930	0.0930	2600	0.2600			20.00
15		830	0.0830	1100	0.1100	750100	2	20.00
18		280	0.0280	1650	0.1650	132000	2	20.00
60		540	0.0540	840	0.0840	18300	4	20.00
103		200	0.0200	127	0.0127	25400	1	20.00

2. Model Setup

model1_therm.thm model1.bsc
model2_therm.thm model2.bsc

Two models with identical geometry were analysed (Figure 1 and Figure 2). In model 2 more extreme thermal conductivity values are considered. A resolution of 0.05 mm/pixel was applied.

- Material Properties: Thermal conductivity and surface emissivity values were identical to those used in THERM.
- Boundary Conditions: Indoor temperature was set to 20 °C with a fixed global surface coefficient of 7.7 W/m²K, and outdoor temperature to 0 °C with a fixed global coefficient of 25 W/m²K.

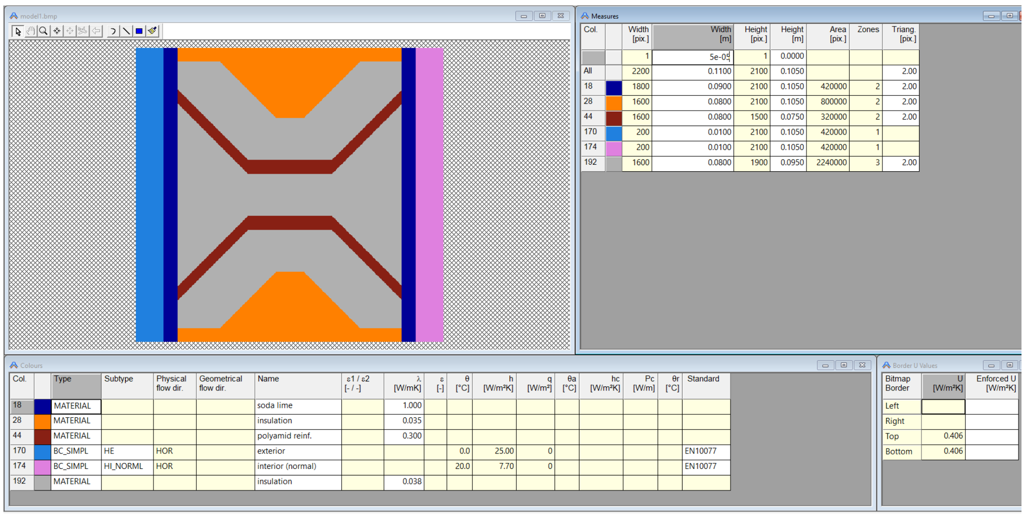


Figure 2. Model 1 data in BISCO format.

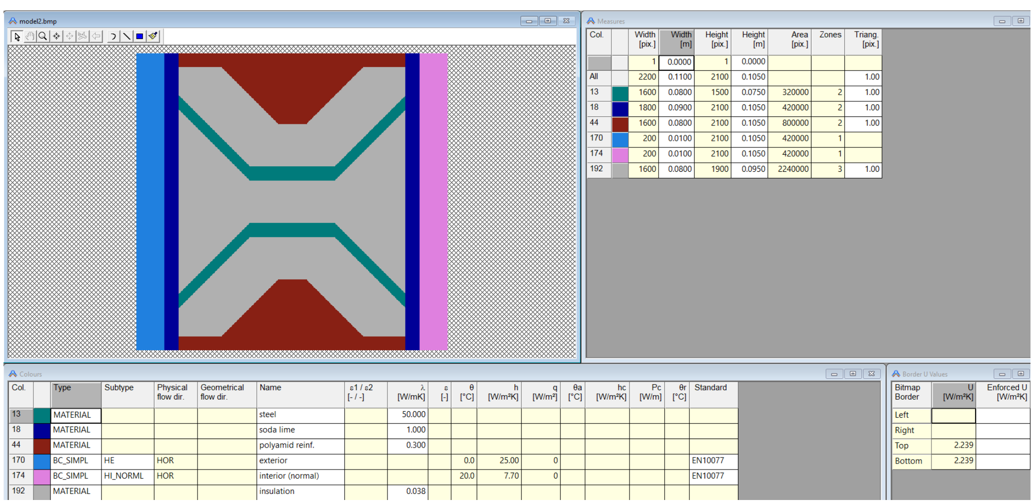
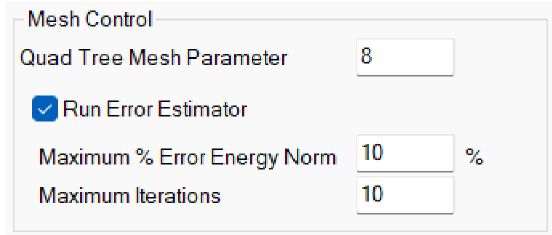


