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Jackopur 50/100/50 mm xps35 pir u-værdi 0,12

Exterior wall
created on 12.11.2021

Thermal protection

U = 0,12 W/(m²K)

EnEV Bestand*: U<0,24 W/(m²K)

excellent — insufficient

Moisture proofing

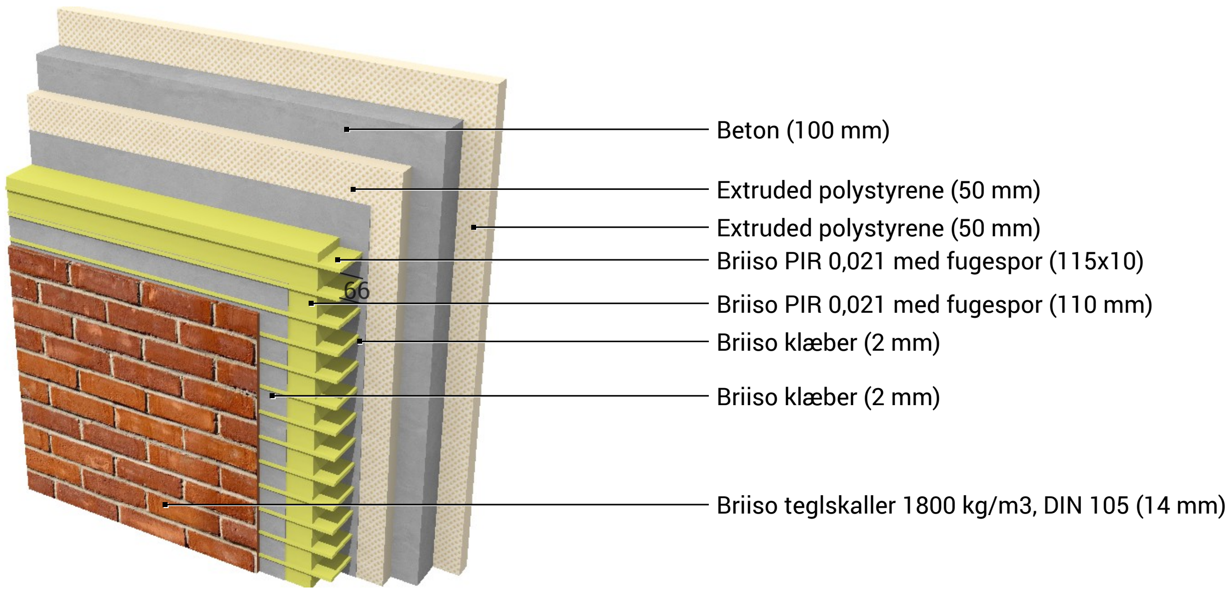
No condensate

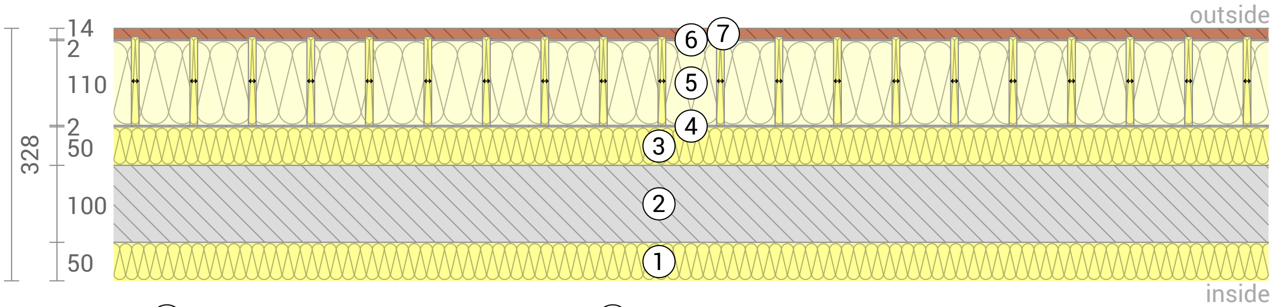
excellent — insufficient

Heat protection

Temperature amplitude damping: >100
phase shift: non relevant
Thermal capacity inside: 191 kJ/m²K

excellent — insufficient





1. Extruded polystyrene (50 mm)
2. Beton (100 mm)
3. Extruded polystyrene (50 mm)
4. Briiso klæber (2 mm)
5. Briiso PIR 0,021 med fugespor (110 mm)
6. Briiso klæber (2 mm)
7. Briiso teglskaller 1800 kg/m3, DIN 105 (14 mm)

<-> Layers marked by arrows are perpendicular to the main axis.

