

MgO SIP roof

Roof construction
created on 6.4.2019

Thermal protection

$U = 0,17 \text{ W}/(\text{m}^2\text{K})$

EnEV Bestand*: $U < 0,24 \text{ W}/(\text{m}^2\text{K})$



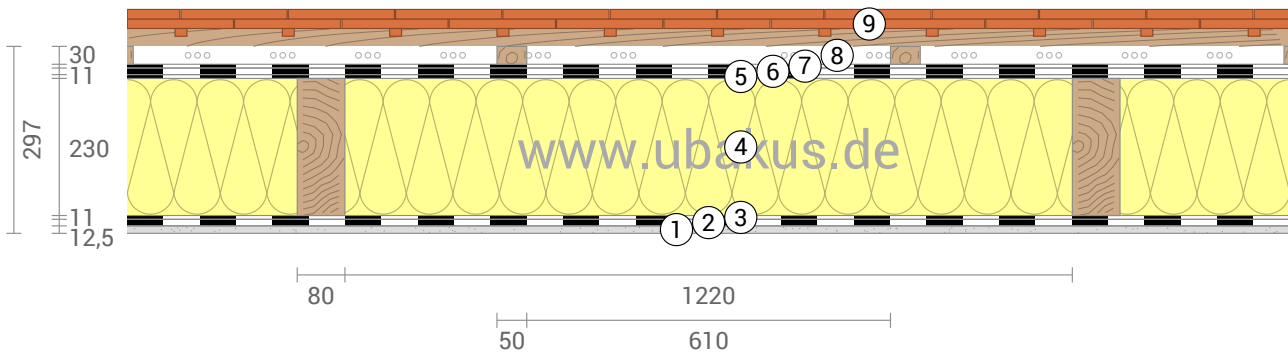
Moisture proofing

Dries 34 days
Condensate: 81 g/m²
Wood moisture: +0,1%



Heat protection

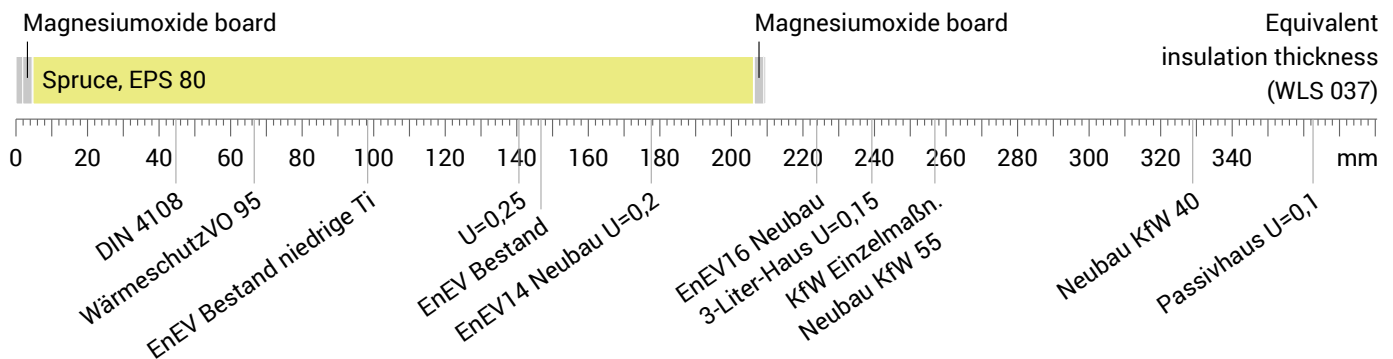
Temperature amplitude damping: 9,4
phase shift: 7,7 h
Thermal capacity inside: 25 kJ/m²K



- ① Gypsum (12,5 mm)
- ② Magnesiumoxide board
- ③ Polyurethane Adhesive Macroplast UR7225B
- ④ EPS 80 (230 mm)
- ⑤ Polyurethane Adhesive Macroplast UR7225B
- ⑥ Magnesiumoxide board
- ⑦ Breather membrane sd=0,05m
- ⑧ Cavity (30 mm)
- ⑨ Roof Tiles (75 mm)

Impact of each layer and comparison to reference values

For the following figure, the thermal resistances of the individual layers were converted in millimeters insulation. The scale refers to an insulation of thermal conductivity 0,037 W/mK.



