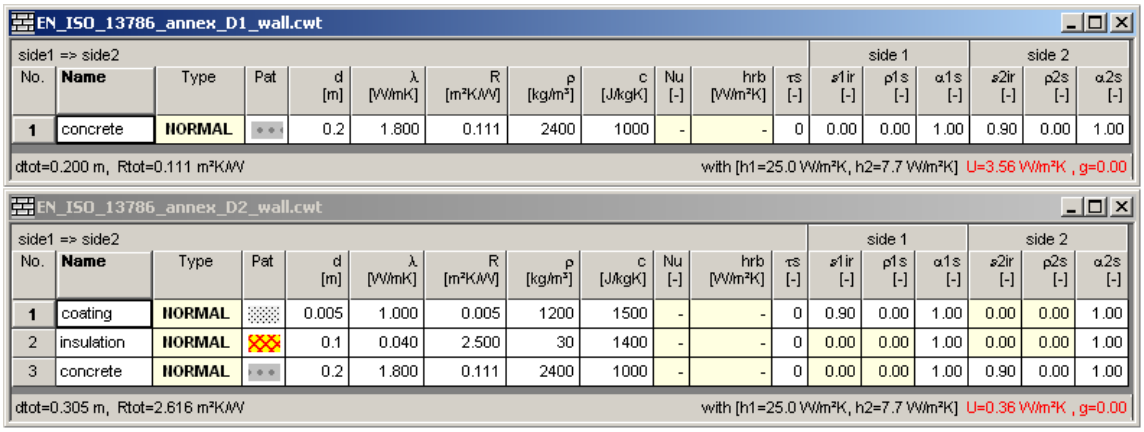
DYNAMIC THERMAL CHARACTERISTICS ACCORDING TO EN ISO 13786

Introduction

In EN ISO 13786[1], a method is given to calculate dynamic thermal characteristics of 1D building components. These characteristics can be derived using the transient Physibel programs CAPSOL (version 4.0w), BISTRA and VOLTRA. For the 2 example components given in annex D of the standard, the characteristics are derived using these programs.

Data highlights

The 2 example walls as defined in annex D of EN ISO 13786 are shown in CAPSOL format in Figure 1 (wall data files EN_ISO_13786_annex_D1_wall.cwt and EN_ISO_13786_annex_D2_wall.cwt).



EN_ISO_13786_annex_D1_wall.cwt

side1 => side2												side 1			side 2		
No.	Name	Type	Pat	d [m]	λ [W/mK]	R [m²K/W]	ρ [kg/m³]	c [J/kgK]	Nu [-]	hrb [W/m²K]	τs [-]	s1ir [-]	ρ1s [-]	α1s [-]	s2ir [-]	ρ2s [-]	α2s [-]
1	concrete	NORMAL		0.2	1.800	0.111	2400	1000	-	-	0	0.00	0.00	1.00	0.90	0.00	1.00

dtot=0.200 m, Rtot=0.111 m²K/W — with [h1=25.0 W/m²K, h2=7.7 W/m²K] U=3.56 W/m²K , g=0.00

EN_ISO_13786_annex_D2_wall.cwt

side1 => side2												side 1			side 2		
No.	Name	Type	Pat	d [m]	λ [W/mK]	R [m²K/W]	ρ [kg/m³]	c [J/kgK]	Nu [-]	hrb [W/m²K]	τs [-]	s1ir [-]	ρ1s [-]	α1s [-]	s2ir [-]	ρ2s [-]	α2s [-]
1	coating	NORMAL		0.005	1.000	0.005	1200	1500	-	-	0	0.90	0.00	1.00	0.00	0.00	1.00
2	insulation	NORMAL		0.1	0.040	2.500	30	1400	-	-	0	0.00	0.00	1.00	0.00	0.00	1.00
3	concrete	NORMAL		0.2	1.800	0.111	2400	1000	-	-	0	0.00	0.00	1.00	0.90	0.00	1.00

dtot=0.305 m, Rtot=2.616 m²K/W — with [h1=25.0 W/m²K, h2=7.7 W/m²K] U=0.36 W/m²K , g=0.00

Figure 1. Example 1 (top) and 2 (bottom) as defined in Annex D of EN 13788 - CAPSOL

Generally spoken, the data input is relatively simple. Some data highlights are the following.