Inside air :	20,0°C / 50%			Thickness:	32,8 cm
Outside air:	-5,0°C / 80%	sd-value:	1116,2 m	Weight:	279 kg/m²
Surface temperature.:	19,3°C / -4,9°C	Drying reserve:	2 g/m²a	Heat capacity:	272 kJ/m²K

☑ EnEV Bestand ☑ BEG Einzelmaßn. ☑ GEG 2020 Bestand ☑ GEG 2020 Neubau

*Comparison of the U-value with den Höchstwerten aus EnEV 2014 Anlage 3 Tabelle 1 (EnEV Bestand); den techn. Mindestanforderungen für BEG Einzelmaßnahmen; den Höchstwerten aus GEG 2020 Anlage 7 (GEG 2020 Bestand); 80% des U-Werts der Referenzausführung aus GEG 2020 Anlage 1 (GEG20 Neubau)

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Jackopur 50/100/50 mm xps35 pir u-værdi 0,12, U=0,12 W/(m²K)

U-Value calculation according to DIN EN ISO 6946

#	Material	Dicke [cm]	λ [W/mK]	R [m²K/W]
	Thermal contact resistance inside (Rsi)			0,130
1	Extruded polystyrene (XPS 035)	5,00	0,035	1,429
2	Beton	10,00	2,000	0,050
3	Extruded polystyrene (XPS 035)	5,00	0,035	1,429
4	Briiso klæber	0,20	1,400	0,001
5	Briiso PIR 0,021 med fugespor	11,00	0,021	5,238
	Briiso PIR 0,021 med fugespor (Width: 1 cm)	11,50	0,021	5,476
6	Briiso klæber	0,20	1,400	0,001
7	Briiso teglskaller 1800 kg/m3, DIN 105	1,40	0,810	0,017
	Thermal contact resistance outside (Rse)			0,040

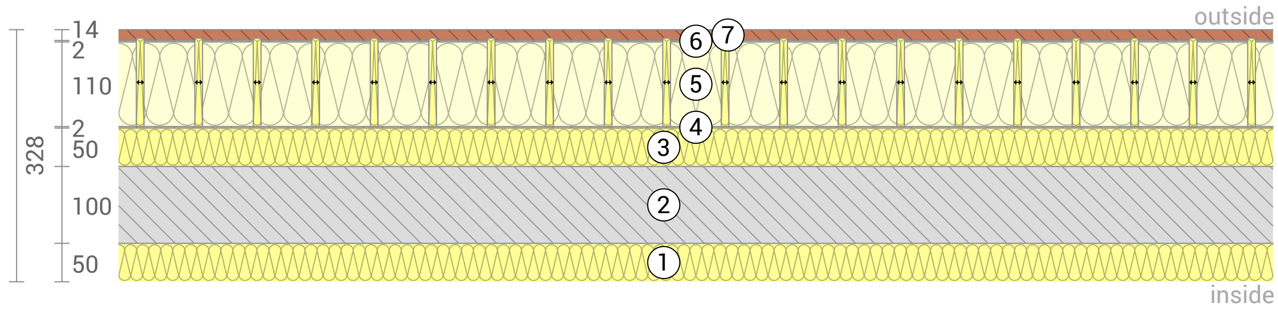
Thermal contact resistances have been taken from DIN 6946 Table 7.
Rsi: heat flow direction horizontally
Rse: heat flow direction horizontally, outside: Direct contact to outside air

Upper limit of thermal resistance $R_{tot;upper}$ = 8,365 m²K/W.
Lower limit of thermal resistance $R_{tot;lower}$ = 8,336 m²K/W.
Check applicability: $R_{tot;upper}$ / $R_{tot;lower}$ = 1,003 (maximum allowed: 1,5)

The procedure may be used.

Thermal resistance R_{tot} = ($R_{tot;upper}$ + $R_{tot;lower}$)/2 = 8,351 m²K/W
Estimated maximum relative uncertainty according to section 6.7.2.5: 0,17%

Heat transfer coefficient U = 1/R_{tot} = **0,12 W/(m²K)**



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Jackopur 50/100/50 mm xps35 pir u-værdi 0,12, U=0,12 W/(m²K)

LCA

Heat loss: 9 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.

