HEAT PUMP NOISE

Operation dependence and seasonal averaging

Caroline Haglund Stignor
Ola Gustafsson
Henrik Hellgren

RISE Research Institutes of Sweden
Built Environment
Energy and Circular Economy
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  - Bosch Termoteknik
  - Thermia Heat Pumps
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  - NIBE
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Background

- In Ecodesign and Energy Labelling Regulations 811 and 813/2013 heat pump energy performance: COP→SCOP (Seasonal COP)
- Noise is evaluated according to EN12102 in one test point
  - A-Weighted sound power level according to e.g. ISO3741
  - Evaluation at ”Standard operating condition” according to EN14511
  - Inverter controlled heat pumps
    - ”Test mode” – manufacturer provide settings
    - Fan and compressor speed according to "Rated Capacity" according to EN14511-3 and EN14825 → C-conditions, i.e.: +7°C outdoor condition, 35% part capacity
Background

- Noise is evaluated as sound power in one test point but vary with heat capacity (partial load) of heat pump – declared value not representative for the heating season.

![Chart showing sound power level vs. part load and outdoor temperature vs. heating demand.]}
Scope and objective

- Focus on air-to-water and brine-to-water heat pumps (ground source)
- Define the noise of heat pumps at different states of operation
- Develop and suggest an improved method for evaluation of noise
- Investigate the relation of heat pump noise characteristics and annoyance
Method

- Laboratory measurements of sound power on 14 heat pumps
  - 7 brine/water
  - 7 air/water
  - EN12102
  - Tests at large range of temperatures and part loads
- Estimation of seasonal noise performance
  - EN14825 methodology
- Listening test – dissimilary rating and preference mapping
Ground source (brine-to-water) heat pumps

Sound power level vs heating capacity - inverter

Higher heating capacity = higher sound power level
Ground source (brine-to-water) heat pumps
Sound power level vs part load – inverter – 0/35

Part load strongly affect the sound power level
Ground source heat pumps
Sound power level vs part load - inverter

Part load = ~10 dBA effect
Temperature = ~2 dBA effect
Air-to-water heat pumps
Sound power level vs part load - inverter

The fan-control affect the sound power level curve
Number of hours in each temperature bin according to EU Regulation 811 and 813/2013 and EN14825

Outdoor temperature (°C)

Bin hours

- Warmer
- Average
- Colder
Seasonal noise

A weighted sound power level was calculated as the log-based average of the sound power level in each bin multiplied with the corresponding bin hours based on **input data from sound tests in all test points in EN14825, see graph**

<table>
<thead>
<tr>
<th>Heat pump type</th>
<th>Soundpower Standard rating conditions dB(A)</th>
<th>Seasonal sound Average climate dB(A)</th>
<th>Seasonal sound Cold climate dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BWHP1</td>
<td>36</td>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>BWHP2</td>
<td>34</td>
<td>39</td>
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<td>AWHP1</td>
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</tr>
<tr>
<td>AWHP2</td>
<td>53</td>
<td>56</td>
<td>58</td>
</tr>
</tbody>
</table>

**Result**

- The seasonal sound power is 4 – 8 dB higher compared to the sound power at rated capacity
- Requires extensive testing!
Seasonal noise – average climate – simplified method

Proposed test point for sound power test: +2°C, 54% (test point B in EN14825), for air source heat pumps +7°C, but part load according to test point B (54%)
Psychoacoustics – Noise vs annoyance - Listening tests

- **Scope:** Determine the prevalent or dominant perceptual features in different ground source (brine-to-water) heat pumps

- **Method:**
  - 3 different heat pump models and 10 different recordings of varying situations with 14 persons
  - Pairwise dissimilarities were investigated
    - equal sound level

- **Results:** The most prominent parameters are compressor speed and the sharpness level. The participants preferred sounds with less sharpness and a compressor speed at higher frequency.
Conclusions and recommendations

- The **compressor and fan speed** are the **dominating factors** for the sound power level of a heat pump. The temperature levels and the temperature lift are of less importance.

- The noise of a heat pump should be evaluated at:
  - The temperature/part load that corresponds best to the seasonal averaged noise = +2°C, 54% (or +7°C, but 54% part load for air source heat pumps)
  - Maximum compressor speed (and fan speed) – to inform about the range

- Listening tests: sounds with less sharpness and a compressor speed at higher frequency are preferred
THANKS FOR LISTENING!

Questions?

CONTACTS

Caroline Haglund Stignor
Caroline.HaglundStignor@ri.se

Ola Gustafsson
Ola.gustafsson@ri.se

Henrik Hellgren
Henrik.Hellgren@ri.se

RISE Research Institutes of Sweden