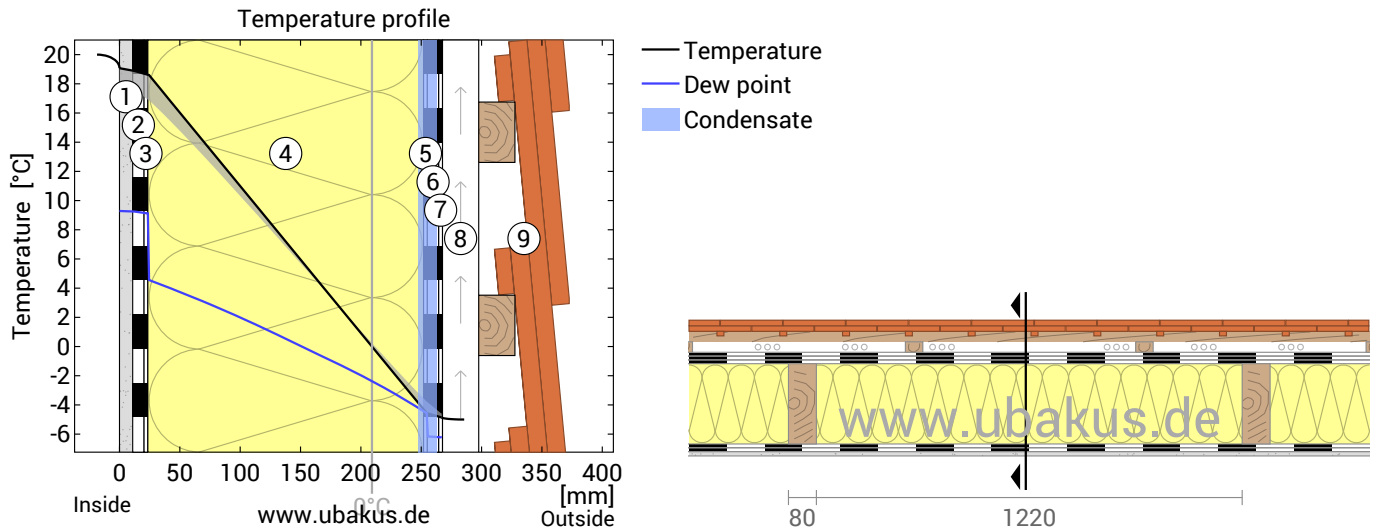
Inside air : 20,0°C / 50%
Outside air: -5,0°C / 90%
Surface temperature.: 18,0°C / -4,8°C

sd-value: 17,1 m

Thickness: 37,2 cm
Weight: 112 kg/m²
Heat capacity: 43 kJ/m²K

MgO SIP roof, $U=0,17 \text{ W}/(\text{m}^2\text{K})$

Temperature profile



- ① Gypsum (12,5 mm) ④ EPS 80 (230 mm) ⑦ Breather membrane $sd=0,05\text{m}$
 ② Magnesiumoxide board ⑤ Polyurethane Adhesive Macroplas... ⑧ Cavity (30 mm)
 ③ Polyurethane Adhesive Macroplas... ⑥ Magnesiumoxide board ⑨ Roof Tiles (75 mm)

Left: Temperature and dew-point temperature at the place marked in the right figure. 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, no condensation occurs. If the curves have contact, condensation occurs at the corresponding position.

Right: The component, drawn to scale.

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*		0,100	18,0	20,0	
1	1,25 cm Gypsum	0,250	0,050	17,6	19,1	8,5
2	1,1 cm Magnesiumoxide board	0,155	0,071	16,9	18,9	10,4
3	0,1 cm Polyurethane Adhesive Macroplast UR7225B	0,170	0,006	16,9	18,6	0,3
4	23 cm EPS 80	0,037	6,216	-4,6	18,6	4,3
	23 cm Spruce (6,2%)	0,130	1,769	-3,8	17,3	6,4
5	0,1 cm Polyurethane Adhesive Macroplast UR7225B	0,170	0,006	-4,6	-3,8	0,3
6	1,1 cm Magnesiumoxide board	0,155	0,071	-4,8	-3,8	10,4
7	0,05 cm Breather membrane $sd=0,05\text{m}$	0,500	0,001	-4,9	-4,6	0,4
	Thermal contact resistance*		0,100	-5,0	-4,6	
8	3 cm Cavity (ventilated layer)			-5,0	-5,0	0,0
9	7,5 cm Roof Tiles			-5,0	-5,0	70,0
	37,2 cm Whole component		5,851			111,9

*Thermal contact resistances according to DIN 6946 for the U-value calculation. $R_{si}=0,25$ and $R_{se}=0,04$ according to DIN 4108-3 were used for moisture proofing and temperature profile.