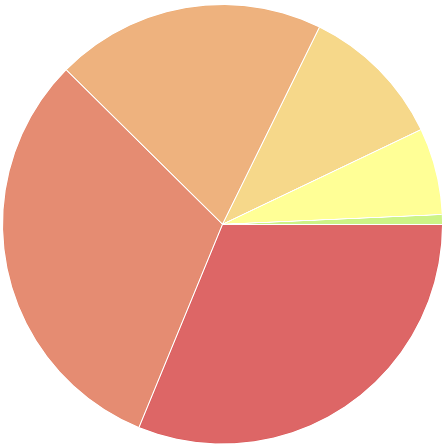
Primary energy (non renewable): 141 kWh/m²

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: 82 kg CO_2 Äqv./m²

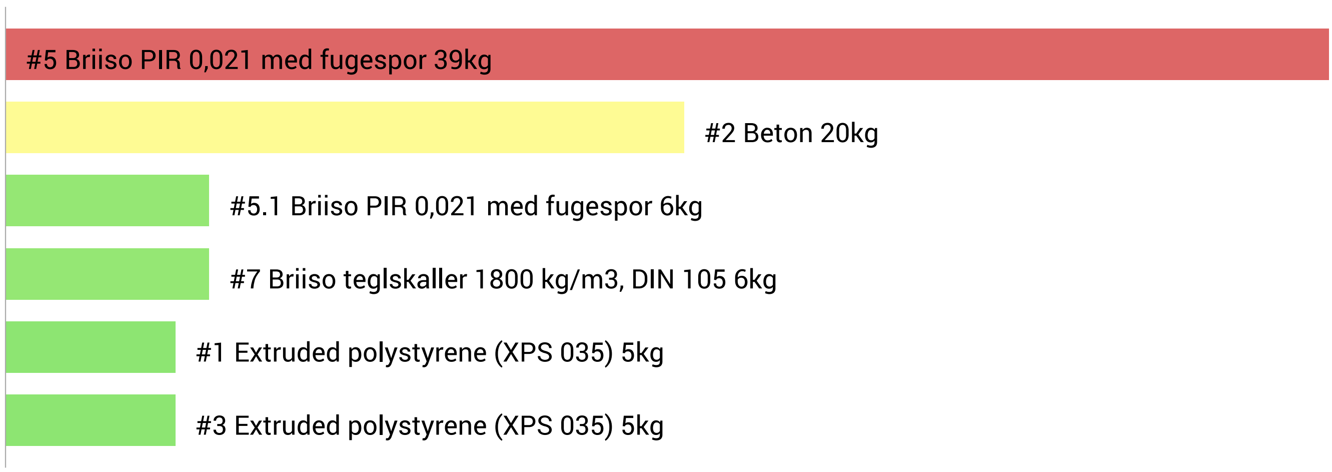
Quantity of released greenhouse gases in the production of building materials used ("cradle to gate").

Composition of non-renewable primary energy of production:



- Extruded polystyrene (50 mm) 31%
- Extruded polystyrene (50 mm) 31%
- Beton (100 mm) 20%
- Briiso teglskaller 1800 kg/m3, DIN 105 (14 mm) 11%
- Briiso PIR 0,021 med fugespor (110 mm) 6%
- Briiso PIR 0,021 med fugespor (115x10) 1%

Composition of the greenhouse potential of production:



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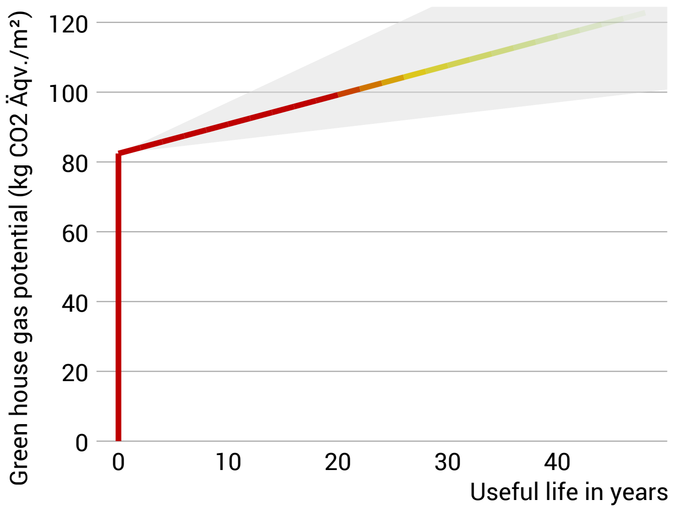
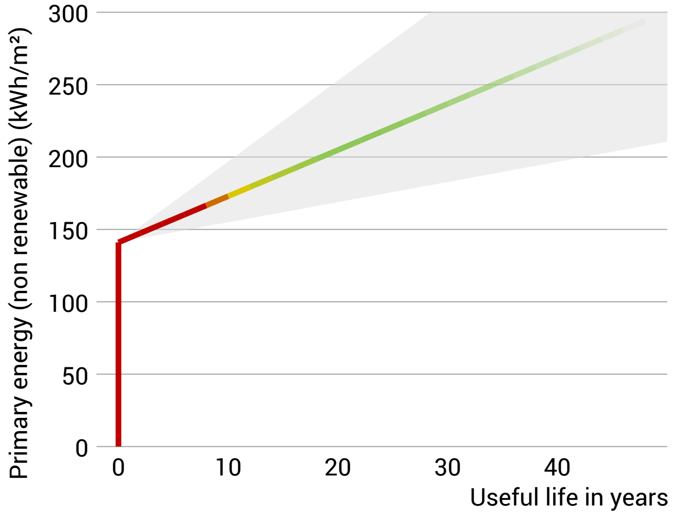
Jackopur 50/100/50 mm xps35 pir u-værdi 0,12, U=0,12 W/(m²K)