- The standard concerns a harmonic thermal analysis. A sinusoidal temperature (mean 0 °C, amplitude 10 °C, period 24h) is defined at one side (external or internal) and a constant temperature 0°C is defined at the other side (internal or external).
- Surface heat transfer coefficients h_e = 25 W/m^{2}K and h_i = 7.7 W/m^{2}K are defined.
- A calculation duration of 1 day with a start-up calculation duration of 5 days (in order to get a harmonic regime) is defined. A time step of 10 minutes and a maximum sub-layer of 0.01 m are specified, resulting in a reasonable precision of the numerical calculation.
- Graphic output (graphs and animations) and text output are defined. In order to derive the wall dynamic thermal characteristics the output of the heat flows at both wall surfaces are essential. The CAPSOL text results were processed in the spreadsheet EN_ISO_13786_annex_D_results.xls. Processing the BISTRA or VOLTRA text results can be done in a similar way.

The wall dynamic thermal characteristics obtained are listed in the next 2 sections. The results are almost identical to the ones listed in the standard. Small differences can be explained by the simulation time step (10 minutes).

[1] EN ISO 13786:2006 *Thermal performance of building components - Dynamic thermal characteristics – Calculation methods*

Example 1 - Results

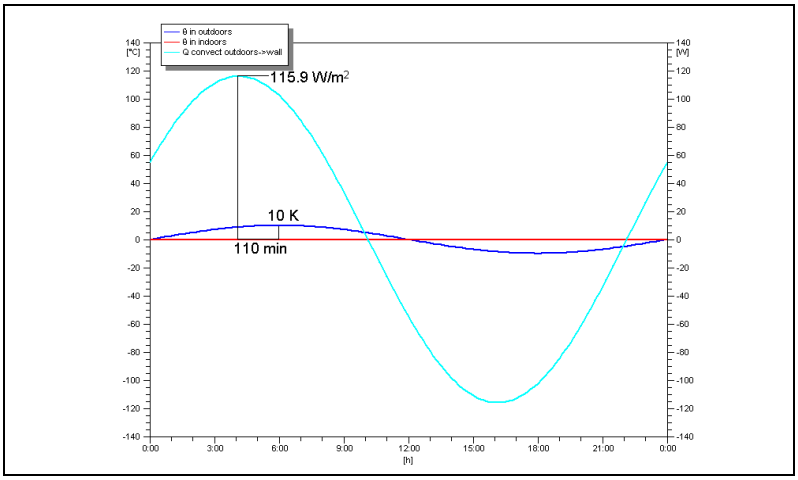


Figure 2. Outdoor (blue) and indoor (red) temperature [°C]; Heat flow at external surface [W/m²]

CAPSOL data
EN_ISO_13786_annex_D1_a_capsol.cap
BISTRA data
EN_ISO_13786_annex_D1_a_bistra.bst
VOLTRA data
EN_ISO_13786_annex_D1_a_voltra.vtr

External thermal admittance
Y_{ee} = 11.59 W/m²K
Time shift
τ_{ee} = 110 min
Animation files
EN_ISO_13786_annex_D1_a_capsol.AVI
EN_ISO_13786_annex_D1_a_voltra.avi

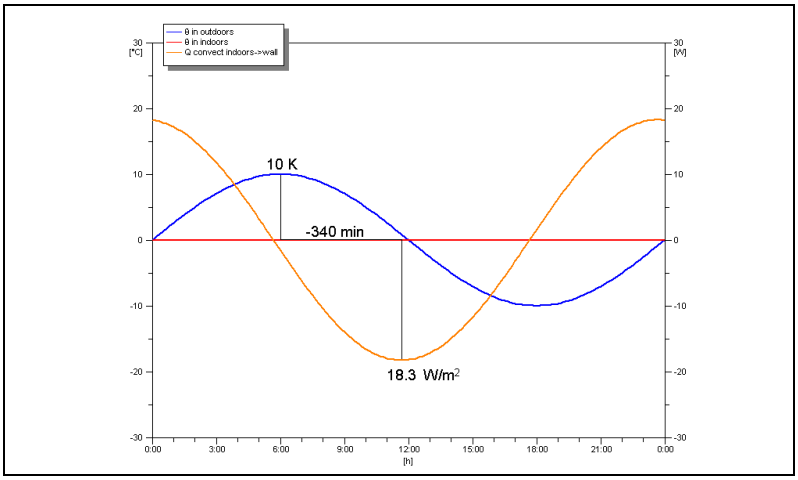


Figure 3. Outdoor (blue) and indoor (red) temperature [°C]; Heat flow at internal surface [W/m²]

