Proceedings of the 9th World Congress on Mechanical, Chemical, and Material Engineering (MCM'23)
Brunel University, London, United Kingdom –August 06-08, 2023
Paper No. HTFF 183
DOI: 10.11159/htff23.183

Flow Characteristics of Synthetic Jet Near Curved Wall

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Extended Abstract

Several experimental and numerical studies have been conducted on the flow characteristics of free and wall synthetic jets, and the results have indicated that these characteristics highly depend on the dimensionless stroke, which is obtained by non-dimensionalizing the stroke (inverse of the oscillation frequency) using the slot width [1-2]. This finding has been applied in the active flow control of the boundary layer and flow separation by installing a synthetic jet on the suction surface of the airfoil [3], and some of the results have been practically applied in flight vehicles. Recently, studies were conducted on jet vectoring by installing a sub-slot of the synthetic jet near the primary jet and using a Coanda surface to reduce input energy loss. Kobayashi et al. [4] and Zhang et al [5] reported that the deflection angle can be controlled using dimensionless frequency of the synthetic and the hybrid-synthetic jet, respectively, and the momentum ratio of the primary and synthetic/hybrid-synthetic jets. However, although they are important during application, there are very few studies on fundamental flow characteristics such as the development conditions of synthetic jets generated near a curved wall (where the Coanda effect acts), and their results are limited [6]. Specifically, the authors did not find any fundamental study on the influence of the dimensionless stroke and ratio of the nozzle width to the surface curvature, that is, the magnitude of the Coanda effect, on the behavior of the synthetic jet generated near a curved wall. In this study, the flow characteristics of a synthetic jet that was tangentially generated from a slot on a curved surface were investigated through experiments and computational fluid dynamics (CFD) assuming two-dimensional incompressible flow. Specifically, the influence of the dimensionless stroke and curvature of the curved wall on the behavior of the generated flow under the action of the Coanda effect was analyzed. Consequently, the effect of the inverse pressure gradient under a constant Reynolds number and dimensionless stroke on the generated flow near the curved wall becomes stronger when the radius of the curved wall is smaller. In addition, the inverse pressure gradient can also affect the behavior of vortex pairs formed near the slot during the blowing phase, resulting in a difference from those of the free and wall synthetic jets, where no centrifugal force is present.

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