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 kWh/a/m² 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 kWh per kWh of heat and a global warming potential of 0,16 kg CO2 eqv/m² per kWh of heat was used. Heat source: Heat pump (air-water).

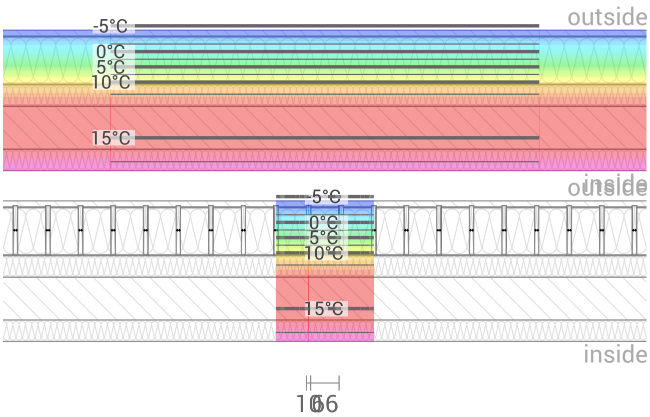
Hints

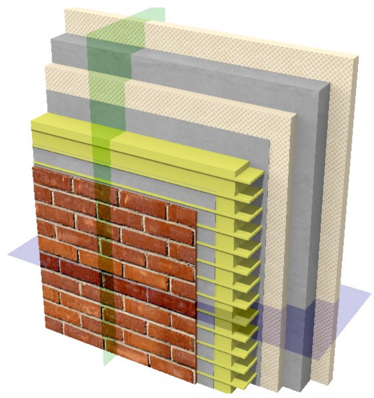
Calculated for the location DIN V 18599, heating period from Mid of October to End of April. The calculation is based on monthly average temperatures. Source: DIN V 18599-10:2007-02

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.

Jackopur 50/100/50 mm xps35 pir u-værdi 0,12, U=0,12 W/(m²K)

Temperature profile





Top left: Temperature profile in the blue section (see right illustration). Bottom left: Temperature profile in the green section.

Layers (from inside to outside)

#		Material	λ [W/mK]	R [m²K/W]	Temperatur [°C] min	max	Weight [kg/m²]
		Thermal contact resistance*		0,250	19,3	20,0	
1	5 cm	Extruded polystyrene (XPS 035)	0,035	1,429	15,0	19,3	1,8
2	10 cm	Beton	2,000	0,050	14,9	15,0	240,0
3	5 cm	Extruded polystyrene (XPS 035)	0,035	1,429	10,7	14,9	1,8
4	0,2 cm	Briiso klæber	1,400	0,001	10,7	10,7	4,0
5	11 cm	Briiso PIR 0,021 med fugespor	0,021	5,238	-4,8	10,7	3,3
	11,5 cm	Briiso PIR 0,021 med fugespor (Width: 1 cm)	0,021	5,476			0,5
6	0,2 cm	Briiso klæber	1,400	0,001	-4,8	-4,8	3,5
7	1,4 cm	Briiso teglskaller 1800 kg/m3, DIN 105	0,810	0,017	-4,9	-4,8	24,5
		Thermal contact resistance*		0,040	-5,0	-4,9	
	32,8 cm	Whole component		8,351			279,3

*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):	19,3°C	19,3°C	19,3°C
Surface temperature outside (min / average / max):	-4,9°C	-4,9°C	-4,9°C