Figure 3. Model 2 data in BISCO format.

For each model, seven BISCO simulations were run with progressively finer meshes, ranging from 2,788 to 4,356,625 nodes. The THERM reference case used approximately 10,000 nodes with the settings as below.



The results of these simulations are shown as follows. (see also mesh_results.xlsx)

Pixel size	Triangle size	Triangle size	Number of nodes	log (nnodes)	Q	Relative error
mm/piz	pix	mm	-	-	W/m	%
0.05	80.0	4.000	2788	3.445293	1.28439	0.62
0.05	50.0	2.500	3682	3.566084	1.28296	0.51
0.05	20.0	1.000	12318	4.09054	1.28082	0.34
0.05	10.0	0.500	44048	4.643926	1.28030	0.30
0.05	5.0	0.250	174693	5.242276	1.27891	0.19
0.05	2.0	0.100	1086859	6.036173	1.27721	0.06
0.05	1.0	0.050	4356625	6.63915	1.27643	0.00
Therm	Mesh control 8/10/10		10054	4.002339	1.2794	0.23

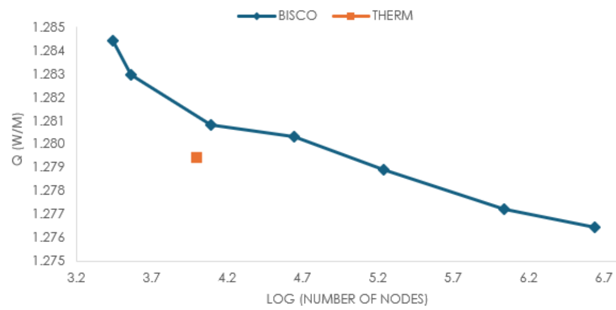


Figure 4. Model 1 – BISCO and THERM results

Pixel size	Triangle size	Triangle size	Number of nodes	log (nnodes)	Q	Relative error
mm/piz	pix	mm	-	-	W/m	%
0.05	80.0	5.000	2791	2.6618127	7.79360	4.083
0.05	50.0	2.500	3684	3.2260841	7.69753	2.800
0.05	20.0	1.250	12316	3.8328919	7.57253	1.131
0.05	10.0	0.500	43891	4.6342455	7.53323	0.606
0.05	5.0	0.250	173254	5.2401372	7.51438	0.354
0.05	2.0	0.125	1087991	5.8431381	7.49384	0.080
0.05	1.0	0.050	4356559	6.6943679	7.48787	0.000
Therm	Mesh control 8/10/10		10054	4	7.5054	0.234

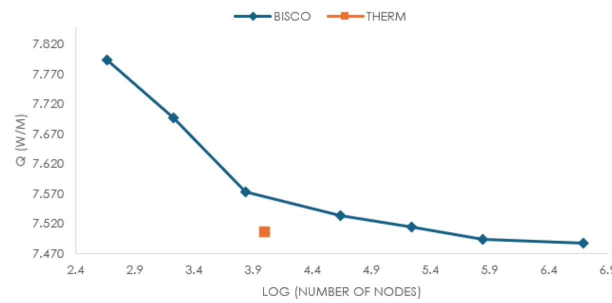


Figure 5. Model 2 – BISCO and THERM results

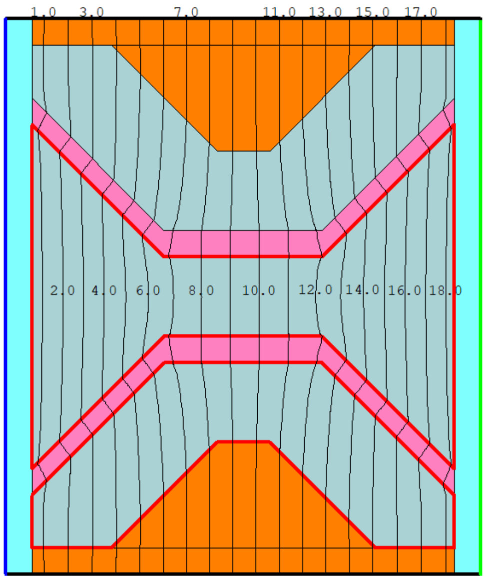


Figure 6. Model 1 THERM results: isotherms.