Surface temperature inside (min / average / max): 18,0°C 18,9°C 19,1°C
 Surface temperature outside (min / average / max): -4,9°C -4,8°C -4,6°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 90% Humidity (Climate according to user input).

Under these conditions, a total of 0,081 kg of condensation water per square meter is accumulated. This quantity dries in summer in 34 days (Drying season according to DIN 4108-3:2018-10).

#	Material	sd-value [m]	Condensate [kg/m ²] [Gew.-%]	Weight [kg/m ²]
1	1,25 cm Gypsum	0,05	-	8,5
2	1,1 cm Magnesiumoxide board	0,17	-	10,4
3	0,1 cm Polyurethane Adhesive Macroplast UR7225B	5,00	-	0,3
4	23 cm EPS 80	6,90	0,075	4,3
	23 cm Spruce (6,2%)	4,60	0,0052	6,4
5	0,1 cm Polyurethane Adhesive Macroplast UR7225B	5,00	0,081	0,3
6	1,1 cm Magnesiumoxide board	0,17	-	10,4
7	0,05 cm Breather membrane sd=0,05m	0,05	-	0,4
	37,2 cm Whole component	17,15	0,081	111,9

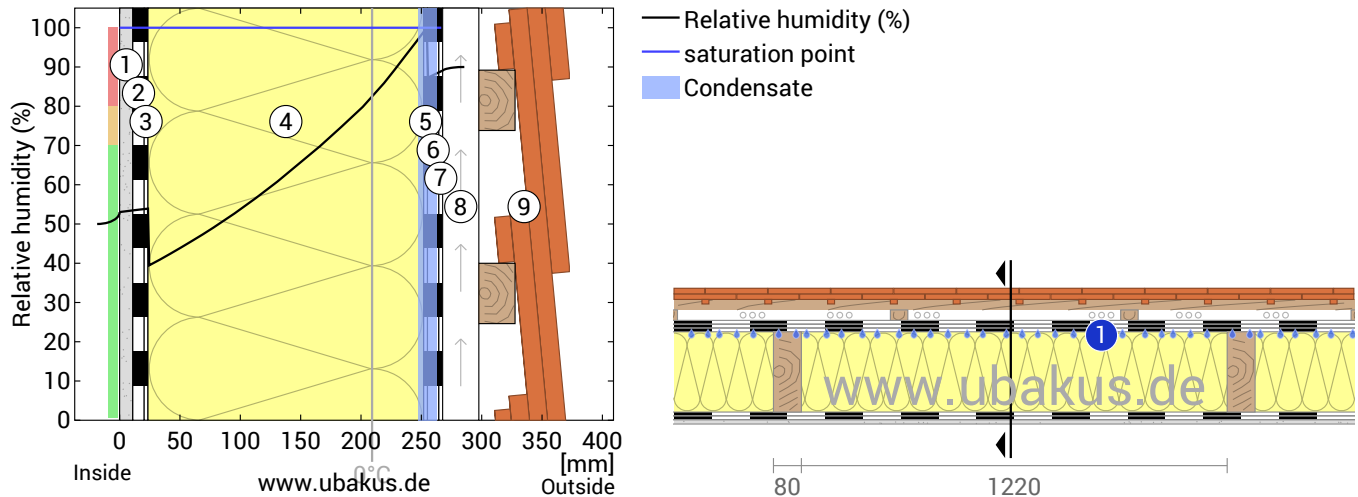
Condensation areas

- ① Condensate: 0,081 kg/m² Affected layers: Polyurethane Adhesive Macroplast UR7225B, Spruce, EPS 80, Spruce

Humidity

The temperature of the inside surface is 18,0 °C leading to a relative humidity on the surface of 57%. Mould formation is not expected under these conditions.

The following figure shows the relative humidity inside the component.