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Moisture proofing

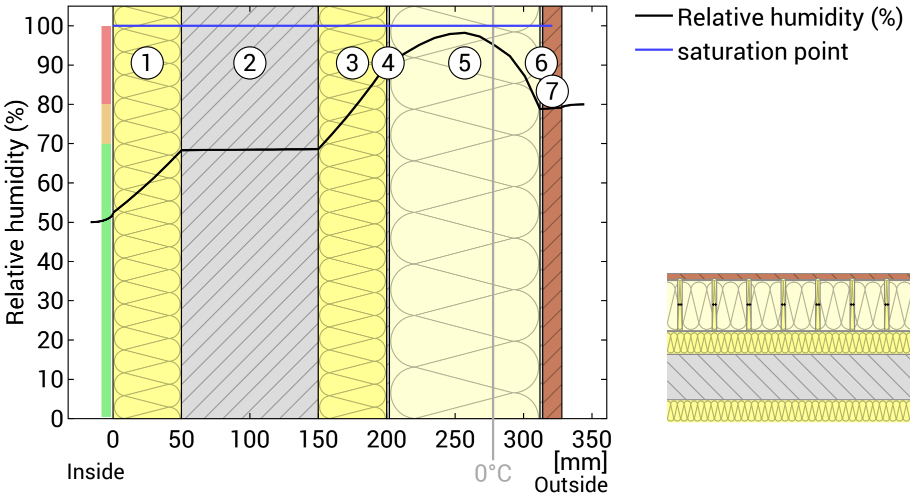
For the calculation of the amount of condensation water, the component was exposed to the following constant climate for 90 days: inside: 20°C und 50% Humidity; outside: -5°C und 80% Humidity. This climate complies with DIN 4108-3.

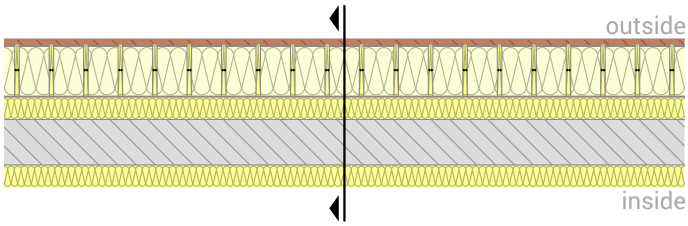
This component is free of condensate under the given climate conditions.

#		Material	sd-value [m]	Condensate [kg/m²]	[Gew.-%]	Weight [kg/m²]
1	5 cm	Extruded polystyrene (XPS 035)	4,00	-		1,8
2	10 cm	Beton	8,00	-		240,0
3	5 cm	Extruded polystyrene (XPS 035)	4,00	-		1,8
4	0,2 cm	Briiso klæber	0,03	-		4,0
5	11 cm	Briiso PIR 0,021 med fugespor	1100	-		3,3
	11,5 cm	Briiso PIR 0,021 med fugespor (Width: 1 cm)		-		0,5
6	0,2 cm	Briiso klæber	0,07	-		3,5
7	1,4 cm	Briiso teglskaller 1800 kg/m3, DIN 105	0,14	-		24,5
	32,8 cm	Whole component	1.116,24			279,3

Humidity

The temperature of the inside surface is 19,3 °C leading to a relative humidity on the surface of 52%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.





① Extruded polystyrene (50 mm)
② Beton (100 mm)
③ Extruded polystyrene (50 mm)
④ Briiso klæber (2 mm)
⑤ Briiso PIR 0,021 med fugespor (110 mm)
⑥ Briiso klæber (2 mm)
⑦ Briiso teglskaller 1800 kg/m3, DIN...

Layers marked with <-> run parallel to the illustrated cutting plane and were not taken into account in the moisture protection calculation.
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.

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Jackopur 50/100/50 mm xps35 pir u-værdi 0,12, U=0,12 W/(m²K)

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 [m²K/W]	sd [m]	ρ [kg/m³]
		Thermal contact resistance		0,250		
1	5 cm	Extruded polystyrene (XPS 035)	0,035	1,429	4	35
2	10 cm	Beton	2,000	0,050	8	2400
3	5 cm	Extruded polystyrene (XPS 035)	0,035	1,429	4	35
4	0,2 cm	Briiso klæber	1,400	0,001	0,03	2000
5	11 cm	Briiso PIR 0,021 med fugespor	0,021	5,238	1100	35
6	0,2 cm	Briiso klæber	1,400	0,001	0,07	2000
7	1,4 cm	Briiso teglskaller 1800 kg/m3, DIN 105	0,810	0,017	0,14	1800
		Thermal contact resistance		0,040		

T [°C]	ps [Pa]	Σsd [m]
19,26	2233	0
15,04	1708	4
14,89	1692	12
10,67	1284	16
10,66	1283	16
-4,83	407	1116
-4,83	407	1116
-4,88	405	1116

