

254 mm facade with insulated cavity

Thermal protection

$U = 0,58 \text{ W}/(\text{m}^2\text{K})$

Interior insulation: No requirement*



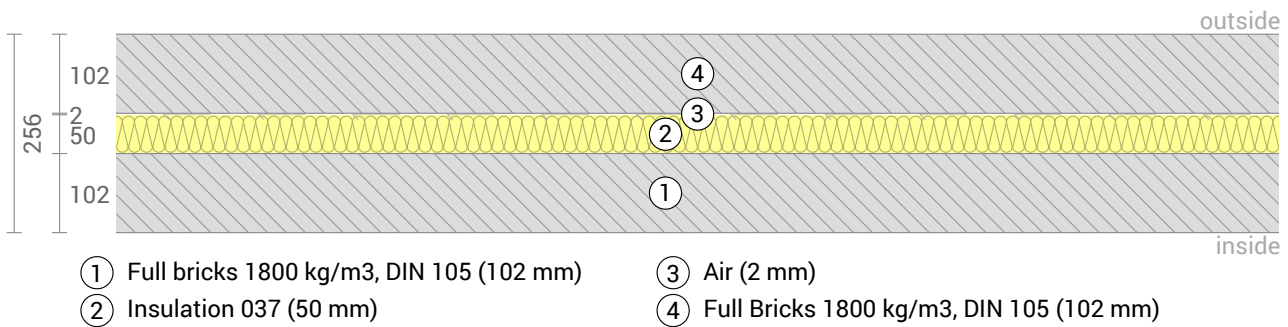
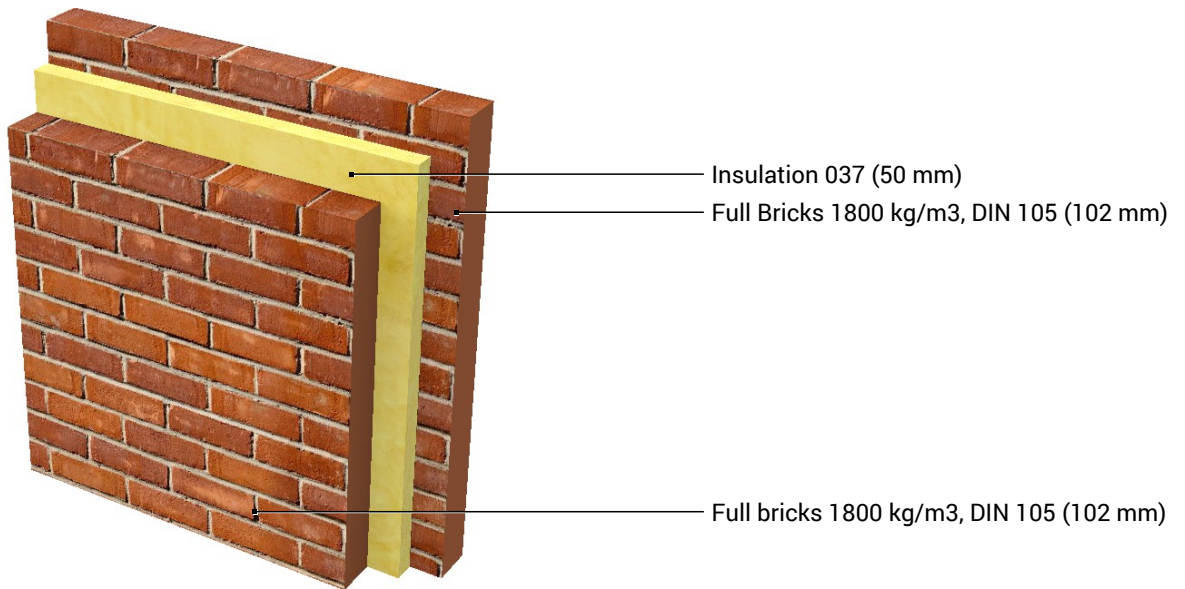
Moisture proofing

No condensate



Heat protection

Temperature amplitude damping: 24
phase shift: 9,7 h
Thermal capacity inside: 166 kJ/m²K