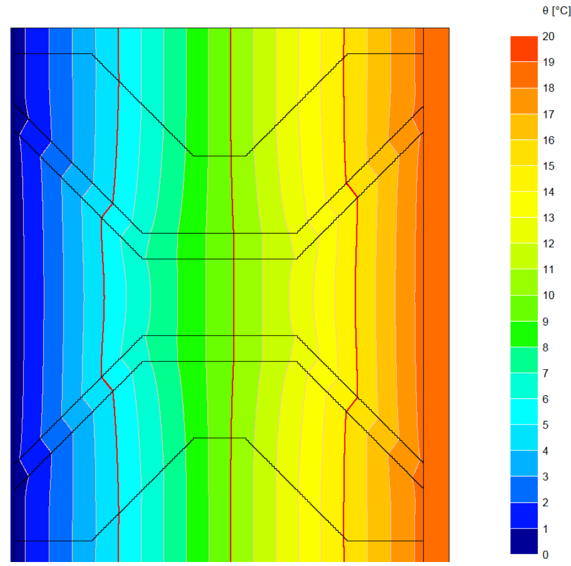


Figure 7. Model 1 BISCO results: isotherms.

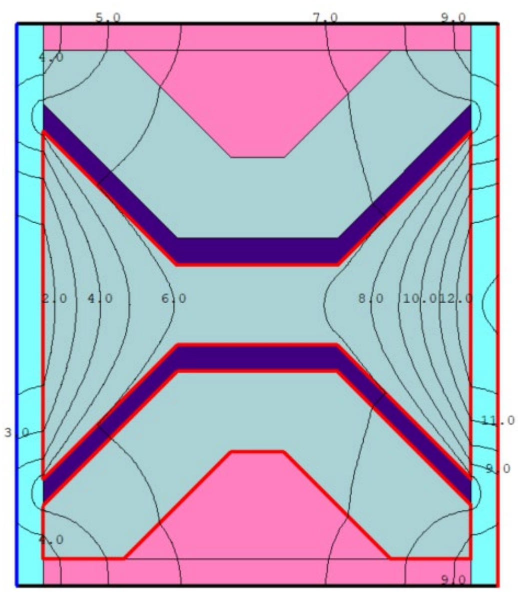


Figure 8. Model 2 THERM results: isotherms.

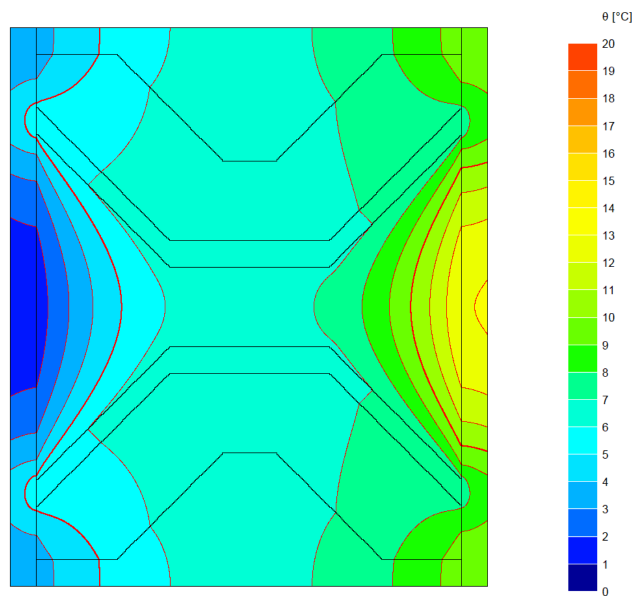


Figure 9. Model 2 BISCO results: isotherms.