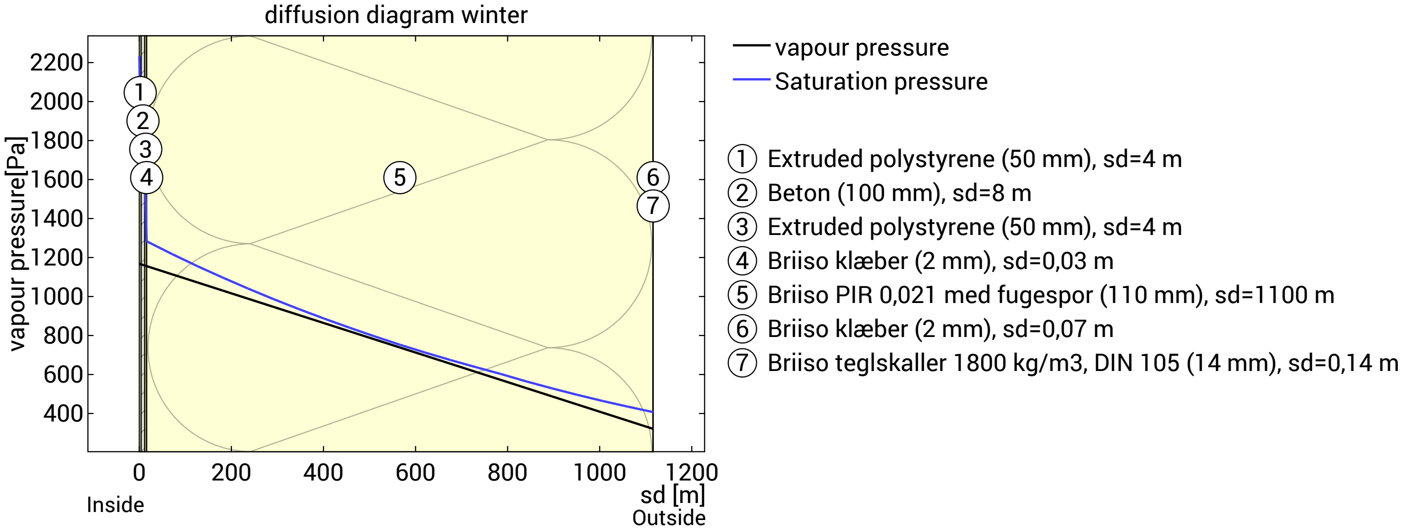
Temperature (T), vapor saturation pressure (ps), and the sum of the sd-values (Σsd) apply to the layer boundary.

Relative air humidity on the surface

The relative humidity on the interior surface is 52%. 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	pi = 1168 Pa
Vapor pressure outside at -5°C and 80% humidity	pe = 321 Pa
Duration of condensation period (90 days)	tc = 7776000 s
Water vapor diffusion coefficient in static air	δ0 = 2.0E-10 kg/(m*s*Pa)
sd-value (Whole component.)	sde = 1.116,24 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: sd=566,03 m; ps=753 pa, within layer Briiso PIR 0,021 med fugespor:

Mev,Tauperiode = tc * δ0 * ((ps-pi)/sd_{ev} + (ps-pe)/(sd_e-sd_{ev})) = **0,000 kg/m²**

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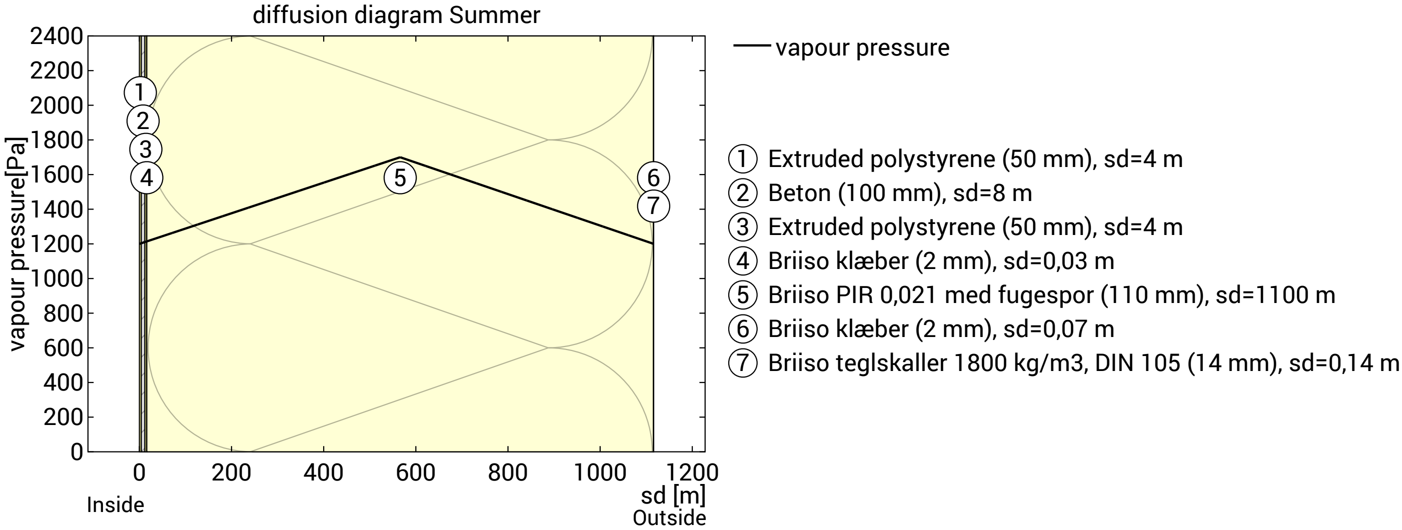
Jackopur 50/100/50 mm xps35 pir u-værdi 0,12, U=0,12 W/(m²K)

