
# Summary of the airtightness track

Around 150 participants attended the joint 35th AIVC –4th TightVent -2nd venticool conference held in Poznan, Poland September 24-25, 2014. The programme consisted of 3 parallel tracks with contributions from 27 countries and international organizations. Over 100 presentations were given covering topics including air infiltration through leaks in the building envelope and ductwork, ventilation in relation to IAQ and health, ventilative cooling and thermal comfort. It has also been a major discussion place for on-going projects and initiatives such as the QUALICHeCK project and platform, the IEA EBC annex 62, the TightVent Europe and venticool platforms, the newly formed Indoor Environmental Quality – Global Alliance (IEQ-GA), etc., based on presentations of results and perspectives as well as interactions with the audience.

The airtightness track of the conference consisted of 6 sessions with 26 presentations. Specific topical sessions dealing with airtightness included the following topics:

- Quality issues in airtightness testing
- Durability of airtightness
- Characterization of airtightness products
- Ductwork airtightness in new and renovated buildings

This article summarizes the main trends and conclusions addressed during the presentations and discussions in the airtightness track of the conference.

A number of presentations addressed **quality issues in airtightness testing**. Leprince et al (2014) compared building preparation rules for airtightness testing in 11 European countries (Leprince & Carrié, 2014). More specifically, the authors investigated the building airtightness testing protocol described in the EN 13829 and focused on its application and interpretation by the various countries including suggestions for improvement of the standard. It was found that building preparation differs significantly from one country to another and that the two methods described in the standard are either too detailed or insufficiently described to fit with the specificities of each country. The authors also underlined that the revision of the standard should: 1) describe more precisely the basic principles of the preparation and 2) allow some flexibility to the countries to specify rules consistent with their energy performance calculation method.

Loncour et al (2014), presented a new framework for the realization of reliable pressurization tests in Belgium and the provisions taken to widen the number of buildings where a valid pressurization test can be performed (Loncour, Delmotte, Mees, & de Strycker, 2014). This new quality framework (STS-P 71-3 – Airtightness of Buildings – pressurization tests, 2014) includes requirements for: 1) the qualification of the testers (accreditation or qualification examination), 2) the testing of material (calibration aspects) 3) the technical criteria (e.g. pressure differences at zero-flow) as well as 4) third party on site control (e.g. by repeating the measurement with the tester's or other system).

Mees et al (2014) developed a ten steps guide to ease the implementation of affordable airtight buildings with the goal to be used by architects (Mees, Delmotte, Loncour, & Martin, 2014). The authors highlighted steps ranging from the definition of the ambition level and the airtight zone within the building, to the choice of equipment type, materials, etc., including the construction process itself.

Carrie (2014) presented corrections on the airflow rate measurements for the characterization of power-law coefficients of the airflow through ventilation system components and ductwork or building leaks (Carrié, 2014). The author gave the analytical expression of these corrections depending on the air viscosity, air density and flow exponent. Even though the impact of the corrections remains fairly small (on the order of 5-8%) in most cases, it can become significant e.g. in the case of the characterisation of ventilation system components for industry application and thus the corrections should be applied systematically when performing such measurements.

Berthault et al. (2014), tested the impact of each component of the ductwork (rigid, circular metal) by setting a full-scale exhaust ductwork of multi-family building in their laboratory in order to better understand the airtightness of ductwork and its impact on flowrates and fan energy use and the reliability of ductwork airtightness tests (Berthault , Boithias, & Leprince, 2014). The results showed that the airtightness level of the ductwork has a major impact on the fan and that, if the ductwork is too leaky, the target air flowrate at air terminal devices may not be reached resulting in a major impact on indoor air quality. The study also concluded that the result of the airtightness test is neither influenced by the pressure drop in the ductwork nor by the location of the measurement device regardless the leakage distribution.