Inside air : 20,0°C / 50%
Outside air: -5,0°C / 80%
Surface temperature.: 16,9°C / -4,5°C

sd-value: 0,6 m
Drying reserve: 12399 g/m²a

Thickness: 25,6 cm
Weight: 368 kg/m²
Heat capacity: 368 kJ/m²K

EnEV Bestand BEG Einzelmaßn. GEG 2020/24 Bestand GEG 2023/24 Neubau

254 mm facade with insulated cavity, $U=0,58 \text{ W}/(\text{m}^2\text{K})$

U-Value calculation according to DIN EN ISO 6946

#	Material	Dicke [cm]	λ [W/mK]	R [m ² K/W]
	Thermal contact resistance inside (Rsi)			0,130
1	Full bricks 1800 kg/m ³ , DIN 105	10,20	0,810	0,126
2	Insulation 037	5,00	0,037	1,351
3	Air	0,20		0,130
4	Full Bricks 1800 kg/m ³ , DIN 105	10,20	0,810	0,126
	Thermal contact resistance outside (Rse)			0,040

Thermal contact resistances have been taken from DIN 6946 Table 7.

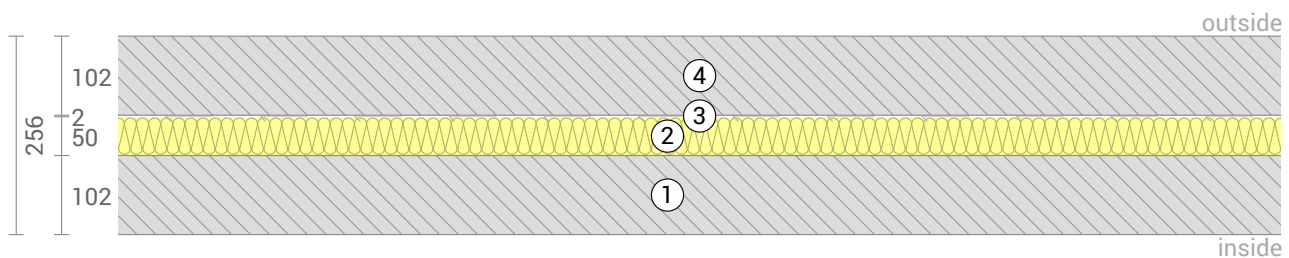
Rsi: heat flow direction horizontally

Rse: heat flow direction horizontally, outside: Direct contact to outside air

DIN 6946 should not be used because the component contains room or outside air.

Heat transfer coefficient from finite-elements method $U = 0,576 \text{ W}/(\text{m}^2\text{K})$

numerical uncertainty ~8,7%



254 mm facade with insulated cavity, U=0,58 W/(m²K)

LCA

Heat loss: 45 kWh/m² per heating season



Amount of heat that escapes through one square meter of this component during the heating period. Please note: Due to internal and solar gains, the heating demand is lower than the heat loss.

Primary energy (non renewable): 234 kWh/m²



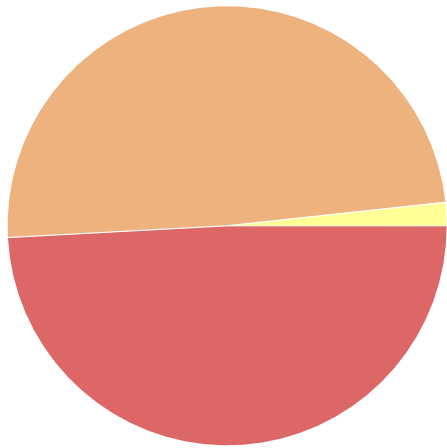
Non-renewable primary energy (= energy from fossil fuels and nuclear energy) that was used to produce the new building materials ("cradle to gate").

Green house gas potential: 90 kg CO2 Äqv./m²



Quantity of released greenhouse gases in the production of building materials used ("cradle to gate").

Composition of non-renewable primary energy of production:



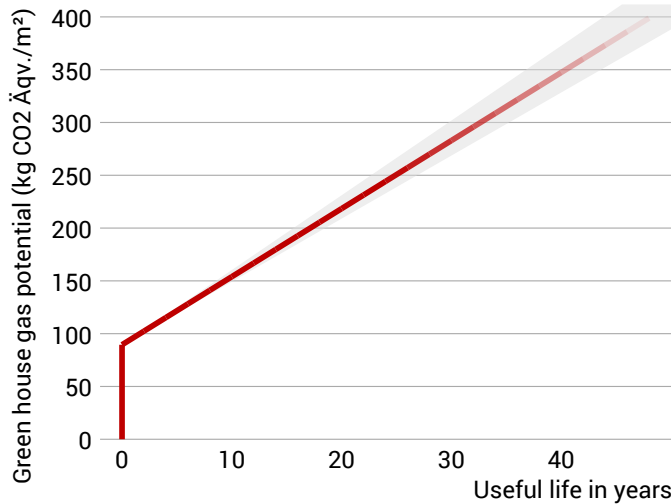
- Full bricks 1800 kg/m³, DIN 105 (102 mm) 49%
- Full Bricks 1800 kg/m³, DIN 105 (102 mm) 49%
- Insulation 037 (50 mm) 2%

