DOCTORAL THESIS ABSTRACT

THE EFFECT OF THE GEOMETRIC PARAMETERS OF THE SYNTHETIC JET ACTUATOR ORIFICE ON FLOW PARAMETERS AND HEAT TRANSFER ENHANCEMENT

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The thesis presents the results of experimental studies evaluating the effect of the geometric parameters of a synthetic jet actuator (SJA) orifice on the flow parameters of the generated synthetic jet, heat transfer enhancement under impingement cooling conditions and the energy efficiency of the SJA. The research was supplemented by an analysis of the acoustic emission of the SJA under operating conditions corresponding to the investigated flow and thermal characteristics. The research problem was identified on the basis of a review of the current state of knowledge, the aim and scope of the research were defined and a thesis statement addressing the impact of the orifice geometric parameters on the flow and thermal characteristics of the synthetic jet actuator was formulated.

The research involved experimental investigations across a wide range of geometric configurations using complementary measurement techniques. Measurements were carried out with four separate laboratory setups for 32 geometric configurations of the SJA, comprising eight values of the relative diameter of the orifice and four values of the relative length of the orifice. The resonant frequencies of the SJA, the radial velocity profiles and the corresponding characteristic velocities as well as Reynolds numbers were determined. The energy efficiency of the SJA and heat transfer enhancement under impingement cooling conditions were also evaluated; the latter considering both the spatial distribution over the cooled surface and the values at the stagnation point. The study was complemented by measurements of the sound pressure level.

The results demonstrated that variation of the geometry of the orifice affects both the values of the investigated operational parameters and the form of the resulting characteristics. In particular, the relative diameter of the orifice was found to have a dominant impact, while the effect of the relative length of the orifice was observed primarily within specific ranges of its values and for specific parameters. It was also demonstrated that the highest values of individual flow, energy and thermal parameters do not coincide at a single common geometric configuration, indicating that the assessment of the impact of orifice geometry depends on the adopted evaluation criterion. At the same time, changes in orifice geometry alter not only the values of individual operational parameters but also the nature of the resulting flow, energy, thermal and acoustic characteristics. The obtained results support the research thesis statement and provide a basis for the conclusions summarizing the effect of orifice geometry on the response of the SJA. The developed resonant frequency model as well as the identified relationships between the geometric parameters of the orifice and the characteristics of both SJA and the jet itself may provide a basis for the preliminary selection of the orifice geometry best suited to the requirements of a particular application.