Noise characteristics and psychoacoustic of outdoor heat pumps

Goecke, David

Fraunhofer Institute for Building Physics IBP
Nobelstraße 12
70569 Stuttgart, Germany

ABSTRACT

Heat pumps are vital for achieving climate-neutral indoor heating and air conditioning, with air-source heat pumps comprising over 70% of the market. However, their increasing prevalence raises concerns about noise emissions, necessitating focused efforts to mitigate these impacts. The network of the publicly funded QUEEN-HP MENESA project addresses this challenge through comprehensive investigations and acoustic evaluations aimed at reducing noise and vibration from outdoor heat pump systems.

To facilitate this research, two specialized laboratories have been established at Fraunhofer IBP. The first, a hemi-anechoic chamber, is equipped with temperature control to enable standardized measurements at -7 °C and 7 °C. This facility employs a movable microphone arrangement to capture spherical sound radiation patterns, allowing for detailed assessments of source location, radiation contributions, and sound power across various operational conditions of the heat pump. The second laboratory, designed as a reverberation chamber, incorporates a reception plate for measuring impact sound, forces, impedances, and sound power. These measurements provide essential input data for simulations predicting vibration distribution within buildings and sound radiation into indoor spaces.

In parallel, the project recognizes the importance of psychoacoustics, which studies human sound perception. Standardized assessment procedures outlined in DIN ISO 12913 emphasize psychoacoustic mapping, introduced in 2021, to better represent perceived noise pollution. Traditional sound pressure levels often fail to capture the true impact of noise, highlighting the need for a psychoacoustic perspective that incorporates metrics such as loudness, sharpness, and tonality. A second project, which will be presented in context, aims to integrate acoustic measurements from the heat pump evaluations with psychoacoustic analyses to create software for psychoacoustic mapping. This approach enables more accurate assessments of environmental noise and enhances the understanding of how heat pump noise affects human perception. An illustrative case study demonstrates the calculation of psychoacoustic mapping using heat pump measurements as sound sources.

KEYWORDS

heat pump noise, radiation, vibration, psychoacoustics, noise pollution, soundscapes