Composition of the greenhouse potential of production:



254 mm facade with insulated cavity, $U=0,58 \text{ W}/(\text{m}^2\text{K})$

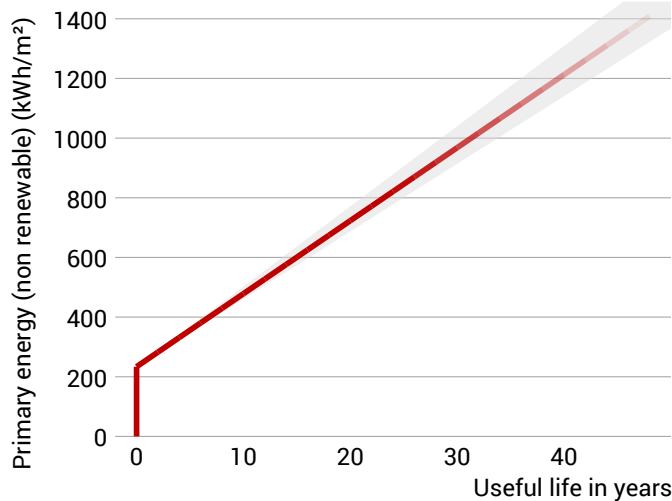
Global warming potential and primary energy for construction and use



The **left figure** shows the global warming potential of the production of the component in the vertical part of the curve. Greenhouse gas emissions (through heating) arising during use of the building are indicated by the upward curve.

The **figure at the bottom left** shows the non-renewable primary energy expenditure for the production of the component in the vertical part of the curve. The primary energy required during use of the building (through heating) is represented by the upward curve.

The longer the component is used unchanged, the more environmentally friendly it is, because the production costs contribute less to the total emissions (indicated by the color of the curve).



Due to unknown solar and internal gains, the heating demand can only be estimated. Accordingly, primary energy consumption and global warming potential during the use phase are only vaguely known. For the estimation it was assumed that solar and internal profits contribute with $4 \text{ kWh}/\text{a}/\text{m}^2$ component area. The light gray area indicates the area in which the curve is located with great certainty. For heat generation, a primary energy input of $0,60 \text{ kWh}$ per kWh of heat and a global warming potential of $0,16 \text{ kg CO}_2 \text{ eqv}/\text{m}^2$ per kWh of heat was used. Heat source: Heat pump (air-water).

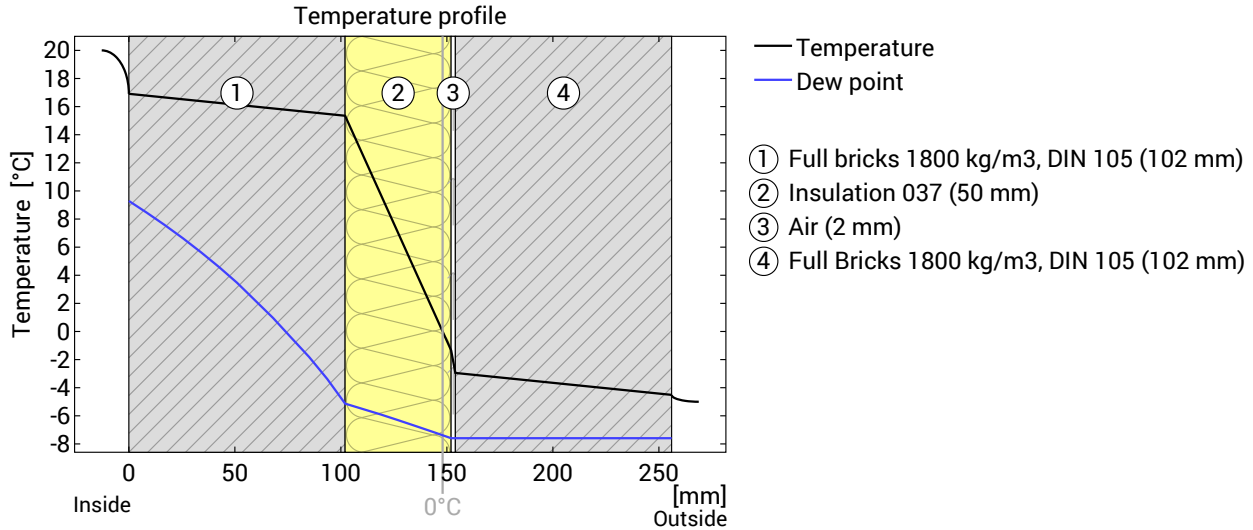
Hints

Calculated for the location DIN V 18599, heating period from Mid of October to End of April. The calculation is based on monthly average temperatures. Source: DIN V 18599-10:2007-02