CAPSOL data
EN_ISO_13786_annex_D1_a_capsol.cap
BISTRA data
EN_ISO_13786_annex_D1_a_bistra.bst
VOLTRA data
EN_ISO_13786_annex_D1_a_voltra.vtr

Periodic thermal transmittance
Y_{ie} = 1.83 W/m²K
Time shift
τ_{ie} = -340 min
Animation file
EN_ISO_13786_annex_D1_a_capsol.AVI
EN_ISO_13786_annex_D1_a_voltra.avi

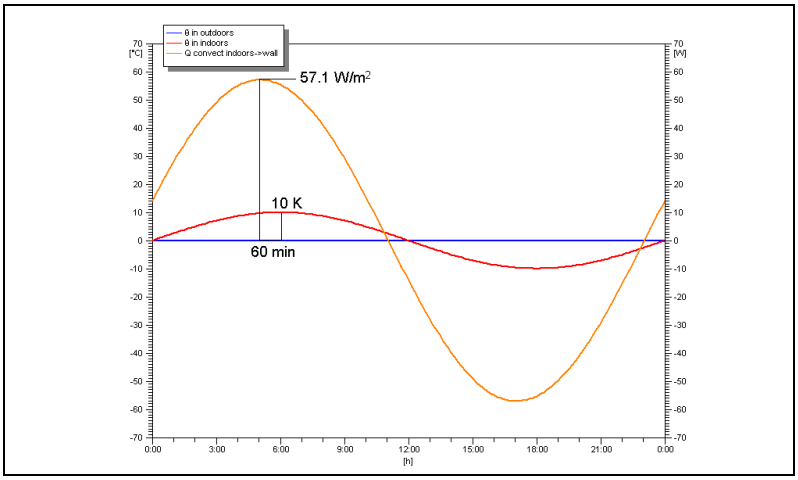


Figure 4. Outdoor (blue) and indoor (red) temperature [°C]; Heat flow at internal surface [W/m²]

CAPSOL data
EN_ISO_13786_annex_D1_b_capsol.cap
BISTRA data
EN_ISO_13786_annex_D1_b_bistra.bst
VOLTRA data
EN_ISO_13786_annex_D1_b_voltra.vtr

Internal thermal admittance
Y_{ii} = 5.71 W/m²K
Time shift
τ_{ii} = 60 min
Animation file
EN_ISO_13786_annex_D1_b_capsol.AVI
EN_ISO_13786_annex_D1_b_voltra.avi

Thermal transmittance U = 3.56 W/m²K
Decrement factor f = Y_{ie} / U = 0.514

Example 2 - Results

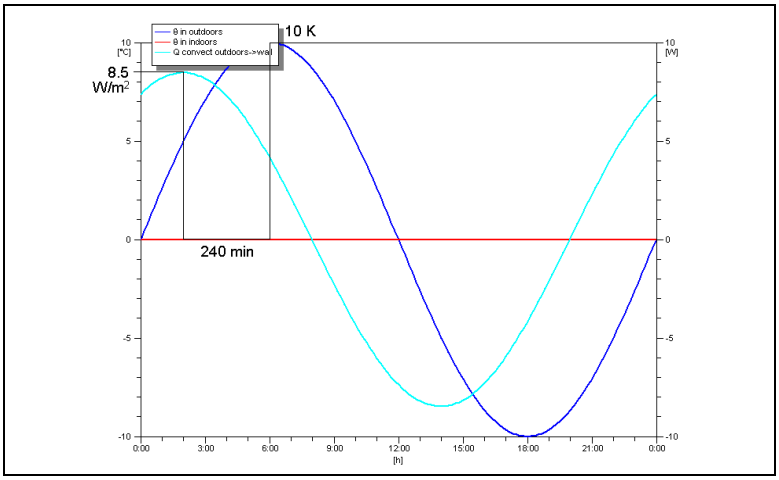


Figure 5. Outdoor (blue) and indoor (red) temperature [°C]; Heat flow at external surface [W/m²]