Evaporation period (summer)

Boundary conditions	
Interior vapor pressure	pi = 1200 Pa
Exterior vapor pressure	pe = 1200 Pa
Saturation vapour pressure in the condensation area	ps = 1700 Pa
Length of drying season (90 days)	tev = 7776000 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 sd=566,03 m, within layer Briiso PIR 0,021 med fugespor: Evaporation mass: Mev = δ0 * tev * [(ps-pi)/sd + (ps-pe)/(sde-sd)] = **0,00 kg/m²**

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 [m²K/W]	sd [m]	ρ [kg/m³]
		Thermal contact resistance		0,130		
1	5 cm	Extruded polystyrene (XPS 035)	0,035	1,429	4	35
2	10 cm	Beton	2,000	0,050	8	2400
3	5 cm	Extruded polystyrene (XPS 035)	0,035	1,429	4	35
4	0,2 cm	Briiso klæber	1,400	0,001	0,03	2000
5	11 cm	Briiso PIR 0,021 med fugespor	0,021	5,238	1100	35
6	0,2 cm	Briiso klæber	1,400	0,001	0,07	2000
7	1,4 cm	Briiso teglskaller 1800 kg/m3, DIN 105	0,810	0,017	0,14	1800
		Thermal contact resistance		0,040		

T [°C]	ps [Pa]	∑sd [m]
19,53	2271	0
14,39	1639	4
14,21	1620	12
9,07	1153	16
9,06	1152	16
-9,79	264	1116
-9,79	264	1116
-9,86	262	1116

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

Dew period (winter)

Boundary conditions	
Vapor pressure inside at 20°C and 50% humidity	pi = 1168 Pa
Vapor pressure outside at -10°C and 80% humidity	pe = 208 Pa
Duration of condensation period (60 days)	tc = 5184000 s
Water vapor diffusion coefficient in static air	δ0 = 1.852E-10 kg/(m*s*Pa)
sd-value (Whole component.)	sde = 1.116,24 m

Condensation area c_1: Condensate in layer Briiso PIR 0,021 med fugespor von sd_{c1i}=126,03m until sd_{c1e}=511,03m; p_{c1i}=1014Pa until p_{c1e}=637Pa; x ~ 21,3 cm

Condensate amount: Mc1 = tc * δ0 * $((p_i-p_{c1i})/sd_{c1i} - (p_{c1e}-p_{c2i})/(sd_{c2i}-sd_{c1e}))$ = **0,000 kg/m²**

No layer boundary in the condensation water area.

Condensation area c_2: Condensate in layer Briiso PIR 0,021 med fugespor
von sd_{c2i}=621,03m until sd_{c2e}=731,03m; p_{c2i}=548Pa until p_{c2e}=468Pa; x ~ 26,25 cm

Condensate amount: Mc2 = tc * δ0 * $((p_{c1e}-p_{c2i})/(sd_{c2i}-sd_{c1e}) - (p_{c2e}-p_e)/(sd_e-sd_{c2e}))$ = **0,000 kg/m²**

No layer boundary in the condensation water area.

Condensation occurs within a layer. The maximum allowed amount of condensation water is therefore 1 kg/m².
Total amount of condensate: Mc = **0,001 kg/m²**

Evaporation period (summer)

Boundary conditions	
Interior vapor pressure	pi = 982 Pa
Exterior vapor pressure	pe = 982 Pa
Saturation vapour pressure in the condensation area	ps = 1403 Pa
Length of drying season (90 days)	tev = 7776000 s
sd-values remain unchanged.	