The climate and energy data on which this calculation is based can, in some cases, show considerable fluctuations and, in individual cases, deviate considerably from the actual value.

254 mm facade with insulated cavity, $U=0,58 \text{ W}/(\text{m}^2\text{K})$

Temperature profile



Temperature and dew-point temperature in the component. The dew-point indicates the temperature, at which water vapour condensates. As long as the temperature of the component is everywhere above the dew-point temperature, no condensation occurs. If the curves have contact, condensation occurs at the corresponding position.

Layers (from inside to outside)

#	Material	λ [W/mK]	R [m ² K/W]	Temperatur [°C]		Weight [kg/m ²]
				min	max	
	Thermal contact resistance*		0,250	16,9	20,0	
1	10,2 cm Full bricks 1800 kg/m3, DIN 105	0,810	0,126	15,4	16,9	183,6
2	5 cm Insulation 037	0,037	1,351	-1,3	15,4	0,8
3	0,2 cm Air			-2,9	-1,3	
4	10,2 cm Full Bricks 1800 kg/m3, DIN 105	0,810	0,126	-4,5	-2,9	183,6
	Thermal contact resistance*		0,040	-5,0	-4,5	
	25,6 cm Whole component		1,737			368,0

*Thermal contact resistances according to DIN 4108-3 for moisture protection and temperature profile. The values for the U-value calculation can be found on the page 'U-value calculation'.

Surface temperature inside (min / average / max): 16,9°C 16,9°C 16,9°C
 Surface temperature outside (min / average / max): -4,5°C -4,5°C -4,5°C

254 mm facade with insulated cavity, $U=0,58 \text{ W}/(\text{m}^2\text{K})$

Moisture proofing

For the calculation of the amount of condensation water, the component was exposed to the following constant climate for 90 days: inside: 20°C und 50% Humidity; outside: -5°C und 80% Humidity. This climate complies with DIN 4108-3.

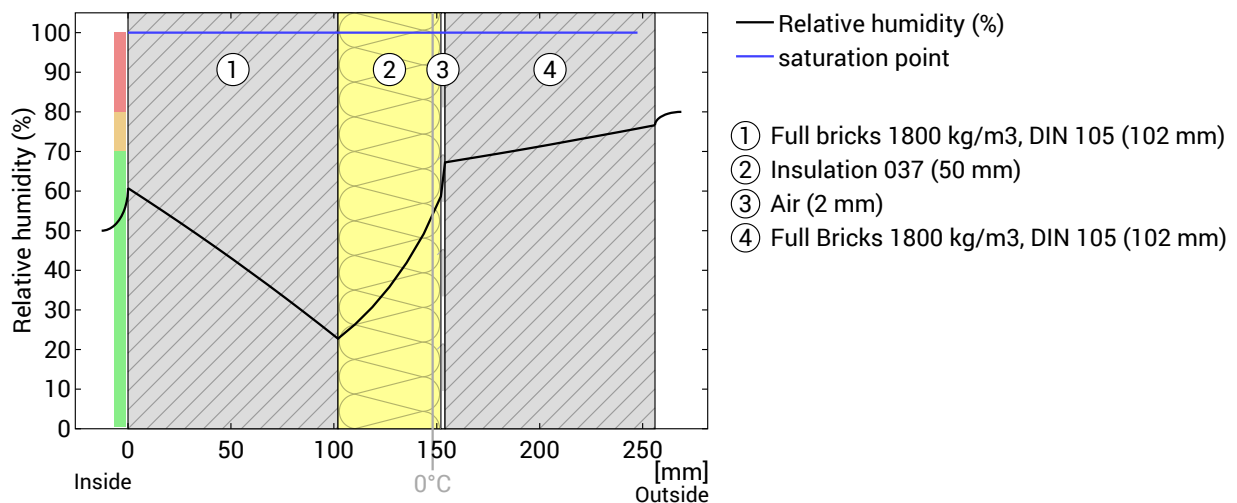
This component is free of condensate under the given climate conditions.

