Key findings of IEA EBC Annex 68 - Indoor Air Quality Design and Control in Low Energy Residential Buildings

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Problem statement

• Highly energy efficient buildings are airtight, and their need for ventilation should be optimized
  • but may be energy consuming
• Risk of high levels of pollutants indoors: Humidity, CO2 and chemical compounds
  • Influence of materials in the building fabric and inventory of buildings
Mission

• With a basis in scientific data and tools, the project shall provide guides for design and operation of buildings towards highest energy efficiency while ensuring good & healthy indoor conditions

• Specific target: New and refurbished residential buildings
Target audience

The project addresses the following stakeholders:

• Building designers (engineers and architects)
• Suppliers of HVAC and control systems
• Suppliers of materials used in building construction and indoor furnishing
• Providers of building management systems

The project shall also address the interests of building owners, facility managers and users, as well as authorities.
Subtasks

- ST1 - Defining the metrics
- ST2 - Pollutant loads in residential buildings
- ST3 - Modeling
- ST4 - Strategies for design and operation
- ST5 - Field measurements and case studies
Participants

1. Austria (Univ. Innsbruck; TU Wien)
2. Belgium (UGent)
3. Canada (BCIT; Health Canada)
4. China (Univ. of Shanghai for Sci. and Techn.; Nanjing Univ.; Tsinghua Univ.; The Univ. of Hong Kong; Shenzhen Institute of Bldg. Res.)
5. Czech Republic (CVUT Praha; TU Liberec; VUT Brno)
6. Denmark (Techn. Univ. of DK; Danish Bldg. Res. Inst.; Techn. Inst.)
7. Estonia (Tallinn Univ. of Techn.)
8. France (Univ. La Rochelle; Univ. de Savoie; Saint-Gobain; Insa Lyon)
9. Germany (TU Dresden; RWTH Aachen; Stuttgart Univ.)
10. Korea (Korea Institute of Civil Engineering & Building Technology)
11. The Netherlands (TU Eindhoven)
12. New Zealand (BRANZ)
13. Norway (NTNU; Univ. of Life Sci.; Inst. of Wood Techn.)
14. United Kingdom (UCL; Strathclyde Univ.; Cardiff Univ.)
15. USA (Syracuse Univ.; Florida Solar Energy Center; NIST; Univ. of Texas at Austin)
16. Finland (Aalto Univ.)
17. Italy (UNIVPM)
18. Japan (Univ. of Tokyo)
19. Slovakia (Techn. Univ. of Kosice)
20. Spain (Eduardo Torroja Inst. for Construction Science)
21. Sweden (IVL)
Subtask 1 – Defining the metrics

Objectives

• Is exposure to pollutants lower in low-energy buildings compared to non-low-energy buildings?
• What are the target pollutants in low-energy residential buildings?
• How to quantify IAQ?
• Can we aggregate IAQ and energy into one index?

AIVC CR 17: Indoor Air Quality Design and Control in Low-energy Residential Buildings- Annex 68 | Subtask 1: Defining the metrics | In the search of indices to evaluate the Indoor Air Quality of low-energy residential buildings
### Annex 68 target pollutants

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Long-term Exposure</th>
<th>Short-term Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELV*</td>
<td>Averaging period</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>48</td>
<td>1 year</td>
</tr>
<tr>
<td>Acrylon</td>
<td>0.35</td>
<td>1 year</td>
</tr>
<tr>
<td>α-Pinene</td>
<td>200</td>
<td>1 year</td>
</tr>
<tr>
<td>Benzene</td>
<td>0.2</td>
<td>whole life</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>9</td>
<td>1 year</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>2</td>
<td>1 year</td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>20</td>
<td>1 year</td>
</tr>
<tr>
<td>PM10</td>
<td>20</td>
<td>1 year</td>
</tr>
<tr>
<td>PM2.5</td>
<td>10</td>
<td>1 year</td>
</tr>
<tr>
<td>Radon</td>
<td>200</td>
<td>1 year</td>
</tr>
<tr>
<td>Styrene</td>
<td>30</td>
<td>1 year</td>
</tr>
<tr>
<td>Toluene</td>
<td>250</td>
<td>1 year</td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td>2</td>
<td>whole life</td>
</tr>
<tr>
<td>TVOC</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mold</td>
<td>200</td>
<td>1 year</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* ELV* concentration in μg/m³ except for carbon dioxide in ppm, radon in Bq/m² and mold in CFU/m²
Subtask 2 – Pollutant Loads in Residential Buildings

Objectives

- This subtask is to collect / provide data about properties for transport, retention and emission of chemical substances in new and recycled materials in residential buildings under various temperature, humidity and airflow conditions.

- Development of reliable methods and data for estimating pollutant loads in residential buildings in the way heating/cooling loads are routinely estimated.

   - Effects of temperature and relative humidity on emissions
   - Model-based testing and evaluation of VOC emissions and sorption
   - Database of VOC emissions for IAQ simulations
   - 3 common exercises

   + 3 common exercises
   + Database of VOC emissions for IAQ simulations
   + Effects of temperature and relative humidity on emissions
   + Model-based testing and evaluation of VOC emissions and sorption
Subtask 3 – Modeling

Objectives

• Survey of contemporary modelling capabilities
• Development of reference cases (common exercises)
• Identification of gaps in current modelling capabilities
• Development of new standards for quality assurance
• Recommendation of a modelling framework (tool coupling, co-simulation)

Annex 68 CHAMPS modeling platform

Annex 60 buildings library

Multizone Building Energy Simulation
HVAC-Systems and Operation Simulation
Building Envelope Systems Simulation
Subtask 4 - Strategies for design and control of buildings

Objectives:

• Gather results and approaches of the other subtasks of the Annex 68 and annex participants
• Address optimal and practically applicable design and control strategies for high IAQ in residential buildings
• Present results in context with existing knowledge

Results:

• Review - standards, national building codes, guidelines with respect to design of IAQ/ventilation in residences
• Survey - interviews with relevant stakeholders with focus on current IAQ design practices: 44 interviews, 6 countries
• The Annex 68 guide for practitioners: Current challenges, innovative solutions and case studies on indoor air quality design and control in residences
  • Focused on practitioners
  • Organized in short informative chapters
  • Includes case studies conducted within the Annex 68
  • Overview of other relevant research – digest by Annex 68 experts
The Annex 68 guide through current challenges, innovative solutions and case studies on indoor air quality design and control in residences

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<td>3/ Ways to design residential ventilation in the future/How to overcome nowadays challenges?</td>
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<td>5/ Conclusions and outlook</td>
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Objectives

- Measurement strategy
- Controlled experiments
- Case study reports
http://www.iea-ebc-annex68.org/