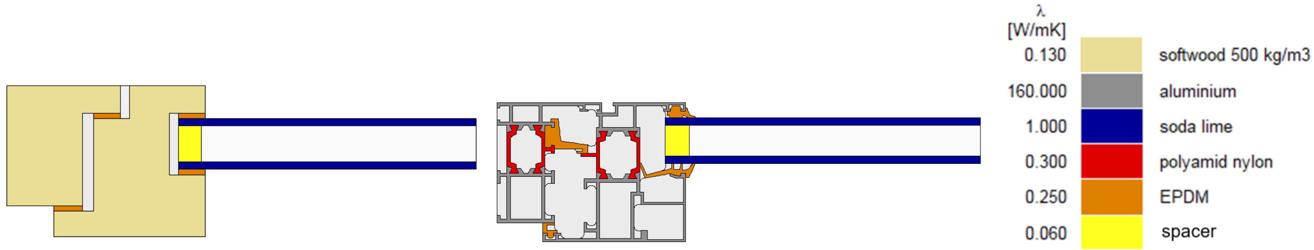
3. Window frame models

Two window frame models were analysed: a wooden frame and a thermally broken aluminium frame. For the BISCO simulations, a resolution of 0.1 mm/pixel was used. Material thermal conductivity and surface emissivity values were set identical to those in THERM.

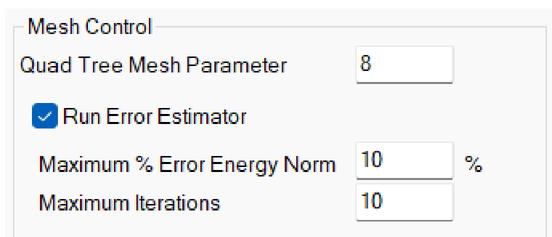
The boundary conditions follow the definitions as per NFRC 100:

Outdoor: exterior air temperature of –18°C, black body radiation with convective surface coefficient of 26 W/m2.K (type BC_SIMP, standard ISO 15099).

Indoor: air and radiation temperature of 21°C (auto enclosure model) (type BC_SKY).



The settings in THERM are set as below, resulting in approximately 2,600 nodes for wooden frame and 6,400 nodes for aluminium frame.

