INDOOR AIR MEASUREMENTS, report

The Tallwood project

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Mission

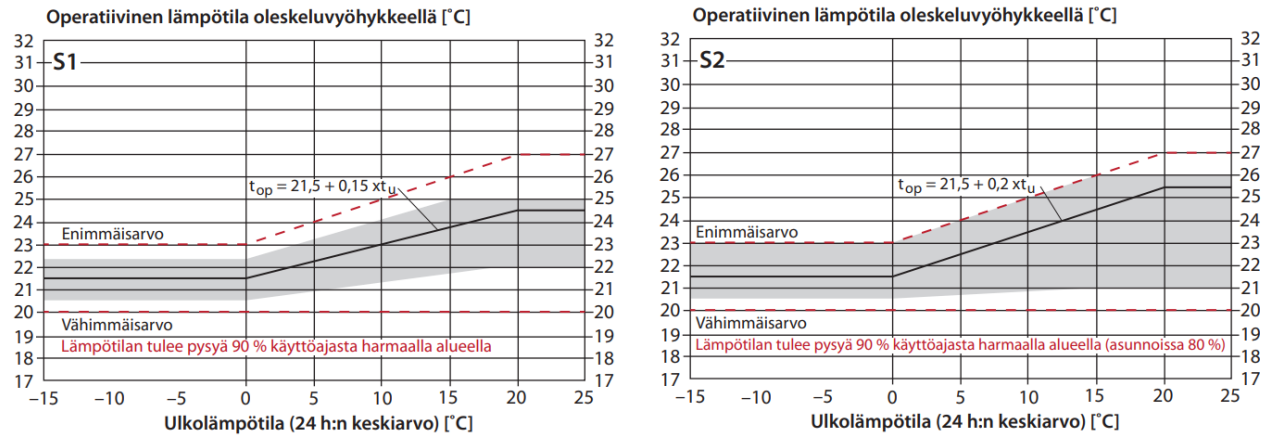
The task was to get information about the indoor air quality of the wooden buildings located in Finland that were involved in the Tallwood project. The target buildings were Oikopolku 2 and Oikopolku 4 in Pudasjärvi and Das Kelo in Rovaniemi.

Theory

An Airthings View Plus 2960 air quality meter was used for the measurements. It contains seven measuring sensors that can be used to measure temperature T, relative humidity RH, air pressure, radon, carbon dioxide CO_2, volatile organic compounds VOC, small particles PM1 and PM2.5

The temperature scale was °C. Relative humidity (RH) tells the absolute amount of water vapor in the air in relation to the amount of saturation water vapor in percent at its current temperature. In summer in Finland, indoor RH usually varies between 40-70%. Relative humidity above 80% should be avoided due to the risk of mold. Air pressure was measured in Pascals. The average air pressure in Finland is about 1 bar = 100000 Pa = 1000 hPa.

Indoor climate classification is used in Finland. In it, the indoor air is divided into three quality classes S1 (individual indoor climate), S2 (good indoor climate) and S3 (satisfactory indoor climate). The picture 1 shows the target values of the operative temperature (in this text, room temperature) in indoor climate categories S1 and S2. Table 1 shows the target values for carbon dioxide, radon and small particles with a diameter of less than 2.5 micrometers.



Picture 1. Target values of room temperature in indoor air categories S1 and S2 [1].

	S1	S2	S3
Hiilidioksidipitoisuuslisä* [ppm]	< 350	< 550	< 800
Radonpitoisuus [Bq/m³]	< 100	< 100	< 200
$PM_{2.5}$ [µg/m³]	< 10	< 10	< 25
$PM_{2.5}$ sisällä/ulkona	< 0,5	< 0,7	–
Ilman suhteellinen kosteus [% RH]	–	–	–
Olosuhteiden pysyvyys [% käyttöajasta]			
toimi- ja opetustilat	90 %	90 %	–
asunnot	90 %	80 %	–

*suurempi kuin ulkoilman hiilidioksidipitoisuus.

Table 1. Target values for indoor air categories [1].

The amount of radon was measured in the unit Bq/m^3. The reference value for radon concentration is 300 Bq/m^3. The reference value means the annual average of the radon concentration and it should not be exceeded. Table 1 shows that indoor air categories S1 and S2 aim for even lower values than the reference value.

The amount of carbon dioxide was measured in ppm (parts per million). The action limit for carbon dioxide is 1150 ppm higher than the carbon dioxide concentration in the outdoor air. The carbon dioxide content of the outdoor air is approximately 350-400 ppm. It is generally thought that indoor air is good if the amount of carbon dioxide is below 800 ppm. Indoor air 800 – 1200 ppm seems stuffy and causes fatigue.