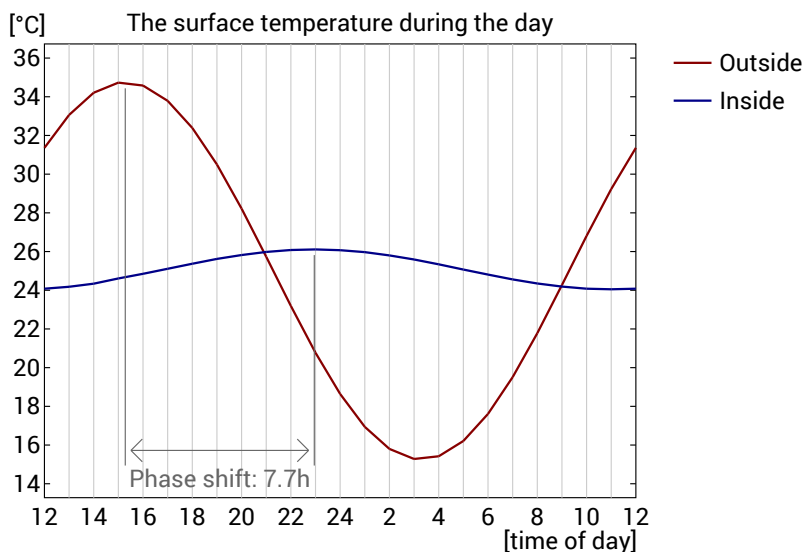
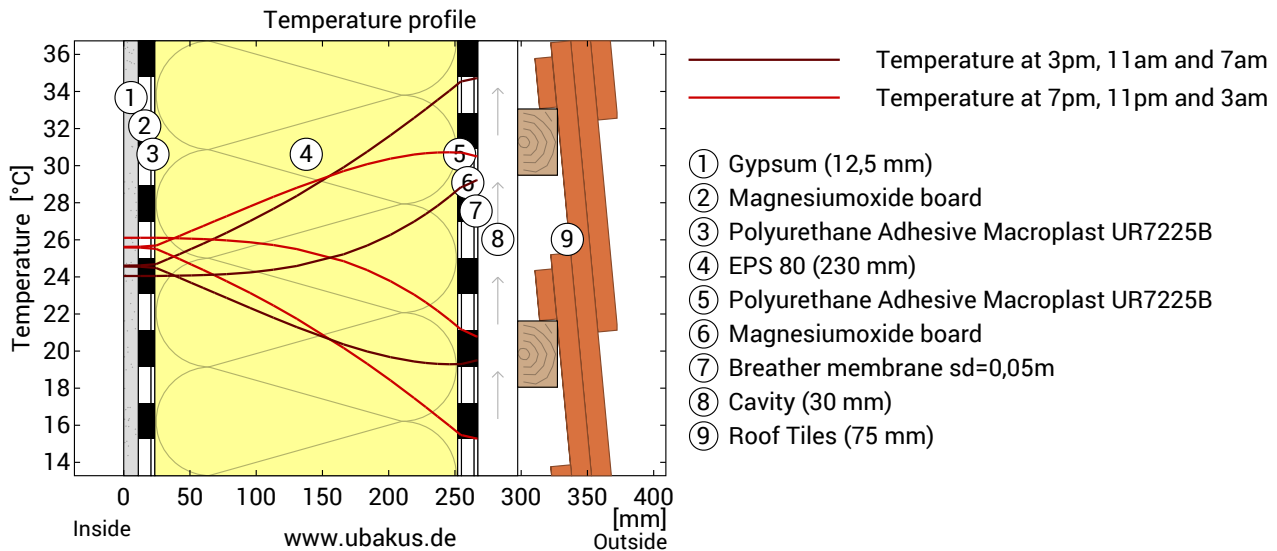
- | | | |
|--------------------------------------|--------------------------------------|------------------------------|
| ① Gypsum (12,5 mm) | ④ EPS 80 (230 mm) | ⑦ Breather membrane sd=0,05m |
| ② Magnesiumoxide board | ⑤ Polyurethane Adhesive Macroplas... | ⑧ Cavity (30 mm) |
| ③ Polyurethane Adhesive Macroplas... | ⑥ Magnesiumoxide board | ⑨ Roof Tiles (75 mm) |

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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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*	7,7 h	Heat storage capacity (whole component):	43 kJ/m ² K
Amplitude attenuation **	9,4	Thermal capacity of inner layers:	25 kJ/m ² K
TAV ***	0,106		

* 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.

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