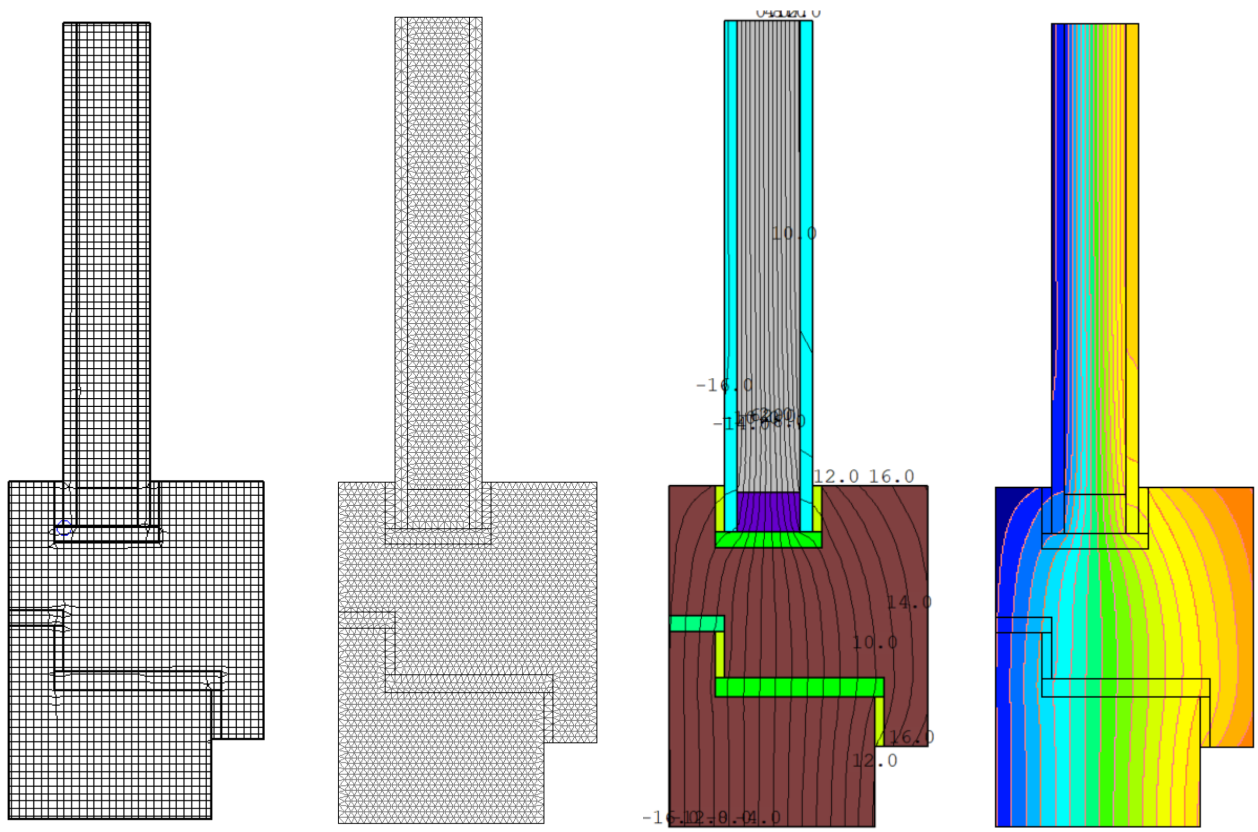


3.1. Wooden frame

Wooden_frame-Jamb.THM

Wooden_frame-NFRC.bsc

BISCO and THERM simulations for a sample wooden frame are compared.



Finite element mesh in THERM, default: 8.

Triangulation mesh in BISCO, default: 20.

Isotherms in THERM

Isotherms in BISCO

Pixel size	Triangle size	Triangle size	Number of nodes	log (nnodes)	Q	Relative error
mm/pix	pix	mm	-	-	W/m	%
0.1	80.0	8.000	345	2.5378191	15.13910	0.597
0.1	50.0	5.000	743	2.8709888	15.10100	0.344
0.1	20.0	2.000	3776	3.577032	15.06260	0.088
0.1	10.0	1.000	14971	4.1752508	15.05440	0.034
0.1	5.0	0.500	59202	4.7723364	15.05050	0.008
0.1	2.0	0.200	370668	5.5689851	15.04950	0.001
0.1	1.0	0.100	1485721	6.1719373	15.04930	0.000
Therm	Mesh control 8/10/10		2590	3.4132998	15.0458	-0.023

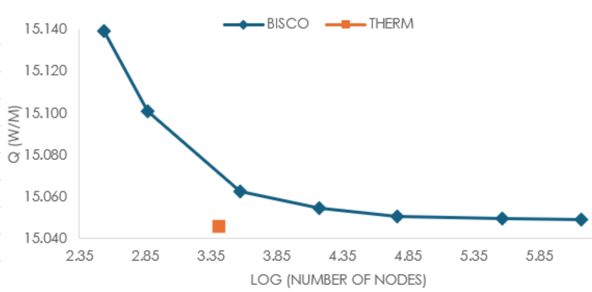


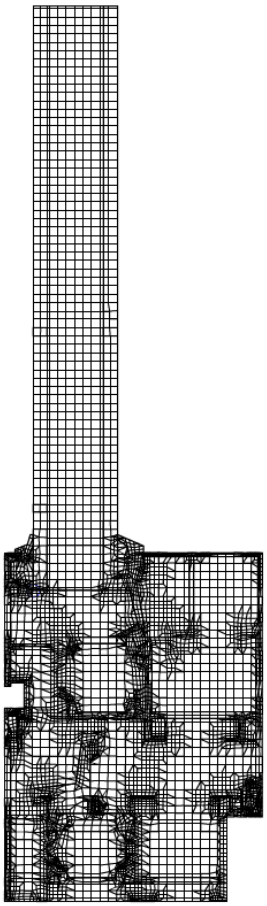
Figure 10. Wooden frame - BISCO and THERM results

