New findings on airtightness measurements of very airtight buildings and apartments

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What is a very airtight building?

Very airtight buildings show a very small $n_{50}$-value - the air change rate at 50 Pa of a BlowerDoor test -

Examples:

• **Storage halls**: $n_{50} = 0.03 \text{ h}^{-1}$ (oxygen reduction / fireprotection)

• **Passive houses**: $n_{50} \ll 0.6 \text{ h}^{-1}$

• or **apartments** with small $n_{50}$-values

What do we see during an airtightness tests of a very airtight building?

BlowerDoor Multipoint Test seems to be very difficult or even impossible.
What happens?

- impossible to get a stable and constant building pressure
- leakage graph shows poor correlation coefficient
- leakage graph shows poor exponent n

Questions

Why is it difficult to measure very airtight buildings?

What does the measurement procedure should look like in order to obtain reliable and repeatable measurement results?
Test Example: Storage Hall

Internal Volume:
46,400 m³

$n_{50} = 0.03 \text{ h}^{-1}$

Pressurization Test

Building Pressure Difference

Fan Pressure (Airflow)

Test Time
2 hours

Graph from TECLOG4
Part of two test points

Building Pressure in Pa

100
50
0
-50
-100
-200
-300

10:30 10:35 10:40 10:45

Time

PARALLEL PARALLEL

Building Pressure Difference

Fan Pressure (Airflow)

Set-Up of one Building Pressure from 0 Pa to 50 Pa

Building Pressure in Pa

50
0

Set-Up Time ca. 300 s or 5 minutes

Valid data points for averaging a test point

Fan Pressure (Airflow)
Answer to one of our questions

Why is it difficult to measure very airtight buildings?

It takes much longer than usual – sometimes several minutes – to get a stable and constant pressure difference during the test

Can we define the set-up times for building pressure differences in practice?
Study from Dipl.-Phys. Joachim Zeller, Germany

Basis of calculations
• ideal gas equation
• Equation for the leakage curve of a building
• assuming a constant airflow (independent of building pressure)

Pressure set-up times for the following example
• start pressure is: 50 Pa
• target pressure is: 40 Pa
• flow exponent $n$ of the leakage graph: 0.67
• Reach target pressure with a tolerance less than ± 0.5 Pa
set-up time in seconds for different $n_{50}$-values

building pressure in Pa

3 h$^{-1}$, 1 h$^{-1}$, 0.6 h$^{-1}$

3 sec, 9 sec, 15 sec
One Result of the Study from Dipl.-Phys. Joachim Zeller

The lower the air change rate at 50 Pa, the longer it takes to reach a stable and constant target pressure when testing a very airtight building.

The time required to achieve a stable pressure difference ("set-up time") is inversely proportional to the air change rate at 50 Pa ($n_{50}$).
Is it possible to determine the time to reach a stable building pressure for the practice?

Yes!

Recommendations for practical work

Estimation of the set-up time for building pressure:

\[ t (s) = \frac{9 \text{ (s/h)}}{n_{50} \text{ (h}^{-1})} \]

Example: \( n_{50} = 0.03 \text{ h}^{-1} \)

\[ t (s) = \frac{9 \text{ (s/h)}}{0.03 \text{ h}^{-1}} \]

\[ = 300 \text{ s} \]
Summary

**Take your time for the measurement**

Test procedure for very airtight buildings:

1. Estimate the set-up time for a test point depending on the planned $n_{50}$-value

2. Check:
   - Is it possible to do an automated test or
   - is it better to work with a data logger software, that provide more information during the test

3. Check test result and leakage graph

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**Literature and Links**


- DIN EN 13829 (2001)
Good things take time!

Thank you!