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Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

U-Value verification measurement of a Minergie-certified building with greenTEG's gSKIN® U-Value Kit

By: Dr. Lukas Durrer, ETH Zürich, D-MAVT, Micro and Nanosystems Group
Tannenstrasse 3, CH-8092 Zurich, Switzerland lukas.durrer@micro.mavt.ethz.ch

Introduction

The aim of this study is to verify if it is possible to exactly measure the U-Value of building envelopes certified by the Minergie-standard using the gSKIN® U-Value Kit.

The object of study is a one-family house which was in its final construction phase during the measurement period in October 2013 (Figure 1). The house was completed on the 1st of July 2014 and is Minergie-certified based on an energy calculation by the energy consultancy Otmar Spescha AG (Schwyz, Switzerland).


Figure 1: Measurement object is a Minergie-certified standard wood construction in Rickenbach, Switzerland (left hand, south-oriented face; right hand, north-oriented face)

The building is a wood frame construction. The walls are constructed based on a three-layer plate inside, a Flumroc insulation layer (WD Flumroc Solo) and a DHF wall for the exterior. Wooden struts contribute to the stability of the walls.

Figure 2 shows the **U-Value for the wall including wooden struts** . Energy consultants at Otmar Spescha AG **calculated** the U-Value for this wall as **0.144 W/(m²K)**. The original certification paper is only available in German.

27 | Aussenwand 2 EG zu Aussenluft
Bauteil Nr. Bauteil-Bezeichnung

Wärmeübergangswiderstand [m²K/W] innen R_{si}: 0.13
außen R_{se}: 0.13

	Teilfläche 1	λ [W/(mK)]	Teilfläche 2 (optional)	λ [W/(mK)]	Teilfläche 3 (optional)	λ [W/(mK)]	Summe Breite Dicke [mm]
1.	3-Schichtplatte	0.130					27
2.	WD Flumroc Solo	0.036	zwischen Holzkonstruktion	0.130			280
3.	DHF Platte	0.100					16
4.							
5.							
6.							
7.							
8.							

Flächenanteil Teilfläche 2: 9.6%
Flächenanteil Teilfläche 3:
Summe: 32.3 cm

U-Wert: 0.144 W/(m²K)

Figure 2: U-Values calculated by Otmar Spescha AG (extract from Minergie certification document)

The **U-Value** for the same wall through a section without struts was calculated at **0.188 W/(m²K).** The following formula shows the calculation of the U-Value for the wall section without the struts:

$$U_{without\ struts} = \frac{1}{R_{el} + \left(\frac{\lambda_{3Schichtplatte}}{d_{3Schichtplatte}}\right)^{-1} + \left(\frac{\lambda_{Flumroc}}{d_{Flumroc}}\right)^{-1} + \left(\frac{\lambda_{DHF}}{d_{DHF}}\right)^{-1} + R_{se}}$$

Set-up description

The U-Value was measured for a north facing wall. The heat flux sensor was mounted in the middle of the inside wall using regular adhesive tape. One of the two temperature probes was mounted in close proximity to the heat flux sensor. The second temperature probe was mounted on the outside wall in roughly the same position as the heat flux sensor (Figure 3).

Figure 3: Mounting of heat flux sensor and temperature probe 1 (inside) and temperature probe 2 (outside)

Several measurements were conducted. The southwall measurement was conducted in November 2014 for a period of 166 hours. Throughout this measurement, special attention was paid to avoid sudden changes in room temperature (constantly closed windows, heating with constant performance, mostly cloudy weather).

Two more measurements were conducted at the north wall during the construction phase in May 2014. For drying out the Anhydrid floor, Secomats were used during the first measurement period. This lead to little temperature variations and a temperature differential above 5°C between the inner and outer temperatures. During the second measurement, massive fluctuations of the inner temperature occurred due to ventilation of the rooms during the daytime.

Results of the south wall measurements

The results of the south wall measurements are shown in Fig. 4. The U-Value is 0.14 W/(m²K) with a standard deviation of 2.8%, which leads to a measurement result in line with ISO 9869 specifications. During the first day of measurement, the radiation of the sun was comparably strong, causing rising interior temperatures from 22°C to 25°C (red line). As a consequence of this rise, more heat was stored in the wall due to the heat capacity of the wall, causing an increased heat flux (blue line). At the same time, the sun caused a rising outer temperature of almost 10°C (yellow line). These two overlapping effects lead to an increased moving average of the U-Value (green line). During the night and the cloudy day that followed, the heat flux was smaller because of the heat stored in the wall. This lead to a drop of the U-Value to 0.1 W/(m²K). During the following days with not much solar radiation, the U-Value rose to a value of 0.14 W/(m²K) as was also calculated by the energy consultancy.

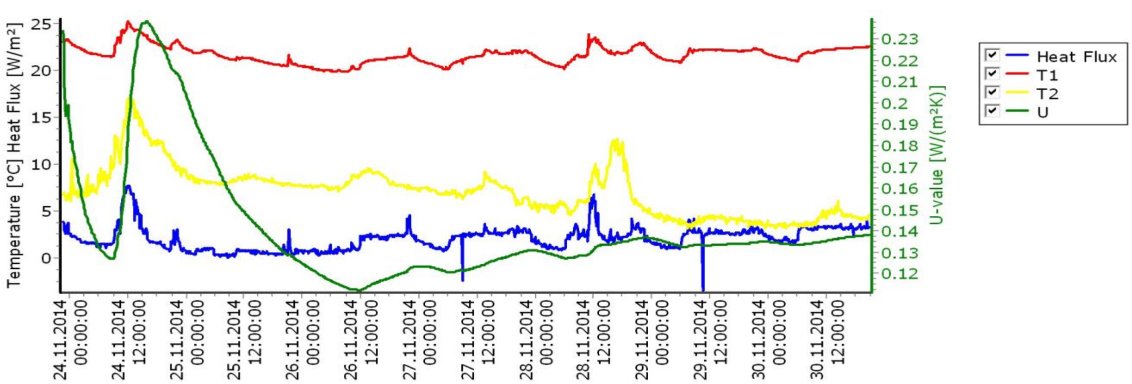

Fig. 4. Results of the south wall U-Value measurements cohering to ISO 9869

Results of other measurements

Results of the measurements of the north wall are shown in the table below and are compared with the calculated values:

Measurement object	**Condition**	**U-Value measured**	**U-Value calculated**	**Within standard deviation criteria according to ISO-Norm**
North wall	Slight variation of inner and outer temperatures	0.12 W/(m²K)	0.12 W/(m²K)	Yes
North wall	Strong ventilation of the rooms caused strong variations of the inner temperature	0.95 W/(m²K)	0.12 W/(m²K)	No

Conclusion

This representative comparison measurement shows the following:

- If properly conducted (according to ISO 9869), it is possible to measure the U-Value of highly insulated walls (Minergie-certified).
- In the case of the measured object, the U-Value measured with greenTEG's U-Value KIT matches the U-Value calculated by the energy consultancy, based on U-Values taken from the official building material catalogues.
- In order to get meaningful measurement results, it is important to keep the inside temperature at a constant level as shown by the difference between the first and second measurement of the north wall. By doing so, one can conduct measurements according to ISO standards even during summer months (e.g. May/June).