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Plane Jet Vectoring near a Flat Plate using Secondary Suction Flow

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Extended Abstract

Jet-flow direction control was originally studied for aircraft attitude control. Furthermore, it has recently shown promise in air conditioning and exhaust ventilation, and in the past five years, in the avoiding pandemic situation. Mechanical thrust vectoring, which changes the geometry of the operating blades, is primarily used to control the direction of the jet flow. Recently, fluidic thrust vectoring technology, which controls the direction of the jet flow without changing the geometry, such as the operating blades, has attracted attention. This method of controls the primary jet flow using the Coanda effect induced by the secondary flow by placing the Coanda surface near the outlet slot.

Mason [1] investigated the effect of the momentum ratio of the primary jet to the secondary flow on the deflection characteristics of the jet, and observed that the jet could be classified into three regions according to the momentum ratio: dead, controllable, and saturated regions. Kobayashi et al. [2] and Zhang et al. [3] applied synthetic jets and pulsating flows to a secondary flow and investigated the relationship between the jet deflection angle and vibration characteristics.

However, the aforementioned jet direction control was performed in the absence of rigid boundaries near the jet. The relationship between the jet behavior and rigid boundaries needs to be known for indoor applications. Studies on fluidic thrust vectoring near rigid boundaries are scare. Tezuka et al. [4] attempted to control the direction of the jet near a flat wall under secondary suction flow conditions; however, their report was limited to a fragmentary discussion.

In this study, fluidic thrust vectoring was investigated by placing a Coanda curved surface and flat plate near the slot outlet and applying suction to the secondary flow. Specifically, observations of flow visualization, velocity distribution measurements, and numerical calculations were used to elucidate the effect of nondimensional flat plate length and offset ratio on the jet deflection characteristics using the momentum ratio of the primary flow to the secondary suction flow as a parameter. The main results are that, in the absence of a wall, the deflection angle of the jet increases stepwise with the momentum ratio, whereas in the presence of a wall, the deflection characteristics depend on the momentum ratio, dimensionless plate length, and offset ratio, and are affected by both the Coanda effect of the plate and the recession of the separation point on the Coanda surface owing to suction. The results of this study revealed that the jet deflection characteristics depend on the momentum ratio, nondimensional plate length, and offset ratio.

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