#	Material	sd-value [m]	Condensate [kg/m ²] [Gew.-%]	Weight [kg/m ²]
1	10,2 cm Full bricks 1800 kg/m ³ , DIN 105	0,51	-	183,6
2	5 cm Insulation 037	0,05	-	0,8
3	0,2 cm Air		-	
4	10,2 cm Full Bricks 1800 kg/m ³ , DIN 105	1,02	-	183,6
	25,6 cm Whole component	0,56	0	368,0

Humidity

The temperature of the inside surface is 16,9 °C leading to a relative humidity on the surface of 61%. Mould formation is not expected under these conditions.

The following figure shows the relative humidity inside the component.



Notes: Calculation using the Ubakus 2D-FE method. Convection and the capillarity of the building materials were not considered. The drying time may take longer under unfavorable conditions (shading, damp / cool summers) than calculated here.

254 mm facade with insulated cavity, $U=0,58 \text{ W}/(\text{m}^2\text{K})$

Moisture protection in accordance with DIN 4108-3:2018 Appendix A

This moisture proofing is only valid for **non-air-conditioned** residential buildings.

Please note the hints at the end of these moisture proofing calculations.

#	Material	λ [W/mK]	R [m ² K/W]	sd [m]	ρ [kg/m ³]	T [°C]	ps [Pa]	Σ sd [m]
Thermal contact resistance			0,250			16,46	1873	0
1	10,2 cm Full bricks 1800 kg/m ³ , DIN 105	0,810	0,126	0,51	1800	14,68	1670	0,51
2	5 cm Insulation 037	0,037	1,351	0,05	15	-4,43	421	0,56
Thermal contact resistance			0,040					

Temperature (T), vapor saturation pressure (ps), and the sum of the sd-values (Σ sd) apply to the layer boundary.

Relative air humidity on the surface

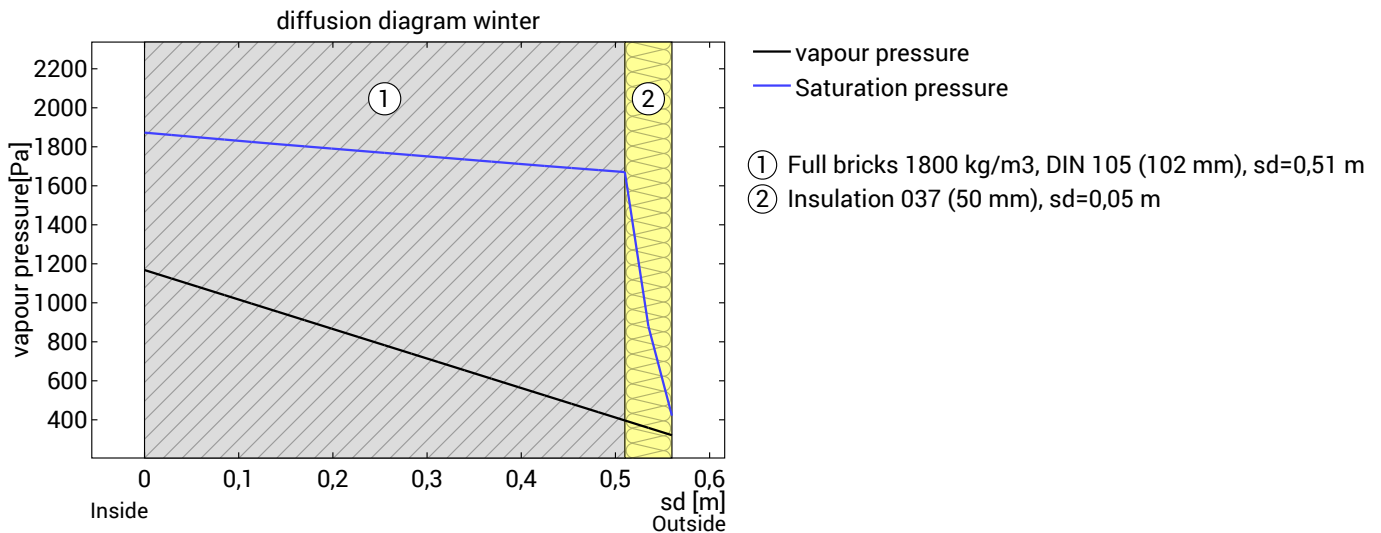
The relative humidity on the interior surface is 62%. Requirements for the prevention of building material corrosion depend on material and coating and have not been investigated.



