Observation of Nonlinear vibro-Acoustic phenomena in the Presence of Elastic Membrane with Different Boundary Conditions.

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Linear behaviors are typically encountered in duct acoustics, where plane waves propagate in rigid ducts, such as intake and exhaust systems.

In this study, a circular elastic membrane is used in different configurations to generate local nonlinear boundary conditions for the end section of a linear waveguide.

The membrane has been applied to simulate an equivalent Nonlinear Energy Sink (NES), where the acoustic power from the primary linear system is irreversibly transferred to NES and dissipated. Different test rig configurations have shown how the boundary conditions affect the behavior of the membrane and the acoustic field in the main duct. The vibrational behavior of the membrane in specific conditions becomes nonlinear and the absorption coefficient of this component exhibits dependence on sound excitation level.

Despite the nonlinear behavior of the membrane, the acoustic waves still propagate linearly in the main duct. For this reason, the classical wave decomposition technique is utilized to study the acoustic field in the main duct. The sound pressure levels, the acoustic pressure and particle velocity profiles are studied at different levels of sound excitations and at different frequencies. Possible theoretical explanations for the NES effect are presented along with the experimental data. Considerations about the energy threshold necessary to “excite” the energy transfer from the duct to the membrane are provided.

References

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