

Modifications of a Handheld Vacuum Cleaner for Noise Control: A Review

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Abstract:

Noise from handheld vacuum cleaners is a persistent concern, since it affects user comfort, product acceptance, and compliance with tightening acoustic regulations. This work presents a review-based study that brings together existing research on the aerodynamic, mechanical, structural, and psychoacoustic sources of noise in these appliances, rather than reporting new experimental or prototype work of our own. Noise in handheld vacuum cleaners mainly arises from the interaction between the rotating impeller and the surrounding diffuser and nozzle passages, along with motor vibration and structural resonance. The literature reviewed covers a wide range of mitigation strategies, including aerodynamic and airflow optimization, impeller and fan redesign, suction nozzle and intake modifications, motor and resonance control, sound-absorbing materials, acoustic metamaterials and microperforated panels, mufflers, psychoacoustic evaluation, computational and experimental methods, and emerging AI-based diagnostic approaches. Across these studies, the clearest finding is that no single technique fully solves the noise problem on its own; combining strategies, such as aerodynamic redesign with passive acoustic treatment, gives better results while keeping suction performance and energy efficiency intact. The review also points to important gaps: most studies focus on individual components rather than the vacuum cleaner as a complete system, there is a trade-off between noise reduction and suction/airflow efficiency, testing is rarely carried out under real operating conditions, and active/adaptive control along with psychoacoustic-AI integration remain largely unexplored for real-time use. Addressing these gaps through integrated, system-level approaches is expected to guide the development of quieter, more efficient, and user-friendly handheld vacuum cleaners.

Keywords:

Handheld vacuum cleaner, noise control, aerodynamic noise, psychoacoustics, fan design.