Dew period (winter)

Boundary conditions

Vapor pressure inside at 20°C and 50% humidity	$p_i = 1168 \text{ Pa}$
Vapor pressure outside at -5°C and 80% humidity	$p_e = 321 \text{ Pa}$
Duration of condensation period (90 days)	$t_c = 7776000 \text{ s}$
Water vapor diffusion coefficient in static air	$\delta_0 = 2.0E-10 \text{ kg}/(\text{m}^*\text{s}*\text{Pa})$
sd-value (Whole component.)	$s_{de} = 0,56 \text{ m}$



The section under investigation is free of condensate under the given climate conditions.



Calculate evaporation potential for the drying reserve in the dew period for the plane with the lowest evaporation potential:
 $s_d=0,23 \text{ m}$; $p_s=1780 \text{ pa}$, within layer Full bricks 1800 kg/m³, DIN 105:

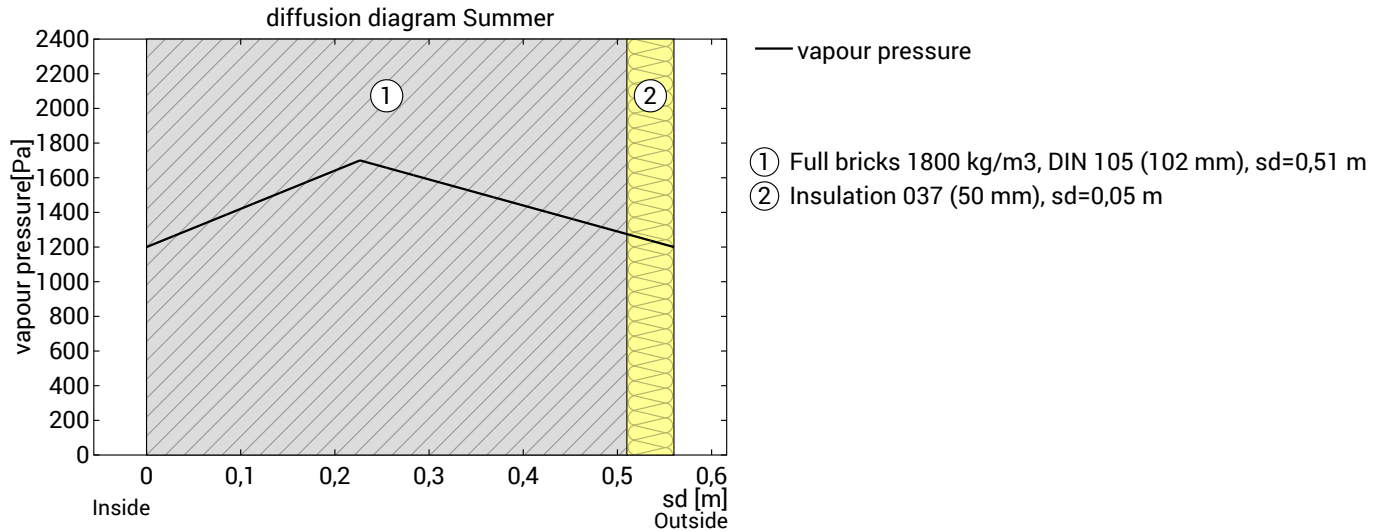
$$M_{ev, \text{Tauperiode}} = t_c * \delta_0 * ((p_s - p_i) / s_{d_{ev}} + (p_s - p_e) / (s_{d_e} - s_{d_{ev}})) = 11,005 \text{ kg/m}^2$$

254 mm facade with insulated cavity, $U=0,58 \text{ W}/(\text{m}^2\text{K})$

Evaporation period (summer)

Boundary conditions

Interior vapor pressure	$p_i = 1200 \text{ Pa}$
Exterior vapor pressure	$p_e = 1200 \text{ Pa}$
Saturation vapour pressure in the condensation area	$p_s = 1700 \text{ Pa}$
Length of drying season (90 days)	$t_{ev} = 7776000 \text{ s}$
sd-values remain unchanged.	



Condensate-free component: The maximum possible evaporation mass for the drying reserve is calculated. Consider the level that has the lowest evaporation potential in the dew period, at $s_d=0,23 \text{ m}$, within layer Full bricks 1800 kg/m³, DIN 105:
 Evaporation mass: $M_{ev} = \delta_0 \cdot t_{ev} \cdot [(p_s - p_i)/s_d + (p_s - p_e)/(s_{de} - s_d)] = 5,76 \text{ kg/m}^2$

Drying reserve (DIN 68800-2)

Using the block climate from DIN 4108-3:2001 for the calculation of the drying reserve. This climate was used when the limits were set in DIN 68800-2.