3.2. Thermally broken frame.

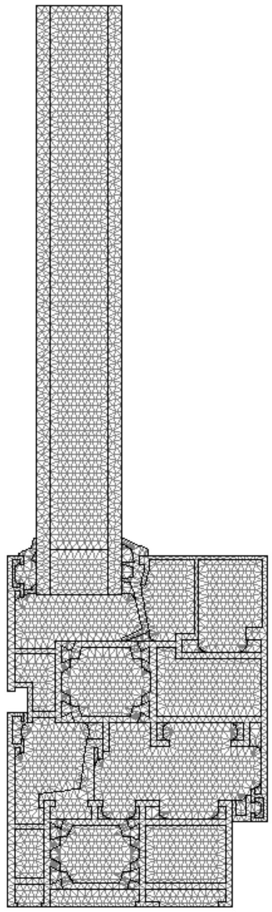
Alu_frame-Jamb.THM

Alu_frame-NFRC.bsc

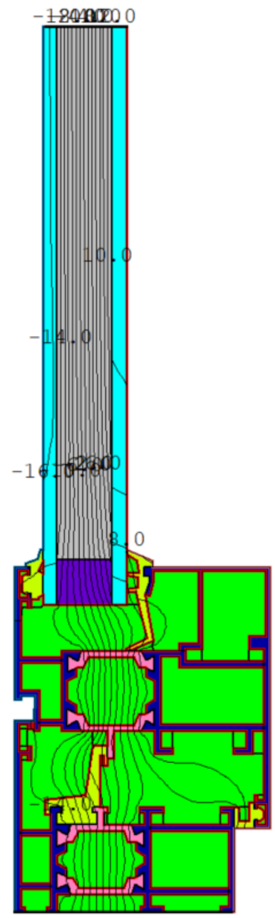
BISCO and THERM simulations for a sample thermally broken frame are compared.



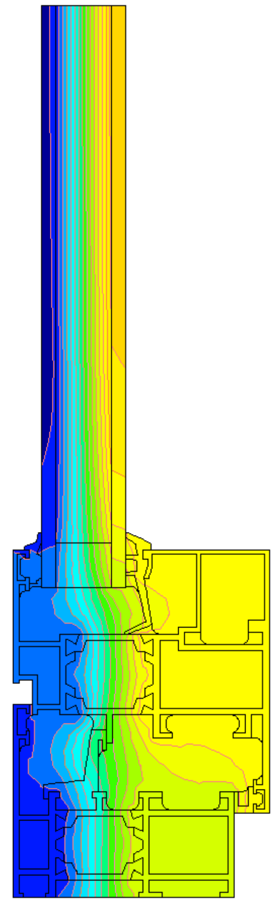
Finite element mesh in THERM, default: 8.



Triangulation mesh in BISCO, default: 20.



Isotherms in THERM



Isotherms in BISCO

Pixel size	Triangle size	Triangle size	Number of nodes	log (nnodes)	Q	Relative error
mm/pix	pix	mm	-	-	W/m	%
0.1	50.0	5.000	1581	3.198932	22.33030	2.049
0.1	20.0	2.000	4056	3.608098	22.08890	0.946
0.1	10.0	1.000	13081	4.116641	21.96740	0.391
0.1	5.0	0.500	49936	4.698414	21.90900	0.124
0.1	2.0	0.200	305744	5.485358	21.88250	0.003
0.1	1.0	0.100	1227129	6.08889	21.88190	0.000
THERM	Mesh control 8/10/10		6383	3.805025	21.9677	0.392

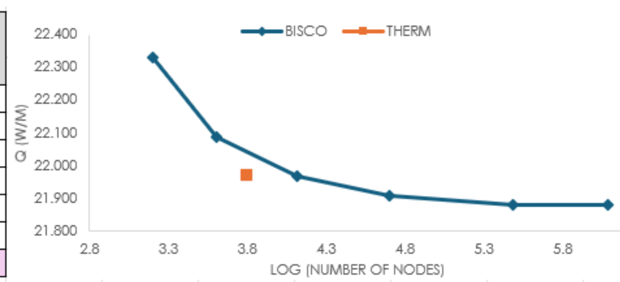


Figure 11. Thermally broken frame - BISCO and THERM results

Discussion

The results show an excellent agreement between BISCO and THERM. Compared to THERM, BISCO requires a grid with a higher number of nodes to achieve a precise result, especially when large thermal conductivity differences occur.