Volatile organic compounds were measured in ppb [parts per billion]. VOC compounds evaporate into the indoor air most commonly from surface materials, furniture, and people's clothes and cosmetics. According to the manufacturer of the measuring device, 0-250 ppb means good indoor air. If the average reading is high (250-600 ppb), it would be good to map the VOC sources and try to eliminate them.

The amount of small particles PM2.5 and PM1 was measured in micrograms/m^3. The smallest PM1.0 particles include soot, bacteria and viruses. When moving to the larger diameter PM2.5, dust particles are also included. When the PM reading is ≤ 10 µg/m^3, the indoor air is good. Readings between 10-25 µg/m^3 are fair and a reading above 25 µg/m^3 is poor.

Performance of the measurement

The measuring devices were initially tested by keeping them next to each other for a few weeks. The measurement results of the period in question were compared and it was found that the measuring devices show the same readings on average.

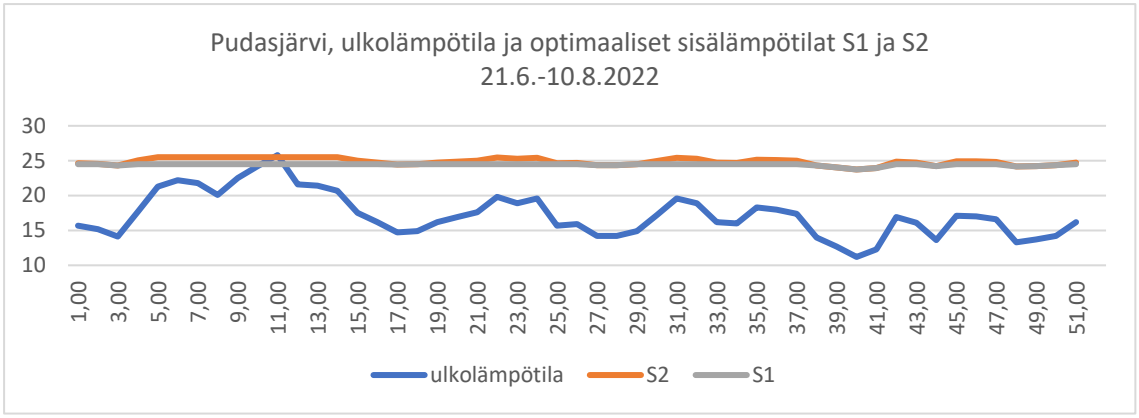
The actual indoor air measurements were performed from June 21 to August 10, 2022.

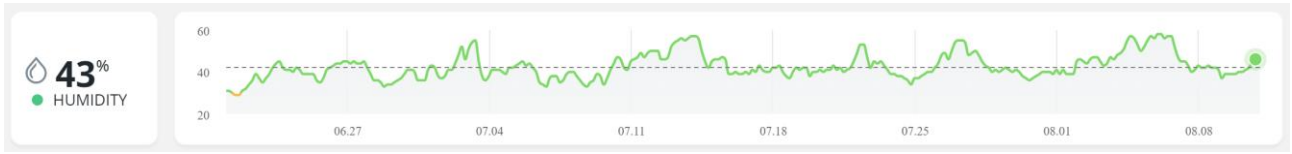
The locations of the measuring devices were as follows:

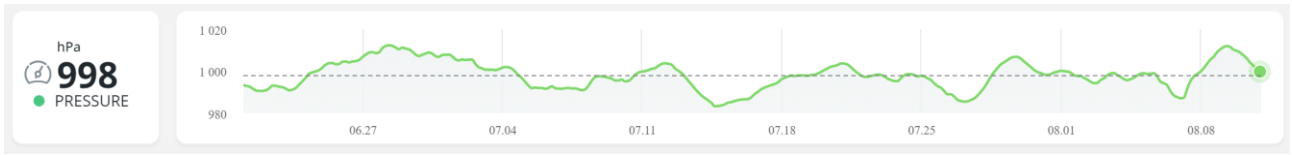
- Measuring device 1: Apartment (kitchen/living room) 2nd floor, Oikopolku 2, Pudasjärvi
- Measuring device 2: Office 1st floor, Oikopolku 4, Pudasjärvi
- Measuring device 3: Conference room 1st floor, Das Kelo, Rovaniemi
- Measuring device 4: Office 1st floor, Das Kelo, Rovaniemi

Measurement results

1 measuring device 21.6.-10.8.2022







Under the conditions at the time of measurement, indoor temperatures should be in indoor air class S1 90% of the time operating time below 25 °C and in indoor air class S2 80% of the operating time below 26 °C. The maximum value should be below 27 °C. At measurement site 1, the temperatures do not meet the criteria of indoor air class 1, but fit the limit values of class S2, except for one hot period lasting a few days, when the maximum temperature was exceeded on several days. There was an air source heat pump in the space. It may be that no one has been in the space in question or at least the use has been minimal. This is also reflected in the small fluctuations in the amount of CO_2.

