PULSE technique -- an alternative for measuring building airtightness, quickly and accurately

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Outline

- Impact of airtightness to building
- Current standard technique
- The PULSE technique
- Historical developments
- Research outcomes
- Ongoing activities and other potential applications
Definition

- Airtightness
- Air leakage
Consequences

Air Leakage Consequences

- Thermal Comfort
- Air Quality
- Moisture Damage
- HVAC Sizing
- Convective Loops

Indoor Environment

Durability

Energy Efficiency

Leaky, Old, Modern, New, Low, Passive
Airtightness regulation

Non-domestic buildings: 30-40 \( \rightarrow \) 4-5 \( \text{m}^3/\text{h.m}^2 \)

UK: Non-domestic

UK: Non-domestic+ Domestic

10 \( \text{m}^3/\text{h.m}^2 \) @50 Pa

AIC 1st Conf
<table>
<thead>
<tr>
<th>Country</th>
<th>Permeability or Air change rate</th>
<th>Pressure (Pa)</th>
<th>Property type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>3.0 (NV)</td>
<td>h⁻¹</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>1.5 (MV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.6 (PH)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>10</td>
<td>m³/h.m²</td>
<td>50</td>
</tr>
<tr>
<td>Belgium</td>
<td>12</td>
<td>m³/h.m²</td>
<td>50</td>
</tr>
<tr>
<td>US&amp;Canada (LEED FOR HOMES 2012 (1 point))</td>
<td>4.25 (z1, 2)</td>
<td>h⁻¹</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>3.5 (z3, 4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.75 (z5-7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 (z8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.2</td>
<td>m³/s</td>
<td>10</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.75</td>
<td>m³/h.m²</td>
<td>4</td>
</tr>
<tr>
<td>France</td>
<td>0.6 (SF) 0.8 (MF)</td>
<td>m³/h.m²</td>
<td>4</td>
</tr>
</tbody>
</table>
Current standard test method - steady pressurisation
Current standard test method - steady pressurisation
The shortcomings of current standard method

**Testing practicality**
- Multiple installation and tear down procedures to follow
- Change of building envelope
- Demand of skilful training to the operative, leading to the scope for human errors.

**Testing accuracy**
- Coarse interpretation of background pressure during testing.
- Uncertainty in extrapolating results down to low pressure.
- Not testing the whole envelope.
- Non-uniform pressure in large buildings.
- Unrealistic high measuring pressure considering hydraulically dissimilar flow at high and low pressure.
- Opening of additional leakage pathways.
Creating new openings
Previous research for alternatives

- AC method
- Decay method
- Pulse method
- Acoustic method
- Tracer gas method

Unsteady approaches
# Key stages of PULSE technique development

<table>
<thead>
<tr>
<th>Year</th>
<th>Funding source</th>
<th>Nottingham academics/researchers (PI in bold)</th>
<th>External involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>Internal funding</td>
<td>Etheridge &amp; Carey</td>
<td>None</td>
</tr>
<tr>
<td>2002-2006</td>
<td>EPSRC Industrial Case Award (PhD)</td>
<td>Etheridge &amp; Cooper</td>
<td>Airflow Developments Ltd</td>
</tr>
<tr>
<td>2010</td>
<td>Swedish Energy Agency</td>
<td>Cooper &amp; Etheridge</td>
<td>University of Gavle, Sweden</td>
</tr>
<tr>
<td>2010-2011</td>
<td>EPSRC First Grant</td>
<td>Cooper &amp; Zu</td>
<td>None directly, various via LoS</td>
</tr>
<tr>
<td>2013-2015</td>
<td>TSB consortium – Scaling Up Retrofit</td>
<td>Cooper, Riffat, Gillott &amp; Zheng</td>
<td>NEF, Elmhurst, EPS LTd, Air &amp; Gas Ltd, &amp; ANDtr</td>
</tr>
<tr>
<td>2015-2018</td>
<td>EU – Horizon 2020 (prop)</td>
<td>Wood &amp; Zheng, (Cooper)</td>
<td>20 in 8 countries</td>
</tr>
</tbody>
</table>
PULSE technique
PULSE technique-tank part
PULSE technique-control part
PULSE technique

- Accurate results at typical infiltration pressures
- Measurement of the whole building envelope
- Quick, easy and portable
- Ability to tether units for large buildings
- Instant results
- Effects of the wind are accurately accounted for
Comparison with the standard technique

Advantages:
- Building integrity
- Short time for setup, implementation and teardown
- Low training requirement
- Accurate measurement of background pressure
- Realistic measuring pressures
Comparison with the standard technique

Disadvantages:
• Inability of detecting the leakage pathways
Current ongoing activities

- Joint venture
- Built2Spec project
- Other potential applications.
Joint venture - Build Test Solutions

- www.pulseairtest.com
- PCT (international patent) filing has been made.
- IP licensed from University of Nottingham
Joint venture - Build Test Solutions

Video link: https://www.youtube.com/watch?v=L3daf6fSqrY
EU H2020 Project

Project website: http://built2spec-project.eu/
EU H2020 Project
Potential for other applications

- Clean rooms, containment labs and large refrigeration enclosures.
- Large buildings
Publications