Condensation water from area c_1 is added to the center of the area in the diffusion diagram, sd_{c1} = 318,53 m
Condensation water from area c_2 is added to the center of the area in the diffusion diagram, sd_{c2} = 676,03 m
Tauwasserausfall in zwei Ebenen. Berechnung der von den beiden Tauwasserebenen weg diffundierenden Diffusionsstromdichten:
gev1 = δ0 * (ps-pi)/sd_{c1} = 2.447e-10 kg/(m²s)
gev2 = δ0 * (ps-pe)/(sde-sd_{c2}) = 1.771e-10 kg/(m²s)

Evaporation times:
tev1 = Mc1 / gev1 = 1619640 s (18,7 Tage)
tev2 = Mc2 / gev2 = 727254 s (8,4 Tage)

Layer 2 dries first. Calculate the total potential evaporation mass:
Mev2 = gev2 * tev2 = 0,000 kg/m²
Mev1 = gev1 * tev2 + [gev1 + δ0 * (ps-pe)/(1116.24-318.53)] * (tev-tev2) = 0,003 kg/m²
Evaporation mass: Mev = Mev1 + Mev2 = **0,003 kg/m²**
The condensation amount of 0,001 kg/m² can dry completely.

Drying reserve: Mr = (Mev - Mc) * 1000 = **2 g/m²/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

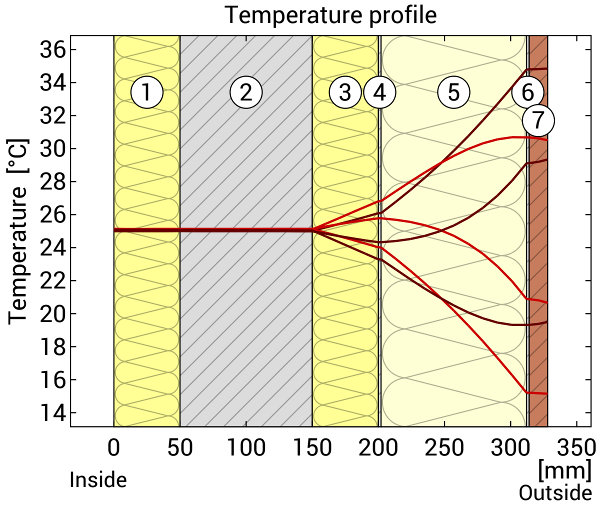
In the case of inhomogeneous constructions, such as skeleton-, stand- or frame constructions, as well as in wooden beam, rafter or half-timbered constructions or the like, the one-dimensional diffusion calculations are only to be demonstrated for the compartment area. Exceptional cases are special constructions in which, for example, The diffusion-inhibiting layer is also laid section-wise over the outer area. In these exceptional cases, the calculation performed here is invalid.

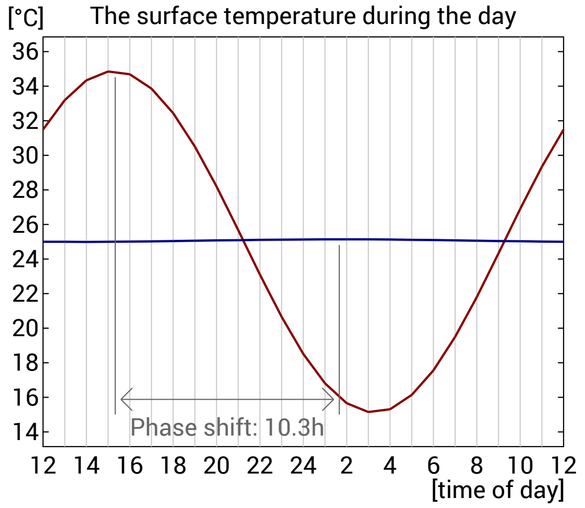
DIN 4108-3 describes in Section 5.3 components for which no moisture proofing is required as there is no risk of condensation water or the method is not suitable for the assessment. It is not possible to assess whether the component under test is underneath.

Jackopur 50/100/50 mm xps35 pir u-værdi 0,12, U=0,12 W/(m²K)

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*	non relevant	Heat storage capacity (whole component):	272 kJ/m²K
Amplitude attenuation **	>100	Thermal capacity of inner layers:	191 kJ/m²K
TAV ***	0,007		

* 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 / 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.

The calculations presented above have been created for a 1-dimensional cross-section of the component.

Hints

All timber layers are rotated

In this construction, all timber layers were rotated by 90°. They therefore run parallel to the cutting plane of the 2D moisture protection calculation and were NOT included in the moisture protection calculation.