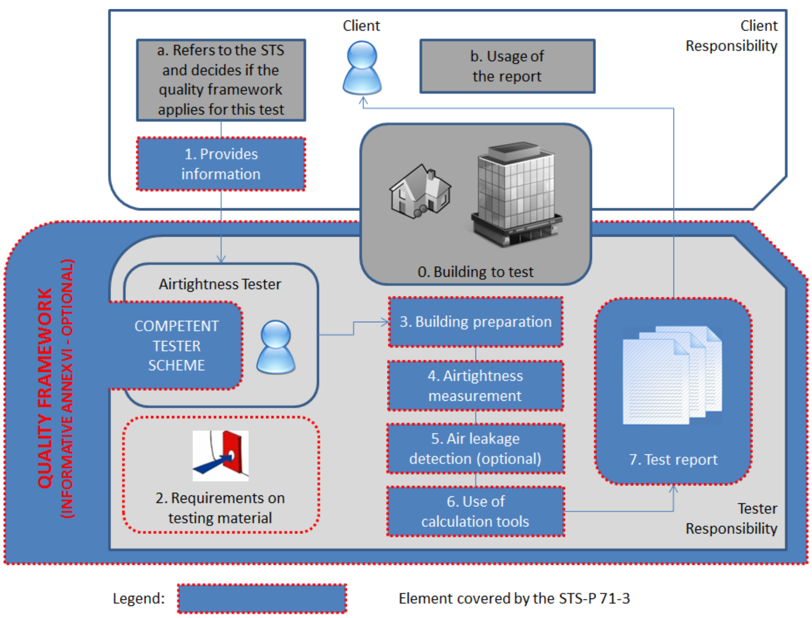


Figure 1: Steps of a pressurization test and elements covered by the STS-P 71-3 *(Loncour, Delmotte, Mees, & de Strycker, 2014)*

Several presentations discussed **building airtightness test methods**. Szymański et al (2014), compared the results of large buildings airtightness measurements using ventilation systems (Szymański, Górka , & Górzeński , 2014) and blower door. Although large building airtightness measurements can be performed using the building's ventilation systems according to EN 13829 standard, obtaining accurate results would require more expertise and effort compared to the classical blowerdoor measurement. Carrié et al analysed the steady wind model error in building pressurization tests in order to understand the impact of wind (Carrié & Leprince, Model error due to steady wind in building pressurization tests, 2014). One key result highlighted by the authors, was that the model error due to the wind on the estimated airflow rate is relatively small for the high pressure point, but it can become very significant with a low pressure point. While the error lies within 12% for wind speeds up to 10 m s-1 at 50 Pa, it can reach 60% at the low pressure point (10 Pa).

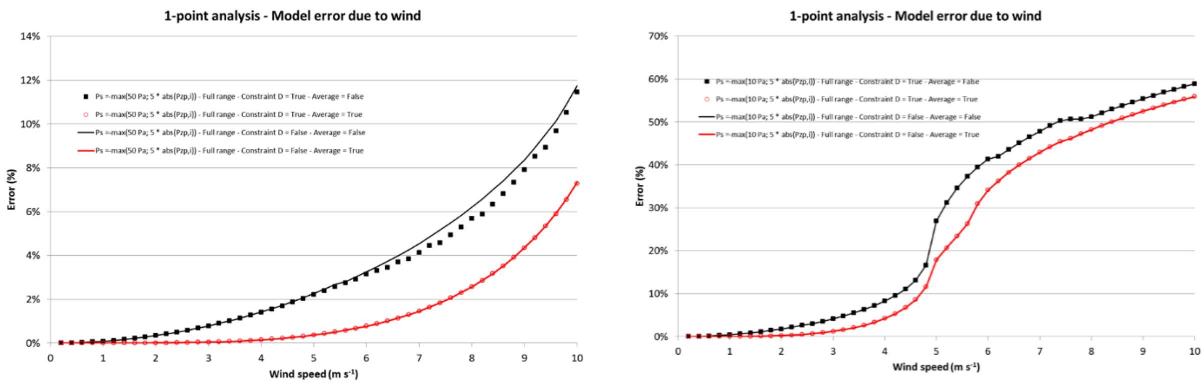


Figure 2: Error due to wind as a function of wind speed and leakage distribution (Carrié & Leprince, Model error due to steady wind in building pressurization tests, 2014)

Another study from Cooper et al (2014) investigated a novel nozzle pulse pressurisation technique for determining the leakage of buildings at low pressure, around 4Pa (Cooper, Zheng, Gillot, & Riffat, 2014). The investigation was based on the 'quasi-steady pulse' concept which produces a pressure pulse inside the building by introducing a certain amount of air in a very short time using an air compressor, solenoid valve, nozzle and control unit. The test results showed that due to short time operation, the technique minimizes the effects of wind and buoyancy force and can be highly repeatable. Compared to a piston pulse technique, the nozzle pulse technique appears to be more reliable for determining building leakage at low pressure. It also gives great convenience in practical applications due because it is more compact and portable although it needs only a few seconds for a test run, barely needs to penetrate the building envelope and can thus establish the leakage of a building very quickly and efficiently.

