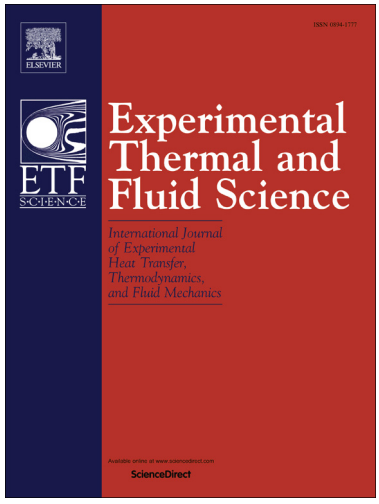

Optimal diameter of nozzles of synthetic jet actuators based on electrodynamic transducers

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Optimal diameter of nozzles of synthetic jet actuators based on electrodynamic transducers

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Abstract

The formulation of the optimization problem was based on the maximization of an objective function, which was alternatively selected from the four integral quantities: volumetric flux, momentum flux, kinetic energy flux, and energetic efficiency. With two potential applications intended (active flow control and heat transfer enhancement), the most appropriate objective function is suggested to be the momentum flux.

In the experimental part of this study, an axisymmetric actuator was investigated in several variants. Two transducers (loudspeakers) and nine nozzle diameters were tested for ten supplied power levels. The working fluid was air, and the driving frequency was adjusted near the first resonance of the actuator. The velocity profiles at the actuator nozzle exit were measured by a hot-wire anemometer.

In the theoretical part of this study, a lumped element model was used with an assumption of an incompressible working fluid. The optimal diameter of the nozzle was found and its dependence on the chosen objective function was revealed. Moreover, the theoretical results were generalized into explicit relationships between the dimensionless optimal nozzle diameter and the loudspeaker parameters. A maximum overall energetic efficiency of 15% was achieved. Outstanding agreement between the theoretical and experimental results was concluded.

Keywords: synthetic jet, design optimization, synthetic jet actuator, volumetric flux, momentum flux, kinetic energy flux, energetic efficiency, resonance, lumped element modeling

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