House model References

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Contents

1 Introduction

This document present the basic information for calculating the house model base on RC network. The specific model can be found in the references.

2 R-C Values

Thermal purely resistive circuits and heat transfer mode is shown in table 1.

Equations for different heat transfer modes and their thermal resistances.

Transfer Mode	Rate of Heat Transfer	Thermal Resistance
Conduction	$\dot{Q} = \frac{T_1 - T_2}{\left(\frac{L}{kA}\right)}$	$\frac{L}{kA}$
Convection	$\dot{Q} = \frac{T_{\text{surf}} - T_{\text{envr}}}{\left(\frac{1}{h_{\text{conv}} A_{\text{surf}}}\right)}$	$\frac{1}{h_{\text{conv}} A_{\text{surf}}}$
Radiation	$\dot{Q} = \frac{T_{\text{surf}} - T_{\text{surr}}}{\left(\frac{1}{h_r A_{\text{surf}}}\right)}$	$\frac{1}{h_r A}$, where $h_r = \epsilon\sigma(T_{\text{surf}}^2 + T_{\text{surr}}^2)(T_{\text{surf}} + T_{\text{surr}})$

Figure 1: Heat transfer mode[1]

Some typical heat transfer resistances [2]:

- Static layer of air, 40 mm (1.57 in) : R = 0.18 $[m^2K/W]$.
- Inside heat transfer resistance, horizontal current : R = 0.13 $[m^2k/W]$.
- Outside heat transfer resistance, horizontal current : R = 0.04 $[m^2K/W]$.
- Inside heat transfer resistance, heat current from down upwards : R = 0.10 $[m^2K/W]$.
- Outside heat transfer resistance, heat current from above downwards : R = 0.17 $[m^2K/W]$.

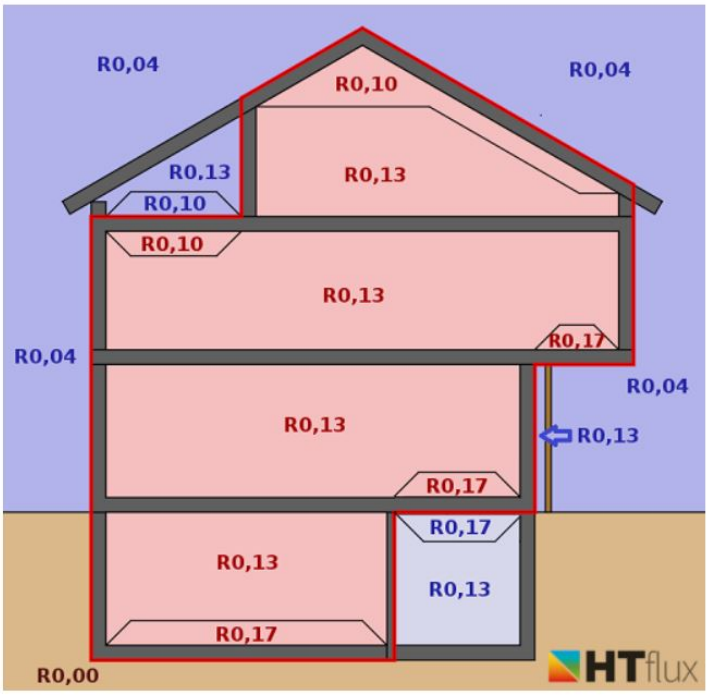

Figure 2: An overview of heat transfer resistance[3]

The Rc values for facades, roof and floor standard until 2020:

Construction	New construction	Renovation
Facades [1]	Rc 4.5 m2K / W	Rc 1.3 m2K / W
Roofs [2]	Rc 6.0 m2K / W	Rc 2.0 m2K / W
Floors [3]	Rc 3.5 m2K / W	Rc 2.5 m2K / W

Figure 3: Rc Values [4]

The values will be used in 2021 has been describes in "EnergieVademecum Energiebewust ontwerpen van nieuwbouwwoningen", chapter 5: Thermische isolatie, thermische bruggen en luchtdichtheid [5].

From 2015, the following RC values apply to new construction in the Netherlands:

Location	*RC value (NEN 1068, until 1-1-2021) [m2K / W]*	*Rc value (NTA 8800, from 1-1-2021) [m2K / W]*
floor	**> = 3.5**	**> = 3.7**
facade	**> = 4.5**	**> = 4.7**
roof	**> = 6.0**	**> = 6.3**

Figure 4: Rc Values [6]

The values used for different types of houses such as: row house, detached house, apartments ..etc can be found in "Voorbeeldwoningen 2011" [6]. An example values for row house which was built from 1975 to 1991 is shown in pictures:

Bouwdelen	Huidig			Besparingspakket			Investeringskosten	
	Opp. (m^2)	Rc-Waarde (m^2 K/W)	U-Waarde (W/m^2K)	Opp. (m^2)	Rc-Waarde (m^2 K/W)	U-Waarde (W/m^2K)	Per m^2	Totaal
Begane grondvloer [3]	51,0	0,52	1,28	51,0	2,53	0,36	€ 20	€ 1.020
Plat dak [3]	-	-	-	-	-	-	-	€ 0
Hellend dak [3]	68,6	1,30	0,64	68,6	2,53	0,36	€ 53	€ 3.640
Achter- en voorgevel								
– Gesloten [3]	40,6	1,30	0,64	40,6	2,53	0,36	€ 21	€ 850
– Enkelglas [3]	3,1		5,20	-		-	€ 139	€ 430
– Dubbelglas [3]	16,2		2,90	-		-	€ 142	€ 2.300
– HR^{++} glas	-		-	19,3		1,80		
Zijgevel								
– Gesloten	58,4	1,30	0,64	58,4	2,53	0,36	€ 21	€ 1.230
– Enkelglas	-		-	-		-	-	€ 0
– Dubbelglas	1,8		2,90	-		-	€ 142	€ 260
– HR^{++} glas	-		-	1,8		1,80		

Figure 5: Rc Values for row house buit in 1975-1991 [7].

3 Envelop house model 2R2C network

The 2R2C structure implemented model.

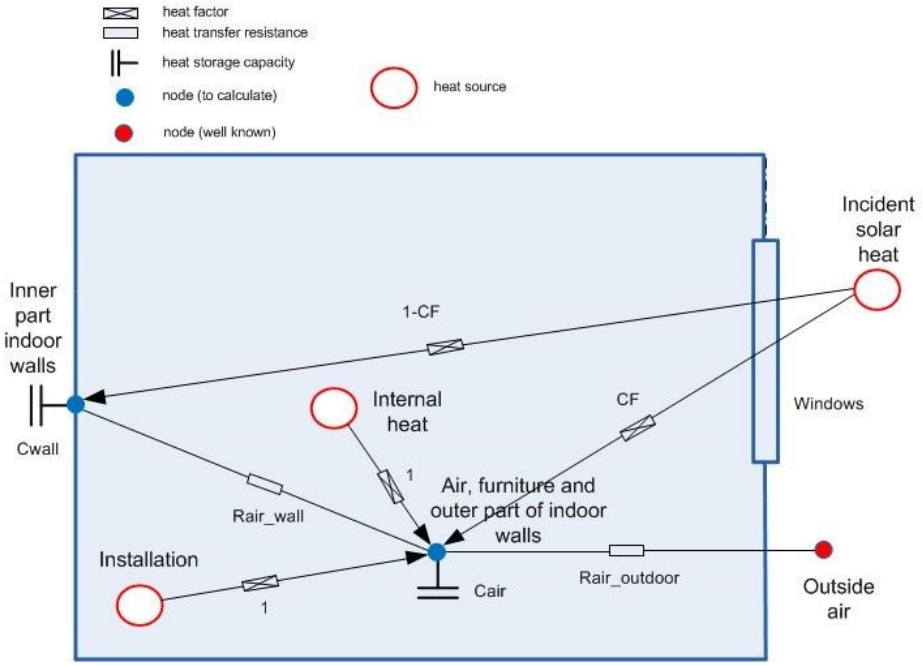

Figure 6: Shematic of envelop model

An equivalent RC network of the house.

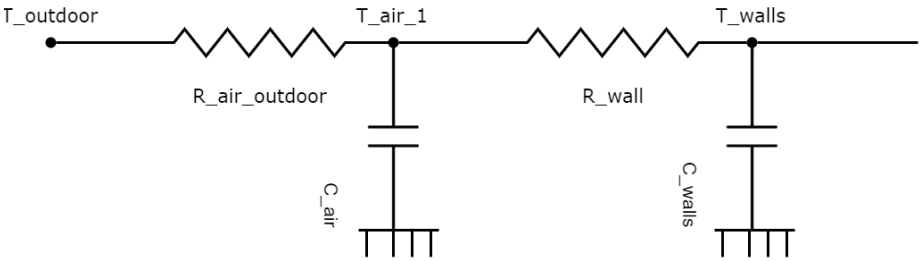

Figure 7: 2R2C house model

There are two capacities Cair and Cwall and two resistances `R_wall` and `Rair_outdoor`. The incident solar heat is divided between Cwall and Cair by the convection factor CF. It is assumed that both internal heat (lighting, occupancy and electric devices) and supplied heat (installation) are fully released at the air node.

4 2 Zones house model 7R4C network

The 7R3C structure implemented is shown in Figure 4.

