Acoustics of interaction of unsteady flows with periodic structures

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ABSTRACT

This thesis deals with chosen topics from the aeroacoustics of periodic structures. A critical analysis of the application of the frequency-domain linearized Navier-Stokes equations on the case of sound transmission above a corrugated plate with non-zero airflow was conducted. It was found out that the correspondence with the experiment is very limited in this case due to problems with the linearization of the hydrodynamical perturbations. An extension and clarification of the previously proposed phenomenological model for sound generation in corrugated pipes were given and the model was tested against the experimental data. In order to assess the influence of finite-amplitude sound propagation on the source-resonance coupling, a weakly-nonlinear model was proposed as an extension to the linear one. Next, it was investigated how the periodic arrangement of heat exchanger coolant tubes affects the sound propagation and whether it can be described as a sonic crystal. It was shown that even for finite structures consisting of four rows of coolant tubes the theory of wave propagation through periodic media is applicable and proves to be in accordance with the experiment. The noise generated by the unsteady flow through the tube array was investigated by numerical simulations. It was demonstrated that the radiated sound intensity is proportional to the previously derived dependence valid for a single cylinder and the Strouhal law governs the fundamental frequency.