Impact of perforated sheet geometry on the insertion loss of absorption silencers

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This study evaluates the influence of perforated sheet geometry on the acoustic and aerodynamic performance of absorption silencers. A modular silencer was developed, enabling the installation of six different perforated metal sheets with varying hole shapes (round, square, elongated), sizes (2–20 mm), and open area ratios (22–45%). Glass wool was used as the sound absorbing filling. Insertion loss, self-noise, and pressure drop were measured in a large reverberation chamber, within the frequency range 50–10,000 Hz, for airflow velocities of 4, 6, and 8 m/s. The results indicate that all configurations provide comparable attenuation at low frequencies. Silencers with small round perforations (diameter 2–6 mm) ensured higher insertion loss and lower self-noise in the 1,000–5,000 Hz mid-frequency range, without any measurable increase in pressure drop compared to variants with larger or elongated holes. For frequencies above 6,300 Hz, perforated sheets with larger holes performed better. Pressure loss differences between all configurations did not exceed 1 Pa at a given flow velocity. The results confirm that aperture size is the primary parameter affecting silencer acoustic effectiveness, while aperture shape and perforation ratio are secondary. These findings provide practical guidelines for optimal silencer design in ventilation systems, ensuring maximum noise reduction with minimal airflow resistance.