#	Material	λ [W/mK]	R [m ² K/W]	s_d [m]	ρ [kg/m ³]	T [°C]	p_s [Pa]	Σs_d [m]
Thermal contact resistance			0,130					
1	10,2 cm Full bricks 1800 kg/m ³ , DIN 105	0,810	0,126	0,51	1800	17,63	2017	0
2	5 cm Insulation 037	0,037	1,351	0,05	15	15,34	1742	0,51
Thermal contact resistance			0,040			-9,27	276	0,56

Temperature (T), vapor saturation pressure (p_s), and the sum of the s_d -values (Σs_d) apply to the layer boundary.

Dew period (winter)

Boundary conditions

Vapor pressure inside at 20°C and 50% humidity	$p_i = 1168 \text{ Pa}$
Vapor pressure outside at -10°C and 80% humidity	$p_e = 208 \text{ Pa}$
Duration of condensation period (60 days)	$t_c = 5184000 \text{ s}$
Water vapor diffusion coefficient in static air	$\delta_0 = 1.852\text{E-}10 \text{ kg}/(\text{m}^2\text{sPa})$
sd-value (Whole component.)	$s_{de} = 0,56 \text{ m}$

The section under investigation is free of condensate under the given climate conditions.

Calculate evaporation potential for the drying reserve in the dew period for the plane with the lowest evaporation potential:
 $s_d=0,23 \text{ m}$; $p_s=1891 \text{ Pa}$, within layer Full bricks 1800 kg/m³, DIN 105:

$$M_{ev, \text{Tauperiode}} = t_c \cdot \delta_0 \cdot ((p_s - p_i)/s_{d_{ev}} + (p_s - p_e)/(s_{de} - s_{d_{ev}})) = 7,907 \text{ kg/m}^2$$

254 mm facade with insulated cavity, $U=0,58 \text{ W}/(\text{m}^2\text{K})$

Evaporation period (summer)

Boundary conditions

Interior vapor pressure	$p_i = 982 \text{ Pa}$
Exterior vapor pressure	$p_e = 982 \text{ Pa}$
Saturation vapour pressure in the condensation area	$p_s = 1403 \text{ Pa}$
Length of drying season (90 days)	$t_{ev} = 7776000 \text{ s}$
sd-values remain unchanged.	

Condensate-free component: The maximum possible evaporation mass for the drying reserve is calculated. Consider the level that has the lowest evaporation potential in the dew period, at $s_d=0,23 \text{ m}$, within layer Full bricks $1800 \text{ kg}/\text{m}^3$, DIN 105:
Evaporation mass: $M_{ev} = \delta_0 * t_{ev} * [(p_s - p_i)/s_d + (p_s - p_e)/(s_{de} - s_d)] = 4,49 \text{ kg}/\text{m}^2$

Dew-water-free component: The evaporation potential of the dew period is also taken into account.

Drying reserve: $M_r = (M_{ev} + M_{ev, Tauperiode}) * 1000 = 12399 \text{ g}/\text{m}^2/\text{a}$

For components which do not contain wood there is no minimum requirement for the drying reserve.

Evaluation according to DIN 4108-3

The component is permissible regarding the moisture protection.