Carrilho et al (2014) introduced a technique for the measurement of infiltration rates from daily cycle of ambient $CO_2$ that requires no tracer gas injection. Unlike conventional tracer gas techniques it takes into account daily, quasi-periodic, variations in the ambient $CO_2$ concentrations produced by photosynthesis and respiration cycle of plants and processes associated with fuel combustion (Carrilho, Mateusa, Batterman, & da Silva, 2014). This novel approach appears to have several advantages since it does not rely on the injection of a tracer gas or the use of metabolic $CO_2$ generated by the building occupants, it produces 24h moving average time series of infiltration rates with the time resolution dictated only by the sampling frequency and it may be less sensitive to mixing assumptions compared to methods which require the injection or generation of a tracer gas inside the building. Although the preliminary results look reasonable, further work is underway for experimental validation.

Several discussions dealt with the **durability of airtightness**. Chan et al. (2014) presented the results of a comparison of air leakage measurements (2013 - 2014) with two sets of prior data (2001- 2003) from 17 new homes located near Atlanta, and 17 homes near Boise weatherized in 2007-2008, in order to determine the evolution of the airtightness of building envelope over time (Chan & Sherman, 2014). It was found that in this ten years' time, the air leakage increased by 15% in the new homes. On the other hand, no increase in air leakage was observed in the weatherized homes, which suggests that the improvements from weatherization were still effective. The authors underlined that the different results from the two groups of homes suggest that the leakage sites may be different. For the weatherized homes, the joints between building components that were sealed (by caulking and weatherstripping around windows and doors) do not change their leakage characteristics with time. However, in new homes, the new and moist wood materials can shrink over the first several years, potentially causing leaks in the building envelope.

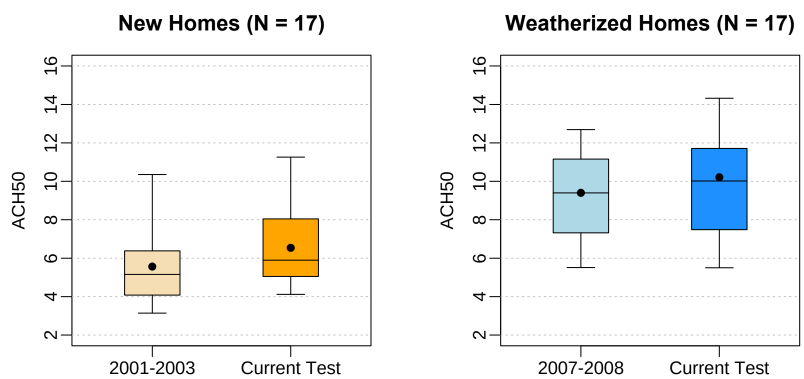


Figure 3: Comparison of the air changes per hour at 50 Pa (ACH50) in two groups of homes, where air leakage were measured previously and were repeated again recently *(Chan & Sherman, 2014)*.

Michaux et al (2014), conducted laboratory tests to evaluate the performance of more than 50 building walls and their materials before and after an accelerated ageing process including exposure to wind cycles (storms) corresponding to 10, 25 and 40 years of lifetime (Michaux, Mees, Evelyne , & Loncour, 2014). Overall, the results show that materials and systems age differently depending on the type of load. Bracke et al. (2014) performed a series of laboratory measurements on wood-frame walls to study different air sealing solutions (Bracke, Van Den Bossche, & Janssens, 2014). More specifically, the use of special airtight gaskets was compared to sealing methods such as sprayed polyurethane foam and the use of pieces of tape. The authors found that the use of standard, rigid airtightness tape is not a durable sealing method and should not be recommended for sealing 3-dimensional connections such as building penetrations. Nevertheless, the authors pointed out that there are specific flexible tapes on the market that perform very well and stressed that sprayed PUR can have excellent results when executed correctly. Also, EPDM gaskets perform well although they result in a higher leakage than flexible tapes and PUR. Wahlgren (2014) studied the seasonal variation of airtightness in three different buildings located in Sweden using a blower door (Wahlgren, 2014). The trend identified through the measurements was that the building envelope becomes leakier when the indoor air is dryer (low relative humidity). As a result, the air leakage was larger during the winter measurements. The decrease in airtightness from summer to winter was found on the order of 8-10%.

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