VOLUME FLOW UNBALANCES AND SHORTCUTS IN DECENTRALIZED AND CENTRALIZED VENTILATION UNITS – FIELD TESTS IN RESIDENTIAL BUILDINGS

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What was done?

- Assessment of ventilation systems in 20 single family homes and 60 dwellings in multi-family buildings.
- Energy Efficiency / User Comfort / Costs
- This paper addresses:
  - Volume flow and unbalances
  - Shortcuts

*Influence on Heat Recovery and Indoor Air Quality*
Tested Devices

Centralized

Decentralized Single Room

Decentralized Pair-wise
Field Measurements
Air flows of ventilation system
Air flow and Shortcuts

\[ m_{\text{extract}} = \frac{i_{\text{extract}}}{C'_{\text{extract}} - C_{\text{extract}}} \]

\[ R_{\text{ext}} = \frac{C_{\text{outside}}}{C_{\text{exhaust}}} \]

\[ R_{\text{int}} = \frac{C_{\text{supply}} - C_{\text{outside}}}{C_{\text{exhaust}} - C_{\text{supply}}} \]

\[ R_{\text{int} \_ \text{inv}} = \frac{C_{\text{extract}} - C_{\text{exhaust}}}{C_{\text{extract}} - C_{\text{supply}}} \]
Volume flow – Centralized Devices

Mean Air exchange rate = 0.37 1/h
Flow unbalances – Centralized Devices

\[ \dot{m}_{\text{supply}} > \dot{m}_{\text{extract}} \]

\[ \dot{m}_{\text{extract}} > \dot{m}_{\text{supply}} \]

Nr. 2, 5, 6
Flow unbalances – Centralized Devices

$\dot{m}_{\text{supply}} > \dot{m}_{\text{extract}}$

HR nominal 0.9

0.47 / 0.46 / 0.28

$\dot{m}_{\text{extract}} > \dot{m}_{\text{supply}}$
Volume flow – Decentralized Devices

All units set to $\dot{V} = 30 \text{ m}^3/\text{h}$

- Supply
- Extract
Flow unbalances – Decentralized Devices

Mean deviation 20 %

Mean deviation -24 %
Sensitivity to Differential Pressure
Shortcuts – Centralized Devices

58 % → CO₂-Con. > 2300 ppm

Decreased Fresh Air flow (by approx. Rint+Rext [%])

Mean Value

<table>
<thead>
<tr>
<th>Resistance Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R\text{int}</td>
<td>4 %</td>
</tr>
<tr>
<td>R\text{int}_\text{inv}</td>
<td>2.5 %</td>
</tr>
<tr>
<td>R\text{ext}</td>
<td>3 %</td>
</tr>
</tbody>
</table>
Shortcuts – Decentralized Devices

- Placement of inlet / outlet
- Same situation inside
- Ventilation efficiency of 0.43

Mean Value
- $R_{\text{int}}$: 1 \%
- $R_{\text{int\_inv}}$: 0.5 \%
- $R_{\text{ext}}$: 11.5 \%
Results

• Volume Flow Unbalances lead to low heat recovery rates (in this case below 50 %).
• Volume Flow Unbalances lead to In-/Exfiltration, reducing the heat recovery of the whole building even further
• High Sensitivity to Differential Pressure of decentralized units can lead to low heat recovery rates, in-/exfiltration and draught risk
Results

• High shortcuts lead to lower indoor air quality and possible to lower heat recovery rates if shortcut happens before heat recovery device

• Mean fresh airflow reduced due to shortcuts about 7 % for centralized and 12.5 % for decentralized devices

• That increases also specific fan power values (mean\textsubscript{centr.} = 0.47 Wh/m\textsuperscript{3} / mean\textsubscript{decentr.} = 0.23 Wh/m\textsuperscript{3})
Conclusion

• Reducing Volume Flow Unbalances and Shortcuts is crucial to good system performance.

• Mean values indicate that ventilation systems show higher values than expected → high heat recovery rates, good indoor quality and low specific fan power as promised may not be achieved in practice.

• Airtight casings, well positioned in-/outlets, air flow balanced fans, tight building envelopes, good hydraulic balancing.
Thank you

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