Electro Optical Components, Inc.
5464 Skylane Boulevard, Suite D, Santa Rosa, CA 95403
Toll Free: 855-EOC-6300
www.eoc-inc.com | info@eoc-inc.com

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gSKIN® application note: U-value Refrigerator

In previous application notes it has been shown that the gSKIN heat flux sensor can precisely map the heat flowing out of a heated building through its walls or windows. In actually the same way it should be possible to measure the heat flowing into a cooled room. This principle can be used to measure the energy efficiency of a refrigerator or a freezer. The consistency of the insulation within a fridge can be analysed or the performance of several cooling devices can be compared. For restaurants or grocery stores with a large cooling need this could be very valuable.

In this case study the U-value of a refrigerator door is measured. This is done by comparing the outcome of two heat flux measurements. The goal of this case study is to examine the reliability and reproducibility of such heat flux measurements for refrigerators.

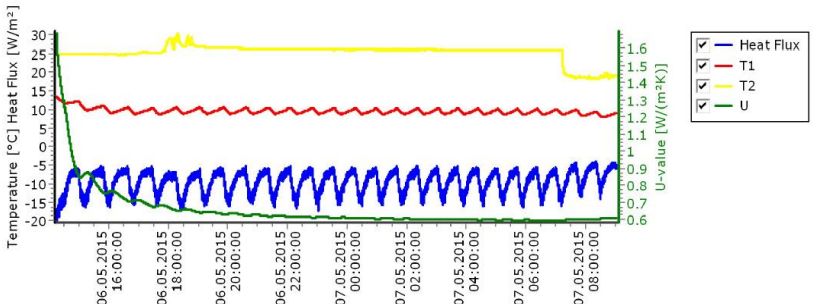
Measurement object and set-up

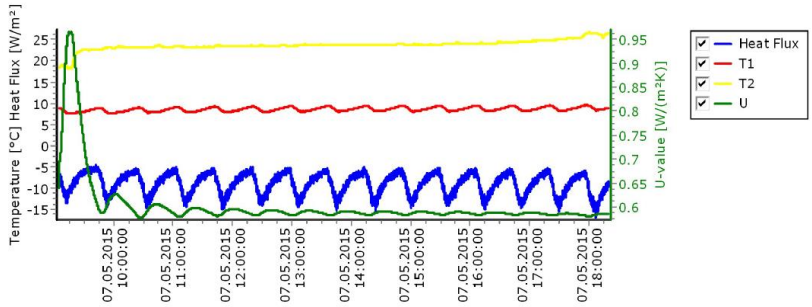
A small freestanding refrigerator of Fust Primotecq, type KS 118.1.IB has been measured. This refrigerator is insulated with polyurethane, has a capacity of 118 litre and the datasheet claims an energy use of 0.47 kWh/24h. It is located in a coffee room in a large office building.

The heat flux sensor was placed on the inside of the fridge door, mainly to avoid or at least reduce the impact of people walking by. One temperature sensor is attached next to it inside the fridge, approximately 5 cm from the door surface and the other temperature sensor is placed on the outside, also with a distance of around 5 cm. The first measurement took around 19 hours from the afternoon till the next morning and the second one lasted 9 hours starting in the morning till the beginning of the evening.

Results

Results of both measurement are shown in the following figures. The graph include the heat flux, the fridge temperature (T1) , the room temperature (T2) and the derived U-value.





The parameters during both measurement fluctuate according to the same pattern. The room temperature is stable most of the time except for the opening of a window in the first measurement. The fridge temperature is varying according to the cooling of the fridge. The heat flux is responding to the changing temperatures and fluctuates between -5 W/m^2 and -15 W/m^2. The U-value is therefore also fluctuating but after a few hours this effect is flattened and the averaged U-value becomes quite stable. The measured U-value in the first measurement is 0.60 W/m^{2}K and in the second measurement 0.59 W/m^{2}K.

Conclusion

Both measurements show the same temperature and heat flux pattern and reach a rather stable U-value after a few hours. The difference in the obtained U-value is negligible (0.01 W/m^{2}K). These measurements show that the door of the refrigerator has a U-value of around 0.60 W/m^{2}K. This seems a reasonable value for an insulated refrigerator door.

Based on these two measurement, heat flux measurements are a reliable and effective method to assess the insulation quality of an refrigerator or freezer in a couple of hours. This method can be especially valuable if the electricity consumption cannot be reliably measured.