CAPSOL data
EN_ISO_13786_annex_D2_a_capsol.cap
BISTRA data
EN_ISO_13786_annex_D2_a_bistra.bst
VOLTRA data
EN_ISO_13786_annex_D2_a_voltra.vtr

External thermal admittance
Y_{ee} = 0.85 W/m²K
Time shift
τ_{ee} = 240 min
Animation file
EN_ISO_13786_annex_D2_a_capsol.AVI
EN_ISO_13786_annex_D2_a_voltra.avi

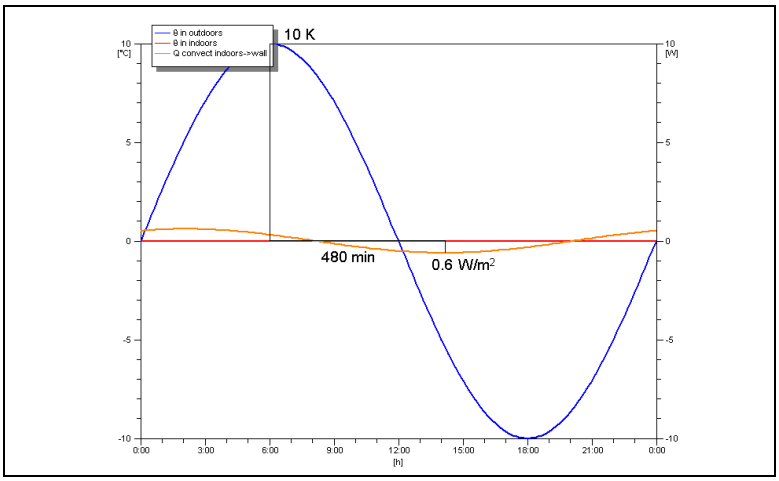


Figure 6. Outdoor (blue) and indoor (red) temperature [°C]; Heat flow at internal surface [W/m²]

CAPSOL data
EN_ISO_13786_annex_D2_a_capsol.cap
BISTRA data
EN_ISO_13786_annex_D2_a_bistra.bst
VOLTRA data
EN_ISO_13786_annex_D2_a_voltra.vtr

Periodic thermal transmittance
Y_{ie} = 0.06 W/m²K
Time shift
τ_{ie} = -480 min
Animation file
EN_ISO_13786_annex_D2_a_capsol.AVI
EN_ISO_13786_annex_D2_a_voltra.avi

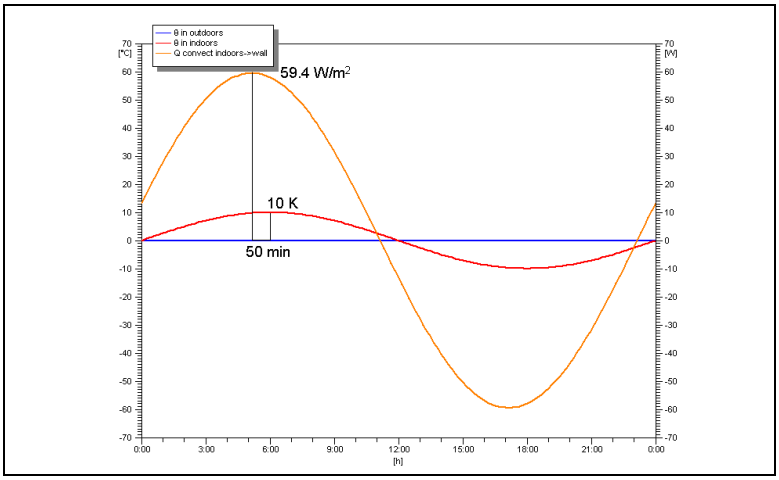


Figure 7. Outdoor (blue) and indoor (red) temperature [°C]; Heat flow at internal surface [W/m²]

CAPSOL data
EN_ISO_13786_annex_D2_b_capsol.cap
BISTRA data
EN_ISO_13786_annex_D2_b_bistra.bst
VOLTRA data
EN_ISO_13786_annex_D2_b_voltra.vtr

Internal thermal admittance
Y_{ii} = 5.94 W/m²K
Time shift
τ_{ii} = 50 min
Animation file
EN_ISO_13786_annex_D2_b_capsol.AVI
EN_ISO_13786_annex_D2_b_voltra.avi

Thermal transmittance	U = 0.359 W/m²K
Decrement factor	f = Y_{ie} / U = 0.167