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The main characteristics of suction control of flow separation of an airfoil at low Reynolds numbers

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Abstract: The suction control of flow separation of a NACA0012 airfoil is studied numerically for Reynolds number Re = 10^4, angle of attack α = 2°, 4°, 6° and 8°, and Re = 10^5, α = 4°. The suppressing effects of suction have been studied under the consideration of many parameters, such as suction coefficient, location, angle, hole width and porosity. The variation of energy consumption and lift-drag ratio during the control process are employed for evaluating the control effects.

Keywords: suction flow control; airfoil; flow separation; flow control

1. Introduction

Flow separation occurs more frequently at low Reynolds numbers, which will induce serious effects on aerodynamic performances of airplanes during take-off and landing, and the maneuvering flight of some UAVs (Unmanned Aerial Vehicles). In order to suppress the flow separation and improve the aerodynamic performances of aircrafts, many kinds of control methods have been developed. Suction control is one of the most promising methods which have been investigated for decades.

There are numerous experiments and numerical simulation performed on the suction control of common NACA airfoils. Acharya et al. [1-2] experimentally investigated the leading-edge suction of pitching airfoils (NACA0012) on flow separation at Re=1.0×10^5, the suction area locates between 2-5% of chord length, and the separation even the dynamic stall can be suppressed. Owens and Perkins [3]

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