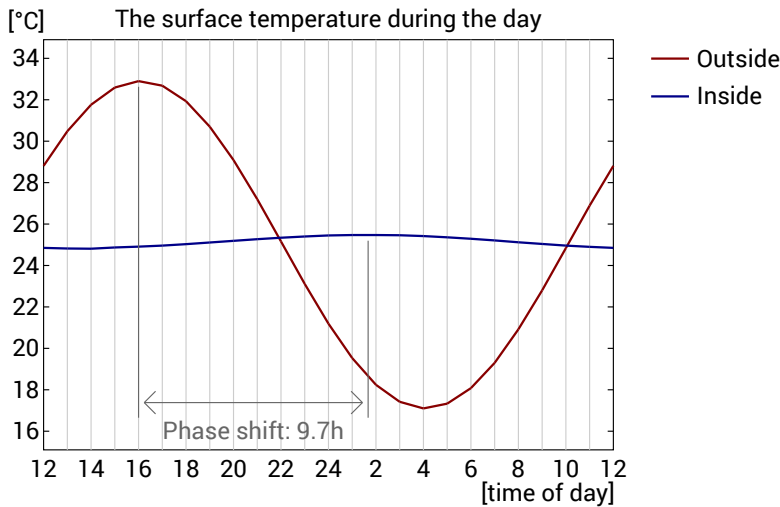
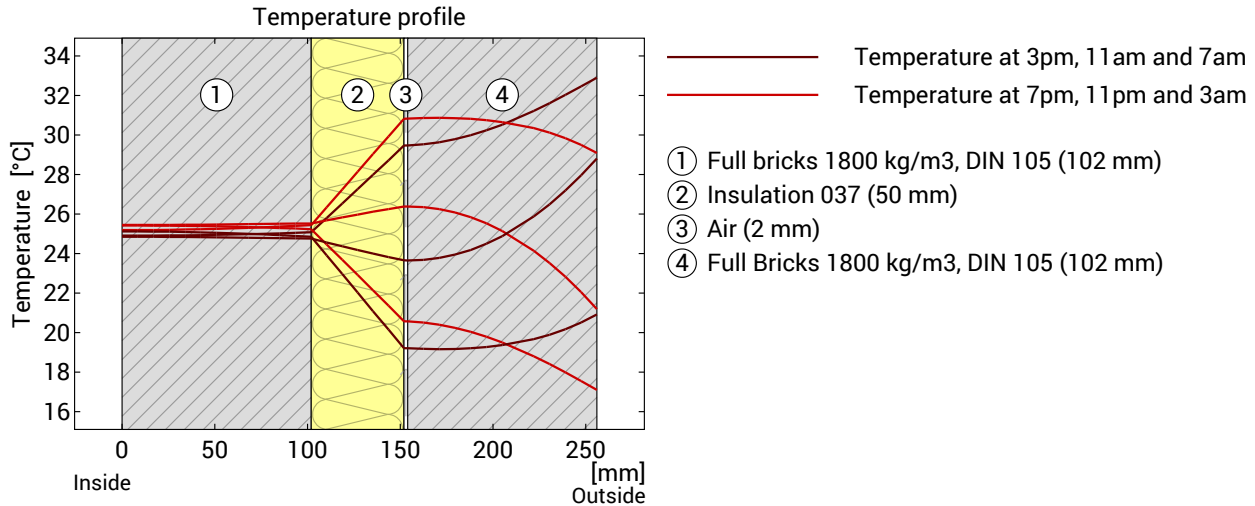
Hints

DIN 4108-3 describes in Section 5.3 components for which no moisture proofing is required as there is no risk of condensation water or the method is not suitable for the assessment. It is not possible to assess whether the component under test is underneath.

254 mm facade with insulated cavity, $U=0,58 \text{ W}/(\text{m}^2\text{K})$

Heat protection

The following results are properties of the tested component alone and do not make any statement about the heat protection of the entire room:



Top: Temperature profile within the component at different times. From top to bottom, brown lines: at 3 pm, 11 am and 7 am and red lines at 7 pm, 11 pm and 3 am.

Bottom: Temperature on the outer (red) and inner (blue) surface in the course of a day. The arrows indicate the location of the temperature maximum values. The maximum of the inner surface temperature should preferably occur during the second half of the night.

Phase shift*	9,7 h	Heat storage capacity (whole component):	368 kJ/m ² K
Amplitude attenuation **	23,8	Thermal capacity of inner layers:	166 kJ/m ² K
TAV ***	0,042		

* The phase shift is the time in hours after which the temperature peak of the afternoon reaches the component interior.

** The amplitude attenuation describes the attenuation of the temperature wave when passing through the component. A value of 10 means that the temperature on the outside varies 10x stronger than on the inside, e.g. outside 15-35 °C, inside 24-26 °C.

*** The temperature amplitude ratio TAV is the reciprocal of the attenuation: $TAV = 1 / \text{amplitude attenuation}$

Note: The heat protection of a room is influenced by several factors, but essentially by the direct solar radiation through windows and the total amount of heat storage capacity (including floor, interior walls and furniture). A single component usually has only a very small influence on the heat protection of the room.

254 mm facade with insulated cavity, $U=0,58 \text{ W}/(\text{m}^2\text{K})$

Hints

Interior insulation

Your component seems to be an interior insulation. Interior insulation generally requires more attention during planning, because condensation on the cold inside of the masonry can hardly be avoided. A vapor barrier seems to solve this problem, but in practice it often does not have the hoped-for effect.

Further information (in german):

- [What you should know about interior insulation](#)