RH varies within normal limits. The amount of radon is very low (≤ 20 Bq/m^3). Carbon dioxide and VOC levels remain normal most of the time. In terms of the amount of carbon dioxide, the space could belong to indoor air class S1. A few times the limit values are exceeded. There have probably been a lot of people in the space at that time. The amount of small particles also remains mostly good. Momentary poor readings seem to occur at times when the room temperature is also high.

2 measuring device 21.6.-10.8.2022

Under the conditions at the time of measurement, indoor temperatures should be below 25 °C for 90% of the operating time in indoor air category S1 and below 26 °C for 80% of the operating time in indoor air category S2. The maximum value should be below 27 °C. The temperatures of measurement site 2 would meet the criteria of indoor air class 1, except for the hot period. The maximum temperature was exceeded on four days in that period.

RH varies mostly within normal limits. A few times it rises high, probably due to the combined effect of outdoor rain and low indoor temperature. The amount of radon is very low (≤ 30 Bq/m^3). It goes up once for some reason. In terms of the amount of carbon dioxide, the space belongs to indoor air class S1. The amount of VOC remains normal most of the time. A few times the limit values are exceeded. There have probably been a lot of people in the space at that time. Regarding small particles, the space belongs to indoor air class S1.

3 measuring device 21.6.-10.8.2022

Under the conditions at the time of measurement, indoor temperatures should be below 25 °C for 90% of the operating time in indoor air category S1 and below 26 °C for 80% of the operating time in indoor air category S2. The maximum value should be below 27 °C. In measurement point 3, the space belongs to indoor air class S1 in terms of temperature.

RH varies mostly within normal limits. A few times it rises high, probably due to the combined effect of outdoor rain and low indoor temperature. The amount of radon is low (≤ 50 Bq/m^3). The amount of carbon dioxide and VOC remain low. In terms of the amount of carbon dioxide, the space belongs to indoor air class S1. The amount of small particles also remains mostly good. By all measures, the space belongs to indoor air class S1.

4 measuring device 21.6.-10.8.2022

Under the conditions at the time of measurement, indoor temperatures should be below 25 °C for 90% of the operating time in indoor air category S1 and below 26 °C for 80% of the operating time in indoor air category S2. The maximum value should be below 27 °C. In measurement point 4, the space belongs to indoor air class S1 in terms of temperature.

RH varies within normal limits. The amount of radon is low (≤ 50 Bq/m^3). The amount of carbon dioxide and VOC remain low. In terms of the amount of carbon dioxide, the space belongs to indoor air class S1. The amount of small particles also remains mostly good. By all measures, the space belongs to indoor air class S1.

Summary

Indoor air quality was good in all measured locations, and in some even excellent. The outdoor temperature affects the indoor temperatures and also the indoor air classification. The outdoor temperature was not measured in this work, because it was taken from the observations of the Meteorological Institute. In the follow-up measurements, you could also think about measuring the outside temperature, especially if there is no measuring station of the Meteorological Institute in the nearby area.

In terms of monitoring summertime temperature control, the measurement time was optimal. The temperatures this summer were not very high, except for one hot period. Otherwise, summertime is not necessarily the best measurement time due to users' vacation periods. It would be interesting to get measurement results from the heating season as well, and it would definitely be worth asking the users of the space for a diary of the number of people and times.

For a more detailed analysis, you could measure the pressure difference between indoor and outdoor air and get information on the operating power of the ventilation. The amount of carbon dioxide in the outdoor air and the relative humidity could also facilitates the explanation of measurement results in unclear cases.

Sources

[1] Rakennustietosäätiö RTS, 2018. RT 07-11299 Sisäilmastoluokitus 2018.

[2] STUK, 2022. Asuntojen radonia koskevat viitearvot ja määräykset. Available: https://www.stuk.fi/aiheet/radon/asuntojen-radonia-koskevat-viitearvot-ja-maaraykset, referred to [2.9.2022].

[3] Valvira, 2016. Sisäilman kemikaalit. Available: https://www.valvira.fi/ymparistoterveys/terveydensuojelu/asumisterveys/kemikaalit, referred to [2.9.2022].

[4] YM, 2018. Laskentaopas, Tilan ulkoilmavirran mitoitus hiilidioksidikuormituksen perusteella 28.2.2018, Ympäristöministeriön uuden rakennuksen sisäilmastosta ja ilmanvaihdosta annetun asetuksen (1009/2017) mukaan [online document].