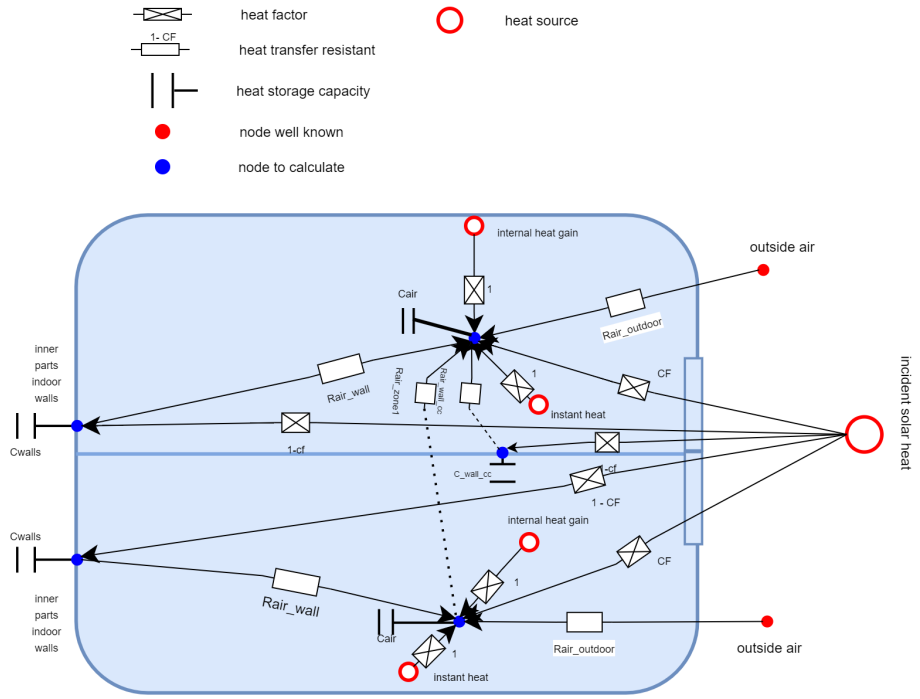

Figure 8: Shematic of 2 zones house model

An equivalent RC network of the house.

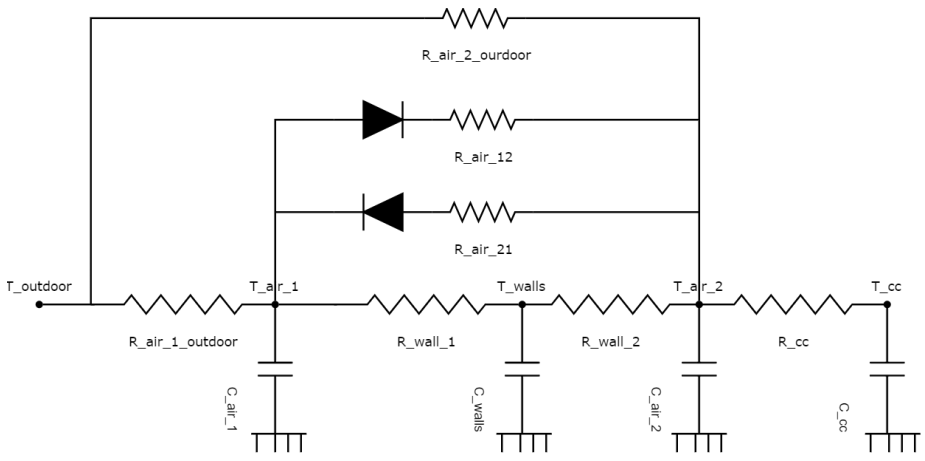

Figure 9: R-C circuits of 2 zones house model

with:

- `T_outdoor` : outdoor temperature $[^oC]$
- `T_air_1` : zone 1 air temperature $[^oC]$
- `T_walls` : walls temperature $[^oC]$
- `T_air_2` : zone 2 air temperature $[^oC]$
- `T_cc` : temperature of the concrete layer between zone 1 and zone 2 $[^oC]$
- `R_air_1_outdoor` : outdoor resistance values.
- `R_wall_1` : walls resistance values.
- `R_wall_2` : walls resistance values.
- `R_cc` : concrete resistance values.
- `R_air_12` : resistance value of air flow from zone 1 to zone 2.
- `R_air_21` : resistance value of air flow from zone 2 to zone 1.

5 NEN and ISO

The list of NEN and ISO standard used in the calculation:

- NTA 8800
- NEN 1068
- ISO 6946
- SO 10077-2
- NEN 7120

References

[1] Lumped-element model

[2] Overall Heat Transfer Coefficient

[3] Heat transfer resistance / surface resistance

[4] Het bouwbesluit over isolatie en de Rc-waarde

[5] EnergieVademecum Energy-conscious design of new-build homes

[6] R-waarde

[7] Voorbeeldwoningen 2011 bestaande bouw

[8] Transmission Heat Loss through Building Elements

[9] Solar Heat Gain Coefficient